Ensuring Sustainable Connectivity in Small Island Developing States

Discussion Draft

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A Global Review of Internet Infrastructure Issues

Internet Society

Ensuring Sustainable Connectivity in Small Island Developing States

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The Internet Society demonstrates its commitment to promoting access for all and to seeking new ways to change how we look at connectivity. We must do all that we can with partners to think innovatively and to connect people. We enable change by enabling connectivity. We try to encourage Internet development and connectivity via regional efforts to build capacity, promote innovation, and raise awareness via research, consultation, and policy engagement. We look forward to continued partnerships with all stakeholders: the private and public sectors, civil society, and local heroes. May we break down barriers and expand opportunities for socio-economic growth. We enable the Internet to enable opportunity and much more.

Jane Coffin
Director, Development Strategy
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Executive Summary

Small Island Developing States (SIDS) are a distinct group of developing countries characterized by vulnerabilities resulting from their small populations, limited export base, higher exposure to global economic disruptions, and frequent natural disasters. Many SIDS face challenges in Internet connectivity due to their remoteness and the high cost of crossing open sea, combined with small populations, low population density and consequent low economies of scale which often lead to higher connectivity costs.

This report aims to shed light on the key connectivity issues for these nations and to help share knowledge on potential strategies to address them for national and regional policy makers, as well as decision-makers in international development assistance agencies. The research for this report was based on a global desk review of all the SIDS countries and in-depth case studies of two SIDS per each region: Haiti and Saint Vincent and the Grenadines in the Caribbean, Cape Verde and Comoros in Africa, and Tonga and Vanuatu in the Pacific.

Despite the challenges, SIDS have made impressive recent progress in improving connectivity. Use of mobile communications has grown rapidly, and in many SIDS is approaching ubiquity. Broadband Internet is increasing (mainly through mobile broadband, which most SIDS have now launched), international connectivity has improved as more SIDS have connected to submarine fibre-optic cable networks, lowering wholesale costs and improving quality of service.

Many of the improvements to connectivity have come about as a result of competition introduced in many SIDS over the last 15 years. Prices have dropped and levels of access have risen. However, the degree of competition varies widely among SIDS in terms of market concentration. To some extent the intensity of competition will always be constrained in SIDS due to the small size of their markets, and this is reflected by the fact that most SIDS have a duopoly market structure. This makes it critical that regulatory oversight is strong, and both operators be on sound and sustainable footing to effectively compete with each other.

The report finds that a number of trends are negatively impacting network operators and thus the quality of competition. Although some of these trends affect the incumbents as well as new operators, arguably the impact has been more negative for historical telecommunication service providers. Some of them have found it difficult to adjust to competition. Non-cost-based interconnection rates have reduced demand for their fixed line services, reducing revenue. Similarly, incumbents have suffered from much reduced international accounting rates and from increased competition in international services, which have traditionally provided a significant portion of their revenues. This is particularly apparent where there has been wider availability of broadband, which has encouraged the use of Over The Top (OTT) services via the Internet, which has cut into traditional voice revenues, particularly from international telephone services.

Despite the wide variation in levels of economic development between the SIDS, it can be observed that across the income groups, some SIDS have weathered these changes well and exhibit ICT sectors that are profitable, with relatively low broadband prices, built on the latest technology and providing widespread access; while other SIDS are not faring as well. This argues for giving a high priority to this area in national development plans, and devising appropriate national broadband and ICT strategies, along with demand-side support for local content creation and use of e-government services. In addition, ensuring reliability and trust in use of Internet services is likely to become more of a priority as broadband use increases, and SIDS will likely need to ensure that effective computer emergency response teams (CERTs) are on hand to respond to security issues.

Going forward as the broadband markets evolve, policy makers will need to adopt new strategies—not only to adjust to changes in private-sector ownership while ensuring continuity and effective competition, but also to stimulate more demand for services in these small and isolated communities. Whereas previously the focus was on showing that broadband provision could work in small markets, the need now is to ensure that it is sustainable by building adoption, and creating content, services, and applications that benefit the public.

The requirements for sustainability need to be examined in the context of the broad impact of improved connectivity: if the wider economic and social benefits are not factored in, then submarine fibre-optic cable may not be financially viable for some SIDS. This partly explains why some have used development assistance grants and soft loans to construct fibre-optic connections.

Equally, with the rapidity of technological evolution it is not yet clear at what population level competition is sustainable, and whether the merits of competition need to be examined within a wider prism. Resolving these issues will be essential to forging a path to ICT sustainability in small island states.

The report also finds that a substantial number of cables that have been built, or are planned, pass close to islands that are unconnected or have only one cable, which makes them vulnerable to disruption. Since it is virtually impossible to add a branch to an existing cable, mechanisms need to be found to avoid these missed opportunities in future, especially as spurs that are designed into existing nearby cable projects are probably the lowest-cost means of gaining access to international fibre connectivity. In most cases, as long as the branching point is included in the initial configuration, the landing station and link to the cable can be added at a later date with relatively low additional cost. Low submarine-cable landing fees are also likely to help encourage this, as has been adopted in the Eastern Caribbean where the ECTEL states have agreed that cable landing fees should be no more than an initial $50,000 and $50,000 per year thereafter.

There is also evidently a key role to be played by the international community in supporting improved connectivity in the SIDS. A number of international initiatives and partnerships that are already active in this area were identified in the study. Given the diversity of SIDS, the challenge is that the projects may be too broad and not relevant for all SIDS. In that regard, development projects might be more fruitful by taking a more concentrated approach, such as focusing on regions or SIDS that are LDCs.

Bilateral assistance has typically flowed from countries with which the SIDS have historical, geographical, or strategic ties. More recently, global and regional development banks are providing substantive assistance via equity, grants, or loans, particularly for the construction of submarine cables.

Going forward, assistance will continue to be needed for major infrastructure projects that support additional international cables, as well as national fibre backbones, particularly in micro island states and the lower income SIDS. At the same time, the increase in connectivity in many SIDS has triggered challenges that are more related to skills development than hardware limitations. This is an area where there is significant need for development partnerships. This includes a need for building regulatory capacity, particularly in environments where market sizes are limited and novel approaches are needed.

There is also an urgent need to develop and scale applications and services across a range of sectors, to accompany the increase in bandwidth. However, in many SIDS there is a shortage of software developers, as well as the innovative entrepreneurs, change management expertise, and enabling start-up ecosystems found in larger countries. One example of development assistance in this area is the World Bank's Entrepreneurship Program for Innovation in the Caribbean[1], which is helping to develop a nurturing ecosystem for high-growth tech start-ups through several of its components.

In terms of supporting ICT and broadband development strategies more generally, along with defining policy and regulatory needs, more information exchange is needed. Convening of multistakeholder groups at national and regional levels to identify and discuss emerging issues should be encouraged, such as via the workshops on SIDS taking place at the regional and global Internet Governance Forums (IGFs).

[1] http://www.infodev.org/EPIC.

Part 1 Review of Connectivity in Small Island Developing States

1 • Introduction

Small Island Developing States were first recognized as a distinct group of developing countries at the United Nations (UN) Conference on Environment and Development in June 1992. They are characterized as having specific vulnerabilities including "small size, remoteness, narrow resource and export base, and exposure to global environmental challenges and external economic shocks, including to a large range of impacts from climate change and potentially more frequent and intense natural disaster."[2]

Many SIDS face challenges in Internet connectivity due to their remoteness and the high cost of crossing open sea, combined with small populations and consequent low economies of scale that often lead to higher connectivity costs. As a result, these countries need innovative solutions and support mechanisms to ensure they are included in the Information Society and can take full advantage of the information and communication technologies (ICTs) that can help address their special needs.

It can be noted that not all SIDS have the same characteristics and there is tremendous diversity among them. However, in general, having just some of the characteristics often has negative implications for connectivity. For instance, small size influences ICT market behaviour, remoteness increases the cost of connectivity and environmental challenges can increase the investment expenditure required to make networks more resilient to destruction of infrastructure by weather incidents.

In order to help identify potential strategies that SIDS could use to improve their connectivity, the Internet Society commissioned this report to provide an overall connectivity review combined with case studies of six island countries: Cape Verde and Comoros (Africa), Haiti and Saint Vincent (Caribbean), and Tonga and Vanuatu (Pacific).

Impacts of Improved Connectivity

Access to the Internet and use of ICTs has a particularly significant impact on small islands by both helping to reduce the isolation of the people living on them and also on their economies. The ICT sector tends to contribute a higher share to the economy in small islands than in other countries. Telecommunication operators in small islands are often among the largest companies, contributing a significant amount to government budgets through taxes, and are leading sources of employment. Some SIDS also leverage the benefit of improved international connectivity to develop offshore software industries that contribute to export earnings and employment[3], including Guyana, Mauritius, Seychelles, Singapore and Suriname. A World Bank report estimates that Pacific islands have the potential to create thousands of ICT

[2] https://sustainabledevelopment.un.org/topics/sids.

[3] Based on countries where ICT services exports exceeded at least 20% of total services exports in 20015. See: http://data.worldbank.org/indicator/BX.GSR.CCIS.ZS?year_high_desc=true.

services export jobs as a result of recent submarine fibre-optic connectivity.[4]

Indirect economic impacts of ICTs are also significant. For example, a study of South Pacific economies found that telecommunications contributes 0.33% to output per worker in the short-run and 0.43% in the long-run to output per worker.[5] An econometric model used to estimate the impact of broadband in Latin America and the Caribbean found that, on average, a 10 percent higher broadband penetration is associated with 3.19 percent higher GDP.[6]

The benefits for small islands from increased and better quality connectivity for small islands are many. Some are similar to the benefits any country receives in areas such as improved public services, the potential for e-commerce, financial inclusion, and so forth. But the impacts are multiplied for small islands because connectivity and related ICTs can overcome obstacles related to large distances and small populations. For example, applications such as telemedicine and online education can help alleviate shortages of doctors and teachers. At the same time, some ICT benefits are particularly relevant to the conditions of small islands, such as higher exposure to disasters: resilient and widespread communications networks can provide early warning of threats, and enhance recovery.

More generally, among other benefits, better communications helps to enhance contacts, reduce travel costs, and increase security. Some of these impacts have been quantified. For example, in a survey in Vanuatu where one third of respondents reported that mobile phones had helped with social networking by enabling more-frequent contact with family and friends, improved group coordination, and increased support.[7] In the Solomon Islands, respondents to the People's Survey conducted in 2011 reported that communications was the second most significant change (after no change) in their life and that it had a "major impact on many … communities".[8]

Agriculture

Agriculture is an area of special relevance to SIDS because many have significant rural populations, and farming and fishing are major livelihoods. Benefits accrue from access to additional markets, enhanced pricing information for both inputs and outputs, and better production due to the availability of information about improved techniques and how to minimize the impact of diseases and pests.

In Fiji, for example, the Ministry of Agriculture collects and compiles information relevant for farmers. Its agents use tablet computers to record pricing information for over 30 products from various markets around the country, and this is disseminated via the Ministry's website[9]. The information helps to increase farmers' profits by comparing prices across different markets, enabling them to sell where they can obtain the best price. The Ministry also compiles information about growing techniques, plant diseases, and similar information, which again is distributed to farmers through its website.[10] In the Solomon Islands, to help fishermen obtain better prices for their fish, the Ministry of Fisheries and Marine Resources has implemented a surveillance system that plots the locations of all fishing vessels and is monitored by staff using special computer software.

Tourism

Some 30 million tourists visited small islands in 2014, a figure equivalent to half of their total population.[11] Given the economic impact of overseas visitors for many small islands, most government tourist agencies already have websites that can be quite sophisticated. For example, the website of the Samoa Tourism Authority (STA)[12] includes an accommodation portal with e-commerce functionality. This enables the STA to market smaller properties that are difficult to list on large travel portals due to fees and other requirements. These smaller properties

[4] http://www.worldbank.org/en/news/press-release/2015/12/17/potential-for-more-than-ten-thousand-new-pacific-island-jobs-through-it-enabled-outsourcing-industries.

[5] Kumar, R.R., et al. "Accounting for telecommunications contribution to economic growth: A study of Small Pacific Island States." *Telecommunications Policy* (2014), http://dx.doi.org/10.1016/j.telpol.2014.08.005i.

[6] http://www19.iadb.org/intal/intalcdi/PE/2013/11427.pdf.

[7] The area with the lowest impact was access to specialized information and services. This is most likely due to the lack of locally relevant mobile applications in these areas. See O'Connor, Seini, Anna Naemon, and Bimbika Sijapati-Basnett. 2012; Net Effects: Social and Economic Impacts of Telecommunications and Internet in Vanuatu: Research Findings Report 2011; Port Vila, Vanuatu: Pacific Institute of Public Policy. http://pacificpolicy.org/blog/2012/05/03/net-effects/.

[8] The survey also notes negative impacts such as already limited household income diverted to paying for mobile services and access to offensive content. See Regional Assistance Mission to Solomon Islands, 2012; People's Survey 2011.

[9] See "Market Watch" at http://www.agriculture.gov.fj/index.php/market-info/market-watch.

[10] See "Farmers Leaflets" at http://www.agriculture.gov.fj/index.php/publications/farmers-leaflets.

[11] http://data.worldbank.org/indicator/ST.INT.ARVL.

[12] http://www.samoa.travel.

are often beach *fales* run by Samoan households aimed at budget-conscious tourists. The portal has a description of the accommodation and provides an online payment facility, something lacking in smaller tourist businesses run by Samoans. When contacted via email, these properties send clients to the STA site to pay. Some 70 places are listed on the site, and it processes 190 bookings a year. According to the STA, its website generates the most traffic in the Samoan tourist industry.

Tourism also has a significant direct impact on mobile operators' revenues, expanding the market and creating scale. According to Vodafone Fiji, in 2004, 80% of tourists from Australia and New Zealand brought phones with them, and of these, 90% roamed on its network. However, this was before the launch of 3G networks on the island, and it is likely that today many tourists purchase local SIM cards, given the price compared to international roaming. A survey of Chinese travellers—accounting for over 100 million international departures in 2015[13]—found that 94% bring their mobile phones. A third purchase local SIM cards during their visits, and 31% use international roaming.[14] Many mobile operators in SIDS have special airport kiosks selling SIM cards to tourists. In the Seychelles, the average overseas visitor spends SCR297 (US$22) a *day* on telecommunications,[15] a figure equivalent to the average *monthly* amount spent by a Seychelles household.[16]

Public Administration

Improved connectivity makes government processes more efficient, enabling online and mobile-based delivery of public services, saving citizens time and money. Tonga illustrates the impact that implementation of an online system can have on the time to register a company. Following the launch of its free online company registration system in December 2014, the number of days to register a business dropped from 14 days to one day.[17] Another example of the use of ICTs in government was seen during the 2014 elections in the Solomon Islands. Citizens were photographed and fingerprinted using a biometric voter registration (BVR) system. An SMS-based information campaign was used to inform the public about candidates, voting procedures, and the locations of polling stations. The Electoral Commission cited the importance of the BVR system for registering over 80% of the eligible voting population.[18]

Education

Online access and tools are important for education, and are particularly relevant for small islands separated by large distances and suffering from shortages of teachers and materials. The availability of computers and the Internet in schools helps promote basic digital literacy, as well as more advanced skills that enable students to seek ICT-related careers. The use of satellite and fibre-optic connectivity for tertiary distance education has enabled the University of the South Pacific (USP), headquartered in Suva, Fiji, to extend its presence to a dozen countries in the region. Its satellite-based USPNet was established in 1973 and today half of its students use distance education via apps, including those for audio/video conferencing and Internet access. Network capacity has been progressively increased, as the highest attrition rates are in countries with poor bandwidth. Now, the deployment of new submarine cables in the region is enabling USP to acquire dark fibre that will support sophisticated distance-learning applications and link students and international educational research networks. Similarly, the University of the West Indies Open Campus provides online learning to some 23,000 students in 17 Caribbean countries across more than 40 locations.[19]

In Barbados, all 93 primary and secondary schools have been provided with Internet access and computers via the Education Sector Enhancement Program (ESEP), launched in 1999. Every teacher has either a personal laptop or easy access to one at school; every school has an IT Coordinator; and some 3,000 IT teachers have been trained in computer-assisted teaching and learning. A report published on completion of the project found that computer mastery was achieved by 75% of school graduates by the end of project, compared to 42% before (measured by the number of students taking the Caribbean Examinations Council IT exam), and that students' scores had significantly improved in English, IT, and Mathematics.[20]

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[13] UNWTO Tourism Highlights, 2016 Edition.

[14] http://www.citm2015.com/foreword.

[15] http://www.nbs.gov.sc/wp-content/uploads/2016/03/VES-2015-Q4.pdf.

[16] http://www.nbs.gov.sc/3640/.

[17] Asian Development Bank. 2014. "Tonga's Innovative Online Business Registry Goes Live – ADB." November 28. http://www.adb.org/news/tonga-s-innovative-online-business-registry-goes-live-adb.

[18] See "SIEC Releases Provisional Voters List" at http://www.siec.gov.sb/index.php/journalist/18-siec-releases-provisional-voters-list.

[19] http://www.open.uwi.edu/about. Also see http://www.oas.org/en/scholarships/virtualeduca/PP/UWI.pdf and http://www.oas.org/en/scholarships/virtualeduca/PP/UWI.pdf.

[20] Inter-American Development Bank (IADB). 2012. *Education Sector Enhancement Program Project Completion Report.* http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=36832475.

Health

Connectivity affects the health sector in various ways, including improving the speed and accountability of administrative processes, increasing efficiency, and lowering costs. Mobile phones can be used to remind patients to take their medicines, online health information can be made available to citizens, and diagnostic information can be transmitted over broadband networks for experts to analyze. Better connectivity among health institutions can help remote clinics access expertise that may only be available at a central hospital, offshore, or even at a leading specialist institution in a completely different part of the world. The potential benefits are substantially improved where the launch of submarine fibre-optic cables has significantly boosted bandwidth, making it possible to transmit high-quality images. For example, the SickKids-Caribbean Initiative connects the Hospital for Sick Children in Toronto, Canada, to six Caribbean countries, making it possible to use telemedicine to improve outcomes for children suffering from cancer.[21]

Financial Services

Better connectivity also strengthens financial inclusion, such as via mobile money services. Of particular relevance for many SIDS with large diasporas, mobile money applications enable users to transfer funds from abroad at considerably less cost than using banks or conventional money transfer operators.[22] According to the World Bank, almost US$500 million was remitted to the Pacific region in 2014, equivalent to 9% of GDP on average.[23] Assuming that the transfers were conducted in increments of NZ$200 (US$166), the total cost for the remittances based on the average fees charged by banks and money transfer operators would have been US$34 million, compared to US$7 million if using mobile money. In other words, using only mobile money would have resulted in a saving of US$26 million in fees.

In Haiti, the mobile money system is used for conditional cash transfers, where recipients receive a monthly credit that can be used for groceries and other supplies, reducing the previous wait in long lines for cash and the risk of theft or misappropriation.[24]

Disaster Relief and Emergency Preparedness

In an area of critical importance to SIDS, the Internet can play a significant role in improving public safety related to disaster relief and emergency preparedness. Small islands are naturally prone to disaster caused by earthquakes and severe weather events, and they have also been affected by climate change, resulting in increased extreme weather events such as tropical cyclones and hurricanes, floods and related landslides, prolonged drought, and wildfires. Connectivity can help address these events by providing remote communities with access to early warning systems and real-time weather information. Remote sensing and geographic information systems (GIS) have expanded the options for risk assessment of multiple hazards, and for monitoring the impact of climate change.

In Haiti, text messages were used to mitigate the impact of the earthquake in January 2010: users were able to send free SMS to report missing persons and problems with shelter and food.[25] One trapped man sent an SMS that was converted to global positioning system (GPS) coordinates so he could be rescued. SMS were also used to direct people to hospitals. In addition, relief organizations set up SMS donation hotlines that collected US$43 million for victims of the disaster.[26]

The Haiti earthquake virtually destroyed its only submarine cable landing station as well as the Haitian police land mobile radio (LMR) system, and much of the wire line infrastructure. However within 48 hours communications was restored to emergency relief organizations, using satellite bandwidth combined with local Wi-Fi links. Shortly after a 'Wi-Fi bridge' was established, linking Haiti to its neighbor on the island, the Dominican Republic, which had not been affected directly by the earthquake.

[21] https://www.coachorg.com/en/newsandevents/resources/GT2015/SP5.2_Global_Telehealth_Presentation_May_13.pdf.

[22] Minges and Stork, 2015.

[23] See "Migration & Remittances Data" at http://go.worldbank.org/092X1CHHD0.

[24] http://fortune.com/2013/08/15/haitis-mobile-redemption/.

[25] http://www.reuters.com/article/us-haiti-telecoms-idUSTRE60O07M20100125.

[26] http://www.cnn.com/2012/01/12/tech/mobile/charity-donations-text-messages/.

2 • General Characteristics of the SIDS

This section provides a general description of the SIDS group of nations—their identification, geography, demographics, socioeconomic status, and special challenges, such as vulnerability to severe weather events and climate change.

The SIDS Group

The UN Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and the Small Island Developing States (UN-OHRLLS) bases its SIDS classification on the members of the Alliance of Small Islands States (AOSIS). The AOSIS is an ad hoc group established by the SIDS consisting of 39 members.[27] While the charts and tables in this report feature the SIDS that are AOSIS members, the issues discussed are often relevant for small island territories or islands that are part of larger countries. Ten SIDS are classed as Least Developed Countries (LDCs): Comoros, Guinea-Bissau, Haiti, Kiribati, Samoa, Sao Tome and Principe, Solomon Islands, Timor Leste, Tuvalu, and Vanuatu. Most of the SIDS are in the Caribbean and Pacific regions; six are in Sub-Saharan Africa, and two are in Asia.

SIDS vary tremendously in demography, geography, and wealth (Table 2.1, next page). Population sizes range from over 11 million in Cuba (closely followed by the Dominican Republic and Haiti) to 1,470 in Niue. Population densities range from 4 people per square kilometre in Guyana to over 1,300 in the Maldives. (Singapore has over 7,800 people per square kilometre, but is in the unique situation of being a city state.)

Geographically, conditions vary widely. Some SIDS have most of their territory on the mainland (e.g., Belize, Guinea-Bissau, Guyana, Suriname), some consist of a single main populated island (Jamaica) while others consist of dozens (Maldives). Some SIDS share an island (e.g., Dominican Republic and Haiti). A few SIDS are or almost completely urban (e.g., Nauru, Singapore), while many have over half their population living in rural areas. Finally, some groups of SIDS are tightly clustered (e.g., in the Caribbean) while others are separated from other countries by hundreds of miles of ocean (e.g., in the Pacific).

Economically, SIDS range in their level of development from the eighth wealthiest economy in the world (Singapore) to nine of the least developed countries. Note that three SIDS were previously LDCs but have since 'graduated': Cape Verde (2007), Maldives (2011) and Samoa (2014). On average, the SIDS group is relatively wealthy: 65% of the economies are in the high or upper middle income groups of the World Bank's classification (Table 2.2, page 13).[28]

This diversity in demography, geography and income makes it impossible to identify a "typical" SIDS nation. Moreover, there is no strict definition for identifying SIDS, as the UN

[27] AOSIS also includes five observer territories: American Samoa, Netherlands Antilles, Guam, US Virgin Islands, and Puerto Rico, http://aosis.org/about/members/.

[28] https://datahelpdesk.worldbank.org/knowledgebase/articles/906519.

Country	Population total	Population (per sq km)	Urban (% of total)	GDP per or latest (US$)
Antigua and Barbuda	91,818	209	24	$14,129
Bahamas	388,019	39	83	$22,897
Barbados	284,215	661	31	$15,661
Belize	359,287	16	44	$4,907
Cabo Verde	520,502	129	66	$3,131
Comoros	788,474	424	28	$791
Cook Islands	14,730	62	74	$20,179
Cuba	11,389,562	107	77	$6,790
Dominica	72,680	97	70	$7,399
Dominican Republic	10,528,391	218	79	$6,374
Fiji	892,145	49	54	$4,916
Grenada	106,825	314	36	$9,157
Guinea-Bissau	1,844,325	66	49	$573
Guyana	767,085	4	29	$4,127
Haiti	10,711,067	389	59	$829
Jamaica	2,725,941	252	55	$5,138
Kiribati	112,423	139	44	$1,292
Maldives	409,163	1364	46	$7,681
Marshall Islands	52,993	294	73	$3,523
Mauritius	1,262,605	622	40	$9,117
Micronesia	104,460	149	22	$3,045
Nauru	10,222	511	100	$11,015
Niue	1,470	6	40	$9,117
Palau	21,291	46	87	$13,499
Papua New Guinea	7,619,321	17	13	$2,222
São Tomé and Principe	190,344	198	65	$1,773
Samoa	193,228	68	19	$3,939
Seychelles	92,900	204	54	$15,476
Singapore	5,535,002	7829	100	$52,889
Solomon Islands	583,591	21	22	$1,982
Saint Kitts and Nevis	55,572	214	32	$16,589
Saint Lucia	184,999	303	19	$7,764
Saint Vincent and the Grenadines	109,462	281	51	$6,864
Suriname	542,975	3	66	$8,984
Timor-Leste	1,245,015	84	33	$1,134
Tonga	106,170	147	24	$4,091
Trinidad and Tobago	1,360,088	265	8	$20,444
Tuvalu	9,916	331	60	$3,818
Vanuatu	264,652	22	26	$3,079

Table 2.1. SIDS Basic Indicators, 2015 (Source: Adapted from World Bank and Secretariat of the Pacific Community.)

High income (>US$12,476)	Upper-middle income (US$4,036–12,475)	Lower-middle income (US$1,026–4,035)	Low income (<US$1,026)
Antigua and Barbuda	Belize	Cape Verde	Comoros*
Bahamas	Cuba	Kiribati*	Guinea-Bissau*
Bahrain	Dominica	Micronesia	Haiti*
Barbados	Dominican Republic	Papua New Guinea	
Nauru	Fiji	Samoa	
Seychelles	Grenada	São Tomé and Príncipe*	
Singapore	Guyana	Solomon Islands*	
St. Kitts and Nevis	Jamaica	Timor-Leste*	
Trinidad and Tobago	Maldives	Tonga	
	Marshall Islands	Vanuatu*	
	Mauritius		
	Palau		
	St. Lucia		
	St. Vincent and the Grenadines		
	Suriname		
	Tuvalu*		

Table 2.2. SIDS by Income Classification, 2015 (Source: World Bank)

Note: Classification is based on gross national income per capita. Cook Islands and Niue are not classified by the World Bank, but would both fall into the high-income category.

* These SIDS are also LDCs, which, in addition to being low income (have a three-year average gross national income of US$1,035 in 2015), are characterized by structural handicaps to economic growth and development.

uses for LDCs.[29] One aim of this report is to untangle socio-economic and geographic factors to explore how they affect ICT take-up and use, and to identify commonalties among groups of SIDS. Given that there are more likely to be similarities among specific subsets of SIDS, it is useful to disaggregate them by small-state criteria. Several international organizations identify a "small states" class that consists of countries with a population of less than 1.5 million.[30] They can be further disaggregated into those that are geographically islands ("island states") and "micro states" (island states with a population below 200,000). See Table 2.3.

Regional Connectivity

While still reliant on satellite links in some cases, most SIDS have been progressively improving their connectivity to the global Internet through increased access to submarine fibre-optic cable networks. This is of major significance because satellite capacity is much more expensive, and combined with the higher latencies of satellite links, dependence on satellite connections had previously hindered Internet take-up.

By 2015, all but nine SIDS were connected to least one submarine cable network, and of the nine that are still not connected, three have announced concrete plans for construction of submarine cables (Table 2.4, next page). Recent initial connections have generally been supported by development partners through loans, equity, or grants, due to the recognition that the benefits of high-speed access to the global Internet outweigh pure commercial concerns that do not take the wider development impact into consideration.

Submarine cable links in the island regions of the Caribbean, Africa, the Pacific, and Asia are discussed in the sections that follow.

[29] http://www.un.org/en/development/desa/policy/cdp/ldc_info.shtml.

[30] IMF, 2014. https://www.imf.org/external/np/pp/eng/2014/032414.pdf.

Large (Pop. > 1.5 million)	Small State		
	Nonisland	Island	
		Macro	Micro (Pop. < 200,000)
Cuba	Timor-Leste	Trinidad and Tobago	Samoa
Haiti	Guyana	Mauritius	São Tomé and Príncipe
Dominican Republic	Suriname	Fiji	St. Lucia
Papua New Guinea	Belize	Comoros	Kiribati
Singapore		Solomon Islands	St. Vincent
Jamaica		Cape Verde	Grenada
Guinea-Bissau		Maldives	Tonga
		Bahamas	Micronesia
		Barbados	Seychelles
		Vanuatu	Antigua and Barbuda
			Dominica
			St. Kitts and Nevis
			Marshall Islands
			Palau
			Cook Islands
			Nauru
			Tuvalu
			Niue

Table 2.3. Classifying SIDS by Small-State Criteria (Adapted from IMF Policy Paper, Staff Guidance Note on the Funds Engagement with Small Developing States, https://www.imf.org/external/np/pp/eng/2014/032414.pdf) Note: Countries are listed in descending order of population.

0	1	2	> 2
Cook Islands[31]	Belize	Antigua and Barbuda	Dominican Republic
Guinea-Bissau	Comoros	Bahamas	Fiji
Kiribati	Cuba	Barbados	Jamaica
Nauru	Guyana	Cape Verde	Singapore
Niue	Haiti	Dominica	St. Kitts and Nevis
Palau*[32]	Marshall Islands	Grenada	Trinidad and Tobago
Solomon Islands*[33]	Micronesia	Maldives	
Timor-Leste	São Tomé and Príncipe	Mauritius	
Tuvalu	Samoa	Papua New Guinea	
	Seychelles	St. Lucia	
	Suriname	St. Vincent	
	Tonga		
	Vanuatu		

Table 2.4. Number of Undersea Fiber Optic Cables Connecting to SIDS, 2016 (Source: Authors' compilation) * Cable under development

[31] http://www.adb.org/projects/50110-001/main#project-pds.

[32] http://www.adb.org/projects/44382-022/main#project-pds.

[33] http://www.adb.org/projects/47320-001/main#project-pds.

nations, and as a result most SIDS are generally well served by international submarine cables. However, the SAPL, Seabras-1, and Monet cables, which are planned for this year and will pass close to many of the Windward Islands that have fewer international connections, but will not land on any of them.

The World Bank is close to finalizing plans for a new submarine cable that is expected to link the ECTEL region countries of three member states of the Eastern Caribbean Telecommunications Authority (ECTEL): Saint Lucia, Grenada, and Saint Vincent and the Grenadines. The bidding for the provision of the cable closed at the end of July 2016, and the contract included a requirement for the cable to land in at least six locations.[34] Although the cable will help to provide national fibre-optic connectivity by landing in islands that previously had none, it may have little impact on the cost of international capacity for traffic outside of these countries, as none of these islands have direct access to other submarine cables landing in the United States or Latin America.

Figure 2.1. Submarine Cable Networks in the Caribbean (Source: Telegeography-PCCW Submarine Cable Map 2016[35])

[34] http://www.worldbank.org/projects/procurement/noticeoverview?id=OP00037674&lang=en&print=Y.

[35] http://submarine-cable-map-2016.telegeography.com/ (Figure 2.1–2.5).

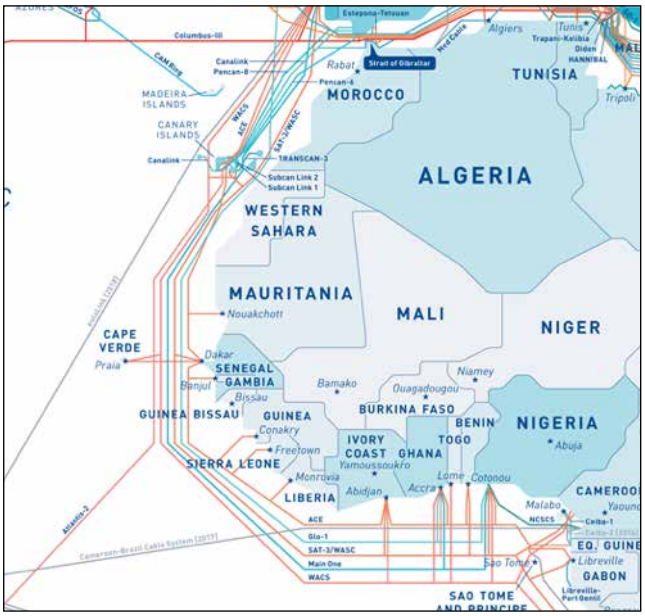

Figure 2.2. Submarine Cable Networks in West Africa (Source: Telegeography-PCCW Submarine Cable Map 2016)

Africa

West Africa

In the West African region, Cape Verde has benefitted from its geographic location and is already served by two cables; it was among the first nations in Sub-Saharan Africa to connect to a submarine cable when it linked to the Atlantis-2 cable in 2000. However, the Eula-link cable from Brazil to Portugal (planned to enter service by 2018), which will pass close by, currently has not been designed to include a landing in Cape Verde, or in other SIDS in the region.

While the Spanish territories of the Canary Islands are relatively well served with domestic and international cables, the Portuguese territories of the Azores and Madeira islands are dependent on only one international cable (Columbus-III).

Guinea-Bissau narrowly missed being part of the ACE cable project, whereas five other countries on the west coast—Benin, the Gambia, Guinea, Liberia, and Sierra Leone—were connected through the support of the World Bank's West Africa Regional Communications Infrastructure Program (WARCIP). Guinea-Bissau was initially included in the programme, but the deterioration in the political situation in the country prevented the project from going forward. It thus remains the only West African country with a coast line that is not connected to a submarine cable.

In the south, the main island of Sao Tome is linked to the world only through the ACE cable, while the other country's main island, Principe, remains dependent on long-distance microwave links with Sao Tome. Although the planned South Atlantic Cable System (SACS) linking Angola with Brazil is expected to pass close to the two islands by 2017, it is not planned to land there or in any other of the islands in the Atlantic.

Further to the south, the island of Saint Helena (a British protectorate) remains without a submarine link or any plans for one. Since 2012, a campaign called "Move This Cable—Connect Saint Helena!" has been lobbying for a branch of the proposed South Atlantic Express (SAEX) cable to land in Saint Helena in order to provide high-speed Internet access and so to foster the island's socioeconomic development.[36] However, the SAEX project appears to have been overtaken by both SACS and the Cameroon-Brazil Cable System (CBCS) planned for 2017 that also will not land in any of the islands in the region.

East Africa

In East Africa, both the Comoros and the Seychelles are vulnerable to cable cuts and the high cost of international capacity, as they each have access to only one cable: EASSy in the case of the Comoros and SEAS in the case of the Seychelles. There are plans to connect the Comoros to the LION cable, a link that would provide redundancy for both Comoros and Madagascar, as it would complete a circular connection to the EASSy cable. The Australia West Express cable, due in 2017, will provide the first submarine link to the military base on the island of Diego Garcia, but is not currently planned to land in any of the other islands on its way to Djibouti, where nine cable landings are either in place or under construction.

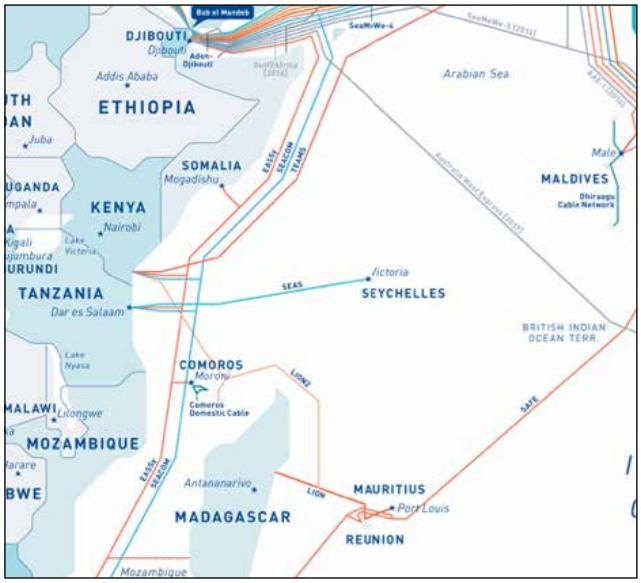

Figure 2.3. Submarine Cable Networks in East Africa (Source: Telegeography-PCCW Submarine Cable Map 2016)

[36] http://www.connectsthelena.org/faq.php.

The Pacific

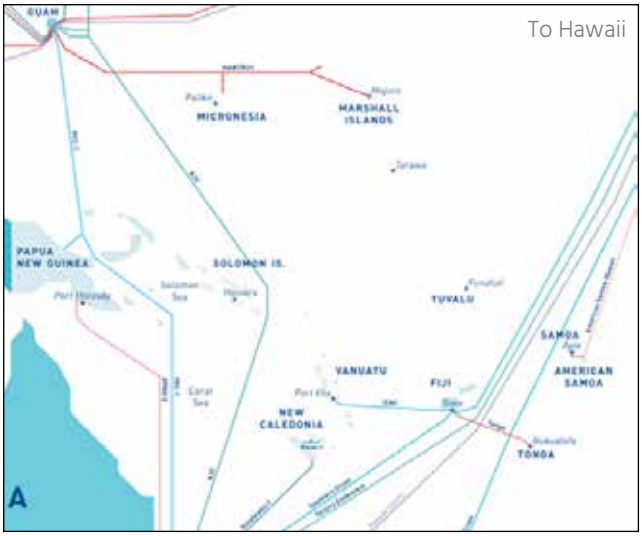

Figure 2.4. Submarine Cable Networks in the Pacific (Source: Telegeography-PCCW Submarine Cable Map 2016)

Due to the Pacific's size and the large number of sparsely distributed islands with small populations it contains, the Pacific region has the largest number of inhabited islands without access to submarine cables, and it is therefore the region most dependent on satellite links. Of note is the planned SEA-US cable running from the Philippines to Guam that will pass close to Palau and the island of Yap, which is part of the Federated States of Micronesia (FSM). To take advantage of this, the Asian Development Bank has loaned Palau US$25 million to obtain a link to the SEA-US cable.[37] It is likely that the FSM will also participate in the project, adding a second international cable link.

A singe cable links a large number of other islands in the Pacific, including the Marshall Islands, French Polynesia, New Caledonia, Samoa, Tonga, and Vanuatu. The Solomon Islands and the Cook Islands are expected to join them if plans for their first submarine links move ahead.[38] Micro island states with neither connections nor plans for connections include Kiribati, Nauru, Niue, and Tuvalu.

Asia

There are three SIDS in Asia: the Maldives, Singapore, and Timor-Leste. Singapore is the most well-endowed SIDS in terms of submarine connectivity, landing more than a dozen cables.[39] The Maldives has leveraged its relative proximity to India and Sri Lanka to obtain two operator-led submarine cables: Dhiraagu-SLT and WARF. In addition, its most populated atolls are connected by a domestic submarine cable system; a second cable is scheduled to launch in 2017. Timor-Leste is considering several proposals; the cheapest would connect to Kupang on the Indonesian side of the island, another possibility is a 750 km cable to Darwin, Australia.[40]

Figure 2.5. Submarine Cable Networks in Asia (Source: Telegeography-PCCW Submarine Cable Map 2016)

[37] http://www.pireport.org/articles/2016/03/15/palau-secures-adb-loan-build-submarine-fiber-optic-cable.

[38] Uncertainties over two proposals have delayed implementation in the Solomon Islands, http://www.parliament.gov.sb/files/hansard/10th_session/3rdMeeting/22%20October%202015.pdf. The ADB is supporting construction of a cable from Cook Islands to Samoa, https://www.adb.org/sites/default/files/project-document/185099/50110-001-cp.pdf.

[39] https://www.ida.gov.sg/~/media/Files/Archive/Policies%20and%20Regulation/Policies_and_Regulation_Level2/20100827100559/SubCableLanding.pdf.

[40] http://www.macauhub.com.mo/en/2015/03/17/timor-leste-studies-proposals-for-a-fibre-optic-connection-to-indonesia-or-australia/.

International deployments and capacity pricing

Although increasing submarine fibre-optic connectivity has generally resulted in lower wholesale prices and higher speeds, the impact varies depending on the number of cables present, their ownership, and the location of the upstream destination where the traffic is exchanged with the rest of the world.

Some cables are operator-owned, and while this may result in lower prices for the operators' own network, if there are no regulatory safeguards, it can also result in higher wholesale prices for other operators, particularly if there is no other competing cable. Recent cable deployments supported by development financing have insisted on open-access frameworks, which has helped mitigate the situation in some cases.

The location of the final peering destination and transit payment arrangements also impact the wholesale price of Internet access. Most international Internet traffic ends up in a large peering centre, such as Miami in the Caribbean and Australia or the United States in the Pacific. When there is a range of options for peering, prices tend to lower. But sometimes there is little choice due to cable configurations and policies. For example, a direct one-hop connection to a major peering centre does not require a transit payment, whereas SIDS that are connected to cables with stops on the way to the ultimate destination may incur third-country transit payments.

Some of the more industrialised SIDS in strategic locations are emerging as hubs for surrounding countries. For example, Singapore is a hub in Asia. Fiji is becoming a hub for the South Pacific, as it connects Tonga, Vanuatu (and soon Samoa) to Australia and the United States via the Southern Cross cable. In the Eastern Caribbean, territories such as Puerto Rico and the British and United States Virgin Islands are hubs linking the Eastern Caribbean Fibre System (ECFS) and Southern Caribbean Fibre to the United States mainland via multiple cables.

Satellite is filling in where there is no submarine cable connectivity, where cable pricing is not cost-based, or as a backup to cable to maintain critical services. Of particular note is the O3b medium earth orbit satellite service, whose low latency and relatively low price (about US$400/Mbps/month, according to an interview with an O3B representative) is enabling operators to provide 3G mobile broadband in a number of SIDS including the Cook Islands, Nauru, Papua New Guinea, Samoa, and Timor-Leste.[41]

[41] https://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/Documents/Events/2015/October-IISS-2015/Presentations/S6A_Mariah_Shuman.pdf.

The Internet Society Case Study Countries

This study was commissioned to provide an overall review of connectivity in SIDS worldwide, as well as more-detailed case studies of the following six SIDS: Cape Verde and Comoros (Africa), Haiti and Saint Vincent and the Grenadines (Caribbean), and Tonga and Vanuatu (Pacific). Summary descriptions of connectivity in the case study SIDS is provided on the pages that follow, the full case studies can be found in Part 2 (page 62).

Cape Verde

The Republic of Cape Verde is an archipelago of 10 volcanic islands in the central Atlantic Ocean about 570 km from the West African tip of the continent, and covering an area of just over 4,000 km^2. With a total population of about 520,000 in 2015, the largest island is Santiago, comprising just over 50% of the total population and in which the capital, Praia, is situated. There are slightly more Cape Verdeans living outside the country.

Aside from the fixed ADSL service, 3G Internet access is provided by the two mobile operators, and there is one small ISP providing services via Wi-Fi in Santa Maria on the Ilha do Sal. 4G services have not yet been launched. The regulator, ANAC, estimates that there were 312,940 Internet users at the end of Q2 2016, of which 84% gained access to Internet via a mobile phone, while 11% accessed it via a tablet or dongle, 5% via ADSL and 0.2% via a Wi-Fi provider in Ilha do Sal.

Cape Verde's government has made consistent and forward-looking efforts to improve the country's connectivity and use of ICTs, efforts that have paid off in relatively high levels of broadband adoption, extent of use by government, and availability of local online services. But because most services are metred, relatively high Internet usage fees remain. This indicates that parts of the value chain are not sufficiently competitive, and is also likely to be partly a result of the limited economies of scale due to a small population scattered across numerous islands.

Comoros

The Comoro Islands are located in the Indian Ocean, off the east coast of Africa, northwest of Madagascar. The archipelago consists of four islands: Anjouan (Ndzuwani), Moheli (Mwali), Grande Comore (Njazidja), where the capital Moroni is located, and Mayotte. The first three islands constitute the Union of the Comoros, while Mayotte is an overseas department of France. The three islands of Comoros possess a total land area of 1,862 km^2, the third smallest land area of any nation in Africa. The population of Comoros was estimated at 788,000 in 2015, ranking it 165th in the world. Comoros is classified by the World Bank as a low-income economy, and by the UN as an LDC. The agriculture, fishing, and tourism sectors have the highest growth potential. Remittances, mainly from diaspora in France, are significant and account for over a quarter of GDP.

Two ISPs provide Internet services: the incumbent Comoros Telecom and new entrant Telma Comoros, which launched at the end of 2016 after receiving a licence in December 2015 following a competitive tendering process. Internet is available via ADSL, leased lines, wireless CDMA dongles (using the MPESSI technology), 2G and 3G, and public Wi-Fi. Fixed broadband is generally only available in urban areas. The 3G network was launched in 2013 by Comoros Telecom, but currently covers only the main cities.

Connection to the EASSy cable, creation of an inter-island fibre-optic backbone and the launch of 3G services have provided a solid connectivity platform for Comoros. In 2017 the Comoros moved to two international cables with the landing of AVASSA, and will in 2018 move to three cables (FLY-LION3). However, tariffs are high, given the low income levels in the country, and discourage take-up. It is expected that the recent award of a second telecom licence and plans for a second international submarine cable link will intensify competition at both the wholesale and retail levels and lead to more widespread adoption of the Internet in the country.

Haiti

The Republic of Haiti is located on the island of Hispaniola, in the Greater Antilles archipelago of the Caribbean. Haiti shares the island with the Dominican Republic and covers an area of 27,750 km^2. With a population 10.7 million people in 2015, Haiti is the most populous country in the Caribbean Community (CARICOM), and the second-most populous country in the Caribbean as a whole. The capital, Port au Prince, has a population of about 1.3 million. The unstable political situation, combined with the impact of hurricanes, environmental degradation (less than one percent of the country is forested, compared to 60 percent just 50 years ago) and the 2010 earthquake (which left over 310,000 people dead), has resulted in Haiti having the lowest Human Development Index in the Americas.

At about 0.5% penetration, Haiti's fixed-line teledensity is amongst the lowest in the world, partly as a result of the damage resulting from hurricanes and the 2010 earthquake. While there is extensive use of mobile voice telephony and broadcast radio, Haiti's Internet use is still at an early stage of development. Considering the country's very low income levels, mobile use is relatively high—at about 70% penetration

and 100 million minutes a month of traffic. In addition, there are more than 350 licenced radio stations and 347 unauthorised stations operating across the country. Due to recent investment, fibre to the premises is now available in the major urban areas. 4G services are in a test phase by the incumbent operator (now partially privatised), and a variety of 4G wireless broadband fixed and mobile technologies are offered by ISPs.

Considering recent growth in backbone network deployment and broadband use, the country is already benefitting from rapid technology change, having avoided sinking large investments in older technologies. Mobile and fixed broadband infrastructure is available in large parts of the country, and it has redundant submarine cable infrastructure, as well as terrestrial fibre capacity to neighbouring Dominican Republic where many other cables land.

Haiti and the Dominican Republic together have a population of approximately 19.5 million–48% of the Caribbean's population. As a result, the two countries have an opportunity to establish the largest telecom market in the region.

Saint Vincent and the Grenadines

The Caribbean islands of Saint Vincent and the Grenadines (SVG) are located in the southern portion of the Windward Islands, where the Caribbean Sea joins the Atlantic. The nation had a total estimated population of 109,460 in 2016, of which about 15% are concentrated in the capital city of Kingstown on the main island of Saint Vincent, where 92% of the total population reside. With a total area of 392 km^2, the country is relatively densely populated (over 300 inhabitants per km^2).

Domestic and international connectivity infrastructure is relatively well developed in SVG, and consequently there is a fairly high penetration of Internet use and telephony. With over 100% mobile penetration (due to multiple SIM cards in use by a single subscriber), and 20% fixed-line penetration, as well as pay TV, the uptake of mobile and fixed broadband is substantial. The national regulatory authority, NTRC, estimated that about 65% of the population were Internet users in 2015, a significant jump from the 47.5% found in 2012.

SVC and other countries in the Eastern Caribbean have benefitted from relatively widespread infrastructure and an enabling policy and regulatory environment for ICT services, in part fostered by ECTEL that in 2000 became the world's first multicountry regulatory telecom agency.

The breakup of the Cable & Wireless telephone monopoly, the entry of Digicel and the creation of ECTEL have facilitated more affordable and pervasive broadband services. However, an already fairly concentrated market with only three players (Lime, Flow, and Digicel), has now been reduced to just two operators by the merger of Lime and Flow. This is likely to put a heavier responsibility on ECTEL and the national regulatory authority NTRC to ensure that the country continues the trend toward improved connectivity, and is not disadvantaged by the duopoly environment. In this respect, the adoption and implementation of the new draft ECTEL regulations is likely to be a key step.

Tonga

The Kingdom of Tonga comprises 171 islands in the South Pacific, and covers a north-to-south distance of roughly 800 km with a land area of 749 km^2. The word *Tonga* means south, referring to the country's location as the southernmost of the Polynesian islands. Forty of the Kingdom's islands are inhabited, and at the time of the 2011 census, the population was 103,252. The island of Tongatapu has 73% of the total population, and is home to the capital, Nuku'alofa. The three major drivers of the economy are agriculture, tourism, and remittances. Tonga's GDP per capita was US$4,114 in 2014, a decrease from 2013, triggering a drop in its World Bank classification from upper-middle income to lower-middle-income.[42] Nevertheless, Tonga is the third-highest ranked Pacific SIDS in the Human Development Index (after Palau and Fiji).

Tonga has two main ISPs: TCC, which provides both wireless and fixed broadband access, and Digicel, which provides wireless access. The Danden Group provides Internet access over satellite (VSAT). Several wireless technologies (WiMAX and 3G) are offered, and TCC provides fixed broadband using ADSL2+ in some areas.[43] There has been rapid take-up of 3G services, with over 50,000 users by the end of 2014. Both operators provide Wi-Fi access throughout the Nuku'alofa Central Business District, and TCC also offers narrowband dial-up services.

The launch of a submarine cable to Fiji in 2013 revolutionized Internet access in Tonga. The increase in bandwidth enabled the introduction of mobile broadband, and the drop in wholesale prices significantly boosted Internet use. The cable's open-access policy and the competitive Internet market have also been enabling factors. The planned deployment of a domestic submarine cable will increase quality and speeds in outlying islands, thereby reducing the digital divide between Tongatapu and the rest of the country.

[42] http://data.worldbank.org/about/country-and-lending-groups.

[43] ADSL2+ provides a minimum download speed of 16 Mbps. See "ITU-T G.992.5 (01/2009)", http://www.itu.int/ITU-T/recommendations/rec.aspx?id=9653&lang=en.

Vanuatu

The Republic of Vanuatu consists of 83 islands in the South Pacific with a total land area of 12,281 km^2 spread out over 360,000 km^2. Sixty-three of the islands are inhabited, and the 2015 mid-year population is estimated at 277,500. The World Bank considers Vanuatu to be a lower-middle income economy, with a per capita income of US$3,148 in 2014, while the UN classifies Vanuatu as an LDC, a status it is expected to graduate from in 2017.[43] Agricultural activities, tourism, and the finance sector are major components of the economy. The category-five cyclone Pam that struck Vanuatu in March 2015 is estimated to have caused damage equivalent to 61% of the country's GDP, and had serious consequences for medium-term economic growth due to the destruction of agricultural and tourist facilities.[44]

In 2016, eight companies had licences to provide telecom services, including Internet.[45] Most subscriptions are with the two main operators: the incumbent Telecom Vanuatu Limited (TVL) and mobile operator Digicel. The other operators offer mainly fixed wireless access (e.g., point-to-point or VSAT) or wholesale services. TVL offers copper-based ADSL and fibre broadband, as well as mobile broadband Internet access. Digicel offers wireless Internet access using both WiMAX and its 3G/4G mobile network. Data from the regulator suggest there were just over 80,000 Internet subscriptions as of December 2015.[46] The vast majority were wireless, given that there were just 4,300 fixed broadband subscriptions.[47]

There have been major ICT changes in Vanuatu since 2008, including the introduction of mobile competition in 2008, the launch of high-speed wireless Internet access in 2011, and connection to the submarine cable to Fiji in 2014. This progress has been complemented by relevant laws and policies covering telecommunications regulation, e-commerce, cyber security, consumer protection, and universal access. The universal access programme will provide Internet access at speeds of at least 2Mbps available to nearly the entire population by 2018.

[43] http://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=818.

[44] http://www.imf.org/external/pubs/ft/scr/2015/cr15149.pdf.

[45] http://www.trr.vu/index.php/en/telecom-industry/licenses/telecommunications-licence [Accessed 15 September 2016].

[46] http://www.trr.vu/index.php/en/telecom-industry/market-and-competition/statistics/2015.

[47] http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx.

3 • Challenges for Improving the Connectivity of SIDS

SIDS have made tremendous advances in connectivity over the last decade. In particular, mobile connectivity has improved significantly, largely due to market liberalisation. Second generation (2G) mobile network coverage is almost ubiquitous in most SIDS (assisted by their small size). More than a dozen SIDS have achieved almost complete 2G coverage, and in two thirds of the SIDS over 90% of the population has access to a GSM signal and, therefore, to low-speed Internet access via GPRS and EDGE technologies (Figure 3.1). Of the remaining SIDS, coverage limitations are related to constrained competition rather than economic or geographic conditions.

Most SIDS are now connected to at least one submarine cable, and many have also deployed national fibre-optic backbones. For some, connectivity issues have more to do with affordability and education than lack of access. Despite the successes achieved in boosting connectivity, challenges remain—particularly when moving to high-speed Internet access.

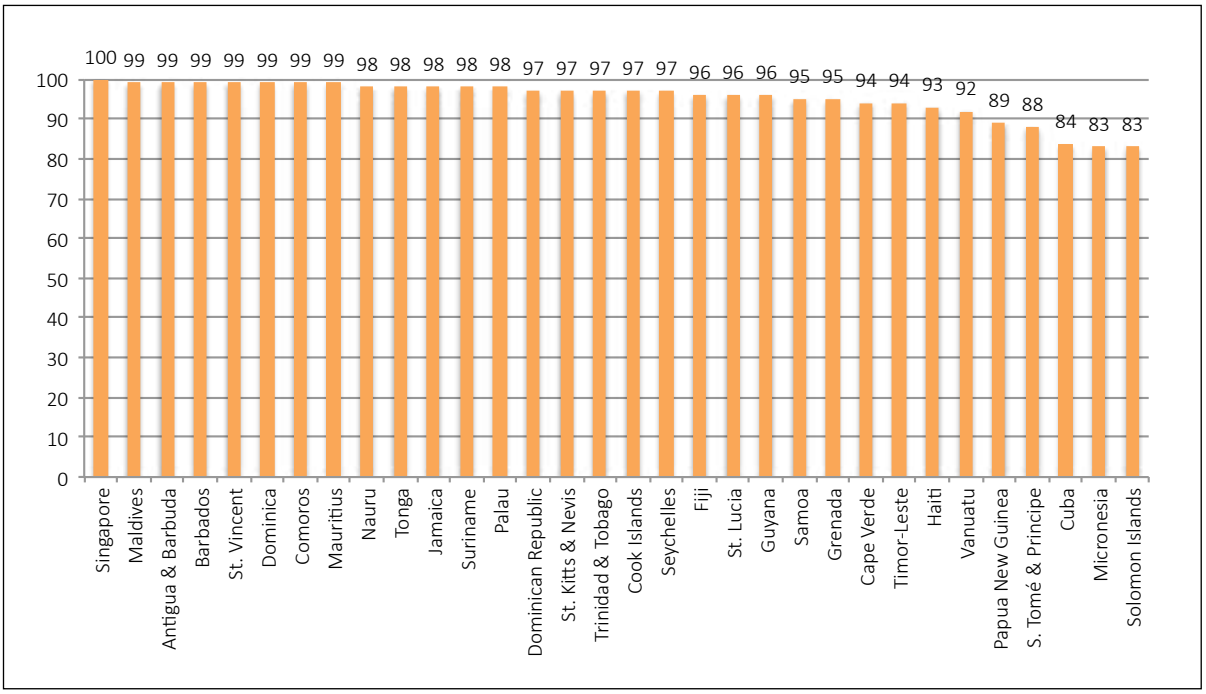

Figure 3.1. Population Coverage by 2G (GSM) Networks in SIDS, 2015
(Source: Adapted from operators' reports.)

The Economic Dimension

As discussed previously, the high cost of connectivity provision is a key challenge for SIDS. There are three aspects to the economic equation that are relevant here:

1. Demographics. Many SIDS have small populations scattered among many islands, and often have low levels of economic activity, limited sources of income, and poor integration into the global economy. This may be even more extreme for marginalised groups, such as ethnic minorities or women and girls.

2. Isolation. Separation by open seas and great distances from sources of upstream connectivity makes a less attractive business case for downstream submarine cable connectivity serving these relatively low-traffic markets.

3. Vulnerability. The low-lying nature of many of the islands, their susceptibility to natural disasters such as earthquakes and extreme weather events, and their vulnerability to the effects of climate change mean that SIDS are more subject to communications infrastructure disruption, and have a particular need for reliable, redundant, and robust communications systems that are able to withstand unpredictable trauma.

In terms of the uptake in basic mobile services (i.e., voice), the picture amongst SIDS is mixed. Group averages vary depending on whether they are weighted by population or are simple country averages. According to supply-side statistics provided by regulators, operators, and industry associations, in 2015 there were some 40 million subscriptions in SIDS (excluding Singapore), with an average penetration of 72 subscriptions per 100 people.

However, the weighted average disguises significant differences. For example, over half of SIDS have more mobile phone subscriptions than people, and in such cases it is hard to interpret and use administrative data for policy measures. A more accurate measure of accessibility is the availability of mobile phones in households (Figure 3.2). Five SIDS have near-ubiquitous access to mobile phones (> 95% of households), while another nine have a relatively high level of access (> 90% of households). That leaves over two dozen SIDS with a household penetration of less than 90% and around half a dozen where less than half of households have a mobile phone. Given the relatively high 2G coverage levels, the barrier appears to be economic.

While 2G is approaching ubiquity, there are huge gaps in the availability, cost, and quality of broadband. In terms of broadband connectivity, there is a significant difference between fixed and mobile broadband in all SIDS.

In many SIDS, the penetration of fixed broadband (wired or wireless) is extremely low: the median penetration is six subscriptions per 100 people. Prices tend to be high because of limited competition and low availability (typically only in the main urban areas). While mobile broadband is often seen as a substitute for fixed, it is usually slower, has higher latency, and is a metered service. It is not equivalent to fixed broadband

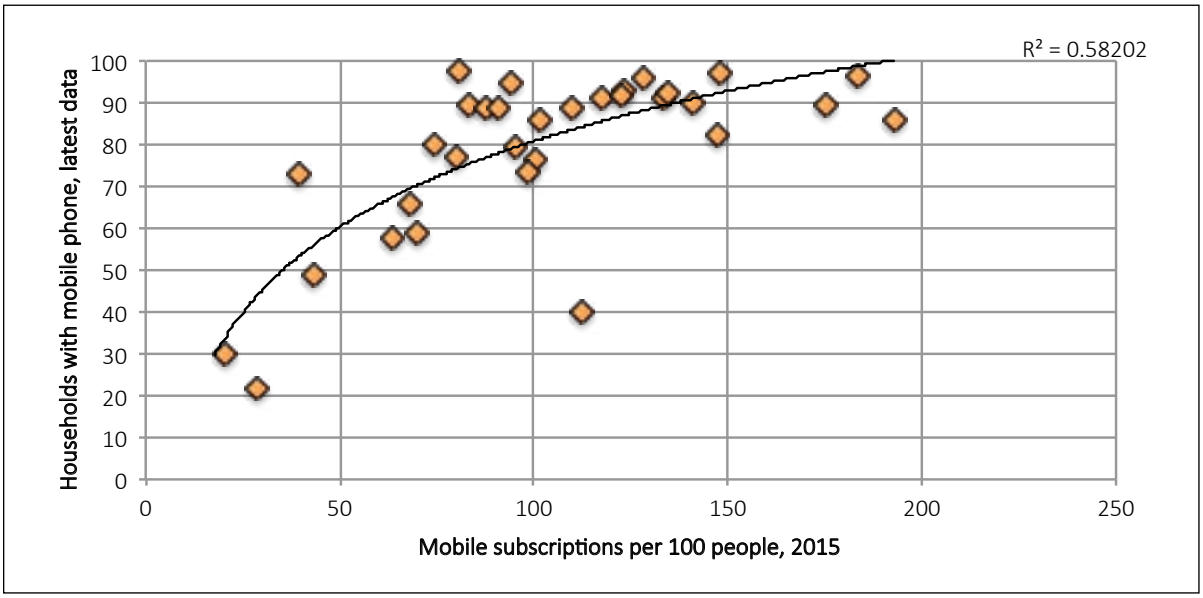

Figure 3.2. Correlation of Mobile Subscription Penetration in SIDS and Proportion of Households with a Mobile Phone, 2015
(Source: Adapted from ITU and household surveys.)

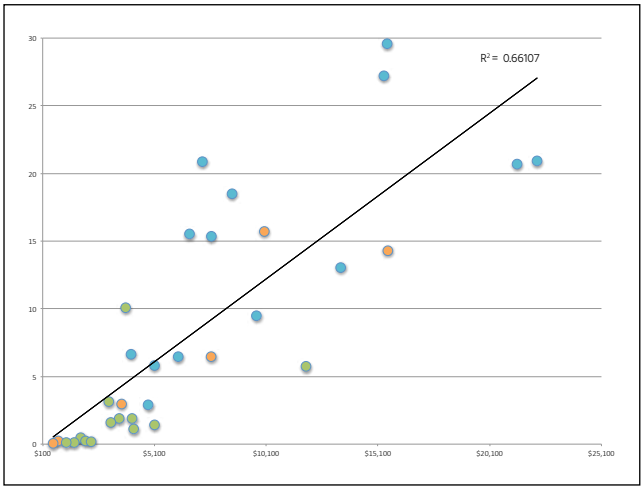

Figure 3.3. Relationship between Fixed Broadband Penetration and GDP per Capita in SIDS, 2015 (Source: Adapted from ITU (broadband penetration) and World Bank (GDP per capita))

Note: Each circle represents a SIDS. Blue = Caribbean, green = Pacific, orange = Africa, Indian Ocean, and Asia.

for services such as Internet-delivered television or video, or other high-bandwidth applications, such as telemedicine. Fixed broadband is often a necessity for small Internet businesses with requirements for virtual private networks (VPNs), data hosting, and access to cloud-based services.

Anglophone Caribbean nations tend to have higher levels of fixed broadband penetration than other SIDS, partly because of higher incomes, and to some extent due to their greater population densities. Further, there is a significant divide in wired broadband penetration between the Anglophone Caribbean and SIDS in other regions, somewhat related to income (Figure 3.3).

There are exceptions to these general tendencies: Saint Kitts and Nevis is neither the wealthiest nor the most densely populated of the SIDS, yet it has the highest fixed broadband penetration—higher than Singapore, which is almost four times wealthier and has a population density of 7,829 persons per km^2, compared to 214 in Saint Kitts and Nevis. Although the country has benefitted from the presence of medical schools and a number other international agencies, according to a report on broadband in the country,[48] success factors include nurturing the foundational components of the broadband ecosystem by promoting basic education and digital literacy, building technology awareness, facilitating access to ICTs, and encouraging a competitive telecommunications environment.

The latter point is particularly relevant as Saint Kitts and Nevis is one of the few SIDS in which there is competition between networks using different fixed broadband technologies, namely ADSL and coaxial (TV) cable.

While most SIDS have introduced some competition in mobile services, fixed-service competition is more limited in many of them. Facilitating fixed operators to offer multiple services, particularly cable TV, could make market entry more attractive. Moreover, uncertainty about ownership and strategic direction, and poor preparation for facing competition from mobile operators has also negatively affected the ability of a number of incumbent operators in SIDS to develop, promote, and expand fixed broadband services.

Mobile broadband has largely stepped in to compensate for the lack of fixed broadband access. However, unlike 2G, which is nearly ubiquitous, the coverage of 3G mobile broadband is not as widespread (Figure 3.4, next page).

Only about half a dozen SIDS have relatively ubiquitous 3G coverage. In general, coverage is relatively high where there is healthy competition (e.g., Maldives, Dominican Republic, Antigua, and Barbuda) or the coverage area is fairly small (e.g., Nauru). There is scope in other countries with competition to push towards a more efficient market level of coverage—regulators should investigate what the bottlenecks are to operators competing for new mobile broadband customers by extending their 3G coverage. It could be that, given geography, population density, and affordability, market conditions in some countries have extended 3G coverage as far as is currently commercially feasible.

Steps could be taken, including awarding more low-frequency spectrum (which covers a larger area than higher frequencies, and thus offers more cost-efficient coverage) or subsidizing the roll-out of infrastructure via direct subsidies, reverse auctions, tax, and other investment incentives. The government in Vanuatu has established a target of 98% mobile broadband coverage in 2018, and to support this has waived the 4% annual revenues that operators are normally required to contribute to the universal access fund, provided they are able to roll out infrastructure to meet the coverage target.[49]

There are conflicting definitions of mobile broadband subscribers among regulators and operators. Some include all subscribers that are capable of accessing the 3G network, regardless of whether they actually access the Internet; whereas others only count subscribers that are actively using mobile broadband

[48] Anius, Diana. 2011. *Broadband in St Kitts and Nevis: Strength in Depth.* Washington, D.C: infoDev/World Bank. http://www.infodev.org/publications.

[49] https://www.ptc.org/assets/uploads/papers/ptc15/3.%20Ron_Box_presentation_to_PTC_15_Final%20Final%20Final.pdf.

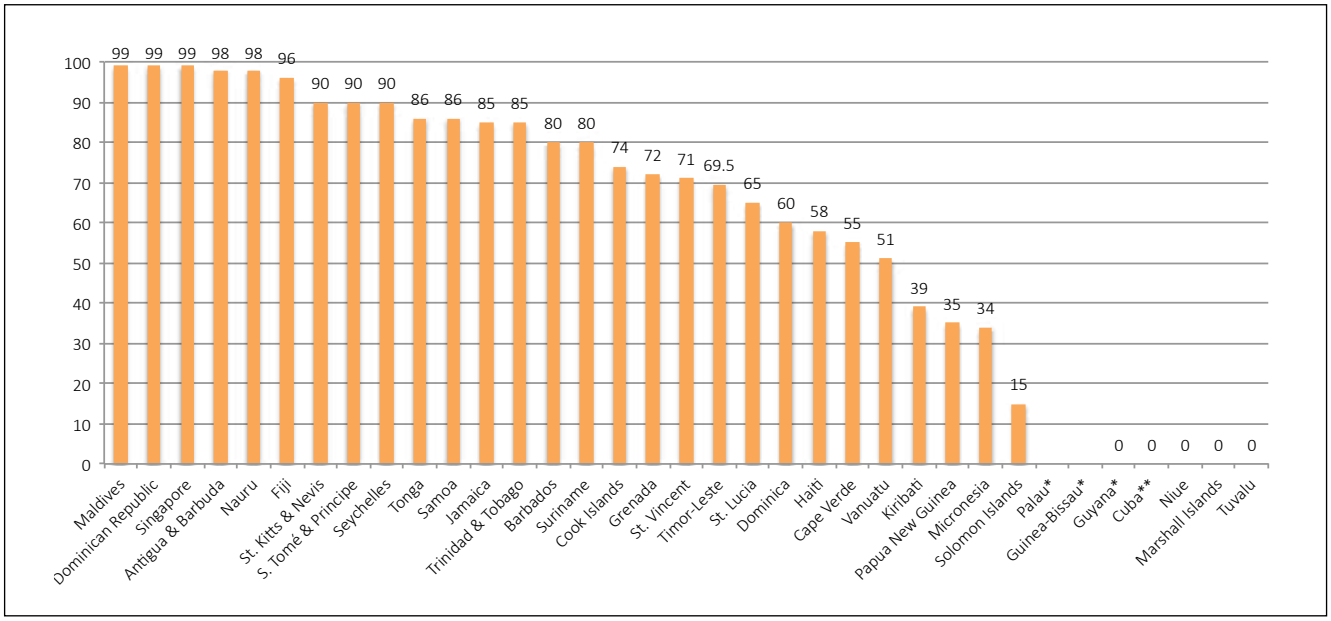

Figure 3.4. 3G Mobile Population Coverage (% of Population), 2015 or Latest Available Data (Source: Adapted from operators' reports. Data not available for Belize, the Bahamas, Comoros, and Mauritius.)

Note: *3G* refers to Universal Mobile Telecommunications Service (UMTS) standards including WCDMA, HSDPA, and HSPA+.

* 3G launched in late 2015 in Guinea-Bissau and Palau, and in 2016 in Guyana.

** Some coverage is available, but only for incoming roamers.

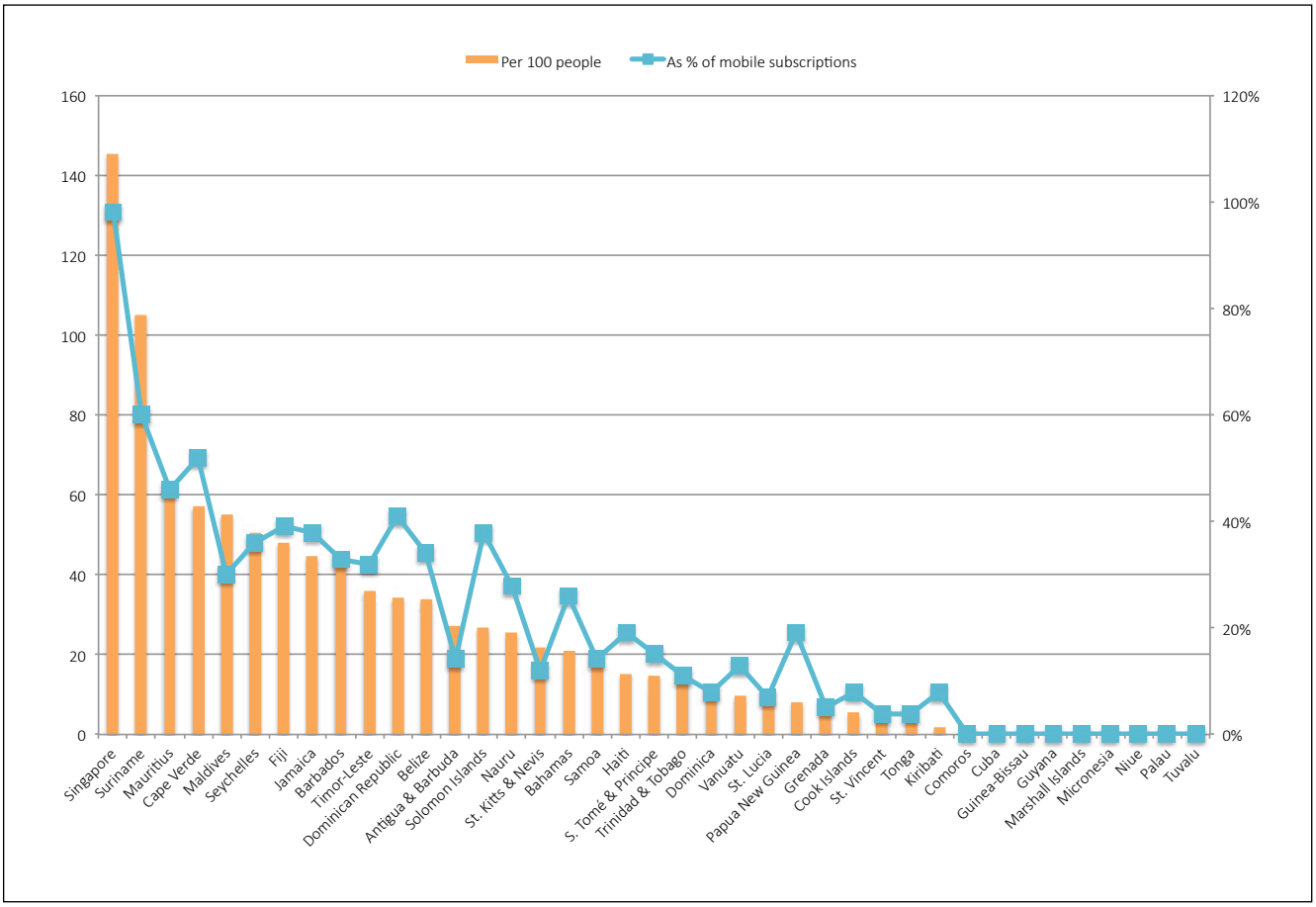

Figure 3.5. Mobile Broadband Subscriptions, 2015 (Source: Adapted from GSMA)

services. Given the variation in definitions, this report uses data from the GSMA industry association to gauge take-up of mobile broadband. According to this data, penetration of mobile broadband subscriptions varies widely, from over 100% in Singapore and the Maldives to zero in nine SIDS that did not have commercial mobile broadband networks in operation at the end of 2015. The median mobile broadband penetration among SIDS is just 15%.

Take-up of fourth generation (4G) mobile technology in SIDS lags behind most other countries. By mid-2016, only 14 SIDS had launched LTE networks[47] comprising 25 operators and using a variety of frequencies (Table 3.1). The decisions by operators whether to launch LTE, what frequencies to use, and whether to use their existing radio access networks or deploy new overlay networks depend on competitors' strategies, geography, spectrum availability, funding, the age of existing infrastructure, and the time frame being considered.[51]

		Frequency (MHz)							
Country	Operator	700	800	900	1700	1800	1900	2300	2600
Antigua and Barbuda	Digicel	Nov-12							
	FLOW				Nov-14				
Bahamas	BTC	Feb-14							
Dominican Republic	Claro				Jul-14				
	Orange					Jul-12			
	Tricom						May-13		
	WIND								Jan-15
Jamaica	Digicel	Jun-16							
Trinidad and Tobago	TSTT								Apr-14
Guinea-Bissau	Orange					Dec-15			
Mauritius	Emtel					May-12			
	MTML					May-15			
	Orange					Jun-12			
Seychelles	Airtel		Nov-14						
Fiji	Digicel					Aug-14			
	Vodafone					Dec-13			
Papua New Guinea	Digicel	Mar-14							
Samoa	Digicel								
	NetVo								
Vanuatu	WanTok							Apr-14	
	Digicel					Jan-16			
Maldives	Dhiraagu					Oct-14			Sep-15
	Ooredoo	Apr-13							
Singapore	M1					Jun-11			Jun-11
	Singtel			Jul-15		Dec-11			Dec-11
	StarHub					Sep-12			Oct-13

Table 3.1. LTE Networks in SIDS, 2016 (Source: Adapted from operators' reports)

[50] Some operators are advertising 3G HSPA+ networks as 4G; in Samoa they were ordered to stop. See http://www.regulator.gov.ws/images/publication/electricity/telecome/Order-2012-T08.pdf.

[51] https://networks.nokia.com/blog/2014/overlay-lte-networks.

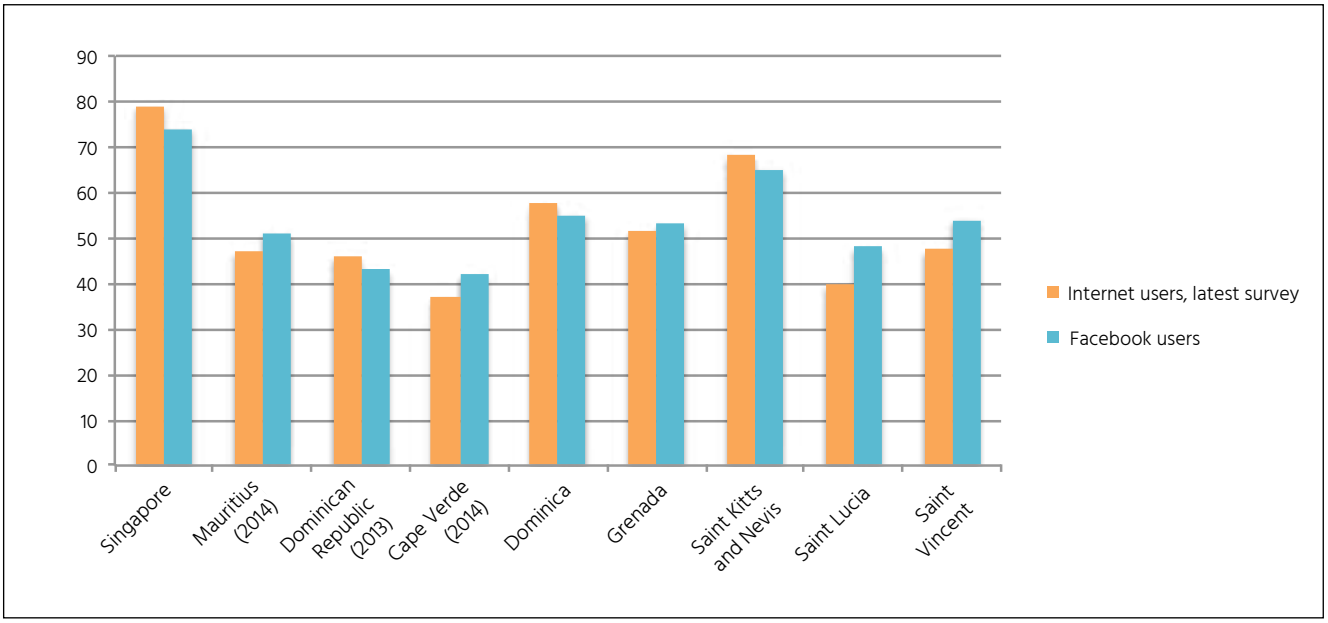

Figure 3.6. Percentage of Internet Users (2014) and Facebook Users (2016) (Source: Adapted from national statistics and Facebook ad engine)
Note: *Internet use* refers to % of surveyed population. *Facebook use* refers to population aged 13+ years as a share of the total.

The switchover from analogue to digital television broadcasting frees spectrum in lower frequencies (700 MHz and 800 MHz). This spectrum is ideal for mobile broadband since it can cover a larger area than higher frequencies, thus reducing deployment costs. However, less than a dozen SIDS have started or completed the digital switchover.[52]

Levels of Internet Utilization

Although approximately half of the SIDS have measured Internet use in their countries, most of these data are dated—they were collected as part of the 2010 Census. This makes it difficult to know how much increased ICT infrastructure has impacted online usage. Statistics on usage of the social media application Facebook is available for all of the SIDS except Cuba (Figure 3.6) and shows a close link between Facebook use and Internet use for SIDS, where relatively recent Internet access surveys have been carried out. For this reason, in this report, the number of Facebook users is used as a proxy for online use.[53]

Facebook usage is somewhat tied to income (Figure 3.7, next page). Singapore leads the SIDS with the highest proportion of the population aged 13 and over using Facebook: 74%. It is followed by Maldives at 66%, and Saint Kitts and Nevis at 65%. In just over a dozen SIDS, over half the population uses the social networking application and the median value is 42% of the population. It is notable that many of the SIDS that are underperforming relative to their income levels are from the Pacific region.

Two factors with a strong influence on online usage are price and education levels (Figure 3.8, next page). All SIDS whose population aged 25 and above has at least seven years of education and where mobile broadband prices are less than 5% of per capita income[54] have a Facebook penetration above the SIDS median value. On the other hand, all SIDS where the average years of schooling is less than seven and mobile broadband prices are more than 5% of income have Facebook penetration significantly less than the median.

These results suggest that prices are more significant than education in driving Facebook use. For example, the Dominican Republic is the only country where Facebook use is above the median among SIDS that have more than seven years of education, but mobile broadband prices greater than 5% of

[52] http://www.itu.int/en/ITU-D/Spectrum-Broadcasting/Pages/DSO/Summary.aspx.

[53] The availability of free Facebook access—either full access bundled with an Internet subscription or "Facebook Zero", where access to a limited, text-only version is provided for free—could impact the statistics. However, neither of these practices appear to be widespread among the SIDs; free bundled Facebook is only available in Mauritius in respect to the mobile broadband tariff packages considered for this report. According to secondary sources, Facebook Zero appears to be available in Fiji, Suriname and Trinidad and Tobago (https://en.wikipedia.org/wiki/Facebook_Zero).

[54] Target established by Broadband Commission. See http://www.broadbandcommission.org/Documents/publications/Broadband_Targets.pdf.

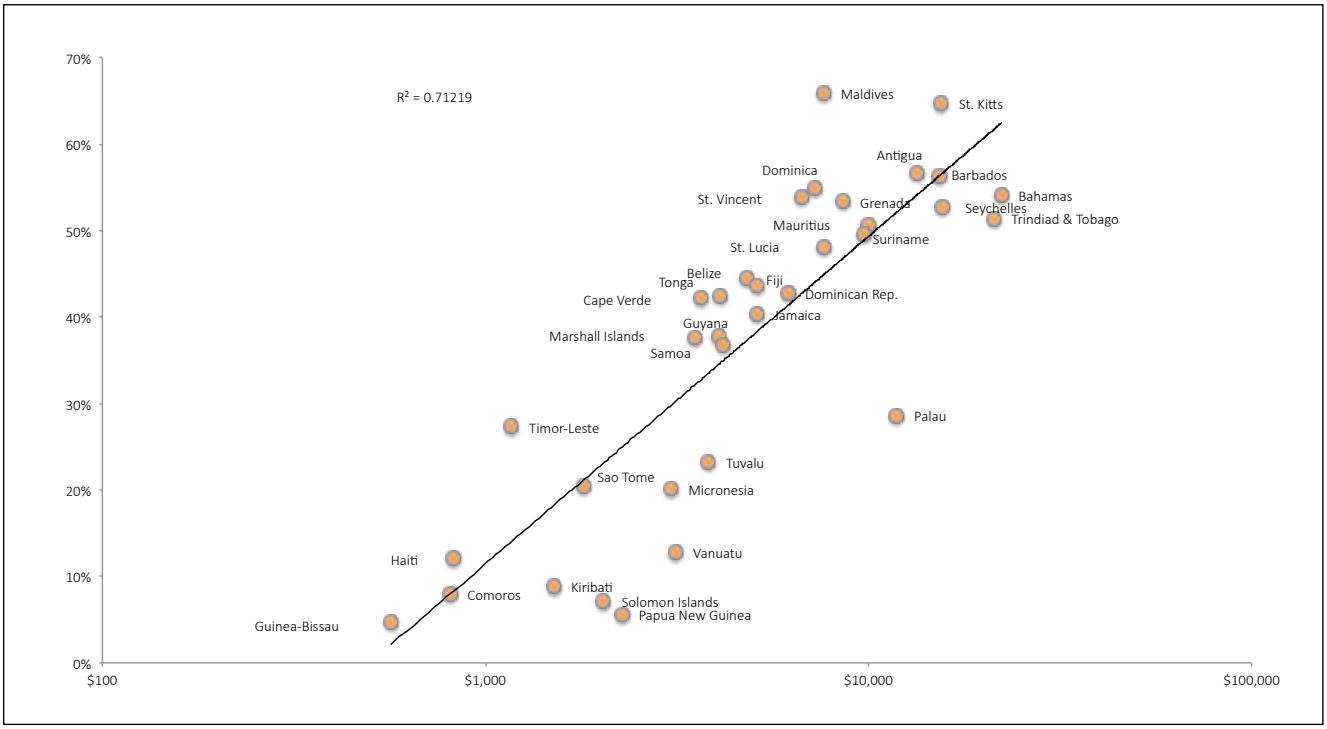

Figure 3.7. Relationship between Facebook Use and GDP per Capita in US$, 2016
(Source: Adapted from Facebook Ad Engine Marketing Data and World Bank.)

Figure 3.8. Relationship between Facebook Use, Years of Schooling, and Monthly Mobile Broadband Costs as a Percent of per Capita Income, 2015
(Source: Adapted from ITU, UNDP and Facebook.)

Note: Each circle represents a country and the size of the circle indicates relative Facebook use (the larger the circle, the higher the proportion of Facebook users among the population). Yellow circles reflect where Facebook penetration is above the SIDS median. Years of schooling refers to average number of years of education received by people ages 25 and older.

income. Samoa, which has the highest years of schooling among the Pacific SIDS, has a lower level of Facebook use than Fiji and Tonga. But Fiji and Tonga have cheaper relative mobile broadband prices. At the same time, among the three countries with relatively low levels of education and low broadband prices, two have Facebook penetration above the SIDS median: the Maldives and Cape Verde.

The case of the Maldives is particularly interesting in that it has a relatively low average for years of schooling among the SIDS, but the second highest Facebook penetration. One reason for higher relative mobile broadband tariffs among Pacific economies is related to access to submarine cables. Pacific economies with a high level of Facebook use either have had access to undersea cables for a long time (e.g., Fiji) or have open access policies to the cable (e.g., Tonga) and a longer experience with competitive markets, which resulted in lower retail Internet prices.

Social, Cultural, and Environmental Issues

Factors such as education, language, and vulnerability to disasters also influence connectivity and ICT access in SIDS.

As discussed, the cost of broadband services appears to have a bigger impact on online usage than years of schooling. However, after a certain point—typically, when most of those with at least a secondary education are online—further increases in Internet use often stagnate. Therefore, investments in ICT infrastructure need to be accompanied by complementary investments in education. This is particularly important in many of the low-income and least-developed SIDS, where years of schooling are relatively low. At the same time, the wider impacts of connectivity are unlikely to be fully realized unless there is a core of software development expertise in the country to develop relevant applications and services. For this reason, it is important to ensure that postsecondary training and certification in computer related subjects is widely available.

Cultural aspects, particularly language, also impact ICT use in SIDS. It is easier to develop or to use already existing content in widely spoken languages, such as English, French, or Portuguese—the official or second languages in many of SIDS, although fluency varies. In most SIDS there is also a local language; in some countries, such as the Pacific Melanesian islands, there are many local languages. This makes the development of online content more complex, particularly given the small populations and often the absence of any standard written language.

Many SIDS are prone to a variety of natural disasters, including cyclones, earthquakes, and tsunamis. Growing connectivity has helped mitigate the impact of disasters, particularly the wide availability of mobile phones, which mean text messages can be used to alert citizens about impending disasters so that they can both prepare and support relief efforts. At the same time, networks need to be resilient to withstand these disasters, which adds to the cost of deployment.

4 • Technical Opportunities for Improved SIDS Connectivity

As described on page 13 ("Regional Connectivity"), a number of submarine cable projects both under construction and being planned will significantly improve connectivity for some SIDS. Assuming that all of these cable projects go ahead, this still leaves almost half the SIDS needing one or more cables (Table 2.4).

Many of the submarine cables that are being planned for other destinations pass relatively close to some of these SIDS (and other islands that are not formally SIDS), and adding spurs to these cables offers an important opportunity for achieving the most cost-effective means of obtaining additional or first-time fibre capacity. See page 39 ("Securing Better International Connectivity") for more on this topic.

Internet Exchange Points

Internet Exchange Points (IXPs) provide many benefits, including reducing the need for international bandwidth, encouraging the development of local content, and improving the Internet experience via lower latency. Despite these benefits, only just over a dozen SIDS have an IXP (Table 4.1). One factor behind the low number of IXPs is the limited Internet competition. Where there are only two ISPs in a country, they may connect directly to keep their own traffic local, thereby replicating some of the benefits of an IXP. But these countries are missing out on the benefits of having content providers connected to a common platform, which would improve performance and reduce needs for international traffic by reducing the duplication of download requests.

Another consideration is the potential for open-access regional IXPs that could aggregate traffic to create scale in order to attract larger ISPs and content providers. This would also decrease reliance on transit centres in developed countries, where peering can be expensive. Fiji would be a logical point for such a regional IXP in the South Pacific, since it lands submarine cable traffic from Tonga and Vanuatu (and soon Samoa). This traffic currently gets handed on to the Southern Cross submarine cable for termination in Australia or the United States. Peering more of the traffic in Fiji would improve performance and reduce the cost of the additional link and transit payment. While Africa lacks a natural hub point on or near an island, the Caribbean has many islands with large numbers of different cable landings, namely Curacao, Dominican Republic, Puerto Rico, Trinidad and Tobago, and the US Virgin Islands.

Emerging Satellite Systems

Until recently, costly traditional geostationary satellites were the only option for SIDS without access to submarine cables. However, technical developments are combining with new business models to provide more satellite bandwidth, better prices, and better quality. A key feature of the new satellite systems is that they are relatively fast to develop and cheap to build and launch compared to their earlier counterparts. In addition, they use low and medium earth orbits (LEO and MEO) which means they are much nearer to the earth's

Country	IXP	City	Year Established	Participants
Belize	Belize Internet Exchange Point (BIXP)	Belize City	2016	NA
Cuba	NAP de Cuba	Habana	2001	5
Dominica	Dominica National Internet Exchange Point (DANIX)	Roseau	2013	3
Dominican Republic	NAP del Caribe	Santo Domingo	2008	14
Grenada	Grenada Internet Exchange (GREX)	Saint Georges	2011	2
Haiti	AHTIC Internet Exchange Point	Port au Prince	2009	9
Jamaica	Jamaica Internet Exchange Point (JIXP)	Kingston	2014	NA
Mauritius	Mauritius Internet Exchange (MIXP)	Port Louis	2006	10
Papua New Guinea	PNG-IXP	Port Moresby	2015	5
Saint Lucia	Saint Lucia IXP	Castries	2014	NA
Singapore	Equinix IBX Singapore	Singapore	2004	NA
Singapore	Singapore Open Exchange (SOX)	Singapore	2001	26
Singapore	Singapore Internet Exchange (SGIX)	Singapore	2010	70
Trinidad and Tobago	Trinidad and Tobago Internet Exchange	Barataria	2014	7
Vanuatu	Vanuatu Internet Exchange (VIX)	Port Vila	2013	NA

Table 4.1. Internet Exhange Points in SIDS (Source: Adapted from IXP website information and Packet Clearing House.)

surface compared to geostationary satellites, and this greatly reduces the time taken for data packets to make the round trip (latency), in order to travel from the earth to the satellite and back again. In these LEO/MEO satellites latency is about 130 milliseconds compared to about 650 milliseconds for a geostationary satellite, greatly improving performance when compared to geostationary satellites, and allowing satellite operators to provide a quality of service that is much closer to fibre.

LEO/MEO satellites also offer considerable savings in the cost of capacity compared to traditional satellites. For example, the O3b system of 12 satellites provides capacity at about US$400 per Mbps, and has a total capacity 192 Gbps.[55] By using two earth station terminals, the capacity available on a single link increases to 800 Mbps on the downlink and 650 Mbps on the uplink. Because they are not in geostationary orbit, the O3b satellites need to be tracked as they pass overhead, so this does require more costly ground-station equipment than for geostationary satellites—about US$300,000 per terminal, compared to as low as US$4,000 for a stationary very-small-aperture terminal (VSAT).

As a result, the service is not oriented to end users, rather it is aimed at providing backhaul links for telecommunication operators seeking either to connect their remote networks where no terrestrial infrastructure exists or to provide backup links. Approximately 31 countries, mainly island states, have adopted the O3b service, including the Cook Islands, Timor-Leste, Papua New Guinea, and Madagascar[56]. The Solomon Islands, and Palau are among other island nations in the process of implementing an O3b link. In American Samoa, the same satellite technology is used as a back-up for the existing fibre-optic network.

[55] *O3b* reportedly stands for the "other 3 billion", which at the time of its launch roughly represented the number of people in the world without broadband access.

[56] http://www.o3bnetworks.com/o3b-networks-earns-via-satellite-satellite-operator-year-award-satellite-2016/.

Extending the O3b model further, new projects currently in the planning phase propose to use constellations of hundreds if not thousands of satellites to provide cheaper and higher-capacity links than are currently available. One such project is OneWeb, backed Virgin Galactic and Qualcomm, which has secured US$500 million in initial investment from additional partners Airbus, Bharti Enterprises, Hughes Network Systems, Intelsat, Coca-Cola, and Totalplay.[57]

OneWeb plans to launch as many as 648 satellites into 20 orbital planes at an altitude of 1,200 km to provide Internet globally at affordable prices. Through miniaturization, OneWeb expects that the cost of each satellite will come down from upwards of US$300 million to around US$500,000[58]. Already developed is a new generation of miniaturized 'CubeSats' that can be fitted together on a modular basis and launched into low-earth orbit for less than US$80,000. Also helping to bring down the overall costs of satellite operations is the reduction in launch costs championed by Elon Musk, whose SpaceX project has developed reusable rockets. SpaceX has also announced plans to launch a constellation of more than 4,000 small satellites to provide broadband services across the globe.

OneWeb and SpaceX will also have competition from existing satellite operators Iridium and Globalstar, who have also begun to launch a series of LEO satellites to provide broadband and voice services.

The relevance of these developments for SIDS will largely depend on the extent to which they are able to take advantage of submarine cable options. These solutions are likely to be particularly attractive for SIDS with only one cable connection (which requires a back-up alternative during periods of cable failure) and those with many small islands.

Wi-Fi, Super-Wi-Fi, Dynamic Spectrum Sharing, and Software-Defined Radio

Wi-Fi's low cost and ubiquity in devices is well known, and mobile operators often rely on the technology to offload traffic from congested 3G and 4G base stations. In addition, many rural communication projects around the world have successfully and cost-effectively adapted and expanded Wi-Fi's reach by using high-gain antennas and adding mesh capability to the radios.[59] In SIDS, Wi-Fi access is generally cheaper and faster than 3G, and therefore an attractive proposition if hotspots are available.

The micro state of Niue provides an interesting example of the widespread use of Wi-Fi throughout the island.[60] Access is free after payment of NZ$25 per computer, and the service is subsidized by earnings from the country's .nu domain name. As a result, over 40% of households reported having Wi-Fi Internet access in the 2011 Census, and more than six out of ten Niueans were using the Internet—one of the highest penetrations in SIDS. A move to start charging for the service due to a fall in domain earnings has caused concern.[61]

Related initiatives exist in other SIDS, particularly those with one main island, or where the geographic size of multiple island states is small. For example, the Barbados Entrepreneurship Foundation launched a project in 2010 to provide free island-wide Wi-Fi coverage by encouraging local businesses to open their Wi-Fi networks by adding a guest account.[62] In the Maldives, the small size of many atolls has made it relatively easy to provide broadband Wi-Fi access.[63]

Wi-Fi uses frequencies that effectively require line-of-sight, and propagate poorly through foliage and buildings. Therefore, in cases where there is dense jungle, small populations spread across outlying islands, or hilly topography, exploiting unused TV spectrum with software-defined radios has the potential to be much more effective than Wi-Fi. For the same amount of power, a TV white-space signal uses lower frequencies that can cover a far wider area than the higher-frequency Wi-Fi signal can, so fewer antennas and base stations are needed. Calculations show that a 600 MHz TV white-space signal has 16 times as much coverage as a 2.4 GHz Wi-Fi signal. Because software-defined radios scan for unused frequencies and are programmed to use specific frequencies at start-up, they can coexist with analogue or digital broadcasting without causing interference. Trials using these dynamic spectrum sharing

[57] http://www.reuters.com/article/us-bharti-oneweb-idUSKBN0P52NO20150625.

[58] http://www.bbc.com/news/science-environment-33268180.

[59] A mesh network relies on software to automatically route connections via the nearest radio to the end location.

[60] http://internetniue.nu/about/.

[61] http://www.radionz.co.nz/international/pacific-news/301950/niue-wifi-operator-back-in-action.

[62] http://www.ict-pulse.com/2011/11/from-bus-stop-to-rum-shop-has-barbados'-wi-fi-project-been-a-success/.

[63] https://www.dhiraagu.com.mv/Dhiraagu_inaugurates_broadband_Internet_service_to_all_atolls_with_the_launch_of_Wireless_Zone_service_in_15_atoll_capitals.aspx.

[64] http://dynamicspectrumalliance.org/pilots/.

systems are now taking place all over the world.[64] The Philippines government has adopted the technology as part of its plan for ensuring universal access to broadband, and a growing number of countries are adapting their regulatory frameworks to take advantage of these systems.

High-Altitude Platforms

Similar to the technical developments with satellites, there exist new wireless technology platforms that promise to reduce costs and spread access via the miniaturization of electronic components. One of these is the potential role of drones as a broadband delivery platform. For example, Facebook's Aquila project plans to use drones with a wingspan greater than a Boeing 737, yet weighing no more than a car, to soar at 60,000 feet (over 18,000 metres) using solar energy and free-space optics in order to bring Internet connections to remote areas. The first Aquila test flight successfully took place in July 2016 and the company has recently run tests showing downlink speeds of up to 36Gbps[65].

Another example is Google's Project Loon, which will use a constellation of balloons 20 km above the Earth's surface in the stratosphere, guided by algorithmic software to calculate wind-speed and direction.[66] The balloons use LTE technology, and will most likely provide a wholesale service to local operators. In Sri Lanka, the government has provided spectrum for Loon, and local operators are expected to retail the service, which will be able to cover the entire island.[67]

In Brazil, the government has been testing the use of tethered balloons in the Amazon as simple Wi-Fi hotspots with wide footprints and visibility in forest environments. And the Bandung Institute of Technology in Indonesia is experimenting with a similar project called Helion.[68]

Offline Solutions

Given the difficulties of obtaining affordable connectivity in many of the remote communities present in SIDS, off-line solutions can be used as an interim measure. These providing an affordable way to bring selected Internet resources out to unconnected locations using small low power servers with wifi and hard drives loaded with relevant data.

Examples that have been in used in the Pacific and Caribbean include the following:

- The Commonwealth of Learning, Aptus ("classroom without walls"), https://www.col.org/services/knowledge-management/aptus.
- Rachel Offline, https://racheloffline.org/collections/rachel.
- The Kenyan Kio Kit, http://education.brck.com/kiokit/.

[65] https://www.forbes.com/sites/haroldstark/2017/05/11/spacex-and-facebook-are-on-a-race-to-globalize-the-internet

[66] http://www.google.com/loon/how/.

[67] https://www.theguardian.com/technology/2016/feb/16/project-loon-google-balloon-that-beams-down-internet-reaches-sri-lanka.

[68] https://www.techinasia.com/helion-indonesian-version-of-google-project-loon.

5 • Towards Improved Policy and Regulatory Environments for Better Connectivity

This section identifies the enabling policy and regulatory environments and national broadband strategies that can help accelerate improved Internet connectivity in SIDS.

Competition Quality

Healthy competition between different operators is one of the key factors in driving down costs and improving coverage and quality of service. There has been progressive liberalisation of the telecom and Internet sectors in many SIDS markets since the turn of the century, shattering the myth that most were too small to sustain competition. The growth of competition has been most visible in the mobile sector, where the number of SIDS with at least two operators has more than quadrupled, from 6 in 2000 to 28 in 2015. One of the operators increasing the level of competition is Bermuda-based and Irish-owned Digicel. When it launched its first operation in Jamaica in 2001, only four SIDS had competition in their mobile sector. By 2009, Digicel was operating in 18 of the SIDS in the Caribbean and Pacific, and 25 SIDS in these regions had a competitive mobile market.

Presumably because of small market sizes and low levels of operator interest, the most prevalent model in the mobile market is a duopoly (present in 59% of SIDS). No SIDS with a population of less than 56,000 have more than one mobile operator (although Palau, with a population of 21,000, had a duopoly until the second operator shut down in 2014). However, the number of operators varies considerably and is not strictly related to population size. The SIDS with the largest population, Cuba, has only one operator due to historical ideological reasons. On the other hand, Saint Kitts and Nevis, with a population of only 56,000, has three.

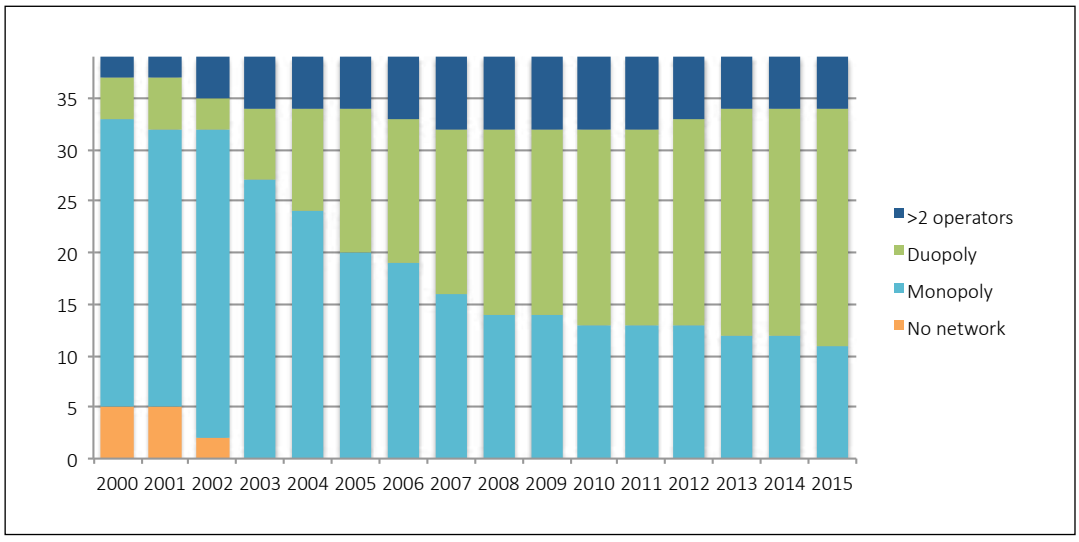

Figure 5.1. Number of Mobile Operators in SIDS (Source: Authors' research)

Several of the SIDS with a single mobile operator have plans to introduce a second. In Comoros, a second operator was licenced in 2015, even though the market has been liberalized since 2008. In the Bahamas, the introduction of mobile competition was on the books for several years before a second licence was awarded in 2015. As a result, there are five SIDS with populations above 50,000 (and where competition is probably viable) that do not have competition in the mobile market: Belize, Cuba, Kiribati, Marshall Islands, and Micronesia.

The Cook Islands also has no competition, and although it has a population of only 13,000, over 100,000 tourists visited in 2015, significantly adding to the potential usage base and providing scope for competition.[69] Therefore, there is the possibility of competition in the remaining SIDS with monopolies, at least in those with populations above 10,000, and particularly when the potential user base of tourists is factored in (Figure 5.2).

The intensity of competition makes a price difference

Market share varies tremendously among mobile operators in SIDS. The Herfindahl–Hirschman Index (HHI)[70] is a widely used measure of market concentration that is also used by some SIDS.[71] It is computed based on the market share of all companies, and the closer the value is to 10,000 the more concentrated the market is. With just two operators, the majority of SIDS cannot aspire to an HHI less than 5,000 (i.e., two operators each with half the market). However, even with duopolies, there are vast differences in the levels of competition. In some cases, the two operators compete on an roughly equal basis, while in others there is a strongly dominant operator. It is interesting to note that virtually all of the SIDS countries

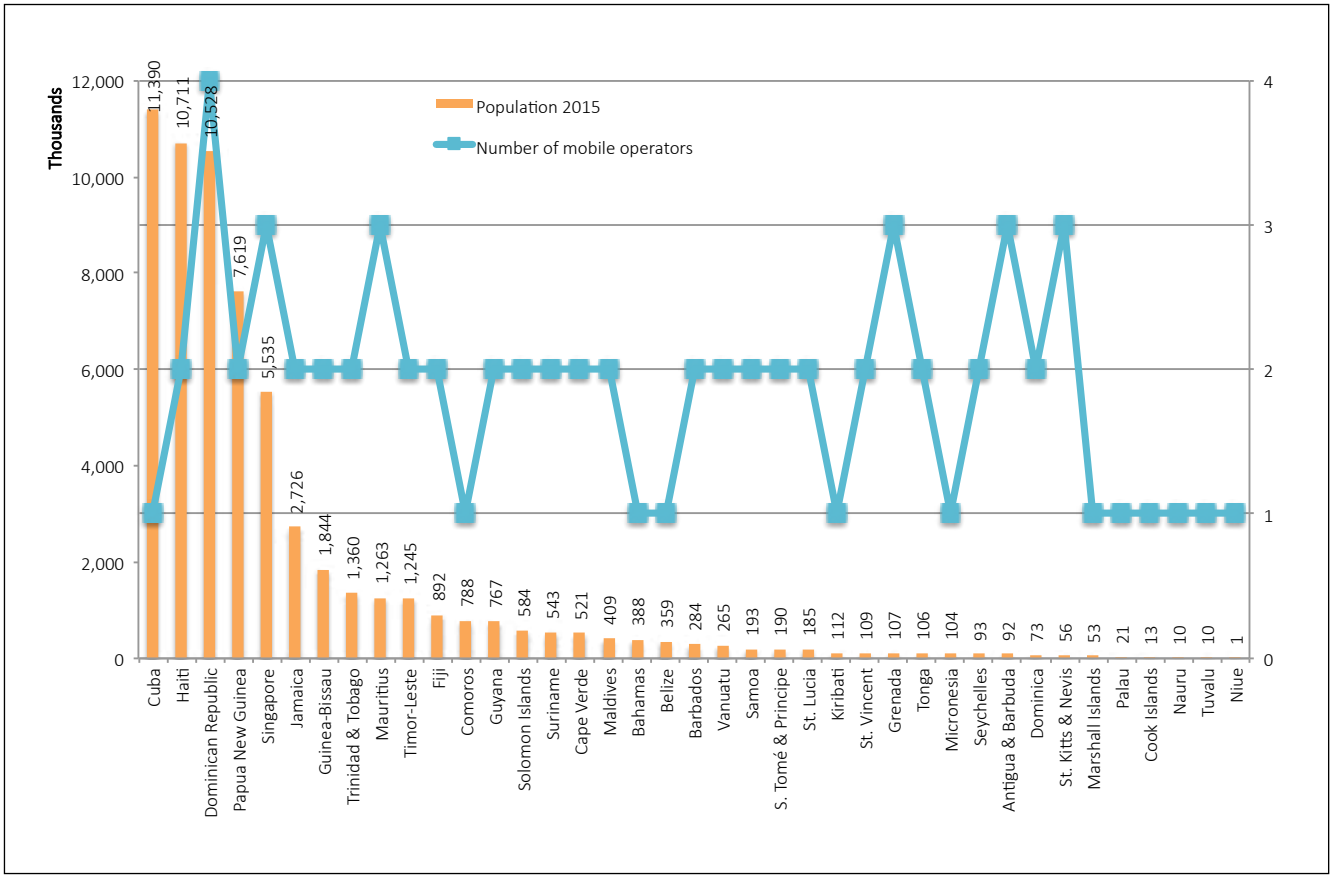

Figure 5.2. Population and Number of Mobile Operators in SIDS, 2015 (Source: Authors' research)

Note: This chart reflects the situation in terms of operational mobile operators at the end of 2015. New mobile licences have been awarded in Bahamas, Comoros and Singapore, and all three have launched or were expected to launch in 2016.

[69] The introduction of competition might alleviate concerns one tourist to the Cook Islands expressed, "I had to wait several days before being able to purchase a local Telecom SIM card for my phone. Internet and phone costs are very expensive." See New Zealand Tourism Research Institute, 2014. *Cook Islands Visitor Survey Results.*

[70] https://www.justice.gov/atr/herfindahl-hirschman-index.

[71] Regulators in Jamaica and Trinidad and Tobago track HHI for various ICT market segments.

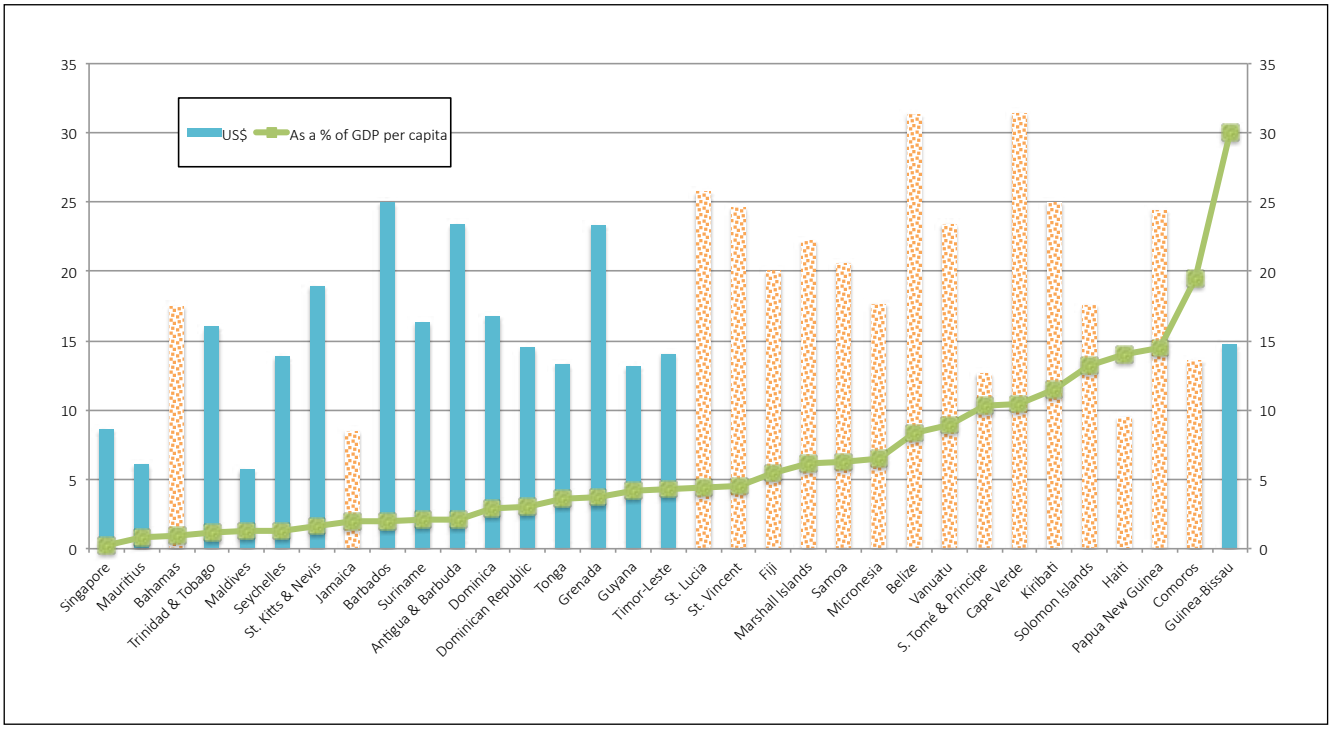

Figure 5.3. Monthly Price of a Basket of Mobile Services in SIDS, 2014 (Source: Adapted from ITU and operator and regulator reports.)

Dotted columns indicate countries where HHI is above 5,200 (i.e., the leading operator has greater than 60% market share). The basket of mobile services is based on an ITU methodology and includes a mix of on-net, off-net peak and off peak calls, and text messages.

with relatively high mobile prices (as a percentage of GDP per capita) are countries where the HHI is greater than 5,200 (i.e., either a monopoly or one operator with more than 60% market share). As shown in Figure 5.3, the only exceptions are Guinea-Bissau (the poorest of the SIDS) and SIDS where tariffs are below the average, but because of low incomes a basket of common mobile services is unaffordable for most citizens.

A number of incumbent operators in SIDS have had a difficult time adjusting to mobile competition from new market entrants. For example, following the introduction of mobile competition in Jamaica in 2001, Cable & Wireless Jamaica began registering losses, a trend it has not overcome: in 2015, its mobile market share was 27%. Such difficulties have been exacerbated by other factors, including high interconnection rates, which because of the lack of regulation have tended to discourage the use of fixed lines, thereby cutting into the incumbent operator's revenues as a result of indirect competition from OTT services delivered over the Internet. Another factor has been uncertainty due to a high level of corporate mergers and acquisitions.

High rates for internetwork voice termination[72] have also affected incumbents by making fixed telephone services less attractive due to higher off-net prices. Although regulators in SIDS have moved to lower termination rates, it is often too late as incumbents have already suffered a significant drop in fixed-line subscriptions. In addition, VoIP and other OTT applications, such as YouTube and Netflix, are eating into traditional voice and TV broadcasting revenues. As the National Telecommunications Authority of the Marshall Islands notes, due to increased OTT usage, the impact of connecting to a submarine cable has a downside for the traditional voice operators:

> *"...large unpredicted decreases to existing revenues have resulted from increased Internet access. After the cable was commissioned, the increasing market penetration in Majuro and Ebeye of DSL and leased lines have resulted in greatly increased broadband access to the Internet, resulting in large losses of revenue from traditional telecommunications services for long distance calls (replaced by VoIP services such as Skype), fax (decreased by the use of e-mail attachments)..."* [73]

[72] The amount paid by an operator to connect a user on its network to a user on another network (off-net calling).

[73] Moss-Adams. 2015. *Report of Independent Auditors and Financial Statements: Marshal Islands National Telecommunications Authority.*

The impact of OTT services, such as Skype and WhatsApp, is reflected in the decline in conventional international telephony traffic. In the Eastern Caribbean, for example, outgoing telephony traffic has dropped by over 40% since 2011 (Figure 5.4, left). Similarly, telephony traffic from the United States to SIDS countries dropped by 41% between 2005 and 2014, and settlement payments shrank by 38% (Figure 5.4, right). Today, mobile operators are also being affected, due to the reduction in voice prices and growing use of OTT applications.

Many of the SIDS' incumbent telecom operators were once owned by groups linked to the colonial past, such as Cable & Wireless (C&W) of the United Kingdom and Portugal Telecom. Over the last decade, these companies have changed corporate focus and divested many of the holdings not deemed essential to their businesses. In addition, the two companies themselves were sold: Cable & Wireless Communications in 2016 (to Liberty Global) and Portugal Telecom in 2015 (its holdings in Portuguese-speaking SIDS were sold to Oi Brazil). In total, over 20 SIDS have been affected by sales of their incumbent operators since 2010 (Figure 5.5, next page).

Some parent company divestures created instability that affected the ability of subsidiaries in SIDS to compete. For example, in Vanuatu in 2007 the government distributed its 33% ownership in Telecom Vanuatu Limited (TVL) to Cable & Wireless and France Telecom as part of a settlement agreement aimed at introducing competition in the country. The government also settled TVL's losses. Cable & Wireless sold its 50% stake to Mauritius Telecom in 2011 for US$5 million, valuing TVL at US$10 million. By 2013, when Telecom Mauritius purchased 40% of France Telecom's shares, the company's value had dropped 90% to US$1 million. This disruption limited TVL's ability to compete with its new competitor Digicel, which entered the market in 2008. By 2013, TVL's market share had dropped to 15%. The unbalanced competition resulted in relatively high prices—Vanuatu had the 25th highest relative mobile affordability among SIDs in 2014—and Digicel has not changed its published voice tariffs for the last five years.

There are benefits to being part of a large group of local operators, such as economies of scale for infrastructure and device purchases. However, local operators are at the mercy of their parent corporations, often headquartered thousands of miles away, regarding commercial and investment decisions.[74]

In some SIDS, international operators have introduced a degree of local ownership in their incumbents in order to make them more sensitive to the domestic market and better able to compete. Bluesky, an investor in several operators in the

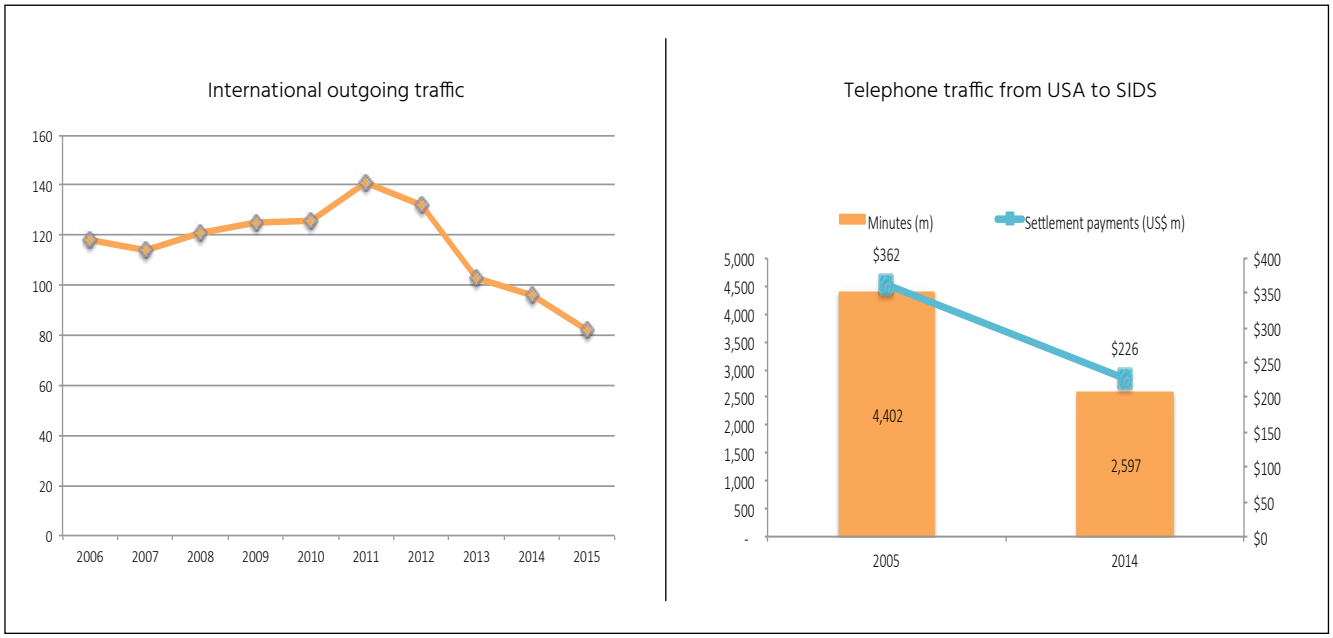

Figure 5.4. Outgoing International Traffic from the Eastern Caribbean (millions of minutes) and the United States to SIDS (Source: Adapted from ECTEL and the US Federal Communications Commission.)

Note: *Eastern Caribbean* refers to Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, and Saint Vincent and the Grenadines.

[74] A Caribbean newspaper article makes the distance point describing a Cable and Wireless Communications (CWC) shareholders meeting as taking place at the "Hilton hotel above the Paddington train station in London." CWC has a stake in many Caribbean operators. See http://thenewtoday.gd/local-news/2014/12/29/cable-wireless-vs-digicel/#gsc.tab=0.

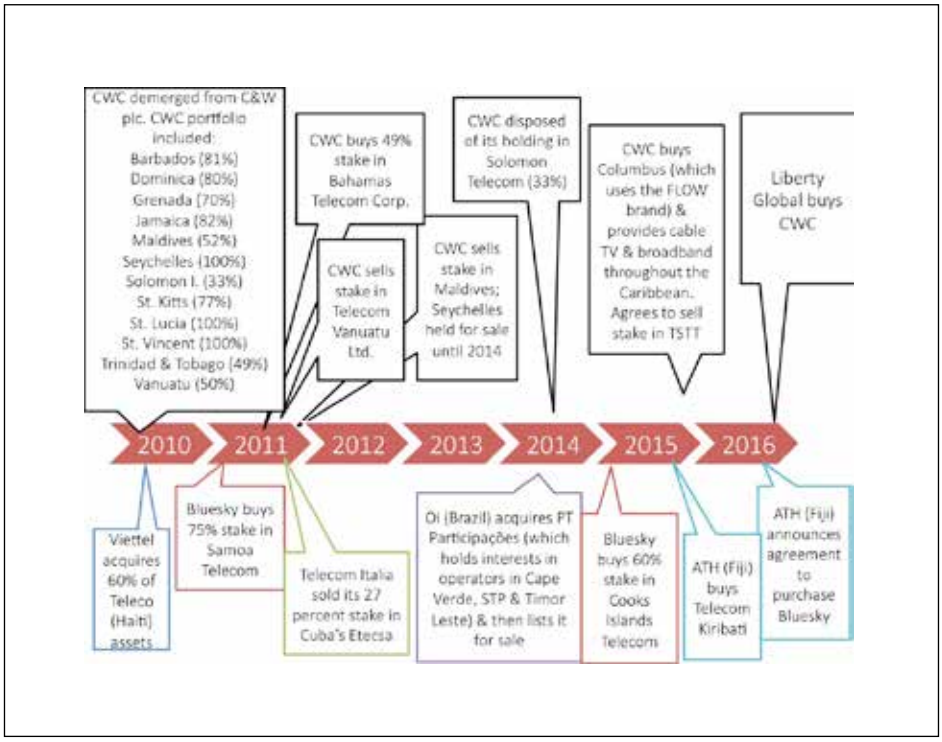

Figure 5.5. Acquisitions and Sales of Incumbent Telecom Operators in SIDS, 2010-2016 (Source: Adapted from operator reports.)

South Pacific, says that local ownership is "critical to the success of its operations."[75] Some SIDS, such as the Maldives, have sold shares in their incumbents to the public, while in others, such as Fiji and the Solomon Islands, investment and pension funds are part owners.

The recent changes in business structure have also reduced competition. Cable & Wireless's acquisition of Columbus, a Caribbean broadband operator and owner of submarine cable assets, has reduced competition in the market for fixed high-speed connections due to overlap in a number of markets and concentrated options for international submarine cable connectivity. The transaction resulted in the provision of fixed broadband becoming a monopoly in Grenada, Saint Lucia, and Saint Vincent and the Grenadines. Regulators are concerned that the gains from competition made in the region will be set back. The Caribbean Telecommunications Union reported the following at a regional Regulatory Forum in December 2014:

> *"On the one hand, participants expressed the concern that the trend towards consolidation, could lead to an erosion of the gains derived from the liberalisation of Caribbean markets, which began in 2000, if it was not met by appropriate measures to encourage competition and safeguard consumer rights. In particular, as a result of the proposed merger between two Pan Caribbean Service Providers, concerns have been heightened across the region that the issue of market consolidation must be addressed through the development of new regulatory frameworks and laws to ensure that consumers are not disadvantaged."*[76]

The consolidation of Cable & Wireless led it to change its branding from LIME to the FLOW brand used by Columbus. ECTEL expressed its concern about the acquisition[77], Trinidad and Tobago insisted that Cable & Wireless sell its stake in the incumbent as a condition for the acquisition[78], and the Caribbean Competition Commission began an investigation.[79]

Similarly, Portugal Telecom's stake in Angolan mobile operator Unitel, albeit under dispute, nonetheless raises competition

[75] http://www.bluesky.as/blueskyweb/wp-content/uploads/2015/07/MEDIA_RELEASE_Bluesky-brand-launches-in-the-Cook-Islands.pdf.

[76] http://oocur.org/Docs/Newsletter/02_Vol%201%20Iss%202%20JAN%202015.pdf.

[77] http://www.jamaicaobserver.com/news/Caricom-investigates-CWC-s-acquisition-of-Columbus-International-Inc.

[78] http://www.guardian.co.tt/business/2016-05-16/liberty-completes-cwc-acquisition.

[79] http://www.caricom.org/media-center/communications/press-releases/ccc-launches-investigation-into-cwcs-agreement-to-acquire-columbus-international-pursuant-to-article-175-6-of-the-rtc/.

questions given that Unitel is the second operator in Cape Verde and Sao Tome and Principe, where Portugal Telecom has a stake in the incumbent operators.

Incumbents in the six case study countries, all of whom provide fixed, mobile, and Internet services, have had mixed fortunes that have negatively impacted the level and quality of competition in the market. The ownership status of their incumbent telecom operators is shown in Table 5.1 (next page).

- Cape Verde. The incumbent, Cabo Verde Telecom (CVT), was 40% owned by Portugal Telecom through its subsidiary PT Ventures. In 2006, Portugal Telecom created Africatel to hold its African subsidiaries. In 2007, 22% of Africatel was sold to Helios, a private equity firm, and Helios later exercised its option to purchase another 3%. In 2014, Portugal Telecom (and its Africatel holdings) was sold to Oi Brazil. An agreement issued by CVT shareholders in 2000 allowed PT Ventures to set and control the financial and operating policies of CVT. In November 2014, the government of Cape Verde, a CVT shareholder, terminated the shareholding agreement and in March 2015, Oi commenced legal proceedings. Oi has been trying to sell Africatel since 2014.[80] Coincidently, the second mobile operator has seen its share of the market rise.
- Comoros. Efforts have been ongoing since 2009 to sell a stake in state-owned Comoros Telecom.
- Haiti. Viettel of Vietnam won an international tender in 2010 and owns 60% of a new telecom company licenced to provide fixed and mobile communications.[81] Viettel has committed to invest US$99 million. A period of instability for the incumbent prior to privatization coincided with the rise of a new mobile operator, Digicel, whose market share had climbed to 76% by 2015.
- Saint Vincent and the Grenadines. The incumbent was 100% owned by Cable &Wireless, and was sold to Liberty Global in 2016. It has undergone several rebranding exercises over last few years (to LIME and then FLOW). Mobile operator Digicel had 64% of the market in 2015.
- Tonga. The state-owned incumbent, Tonga Communications Corporation (TCC), was formed in 1978 to provide domestic telecom services, while Cable & Wireless provided international services. In 2001, the assets of Cable & Wireless were purchased and merged with TCC. The stability enabled TCC to more effectively compete. It was responsible for about half the mobile market in 2015.
- Vanuatu. Ownership of Telecom Vanuatu Limited (TVL) was equally divided between the government, Cable & Wireless and France Telecom. As part of sector liberalisation, the government sold its shares in TVL to the two remaining shareholders. In 2011, Cable and Wireless sold its 50% stake to Mauritius Telecom (itself owned 40% by Orange (formerly France Telecom) and 59% by the government of Mauritius). In 2013, Mauritius Telecom increased its ownership of TVL to 90% with 10% held by Orange. The ongoing changes to TVL's ownership have influenced its competitiveness and by 2015, its mobile market share had dropped to less than a third.

One noticeable trend is growing South-South investment as operators from developed countries pull out of small islands, or governments open markets to privatization. For example, Viettel invested in a new multiple-service telecom operator in Haiti, as well as a mobile operator in Timor-Leste, Middle Eastern operators own stakes in networks in the Maldives, and African operators own mobile companies in Guinea-Bissau. SIDS are also investing in other SIDS, with Mauritius Telecom assuming control of Telecom Vanuatu, and Fiji's ATH purchasing the state-owned telecom operator in Kiribati.

Securing Better International Connectivity

Connecting the islands to submarine cables has clearly increased bandwidth and decreased prices, but the extent of the impact varies depending on the ownership model. Cables owned by consortiums of telecom operators do not always offer cost-based prices to those outside of the group, information is often difficult to understand, and wholesale pricing is rarely published. As a result, operators without direct access to a submarine cable can be at a competitive disadvantage, particularly in countries with only one cable or where mergers have reduced competition, as noted for the Caribbean by the Caribbean Telecommunications Union in 2014:

> *The ownership structure of subsea fibre systems, which are the connectivity arteries for both regional and international data traffic flows, was identified as a matter of priority concern to all countries of the region. It was felt that the significant consolidation of ownership of this essential infrastructure, which would result from the proposed acquisition transaction, highlights the urgent need for improved regional cooperation in addressing the activities of Pan Caribbean Service Providers.*[82]

[80] http://oocur.org/Docs/Newsletter/02_Vol%201%20Iss%202%20JAN%202015.pdf.

[81] http://www.jamaicaobserver.com/news/Caricom-investigates-CWC-s-acquisition-of-Columbus-International-Inc.

[82] http://oocur.org/Docs/Newsletter/02_Vol%201%20Iss%202%20JAN%202015.pdf.

Incumbent (Country)	Shareholding		Notes
	Directly by Gov't	Other	
Cabo Verde Telecom	3.4%	96.6%	Shareholdings include 40% owned by Brazil's Oi through PT Ventures, 38% by national social provident fund, 14% by local private groups and 5% by Angolan state oil company. Oi inherited PT Ventures through its acquisition of Portugal Telecom in 2014. There is a legal dispute over the cancellation of the CVT shareholders agreement due to Oi's purchase.
Comoros Telecom	100%	0%	Efforts to sell 51% the operator to a strategic investor have been ongoing since 2009.
Teleco (Haiti)	40%	60%	Viettel of Vietnam won the 2010 privatization process resulting in its owning 60% of a new company with all licences and frequencies to operate fixed and mobile telecommunications.
Cable & Wireless Saint Vincent and the Grenadines Limited	0%	100%	Owned by Cable & Wireless Communications (CWC), has gone through two rebranding exercises over last few years. In 2016, CWC was sold to Liberty Global in 2016.
Tonga Communications Corporation (TCC)	100%	0%	There has been no change since 2001.
Telecom Vanuatu Limited (TVL)	0%*	100%	Through a series of deals over the last few years, Mauritius Telecom now owns 100% of the shares. Mauritius Telecom in turn is 33% owned by the Mauritius government and 40% by France Telecom.

Table 5.1. Ownership Status of Incumbent Telecom Operators in Case-Study Countries (Source: Author research)

Examples from the South Pacific illustrate different ownership and regulatory issues relating to undersea cables:

- Samoa. In 2013, Digicel accused the incumbent operator Bluesky of anticompetitive behaviour in respect to the prices it charged for access to the Samoa-American Samoa (SAS) cable that is connected to the American Samoa-Hawaii Cable System (ASH). Given the high price for access to bandwidth over the cable, Digicel has, for the most part, used the O3b satellite service.[83] In 2015, the Samoan Office of the Regulator ordered Bluesky to provide a Reference Access Offer (RAO), including access to international bandwidth at prices equivalent to what Bluesky pays, in order to offer retail Internet.[84] In December 2015, Bluesky's RAO was published.[85] The current wholesale prices for capacity on the cable are

[83] http://www.businesswire.com/news/home/20160718005108/en/O3b-supports-Digicel-launch-LTE-service-Samoa.

[84] http://www.regulator.gov.ws/images/publication/electricity/telecome/Order-2015-T02.pdf.

[85] http://regulator.gov.ws/images/publication/regulatory/Bluesky-Reference-Access-Offer-Wholesale-Submarine-Capacity-Services.pdf.

high at US$1,500/Mbps/month.[86] Meanwhile, the US$34 million Tui-Samoa cable is being built to Fiji, and will be managed by the Samoa Submarine Cable Company (SSOC). The project is supported by the Asian Development Bank (ADB), the World Bank, and the government of Australia. It has been established as a public-private partnership with multiple investors, including both Bluesky and Digicel.[87] It is estimated that the price of wholesale bandwidth will decrease to just over US$100/Mbps/month by the time the cable is in operation.[88] Meanwhile, a third system, the Moana Cable, is being constructed by Bluesky to link Samoa to New Zealand and Hawaii.[89]

- Fiji. Fiji offers an example of the regulation of the wholesale pricing of bandwidth on submarine cables. In 2010, the country's competition watchdog, the Commerce Commission, found that because the international operator FINTEL controlled the Southern Cross landing station, it had significant market power (a regulatory term used to designate operators that have dominance in a particular market). The Commission concluded that this could be detrimental to the country in terms of high bandwidth costs. It imposed a steady downward trend (glide path) for bandwidth cost reductions, and warned ISPs that if the price drops were not passed on to consumers the Commission would also regulate retail prices.[90] Since 2010, the glide path has resulted in a price reduction of 63% on Australian routed traffic and 83% on traffic to the United States (Figure 5.6 right, next page). In January 2015, the maximum prices for the Australian route stood at US$139/Mbps/month, and US$119 for the US route.

- Tonga. Access to the submarine cable is based on the principle of open access. The Tonga-Fiji cable was financed by a World Bank grant and is owned and operated by Tonga Cable Limited, whose owners include the government and the incumbent operator. Prices are the same for all ISPs who buy capacity, including the incumbent Digicel and the University of the South Pacific. Since the cable cost less than expected, the savings will be used to roll out fibre to some of Tonga's outer islands. Given the amount of bandwidth on the cable to Fiji, analysts have suggested charging an annual flat fee—sufficient enough to recoup cable costs over the cable's expected lifetime—that would provide ISPs with as much bandwidth as they need.[91] This would be an innovative initiative to trigger digital businesses and other opportunities created by the virtually unlimited international bandwidth.

- Vanuatu. The 1,259 km Interchange Cable Network 1 (ICN1) linking Vanuatu to Fiji is owned by the wholesale bandwidth provider Interchange, and was completed in January 2014 with an initial capacity of 20 Gbps. It is estimated that the average price for bandwidth was around US$350/Mbps/month in 2014, compared to around US$1,000 on satellite. Theoretically, Interchange was to be a wholesale operator of bandwidth that treated all purchasers equally. In reality, there were pricing discrepancies among different parties, and in 2016 the regulator found Interchange to be dominant in the wholesale international Internet market and obligated it to provide monthly price lists and evidence that they are cost-based.[92]

In summary, affordable and secure provision of connectivity for the end-user requires low-cost and reliable international access, ideally via access to as many different submarine cables as possible. This can best be achieved by drawing on a variety strategies to suit the local context of each SIDS. The most important of these are:

1 Piggy-backing. Taking advantage of nearby submarine cables planned for other destinations. As described on page 13 ("Regional Connectivity"), there are a substantial number of existing and planned cables that bypass many of the SIDS. In some cases they pass close to islands that have either no connectivity or only one link, which makes them vulnerable in the event of cable disruption. Since it is virtually impossible to add a branch to an existing cable, mechanisms need to be found to avoid these missed opportunities in the future, particularly as spurs that are designed into existing

[86] http://documents.worldbank.org/curated/en/813211467999714829/pdf/PAD1264-PAD-P128904-IDA-R2015-0150-1-Box391454B-OUO-9.pdf.

[87] http://www.samoagovt.ws/2015/12/update-on-tui-samoa-cable-project/.

[88] http://documents.worldbank.org/curated/en/813211467999714829/pdf/PAD1264-PAD-P128904-IDA-R2015-0150-1-Box391454B-OUO-9.pdf.

[89] https://networks.nokia.com/press/2015/alcatel-lucent-and-bluesky-pacific-group-launch-new-submarine-cable-system-enhance-connectivity.

[90] Fiji Commerce Commission. 14 November 2013. *Final Determination on Prices and Access for Southern Cross Capacity and Network.* http://www.commcomm.gov.fj/wp-content/uploads/2012/07/Final-determination_Access-to-Capacity-and-Network_Nov-2013.pdf.

[91] Minges and Stork, 2015.

[92] http://www.trr.vu/index.php/en/public-register/publications/latest-news/596-determinations-2016-determination-and-findings-relating-to-the-wholesale-international-Internet-services-market-and-speedcast-s-complaint-against-interchange-limited.

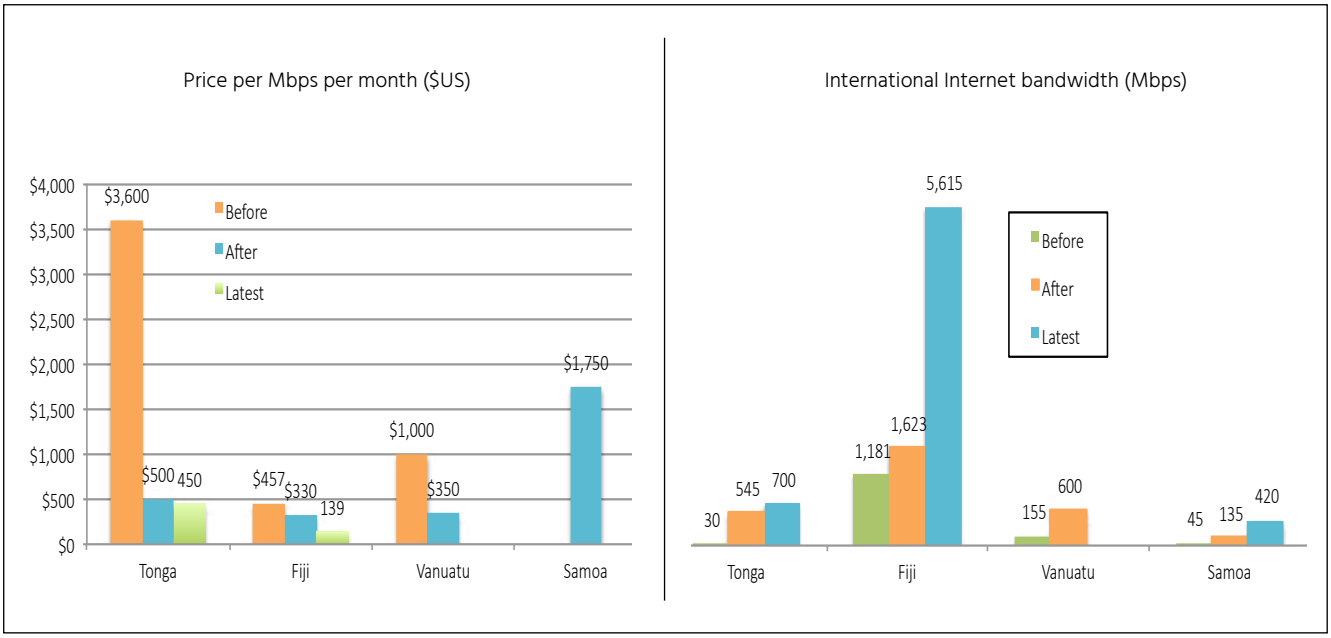

Figure 5.6. IP Transit Costs and International Bandwidth in South Pacific SIDS following the Launch of a Submarine Cable or Price Regulation
(Source: World Bank, PRIF)

Note: In the left chart, data for Tonga refer to price of wholesale capacity link, data for Fiji to the regulated price of IP transit, for Vanuatu to the estimated price of IP transit and for Samoa to the price of international bandwidth on the ASH cable.

nearby cable projects are likely the lowest-cost means of gaining access to international fibre connectivity. In most cases, as long as the branching point is included in the initial configuration, the additional landing station and link to the cable can be added later at a relatively low incremental cost. However, bringing a cable-laying ship to a remote location is costly. If an intervention can be made in time, spurs could be included as part of the main project in order to connect these islands. Unfortunately, so far there are no international mechanisms to raise awareness of these opportunities, and no legal procedures to compel cable operators with projects that pass close to unconnected islands to ensure that their cables make provision for them. This could be a fertile area for regional and global intergovernmental organizations to develop appropriate policies, and for international development organizations to provide the necessary financing in cases where the SIDS cannot raise the necessary finance internally.

2 Island-hopping. Subregional projects that involve the collaboration of a group of SIDS could potentially reach the necessary economies of scale to justify the return on investment, while a single SIDS link might not. A typical example would be a cable to link the islands of Annobón, Sao Tome, Principe, and Malabo (Equatorial Guinea) to mainland Africa, thereby providing Annobón and Principe with their first submarine cable and providing backup links for Sao Tome and Malabo. In addition, extensions to island-hopping projects that are already planned—e.g., the CARCIP project to connect Saint Lucia, Grenada, and Saint Vincent—could be a valuable opportunity to connect other islands that would otherwise be left out due to the much higher cost of an independent project.

3 Minimizing barriers to entry. Encouraging the largest number of different cables to land is an effective way to support a competitive market in international capacity. This may require providing incentives, such as tax waivers and wholesale access to local markets, and reducing overheads, such as licence fees, land costs for landing stations, and low cable landing fees. For example, in the Caribbean, ECTEL member states have agreed that cable landing fees should be no more than an initial $50,000, plus $50,000 per year thereafter.

4 Ensuring open access. Where there are limited numbers of competing cables present, ownership and control by one or two operators must be avoided, and access should be made available to new entrants on an open-access basis (i.e., under the same conditions for all operators). This usually requires the establishment of a Special Purpose Vehicle (SPV) in which operators can purchase shares that provide them with access to an amount of bandwidth corresponding to the size of their

share ownership. As indicated earlier, this method has been used successfully with the ACE cable landings along the west coast of Africa, where the World Bank loaned funds to regional governments so they could participate in the project, and the governments then repaid the loans as operators bought into the SPV.

5 Wholesale price control. In cases where an operator has significant market power, regulations can be used to set wholesale prices for capacity and to declare cable stations "essential facilities" to which all operators must have equal access unless there are technical limitations to this. Similarly, unless regulatory controls are in place, cable station owners may charge excessive fees for cross-strapping, which involves using a short piece of fibre cable to provide a connection between one cable station and another. In some cases, where there are no price controls, these fees can be equivalent to the cost of the international capacity.

6 Regional hubs. Some SIDS have emerged as significant transit points for other island nations. In the Pacific, cables from Tonga and Vanuatu (and soon Samoa) land in Fiji for onward connectivity via the Southern Cross cable to Australia and the United States. Operators in Tonga, Vanuatu, and eventually Samoa pay an additional charge to get their traffic to Australia or the United States for peering. Costs could be lowered if operators in the region aggregated their traffic in Fiji in order to obtain discounts for the resulting larger volume of data. Another option would be for Fiji to host popular content so traffic could be exchanged there. Telecom Fiji already caches Google content, leading to a savings of 600 Mbps in peak-time upstream traffic.[93]

National ICT Strategies

Aside from the special case of Singapore, there are few examples among the SIDS of concerted efforts to establish national ICT strategies as a development priority. The Maldives, however, is a good example of effective transition to ICT sector liberalisation that has generated impressive results. The 2001 Telecommunication Policy announced that the sector would be liberalized, giving the incumbent operator time to adjust. A regulator was established in 2003, followed by the introduction of competition in Internet and mobile services. A second Telecommunications Policy was introduced in 2006 and the National Broadband Policy in 2014. ICT sector development was discussed among all stakeholders, and the predictability of the process encouraged the two main telecom operators and their strategic partners to undertake the necessary investments to achieve national goals. Today there is a consensus approach to competition issues, rather than the litigious situation often prevailing in other SIDS.

As described in the Maldives case study (following page), Cape Verde's national ICT strategy is also an example of forward-looking efforts to improve connectivity and use of ICTs in a low-income SIDS country. This has resulted in relatively high levels of broadband adoption, and substantial use by government, along with availability of local online services.

[93] https://www.pacnog.org/pacnog17/presentations/telecom-fiji.pdf.

Exogenous and Endogenous Factors Driving Connectivity in the Maldives

A mix of internal (to the ICT sector) and external factors can drive rapid and sustained Internet uptake on small islands. The Maldives is a good example of how these factors work together. In 2000, the Maldives was an LDC with a GDP per capita of approximately US$2,000. Despite a challenging geography of some 200 inhabited islands, the Maldives has witnessed ICT prosperity. By the 2014 Census, 97% of households had a mobile phone, 63% had Internet access, and 66% of the population used Facebook (the second highest rate in SIDS after Singapore). The Maldives introduced mobile competition in 2005, and today all inhabitants are covered by a 3G signal, and over half by a 4G signal.

In 2007, submarine cables were deployed to India and Sri Lanka, and in 2012 a national fibre-optic network was completed linking all the main islands. A second fibre backbone is scheduled for completion in 2017. One factor facilitating these achievements was a stable and predictable regulatory environment with a clear timetable for sector liberalisation and spectrum allocation. Universal service objectives were realistic and carried out in collaboration with the operators. Steps were taken to widen the ownership of the incumbent, Dhiraagu, by offering 6% of government shares in a public offering in 2011. The Cable & Wireless's 52% ownership in the company was purchased by the Bahrain Telecommunications Company in 2013, ensuring a smooth transition.

A second major factor was the country's economic growth, fuelled by tourism and fishing. The Maldives graduated from LDC status in 2011. By 2015, GDP per capita had grown to US$7,680—more than three and half times higher than it was 15 years earlier, classifying the nation as an upper-middle income economy. This rise has eradicated affordability as a barrier to ICT access, and the communications sector has grown rapidly. In 2003, telecommunications added MVR 762 million (US$60 million) in value to the economy, accounting for 5.7% of GDP. By 2015, this had risen to MVR 2,404 million (US$156 million), or 9% of GDP.

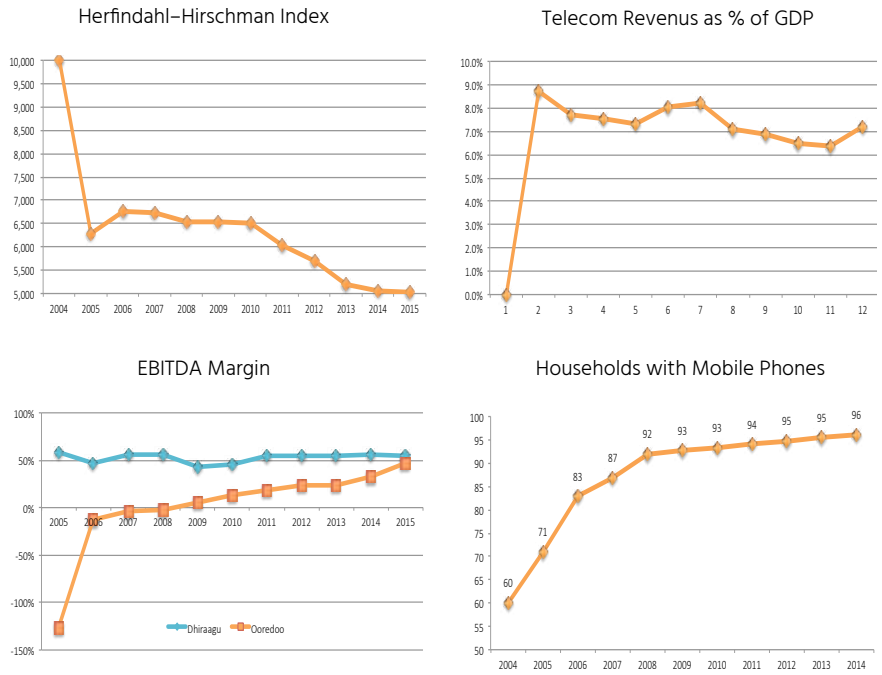

Figure 5.7. Eleven Years of Competition in the Maldives (Adapted from the Dhiraagu, Ooredoo, and Maldives National Bureau of Statistics.)

Electricity

Lack of electricity is a challenge to extending connectivity in some of the low- and lower-middle-income SIDS. It not only limits the use of access devices, but also significantly adds to the costs for maintaining power to wireless base stations and other network equipment. Orange Bissau explicitly cites the lack of electricity as a barrier to Internet growth in the country.[94] The 2008 Census in Guinea-Bissau reported that only 1% of households were connected to the electrical grid, while 70% used candles for light. In fact, the availability of electricity might be a more indicative marker of development in an economy than per capita income. Electricity availability in the low- and lower-middle-income SIDS is shown in Table 5.2.

There is generally a significant gap between urban and rural locations. The data suggest that the level of development may be higher in Samoa and Tonga than their per capita incomes suggest, as they have relatively high levels of electrification.

The data are also contrasted with mobile phone ownership. What is striking is that in almost all of these countries more households have mobile phones than electricity. This suggests that households without grid, solar or generator electricity might be using car batteries or charging their phones somewhere outside the household. The implication is that a lack of household electrification is not a strict barrier to mobile phone ownership, and that a lack of mobile phones might suggest no coverage in the area.

		Households with Electricity			Households with Mobile Phones		
Country	Source	Total	Urban	Rural	Total	Urban	Rural
Cape Verde	2010 Census	80.8	89.6	63.8	75.7	84.2	59.4
Comoros	2012 DHS	69.3	85.1	61.4	73.0	86.6	66.3
Guinea-Bissau	2009 Census	4.9	9.0	1.5	62.1	85.0	43.2
Guyana	2009 DHS	77.6	90.9	72.3	79.7	87.2	76.8
Haiti	2012 DHS	37.9	70.6	15.2	77.2	90.9	67.7
Kiribati	2010 Census	63.1	*	*	29.9	*	*
Micronesia	2010 Census	64.5	*	*	*	*	*
Papua New Guinea	2009-10 HIES	19.5	71.2	9.0	49.1	89.2	42.5
Samoa	2011 Census	96.4	*	*	95.7	*	*
Sao Tome and Principe	2008-09 DHS	56.9	69.8	44.2	48.7	55.4	42.1
Solomon Islands	2009 Census	21.2	*	*	20.6	*	*
Timor-Leste	2009-10 DHS	38.0	83.4	24	40.1	73.5	29.8
Tonga	2012 DHS	92.8	97.7	91.3	93.8	95.8	93.1
Vanuatu	2013 DHS	31.7	86.2	8.5	80.0	96.5	73.0

Table 5.2. Availability of Electricity in Households in Low- and Lower-Middle-Income SIDS

DHS = Demographic Health Survey, HIES = Household Income and Expenditure Survey.
* The census did not disaggregate data by location.

[94] Orange. 2016. 2015 Registration Document.

Nauru: Well-Connected but Only Partly Online

Nauru presents an interesting example of the different connectivity challenges faced in SIDS. A coral island located in Micronesia, its closest neighbour is Banaba island, part of Kiribati 330 km to the east. According to the 2011 Census, Nauru's population was 10,084. Digicel launched as the only mobile operator in September 2009, and its seven base stations cover 99% of the 21 km^2 island. 3G was introduced in August 2014 after connecting to O3b's low-latency satellite network. A prepaid mobile broadband package with a 1.5 GB data allowance is US$22 a month or 2.4% of per capita income.

The island nation has all the ingredients of strong connectivity, with affordable and ubiquitous mobile broadband coverage. Yet, according to the 2011 Census, while 90% of households had a mobile phone, only 27% of the population aged 15 and older used the Internet. The low online usage is related to language and education. The local language is Nauruan, for which only limited digital content is available, and although 66% of the population speaks English, only 29% have a complete secondary education, a figure that closely matches online usage. Therefore getting more Nauruans online will require efforts to raise digital literacy.

(Source: Digicel, Nauru Statistics Office, 03b, and Facebook.)

In Haiti, Digicel generates power through its own generators to address the problem of limited and unreliable grid electricity.[95] Digicel Haiti's former chairman launched RE-VOLT in order to provide solar-power systems to households. Each system includes a mobile phone charger, and the monthly fee of HTG 250 (about US$5) can be paid using Digicel's mobile money platform.[96] In Papua New Guinea, Digicel uses solar-powered cell sites to provide service in rural areas via the Rural Communications Project.[97]

Universal Service

Universal service is important for closing gaps in connectivity, such as 2G and 3G mobile coverage in areas that are not viewed as financially viable. It is also important for boosting digital skills in order to get more of the population online, particularly where there is already a high level of connectivity.

Many SIDS have Universal Service programmes that are typically financed by obligatory contributions from operators. Papua New Guinea's National ICT Authority uses the Universal Access and Service (UAS) fund to finance a rural communications infrastructure of 59 cell sites that, in turn, provide service to approximately half-a-million previously unserved citizens.[98] In Vanuatu, the Universal Access Policy calls for 3G coverage with speeds of at least 2 Mbps for 98% of the population by 2018.[99]

[95] Digicel, 2015.

[96] http://cleantechnica.com/2015/10/27/re-volt-to-bring-low-cost-solar-to-rural-haiti/.

[97] http://www.worldbank.org/en/news/feature/2015/09/29/connecting-the-unconnected-in-papua-new-guinea.

[98] http://www.worldbank.org/en/results/2014/12/02/papua-new-guinea-rural-communications-project.

[99] https://www.ptc.org/assets/uploads/papers/ptc15/3.%20Ron_Box_presentation_to_PTC_15_Final%20Final%20Final.pdf.

6 • The Role for the International Community in Supporting Better SIDS Connectivity

There have been a number of global, regional, and SIDS-focused summits. Some have called, both directly and indirectly, for the enhancement of small island connectivity with the assistance of development partners. For example, some 300 so-called partnerships were announced during the Third International Conference on Small Island Developing States held in Samoa in September 2014.[100] Since these partnerships are classified by thematic areas related to sustainable development (rather than to ICT), it is difficult to know how many are concerned with connectivity. Several partnerships that *are* directly related to ICT include: Addressing Connectivity for the Sustainable Development of SIDS (Intelsat, Inmarsat, Kacific, ITSO),[101] Bridging Broadband Barriers for SIDS Sustainable Development (ITU, UNISDR),[102] the ICT4SIDS Partnership,[103] and ICTs for Disaster Risk Reduction and Climate Change Adaptation for SIDS (ITU, with other partners to be confirmed)[104]. A challenge with these types of initiatives is that, given the diversity of SIDS, the projects may be too broad—and therefore not relevant for all SIDS. With that in mind, development projects might be more fruitful by taking a more concentrated approach, such as focusing on regions or on SIDS that are LDCs.

Bilateral assistance has typically flowed from countries with which the SIDS have historical, geographical, or strategic ties. For example, the Rural Utilities Service of the US Department of Agriculture has made loans to telecom operators in the Marshall Islands and Palau, which are members of the Compact of Free Association.[105]

More recently, global and regional development banks are providing substantive assistance via equity, grants, or loans, particularly for the construction of submarine cables. These often contain a regulatory support component that is sometimes part of a regional connectivity project (Table 6.1). In Samoa, the cost of a 1,300 km submarine cable was US$33 million (including route survey, cable construction, and equipment),[106] equivalent to over 4% of the country's GDP. The ADB, the World Bank, and the government of Australia provided a grant for construction of the cable.

Going forward, assistance will continue to be needed for major infrastructure projects that support additional international cables, as well as national fibre backbones—particularly in micro island states and the low-income SIDS. At the same time, the increase in connectivity in many SIDS has triggered challenges that are more related to skills development than

[100] http://www.sids2014.org/partnerships/.

[101] https://sustainabledevelopment.un.org/partnership/?p=8032.

[102] http://www.sids2014.org/index.php?page=view&type=1006&nr=2448&menu=1507.

[103] http://www.ict4sids.com.

[104] http://www.sids2014.org/index.php?page=view&type=1006&nr=2454&menu=1507.

[105] http://www.nal.usda.gov/ric/10851.

[106] http://www.adb.org/sites/default/files/project-document/177234/47320-001-grj.pdf.

Country	Development Partners	Project
Comoros	World Bank	Regional Connectivity Infrastructure Program (Submarine cable to Mayotte and Madagascar). Overall cost of the project: US$34 million financed by a grant from the World Bank (US$22 million) with the remainder financed by the private sector.
Tonga	World Bank	Pacific Regional Connectivity Program (Tonga-Fiji Asian Development Bank cable). Overall cost of the project: US$34 million financed by grants from the World Bank, ADB and PRIF (US$27.4 million) with the remainder from the government of Tonga.
Samoa	World Bank Asian Development Bank (ADB) Australian government	Samoa Connectivity Project (Submarine Cable from Samoa to Fiji). Overall cost of the project: US$50 million financed by grants from the World Bank, ADB, and Australia (US$36 million); the government of Samoa (US$6 million); and the rest by the Samoa Submarine Cable Company.
Seychelles	European Investment Bank (EIB) African Development Bank (AfDB)	Seychelles East Africa Submarine Cable. Overall cost of the project: estimated at EUR 27.2 million, has been financed through 40% equity and 60% long-term debt by EIB and AfDB.[107]

Table 6.1. Examples of Development Partner Support for Submarine Cables in SIDS (Source: Adapted from World Bank and European Investment Bank.)

hardware limitations. This is an area where there is significant need for development partnerships. This includes a need for building regulatory capacity, particularly in environments where market sizes are limited and novel approaches are needed.

There is also an urgent need to develop applications and services across a range of sectors to accompany the increase in bandwidth. However, many SIDS have a shortage of both software developers and the kind of innovative entrepreneurs and enabling start-up ecosystems found in larger countries. An example of development assistance in this area is the World Bank's Entrepreneurship Program for Innovation in the Caribbean, which helps develop nurturing ecosystems for high-growth tech start-ups through connection to several of its own components.[108]

In terms of supporting ICT and broadband development more generally, as well as defining policy and regulatory needs, the convening of multistakeholder groups at both national and regional levels in order to identify and discuss emerging issues can be encouraged. An example of this is the recent Pacific Internet Governance Forum held in Vanuatu in May 2017.

[107] http://www.eu-africa-infrastructure-tf.net/activities/grants/seychelles-east-africa-submarine-cable.htm.

[108] http://www.infodev.org/EPIC.

7 • Conclusions: Towards ICT Sustainability in Small Islands

The liberalisation achieved over the last dozen years has resulted in a giant leap in connectivity. The majority of SIDS have launched mobile broadband networks and are now connected to submarine cables, and, therefore, increasing quality and lowering prices. This rise in connectivity has been triggered by the liberalisation of telecom markets. The authors of this report observe a significant relationship between pricing and market concentration, and conclude that pricing is more important than education levels in predicting online penetration.

A key difficulty for SIDS in reducing the cost of access is sustaining competition in the ICT sector, and there are indications that recent developments may threaten the gains from liberalisation achieved over the last dozen years. Disruptions from the corporate reorganization activities of parent companies have coincided with the seismic shifts and consolidation in the industry resulting from the move to broadband and OTT services. This, combined with the small and isolated low-income populations of most of the SIDS, makes for a particularly challenging policy and regulatory environment.

This argues for giving a high priority to this area in national development plans and for devising appropriate national broadband and ICT strategies. This is particularly significant in light of the important economic role telecommunications had in the recent colonial past, when Cable & Wireless and Portugal Telecom operated telecom services in many SIDS. In those days, island economies consistently had the highest telecom revenues as a proportion of GDP, and telecom utilities were typically one of the biggest employers. Although tourism was often an important driver of demand, island economies generally were much more dependent on telecoms than other countries. A higher percentage of their calls were international (both incoming and outgoing), and a higher percentage of their citizens had family members living abroad, perhaps sending remittances. Thus, telecoms provided both economic and social lifelines. Settlement payments were often the most significant form of international currency and, therefore, the country's biggest so-called export.

In the Internet-driven world of today, it is not surprising that some SIDS are concerned about the impact of revenue cannibalizing OTT services, such as Skype and Whatsapp, and that they have been reluctant to fully adopt competition and privatization. The SIDS are being forced to move from a secure equilibrium to a new and less-secure environment in which services are more plentiful and cheaper, but are also a lot less profitable, and in some cases, a drain on national finances. As a result, many SIDS will need to develop strategies to address the issues faced by their 'distressed' incumbents.

The Comoros illustrates that shifting equilibrium. It is one of the low-income SIDS, was first connected by submarine cable in 2011, in 2017 moved to two international cables (AVASSA), and will in 2018 move to three (FLY-LION3). Competition arrived on the islands in December 2016 and, not surprisingly, the new operator Telma Comores captured 10 percent of the market in the first few weeks of operation.

Comores Telecom belatedly began restructuring in the face of competition. It laid off 1,000 employees, but probably still has close to 2,000, making it the largest employer on the island. It has not published an annual report since 2012, and has most likely moved from profitability to loss during that period. Comores Telecom has also taken on large debts from China EXIM bank in purchasing the AVASSA network, and a costly national backbone from Huawei.

Since 2010, 22 SIDS have experienced changes of ownership in their incumbent operators, sometimes affecting their ability to compete. The Cable & Wireless acquisition of Columbus also impacted competition in the Caribbean, resulting in a monopoly of fixed broadband services in several countries, as well as a concentration of submarine cable systems.

To be sustainable, the ICT sector in SIDS needs a predictable environment where operators can survive and consumers have widespread and affordable access to services. The author's analyses indicate that although disruptive, competition has been viable in most SIDS. Going forward, policy makers and regulators must be more proactive by assuming that market changes in advance, in order to have time to adjust regulations accordingly. It is possible to automate this via *ex ante* regulations that kick in if market dominance is identified and that would provide transparent remedies for wholesale pricing, quality, and service coverage.[109] At the same time, SIDS regulators could benefit from better access to professional assistance with international experience in renegotiations of licences, submarine capacity agreements, and so forth.

The handful of nations that started the liberalisation process early, where governments have shown a strong commitment to the ICT sector, and in which multiple local stakeholders are involved have planted the seeds for sustainability of their ICT sectors. Affordability and access is often as high in these countries as it is in developed nations. It is noteworthy that these nations include both small states and micro island states, suggesting that scale need not be a barrier to ICT connectivity.

In fact, excluding Singapore, none of the large SIDS (with populations greater than 1.5 million) are performing well. The top performers include most of the Anglophone nations in the Eastern Caribbean, Fiji, Mauritius, and the Seychelles. Most have multiple stakeholders in their incumbent operator, which adds to sustainability. And all except the Bahamas have a competitive mobile market. The Bahamas, the second wealthiest SIDS, is an outlier in this group, as mobile services were a monopoly until 2016. Nevertheless, there is competition for fixed broadband services and the incumbent operator has been preparing for the introduction of mobile competition by reducing prices, expanding coverage, and launching new services.

A second group of SIDS is generally performing better than other developing countries, but below the world average. In these countries, competition has often been hampered either by disruptions to one of the competitors affecting sustainability of the ICT sector or there has been no competition. Although ICT coverage is relatively high in these countries, either affordability is an issue or there are other exogenous barriers that inhibit online access, such as digital literacy. Promoting more competitive markets, combined with developing appropriate, forward-looking regulation, and enhancing basic ICT education would increase connectivity in these countries.

Finally, a third group of SIDS suffers from development challenges often related to low incomes, large rural segments, small populations, geographical complexities, or monopolies in their ICT services sectors. This group includes all of the SIDS that are LDCs, as well as some micro island states. In these countries, connectivity is also sometimes affected by governance challenges combined with development vulnerabilities. It is likely that these SIDS will need the assistance of development partners, not only to support the deployment of broadband infrastructure, but also in local content and applications development.

[109] Marius, Michele. 2016. "Competition versus Economies of Scale: The Challenge of Telecoms in the Caribbean." ICT Pulse, September 14. http://www.ict-pulse.com/2016/09/competition-economies-scale-challenge-telecoms-caribbean/.

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9 • Statistical Tables

Country	Fixed telephone subscriptions					Fixed broadband subscriptions			Households with Internet access	
	(000s)	Year	Per 100 people	House-holds with (%)	Year	(000s)	Year	Per 100 people	%	Year
Antigua & Barbuda	20	2014	22	...		11	2014	12	...	
Bahamas	121	2015	31	...		81	2015	21	...	
Belize	21	2015	6	...		10	2015	3	...	
Barbados	150	2015	53	88	2010	67	2015	24	47	2010
Cook Islands	...		...	72	2011	...		...	29	2011
Comoros	26	2014	3	12	2012	1	2014	0.1	...	
Cape Verde	58	2015	11	31	2014	15	2015	3	32	2014
Cuba	1,265	2014	11	...		8	2015	0.1	...	
Dominica	15	2014	21	...		15	2014	21	49	2014
Dominican Republic	1,151	2015	11	...		681	2015	6	18	2013
Fiji	150	2014	17	...		14	2015	2	...	
Micronesia	7	2015	6	...		2	2014	2	...	
Guinea-Bissau	...		...	...		...		...	...	
Grenada	27	2014	25	45	2014	20	2014	19	40	2014
Guyana	154	2015	20	...		54	2015	7	...	
Haiti	41	2015	0	...		...		...	...	
Jamaica	254	2015	9	18	2011	163	2015	6	19	2011
Kiribati	1	2015	1	...		0	2015	0	...	
St. Kitts & Nevis	20	2014	36	47	2014	16	2014	29	61	2014
St. Lucia	35	2014	19	34	2014	31	2014	17	33	2014
Maldives	22	2015	5	9	2014	23	2015	6	63	2014
Marshall Islands	2	2014	4	...		1	2014	3	11	2011
Mauritius	380	2015	30	72	2014	182	2014	14	52	2014
Niue	1	2015	68	50	2011	...		...	43	2011
Nauru	...		...	...		...		...	28	2011
Palau	7	2015	34	72	2014	1	2015	6	12	2014
Papua New Guinea	150	2015	2	...		15	2015	0	...	
Singapore	2017	2015	36	82	2013	1454	2014	27	88	2015
Solomon Islands	7	2014	1	1	2013	2	2014	0	3	2013
S. Tomé & Principe	7	2015	4	...		1	2015	0.5	...	
Suriname	85	2015	16	...		46	2014	9	12	2010
Seychelles	21	2015	23	41	2013	13	2015	14	34	2013
Timor-Leste	3	2015	0	1	2010	1	2015	0	...	
Tonga	13	2015	12	54	2012	2	2015	2	9	2011
Trinidad & Tobago	270	2015	20	...		279	2015	20	...	
Tuvalu	2	2015	15	...		...		...	...	
St. Vincent	20	2014	18	34	2014	17	2014	16	38	2014
Vanuatu	5	2015	2	2	2013	4	2015	2	...	
Samoa	11	2015	6	20	2011	2	2015	1	38	2014

Table 9.1. Fixed Networks (Source: Adapted from national regulatory authoritieis, national statistical offices, operators, and ITU)

2015 Country	2G Mobile coverage (% of population)	Mobile subscriptions (000s)	Mobile subscriptions Per 100 people	Households with mobile phone (%)		Herfindahl-Hirschman Index (HHI)†
Antigua & Barbuda	98	177	193	86	2011	4,394
Bahamas	...	311	80	98	2013	10,000
Barbados	99	335	118	91	2011	5,098
Belize	...	360	100	76	2011	10,000
Cape Verde	94	646	124	89	2014	5,313
Comoros	...	378	49	73	2012	10,000
Cook Islands	...	9	68	66	2011	10,000
Cuba	85	2,637	23	22	2012	10,000
Dominica	94	77	107	93	2014	5,018
Dominican Republic	99	8,797	84	89	2013	4,273
Fiji	96	1,029	115	93	2012	5,578
Grenada	95	112	105	89	2014	5,200
Guinea-Bissau	...	1,240	67	...	2011	5,053
Guyana	96	658	86	89	2014	5,233
Haiti	93	7,412	69	77	2012	6,352
Jamaica	98	3,002	110	91	2011	5,968
Kiribati	56	23	20	30	2011	10,000
Maldives	99	740	181	96	2014	5,014
Marshall Islands	...	34	63	58	2011	10,000
Mauritius	99	1,762	140	92	2014	4,029
Micronesia	83	19	18	...	2011	10,000
Nauru	98	9	91	89	2011	10,000
Niue	...	1	95	79	2011	10,000
Palau	...	24	112	86	2014	10,000
Papua New Guinea	89	3,300	43	49	2011	9,418
S. Tomé & Principe	...	187	98	74	2012	7,173
Samoa	95	248	128	96	2011	6,165
Seychelles	...	148	160	90	2011	5,061
Singapore	100	8,211	148	97	2013	3,779
Solomon Islands	83	409	70	59	2013	5,684
St. Kitts & Nevis	97	73	133	91	2014	5,032
St. Lucia	96	188	102	92	2012	5,722
St. Vincent	98	110	101	91	2014	5,392
Suriname	98	952	175	89	2011	4,718
Timor-Leste	94	1,377	111	40	2011	5,039
Tonga	98	100	94	95	2012	5,032
Trinidad & Tobago	97	2,123	156	...	2011	5,050
Tuvalu	...	7	69	...	2011	10,000
Vanuatu	92	198	75	80	2013	7,293

9.2. Mobile Market (Source: Adapted from national regulatory authorities, national statistical offices, operators, and GSMA)

† Based on mobile subscriptions market share. 10,000 = monopoly.

2015	3G coverage		Mobile broadband subscriptions			Mobile Internet users			Mobile Facebook users (8/2016)		
Country	% of population		000s	Per 100 people	% of mobile subscribers	000s	% of population	% of mobile subscribers	000s	% of population	% of mobile subscribers
Antigua & Barbuda	98		25	27	14%	...	...	...	47	51%	27%
Bahamas	...		183	47	59%	183	47	59%	190	49%	61%
Barbados	80		125	44	37%	173	61	52%	140	49%	42%
Belize	...		122	34	34%	...	...	...	140	39%	39%
Cape Verde	55		354	68	55%	...	...	...	200	38%	31%
Comoros	...		...	...	...	36	5	9%	49	6%	13%
Cook Islands	74	2014	1	5	8%	...	...	...	6	42%	62%
Cuba	0		-	0	0%	...	...	...	...	...	...
Dominica	60		30	...	39%	...	...	...	36	50%	47%
Dominican Republic	99		3,644	35	41%	4219	40	48%	4,100	39%	47%
Fiji	96		429	48	42%	...	...	...	360	40%	35%
Grenada	72		28	...	25%	...	...	...	51	48%	46%
Guinea-Bissau	0	2014	-	...	0%	...	...	...	71	4%	6%
Guyana	0		-	0	0%	...	...	...	260	34%	40%
Haiti	58		1,634	15	22%	...	...	...	1,200	11%	16%
Jamaica	85		1,300	48	43%	1406	52	47%	1,000	37%	33%
Kiribati	39	2014	2	2	8%	...	...	...	9	8%	40%
Maldives	99		228	56	31%	...	...	...	250	61%	34%
Marshall Islands	0	2014	-	0	0%	...	...	...	17	32%	51%
Mauritius	...		464	37	26%	640	51	36%	560	44%	32%
Micronesia	34	2014	...	...	...	...	...	...	17	16%	92%
Nauru	98		3	25	28%	...	...	...	3	26%	29%
Niue	0		-	0	0%	...	...	...	...	...	...
Palau	0		0.1	0.4	0%	...	...	...	5	23%	21%
Papua New Guinea	35		627	8	19%	...	...	...	390	5%	12%
S. Tomé & Principe	...		28	15	15%	...	...	...	32	17%	17%
Samoa	86		35	18	14%	...	...	...	64	33%	26%
Seychelles	90		18	19	12%	...	...	...	42	45%	28%
Singapore	99	2014	7,990	144	97%	...	...	...	3,800	69%	46%
Solomon Islands	15	2014	155	27	38%	...	...	...	35	6%	9%
St. Kitts & Nevis	90		39	...	53%	50	91	68%	33	59%	45%
St. Lucia	65		15	...	8%	17	9	9%	80	43%	43%
St. Vincent	71		42	...	38%	48	44	44%	54	49%	49%
Suriname	80		571	105	60%	...	...	...	250	46%	26%
Timor-Leste	...		128	10	10%	...	...	...	290	23%	22%
Tonga	86		4	4	4%	...	...	...	40	38%	40%
Trinidad & Tobago	85		198	15	9%	645	47	30%	640	47%	30%
Tuvalu	...		-	0	0%	...	...	...	2	16%	24%
Vanuatu	51		26	10	13%	...	...	...	30	11%	15%

Table 9.3. Mobile Broadband (Source: Adapted from national regulatory authorities, operators, Facebook, and GSMA)

2015	International Internet bandwidth			Average speeds (Mbps)	
Country	Mbps	Bits per person	CAGR 2010-latest	Download	Upload
Antigua & Barbuda	...	...	...	2.5	1.0
Bahamas	...	...	...	15.1	3.6
Barbados	11,110	39,205		16.8	4.2
Belize	...	...	...	2.2	1.8
Cape Verde	...	...	...	2.3	0.3
Comoros	600	761	109%	2.0	0.9
Cook Islands	...	...	...	2.7	0.3
Cuba	...	...	...	1.3	2.6
Dominica	...	...	...	5.8	1.4
Dominican Republic	...	...	...	11.8	2.3
Fiji	5,615	6,334	39%	9.5	1.4
Grenada	...	...	...	5.0	0.7
Guinea-Bissau	...	...	...	0.2	0.2
Guyana	...	...	...	1.4	0.6
Haiti	...	...	...	2.3	1.7
Jamaica	...	...	...	12.6	2.0
Kiribati	...	...	...	0.2	0.1
Maldives	...	...	...	2.7	0.9
Marshall Islands	...	...	...	1.2	0.5
Mauritius	21,305	16,874	44%	2.9	0.8
Micronesia	290	2,787		0.6	0.6
Nauru	...	...	...	0.6	0.3
Niue	...	...	...	0.8	0.0
Palau	...	...	...	0.2	0.1
Papua New Guinea	...	...	...	1.6	0.7
S. Tomé & Principe	775	4,159	97%	3.4	1.4
Samoa	420	2,174	56%	1.0	1.3
Seychelles	2,092	22,520	63%	3.7	1.0
Singapore	2,789,200	509,934	46%	27.4	16.2
Solomon Islands	230	402		0.6	0.2
St. Kitts & Nevis	...	...	...	4.4	1.2
St. Lucia	...	...	...	3.5	0.8
St. Vincent	...	...	...	6.3	1.5
Suriname	...	...	...	2.2	0.7
Timor-Leste	...	...	...	0.8	0.8
Tonga	330	3,125		1.1	2.0
Trinidad & Tobago	14,680	10,838		22.6	2.3
Tuvalu	20	2,022		0.2	0.1
Vanuatu	600	2,318	86%	0.8	0.4

9.4. International Bandwidth and Speeds (Source: Adapted from national regulatory offices, World Bank, and testmy.net)

	Internet users			Facebook users					
Country	% of surveyed population	Year	Note	(000s) 2011	(000s) 2016	% of population 2011	% of population 2016	User change (%, 2011-2016)	Penetration change (p.p., 2011-16)
Antigua & Barbuda	48	2011	0+	32	52	36%	57%	65%	21
Bahamas	63	2010	Age 3+, Internet access	146	210	40%	54%	43%	14
Barbados	...			110	160	39%	56%	46%	17
Belize	27	2010	5+	47	160	14%	45%	241%	30
Cape Verde	37	2014	10+, in last 3 months	47	220	9%	42%	371%	33
Comoros	...			7	63	1%	8%	846%	7
Cook Islands	38	2011	Household access at any location	...	6	...	49%	...	...
Cuba	27	2014		...	...	...	...	...	...
Dominica	58	2014	Fixed Internet, 15+	20	40	27%	55%	104%	28
Dominican Republic	46	2013	12+, last year	2,514	4,500	25%	43%	79%	18
Fiji	...			125	390	14%	44%	213%	29
Grenada	52	2014	Fixed Internet, 15+	34	57	33%	53%	65%	21
Guinea-Bissau	...			...	86	...	5%	...	...
Guyana	...			89	290	12%	38%	226%	26
Haiti	...			176	1,300	2%	12%	639%	10
Jamaica	28	2010	14+ used in last year	541	1,100	20%	40%	103%	20
Kiribati	15	2010	Age 10+	2	10	2%	9%	317%	7
Maldives	...			99	270	29%	66%	172%	37
Marshall Islands	...			4	20	7%	38%	424%	30
Mauritius	47	2014	12+	254	640	20%	51%	152%	30
Micronesia	...			8	21	8%	20%	169%	13
Nauru	27	2011	15+.	0.1	3		27%	2233%	27
Niue	63	2011	4+	...	...	...	...	...	...
Palau	...			...	6	...	29%	...	...
Papua New Guinea	...			32	430	0%	6%	1250%	5
S. Tomé & Principe	...			1	39	1%	20%	2608%	20
Samoa	13	2014	0+	6	71	3%	37%	1023%	33
Seychelles	...			19	49	22%	53%	158%	31
Singapore	79	2014	7+, used in the last year	2,295	4,100	44%	74%	79%	30
Solomon Islands	4	2013		14	42	3%	7%	203%	5
St. Kitts & Nevis	68	2014	Used fixed Internet, 15+	21	36	40%	65%	70%	25
St. Lucia	40	2014	used fixed Internet, 15+	46	89	26%	48%	93%	22
St. Vincent	47	2014	used fixed Internet, 15+	35	59	32%	54%	68%	22
Suriname	...			64	270	12%	50%	319%	37
Timor-Leste	...			...	340	...	27%	...	...
Tonga	46	2011	Household access at any location	7	45	6%	42%	574%	36
Trinidad & Tobago	80	2013	TATT survey	404	700	30%	51%	73%	21
Tuvalu	...			2	2	15%	23%	53%	8
Vanuatu	7	2009	15+.	5	34	2%	13%	551%	11

9.5. Internet Use (Source: Adapted from national statistical offices and Facebook)

2016	Fixed broadband prices						
Country	Monthly price (US$)	% of GDP per capita	Speed (Mbps)	US$ per Mbps	Cap (GB)	US$ Per GB	Fastest available (Mbps)
Antigua & Barbuda	$42.59	3.6%	1	$43		$0.00	5
Bahamas	$29.99	1.6%	8	$4		$0.00	16
Barbados	$32.50	2.5%	15	$2		$0.00	1,000
Belize	$19.50	4.8%	0.51	$38		$0.00	16
Cape Verde	$9.96	3.8%	12	$1	5	$1.99	12
Comoros	$41.71	61.8%	0.51	$81		$0.00	4
Cook Islands	$17.48	1.1%	2	$9	2	$8.74	12
Cuba	$181.82		0.26	$710		$0.00	8
Dominica	$28.00	4.5%	2	$14		$0.00	8
Dominican Republic	$22.09	4.2%	2	$11		$0.00	100
Fiji	$15.80	3.9%	10	$2	10	$1.58	10
Grenada	$29.44	3.9%	12	$2		$0.00	100
Guinea-Bissau							
Guyana	$24.21	7.0%	1.5	$16		$0.00	10
Haiti	$55.00	79.6%	1	$55		$0.00	8
Jamaica	$20.10	4.7%	1	$20		$0.00	100
Kiribati	$187.97	174.6%	0.26	$734		$0.00	1
Maldives	$18.87	3.0%	4	$5		$0.00	100
Marshall Islands	$49.95	17.0%	0.26	$195		$0.00	2
Mauritius	$14.23	1.9%	10	$1		$0.00	100
Micronesia	$20.00	7.9%	0.51	$39		$0.00	8
Nauru							
Niue							
Palau	$659.95	58.7%	0.25	$2,683		$0.00	
Papua New Guinea	$342.96	181.5%	0.51	$670		$0.00	20
S. Tomé & Principe	$27.73	18.4%	1	$28	12	$2.31	16
Samoa	$38.67	11.8%	2	$19	3.07	$12.59	2
Seychelles	$13.15	1.0%	1	$13	3	$4.38	2
Singapore	$36.42	0.8%	500	$0.07		$0.00	10,000
Solomon Islands	$63.21	38.3%			1	$63.21	
St. Kitts & Nevis	$35.19	2.6%	2	$18		$0.00	48
St. Lucia	$33.70	5.2%	2	$17		$0.00	100
St. Vincent	$33.65	5.9%	2	$17		$0.00	100
Suriname	$48.63	6.5%	2	$24		$0.00	6
Timor-Leste	$49.00	51.8%	2	$25	6	$8.17	2
Tonga	$13.74	4.0%			2	$6.87	21
Trinidad & Tobago	$30.51	1.8%	5	$6		$0.00	40
Tuvalu							
Vanuatu	$27.30	10.4%	0.51	$53		$0.00	4

9.6. Fixed Broadband Prices (Source: Incumbent website and generally refer to DSL or FTTH.)

Notes: Refers to price for entry-level broadband of at least 256 kbps. Prices at September 2016, converted to US$ using 2015 annual average exchange rate. % of income calculated using 2015 GDP per capita (World Bank).

Mobile broadband monthly price (prepaid), minimum 1 GB, Small Island Developing States, US$, August 2016					
Country	Price for at least 30 days (US$)	As a % of GDP per capita	Data Cap (MB)	$ Per GB	Note
Antigua & Barbuda	$25.92	2.2%	1,400	$18.51	Digicel, 2x700MB
Bahamas	$20.00	1.1%	1,000	$20.00	BTC, Ex-VAT
Barbados	$13.50	1.0%	1,500	$9.00	Digicel
Belize	$15.00	3.7%	1,000	$15.00	BT
Cape Verde	$5.03	1.9%	1,000	$5.03	CVMovel
Comoros	$16.91	25.1%	1,000	$16.91	CT
Cook Islands	$34.97	2.2%	1,000	$34.97	CIT
Cuba					No 3G network
Dominica	$17.41	2.8%	1,500	$11.60	Digicel
Dominican Republic	$13.21	2.5%	2,000	$6.60	Claro
Fiji	$11.90	2.9%	3,072	$3.88	Vodafone.
Grenada	$16.67	2.2%	1,000	$16.67	Digicel
Guinea-Bissau	...	...	...	...	Tariffs not available
Guyana	$9.69	2.8%	1,000	$9.69	Digicel, 2x500MB
Haiti	$10.65	15.4%	1,800	$5.92	Digicel
Jamaica	$14.97	3.5%	2,000	$7.49	Digicel
Kiribati	$37.59	34.9%	1,800	$20.89	TKSL
Maldives	$12.95	2.0%	2,000	$6.47	Dhiraagu
Marshall Islands					No 3G network
Mauritius	$8.53	1.1%	1,000	$8.53	1GB+500 SMS, unlimited Facebook: MT.
Micronesia	$30.00	11.8%	2,000	$15.00	MT, including 60 minutes calls and unlimited SMS.
Nauru	$22.56	2.5%	1,500	$15.04	Digicel
Niue					No 3G network
Palau	$49.90	4.4%	1,000	$49.90	PT
Papua New Guinea	$24.55	13.0%	1,200	$20.46	Digicel
S. Tomé & Principe	$9.05	6.0%	2,000	$4.53	CST
Samoa	$9.38	2.9%	1,000	$9.38	Digicel
Seychelles	$14.95	1.2%	1,000	$14.95	C&W.
Singapore	$7.30	0.2%	1,000	$7.30	ST
Solomon Islands	$25.28	15.3%	2,000	$12.64	OUR 2 x 2 week 1GB plans.
St. Kitts & Nevis	$17.03	1.2%	1,000	$17.03	C&W
St. Lucia	$14.81	2.3%	1,000	$14.81	Digicel
St. Vincent	$14.81	2.6%	1,000	$14.81	Digicel
Suriname	$36.00	4.8%	1,500	$24.00	Digicel
Timor-Leste	$15.00	15.9%	1,000	$15.00	Timor Telecom
Tonga	$7.11	2.1%	1,000	$7.11	Digicel
Trinidad & Tobago	$23.35	1.4%	2,000	$11.68	TSTT
Tuvalu					No 3G network
Vanuatu	$9.18	3.5%	1,000	$9.18	Digicel

9.7. Mobile Broadband Prices (Source: Operator data plans from websites.)

Notes: Converted to US$ using 2015 annual average exchange rate. GDP per capita data from World Bank.

	Telecom revenue					Communications value added					Information & Communication value added				
Country	US$ m	Year	% GDP	CAGR (2010-latest)	Per Person (US$)	US$m	Year	% GDP	CAGR (2010-latest)	Per Person (US$)	US$ m	Year	% GDP	CAGR (2010-latest)	Per Person (US$)
Antigua & Barbuda	...		...	...	...	$39	2015	3.0%	-1.9%	$420	...		...	...	...
Bahamas	$444	2015	5.0%	0.6%	$1,144	$348	2014	4.1%	2.7%	$898	$348	2014	4.1%	2.7%	$898
Barbados	...		...	...	...	...		...	...	...	...		...	...	...
Belize	...		...	...	...	$113	2013	7.0%	5.6%	$315	...		...	...	...
Cape Verde	...		...	...	...	$59	2015	3.6%	-2.4%	$113	...		...	...	...
Comoros	...		...	...	...	...		...	...	...	...		...	...	...
Cook Islands	...		...	...	...	...		...	...	...	...		...	...	...
Cuba	...		...	...	...	...		...	...	...	...		...	...	...
Dominica	$40	2014	7.6%	1.7%	$550	$25	2015	4.6%	3.4%	$342	...		...	...	...
Dominican Republic	...		...	...	...	$1,048	2015	1.6%	0.3%	$100	$1,017	2014	1.6%	-0.4%	$97
Fiji	$225	2014	5.0%	-0.7%	$252	$158	2014	3.5%	2.4%	$177	$196	2014	4.3%	1.7%	$220
Grenada	$66	2014	7.2%	1.8%	$614	$20	2015	2.1%	-4.7%	$191	...		...	...	...
Guinea-Bissau	...		...	...	...	$37	2013	3.6%	10.8%	$20	...		...	...	...
Guyana	...		...	...	...	$128	2014	4.2%	4.8%	$166	...		...	...	...
Haiti	...		...	...	...	...		...	...	...	...		...	...	...
Jamaica	...		...	...	...	$381	2014	2.7%	-7.6%	$140	...		...	...	...
Kiribati	...		...	...	...	$5	2013	2.9%	0.5%	$44	...		...	...	...
Maldives	$227	2015	7.2%	3.5%	$555	$218	2015	6.9%	8.0%	$533	...		...	...	...
Marshall Islands	$8	2014	4.5%	0.9%	$157	...		...	...	...	...		...	...	...
Mauritius	...		...	...	...	...		...	...	...	$432	2015	3.8%	-0.3%	$342
Micronesia	$13	2015	4.3%	0.9%	$128	...		...	...	...	...		...	...	...
Nauru	...		...	...	...	...		...	...	...	...		...	...	...
Niue	...		...	...	...	...		...	...	...	...		...	...	...
Palau	$13	2015	4.5%	6.7%	$607	...		...	...	...	$7	2013	3.3%	3.1%	$350
Papua New Guinea	...		...	...	...	...		...	...	...	...		...	...	...
S. Tomé & Principe	$16	2013	5.4%	-0.7%	$86	...		...	...	...	...		...	...	...
Samoa	...		...	...	...	$36	2015	4.8%	-1.4%	$187	...		...	...	...
Seychelles	...		...	...	...	...		...	...	...	$70	2014	4.9%	22.1%	$749
Singapore	$10,977	2014	3.6%	1.6%	$1,983	$4,180	2014	1.4%	6.6%	$755	$12,445	2014	4.1%	10.8%	$2,248
Solomon Islands	...		...	...	...	$11	2014	0.9%	-6.8%	$18	...		...	...	...
St. Kitts & Nevis	$49	2014	5.7%	1.4%	$886	$35	2015	3.8%	1.9%	$627	...		...	...	...
St. Lucia	$83	2014	5.9%	-4.4%	$446	$65	2015	4.5%	-2.2%	$350	...		...	...	...
St. Vincent	$51	2014	7.0%	-1.4%	$467	$28	2015	3.7%	2.2%	$252	...		...	...	...
Suriname	...		...	...	...	...		...	...	...	...		...	...	...
Timor-Leste	$75	2012	5.8%	14.4%	$60	...		...	...	...	$56	2013	4.2%	7.6%	$45
Tonga	...		...	...	...	$13	2013	3.0%	2.0%	$121	...		...	...	...
Trinidad & Tobago	$876	2015	3.2%	4.2%	$644	...		...	...	...	...		...	...	...
Tuvalu	...		...	...	...	...		...	...	...	...		...	...	...
Vanuatu	...		...	...	...	$26	2013	3.2%	14.2%	$97	$35	2014	4.3%	0.1%	$131

9.8. ICT Sector and the Economy (Source: Adapted from telecom operators, telecom regulators, national statistical offices, and UN.)

Notes: Data in current prices and converted to US$ using annual average exchange rate. *Communications Value-Added* refers to ISIC (Rev. 3) 64 Posts and telecommunications. *Information and Communications Value-Added* refers to ISIC (Rev. 4) Section J (Publishing, Broadcasting, Film, Telecom, and Computer and Information Services).

Country	Fixed-telephone subscriptions (per 100 people)	Fixed broadband subscriptions (per 100 people)	Mobile subscriptions (per 100 people)	Mobile-broadband subscriptions (per 100 people)	Households with a computer	Households with Internet access at home	Facebook users (% of population)	OVERALL
Antigua & Barbuda	🟢	🟢	🟢	🔴	🟡		🟢	1.5
Bahamas	🟢	🟢	🔴	🟢	🟢		🟢	1.7
Barbados	🟢	🟢	🟢	🟡	🟢	🟢	🟢	1.9
Belize	🔴	🔴	🟢	🔴	🟡		🟢	0.8
Cape Verde	🟡	🔴	🟢	🟢	🟡	🔴	🟡	1.0
Comoros	🔴	🔴	🔴				🔴	0
Cook Islands			🔴	🔴		🟡	🟡	0.5
Cuba	🟡	🔴	🔴	🔴				0.3
Dominica	🟢	🟢	🟢	🟡	🟢	🟢	🟢	1.9
Dominican Republic	🟡	🔴	🔴	🔴	🔴	🔴	🟡	0.3
Fiji	🟢	🔴	🟢	🟢			🟢	1.6
Grenada	🟢	🟢	🟢	🔴	🟢	🟡	🟢	1.6
Guinea-Bissau			🔴	🔴			🔴	0
Guyana	🟢	🔴	🔴	🔴			🟡	0.6
Haiti	🔴		🔴	🔴			🔴	0
Jamaica	🟡	🔴	🟢	🟢	🟡	🔴	🟡	1.0
Kiribati	🔴	🔴	🔴	🔴			🔴	0.0
Maldives	🔴	🔴	🟢	🟢	🟢	🟢	🟢	1.4
Marshall Islands	🔴	🔴	🔴	🔴	🔴	🔴	🟡	0.1
Mauritius	🟢	🟢	🟢	🟡	🟢	🟢	🟢	1.9
Micronesia	🔴	🔴	🔴				🔴	0
Nauru			🔴	🔴	🟡	🟡	🔴	0.4
Niue	🟢		🟡	🔴	🟢	🟢		1.6
Palau	🟢	🔴	🟢	🔴		🔴	🔴	0.7
Papua New Guinea	🔴	🔴	🔴	🔴	🔴		🔴	0
S. Tomé & Principe	🔴	🔴	🟡	🔴			🔴	0.4
Samoa	🔴	🔴	🟢	🔴	🔴	🟡	🟡	0.6
Seychelles	🟢	🟢	🟢	🔴	🟡	🟡	🟢	1.4
Singapore	🟢	🟢	🟢	🟢	🟢	🟢	🟢	2.0
Solomon Islands	🔴	🔴	🔴	🔴		🔴	🔴	0
St. Kitts & Nevis	🟢	🟢	🟢	🟢	🟢	🟢	🟢	2.0
St. Lucia	🟢	🟢	🟢	🔴	🟡	🟡	🟢	1.4
St. Vincent	🟢	🟢	🟢	🟡	🟢	🟡	🟢	1.7
Suriname	🟢	🟡	🟢	🟢	🟡	🔴	🟢	1.4
Timor-Leste	🔴	🔴	🟢	🟡			🔴	0.6
Tonga	🟡	🔴	🟡	🔴	🟡	🔴	🟡	0.7
Trinidad & Tobago	🟢	🟢	🟢	🔴			🟢	1.6
Tuvalu	🟢		🔴	🔴			🔴	0.5
Vanuatu	🔴	🔴	🔴	🔴			🔴	0

9.9. ICT Scorecard (Author research)

Notes:
- 🔴 Worse than developing country average
- 🟡 Better than developing country average
- 🟢 Better than world average

Rank	Country	Sub-Region	EGDI	Online Service Component	Telecomm. Infrastructure Component	Human Capital Component
100	Antigua and Barbuda	Caribbean	0.4892	0.1812	0.5412	0.7453
93	Bahamas	Caribbean	0.5108	0.4275	0.3842	0.7207
54	Barbados	Caribbean	0.6310	0.4420	0.6397	0.8113
122	Belize	Central America	0.3825	0.3188	0.1834	0.6454
103	Cape Verde	West Africa	0.4742	0.4565	0.3629	0.6031
176	Comoros	Eastern Africa	0.2155	0.0507	0.1073	0.4885
131	Cuba	Caribbean	0.3522	0.1957	0.1103	0.7507
109	Dominica	Caribbean	0.4577	0.3043	0.4305	0.6384
98	Dominican Republica	Caribbean	0.4914	0.5072	0.2992	0.6676
96	Fiji	Oceania	0.4989	0.4130	0.3326	0.7509
88	Grenada	Caribbean	0.5168	0.3696	0.3988	0.7820
181	Guinea-Bissau	West Africa	0.1818	0.1087	0.0828	0.3538
126	Guyana	South America	0.3651	0.2826	0.2432	0.5694
178	Haiti	Caribbean	0.1931	0.1667	0.1004	0.3124
112	Jamaica	Caribbean	0.4534	0.3551	0.3193	0.6859
145	Kiribati	Oceania	0.3122	0.2101	0.0665	0.6599
117	Maldives	Southern Asia	0.4330	0.2319	0.4370	0.6301
156	Marshall Islands	Oceania	0.2695	0.0290	0.0849	0.6947
58	Mauritius	Eastern Africa	0.6231	0.7029	0.4596	0.7067
146	Micronesia (Federated States of)	Oceania	0.3103	0.1449	0.1197	0.6663
152	Nauru	Oceania	0.2868	0.0942	0.2448	0.5214
111	Palau	Oceania	0.4546	0.1087	0.3684	0.8867
179	Papua New Guinea	Oceania	0.1882	0.1667	0.0739	0.3240
94	Saint Kitts and Nevis	Caribbean	0.5034	0.2826	0.5301	0.6976
114	Saint Lucia	Caribbean	0.4531	0.2754	0.4094	0.6744
115	Saint Vincent and the Grenadines	Caribbean	0.4494	0.2971	0.3756	0.6754
121	Samoa	Oceania	0.4019	0.3406	0.1576	0.7076
168	Sao Tome and Principe	Central Africa	0.2390	0.0435	0.1547	0.5188
86	Seychelles	Eastern Africa	0.5181	0.4058	0.4624	0.6861
4	Singapore	South-Eastern Asia	0.8828	0.9710	0.8414	0.8360
164	Solomon Islands	Oceania	0.2406	0.1667	0.1150	0.4402
110	Suriname	South America	0.4546	0.2971	0.4116	0.6551
160	Timor-Leste	South-Eastern Asia	0.2582	0.2174	0.0728	0.4843
105	Tonga	Oceania	0.4700	0.3696	0.2302	0.8102
70	Trinidad and Tobago	Caribbean	0.5780	0.5290	0.4973	0.7077
151	Tuvalu	Oceania	0.2950	0.0217	0.1981	0.6651
149	Vanuatu	Oceania	0.3078	0.1667	0.1684	0.5884
	SIDS Average		**0.4093**	**0.2879**	**0.2977**	**0.6422**

9.10. UN E-Government Development Index

Part 2 Case Studies of Six Small Island Developing States

1 • Cape Verde

Key Features[1]

The Republic of Cape Verde comprises an archipelago of 10 volcanic islands in the central Atlantic Ocean about 570 km from the West African tip of the continent, and covering an area of just over 4,000 km^2 (Figure 1.1).[2] With a total population of approximately 520,000 (2015), all but one of the islands is inhabited. Just over 50% of the total population resides on Santiago, the largest island, in which the capital, Praia, is situated. There are slightly more Cape Verdeans living outside the country than in it.

Although lacking in natural resources, Cape Verde is one of the most developed countries in Africa, with a GNI per capita of US$3,290 in 2015 and a GDP of US$1.9 billion. Approximately 50% of its export income is generated by the fishing industry. Cape Verde's strategic location at the crossroads of mid-Atlantic air and sea lanes has been enhanced by improvements at its harbours and international airports.

In 2008, Cape Verde graduated to middle-income status and it has been a stable representational democracy since the 1990s. The country is recognised in Africa for its good governance—it received the third-highest ranking for governance performance in the 2015 Mo Ibrahim Index of African Governance (out of 52 countries, after Mauritius and Botswana).

Portuguese is the official language and the literacy rate is 87%. In 2015, 23% of the population had either attended or graduated from secondary school; 9% of men and 8% of women held a bachelor's degree or had attended university.

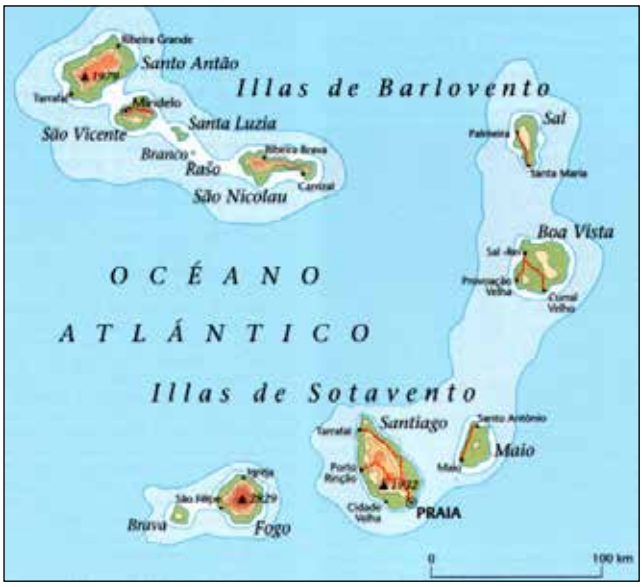

Figure Case Study (CS) 1.1. Map of Cape Verde

Status of Internet Use

When the communications sector was liberalized in 2005, a competitor to the incumbent operator entered the market and accelerated the penetration of services. Broadband services expanded when the WACS submarine cable arrived and provided significantly more international capacity.

In addition to a fixed ADSL service, 3G Internet access is provided by two mobile operators, and there is one small ISP providing services via Wi-Fi in Santa Maria on the Ilha do Sal. 4G services have not yet been launched. OpenSignal reports an average 3G download speed of 1.7 Mbps.[3]

National Communications Agency[4] *(Agência Nacional de Comunicações)* estimates that there were 312,940 Internet users at the end of Q2 2016, of which 84% gained access to Internet through a mobile phone, while 11% accessed it via a tablet or dongle, 5% via ADSL and 0.2% via the Wi-Fi provider in Ilha do Sal.

VoIP is gaining in popularity, and usage increased from 32,000 minutes in Q2 2015 to 166,000 minutes in Q2 2016. But, this is still relatively low compared to the 2 million minutes in outgoing international calls and 13 million incoming calls.

ANAC also tracks the number of leased lines, which dropped by about 8% compared to Q2 2015 year to 488 (of which 36 were circuits to other providers and 452 were retail circuits).

[1] Unless otherwise indicated the figures are derived from the National Institute of Statistics http://www.ine.cv or http://www.anac.cv.

[2] http://noticias.sapo.cv/info/artigo/1238715.html.

[3] http://opensignal.com/networks/cabo-verde/cvmovel-cobertura.

[4] http://anac.cv.

	Total (% annual change)	Penetration (% of population)
Population	529,000	
Mobile subscriptions (SIM cards)	624,947 (-3%)	118%
Internet users	312,940 (-14%)	59%
Mobile broadband (3G) subscriptions	35,553 (-16%)	6.7%
3G coverage (population)	94%	55%
Fixed broadband subscribers (ADSL)	14,994(-13%)	3%
Fixed wireless subscribers (Wi-Fi)	700	
IPTV subscribers	11,211(-6%)	2%
Fixed lines	59,249	11%
International capacity in use	5.75(Gbps)	11 (Kbps/capita)
AS numbers	3	
IP addresses (v4/v6)	34,304	
ccTLD domain names registered	1,400	

Table CS 1.1. Market Statistics, Q2 2016 (Sources: http://anac.cv/images/indicadoresestatisticos2trimestre2016comunicacoeselectronicas.pdf, http://www.nirsoft.net/countryip/vc.html, http://research.domaintools.com/statistics/tld-counts, http://bgp.he.net, http://www.facebook.com, http://www.google.com)

ICT Policy and Regulatory Framework

Institutional structures

ANAC is the authority responsible for telecom and Internet services, TV, and spectrum. It has operated the domain name registry for the .cv ccTLD since 2006.[5]

ICT Strategies, policies, and regulations

The telecom sector was liberalized in 2005. Since that time, a series of initiatives to improve the enabling policy and regulatory environment for ICTs has been put into play. Most recently, a national broadband strategy *(Estratégia Nacional de Banda Larga, ENBL),* was approved by the Council of Ministers in November 2015.[6] The ENBL aims to increase the availability of connectivity in general, promote public-private partnerships, focus resources on the strategic sectors of the country's transformation agenda (sea, aero navigation, financial services, and ICTs), and expand digital learning programmes.

The strategy envisions the creation of an entity to monitor progress and a cross-sectoral coordination mechanism to maximize synergies. The programme has a set timeframe for implementation, and will close at the end of 2018. Its final report is due in March 2019.

The government has been trying to interest a third operator in entering the market, but so far it has not been successful. In November 2015, ANAC finalised a public consultation on the provision of 4G services. It expects that the 800 MHz band will be made available for 4G services, even though the analogue-to-digital switchover of the TV broadcasting is not complete because only one channel is currently in use (by the national TV broadcaster).

Since 2009 the government has had regulations that establish key public infrastructure *(PKI-Chaves Públicas de Cabo Verde, ICP-CV).*[7]

[5] http://dns.cv.

[6] http://www.governo.cv/index.php/rss/6277-governo-aprova-estrategia-nacional-para-a-banda-larga.

[7] http://anac.cv/index.php?option=com_content&view=article&id=62&Itemid=56&lang=en.

Government ICT programmes

The government has an Interministerial Commission on Innovation and the Information Society *(Comissão Interministerial para a Inovação e Sociedade de Informação)* that is headed by the Prime Minister. The Commission has established a specialised ICT agency *(Núcleo Operacional da Sociedade de informação – NOSi)*[8] to support the implementation of public sector ICT activities. In 2014, NOSi became a parastatal entity *(Entidade Pública Empresarial, EPE)*.

The government hopes to create a so-called cyber-island that could provide such services as business process outsourcing, back-office operations, and software development and maintenance. To support this vision, the government has taken a EUR 31.6 million loan from the ADB in order to create the Praia Technology Park.[9]

Network Infrastructure

International connectivity

Atlantis-II was Cape Verde's first link, a 12,000 km cable initiated by Brazil's parastatal operator, Embratel, in 2000 in order to link Brazil to Europe via Portugal. The link also includes Argentina, Senegal, Cape Verde, and the Canary Islands (Figure 1.2). Although the cable has an ultimate design capacity of only 160 Gbps, it provides Cape Verde with a direct link to Dakar, Senegal, where other submarine cables can be accessed.

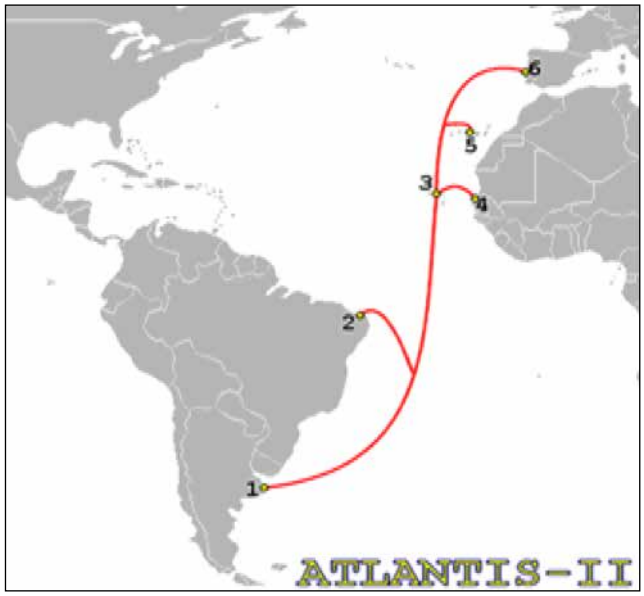

Figure CS 1.2. Map of the Atlantis-II Submarine Cable (Source: Embratel)

1 = Las Toninas, Argentina
2 = Fortaleza, Brazil
3 = Cape Verde
4 = Dakar, Senegal
5 = Canary Islands, Spain
6 = Sesimbra, Portugal

More recently, CV Telecom has invested in the West African Cable System (WACS)[10] that began operations in May 2012, and links 14 countries along the west coast of Africa to Portugal and the United Kingdom. The cable has a design capacity of 14.5 Tbps. In addition, some high-frequency radio telephone links are operated to Senegal and Guinea-Bissau.

Pricing data

Wholesale international pricing data is not published.

Public network operators

The dominant Internet provider on the island is CV Telecom, a subsidiary of Portugal Telecom (PT). Brazilian operator Oi was a 40% shareholder in CV Telecom, but announced it would be selling its shares to PT in September 2016.

The CV Telecom group provides fixed and mobile voice and Internet services, as well as IP-TV under the brands CV Telecom (fixed line voice services), CV Movil (mobile voice and data), and CV Multimedia (voice, data, and TV).

CV Telecom has domestic fibre-optic infrastructure on the major islands, and also operates an interisland submarine cable, thereby providing a ring that interconnects the islands (Figure 1.3, next page). At the time of its launch, it connected six of the most populated islands; the remaining islands were connected in 2011.

[8] http://nosi.cv.

[9] http://www.afdb.org/fileadmin/uploads/afdb/Documents/Boards-Documents/Cape_Verde_-_Technology_Park_Project_-_Appraisal_Report.pdf.

[10] http://wacscable.com.

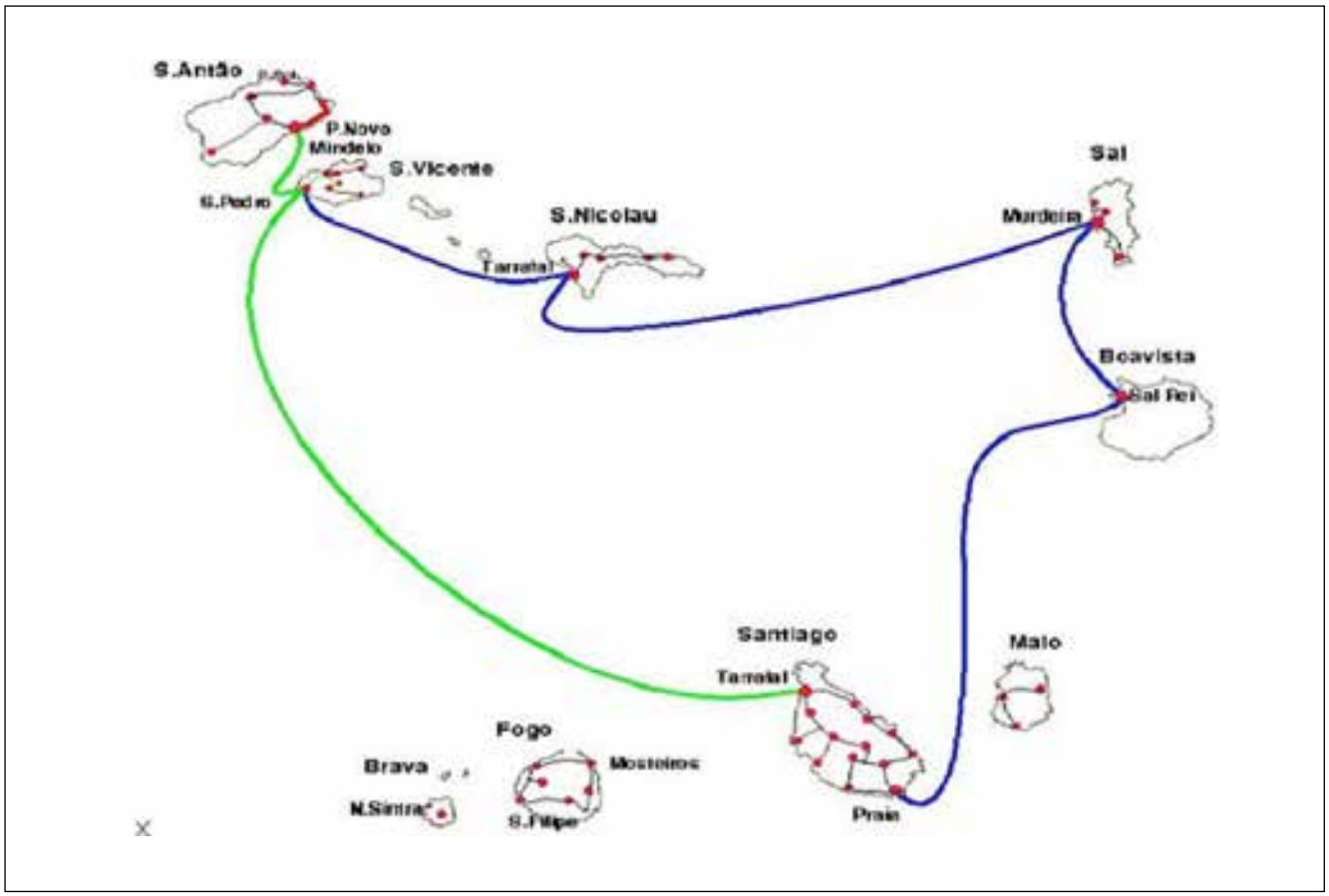

Figure CS 1.3. Map of Initial Interisland Submarine Cable Network in Cape Verde, 2002 (Source: CV Telecom)

In 2012, ANAC determined that CV Telecom had too-significant market power. It imposed a number of obligations on the operator, specifically that it provide wholesale services at regulated prices and allow access to its facilities for other operators.

Its sister company, CV Movil, claims to cover 94% of the population (Figure 1.4), but does not distinguish between 3G and lower-speed services, such as EDGE. CV Movil's service provides 12 Mbps downstream, but only 1 Mbps upstream.

The second mobile operator in the country is Unitel Mais (T+).[11] It is owned by the Angolan Unitel group that also has operations in Sao Tome e Principe. The operator provides fixed and mobile voice services via its 3G platform. In addition, Cabocom[12] provides a Wi-Fi service on the island of Ilha do Sal (Figure 1.5, next page).

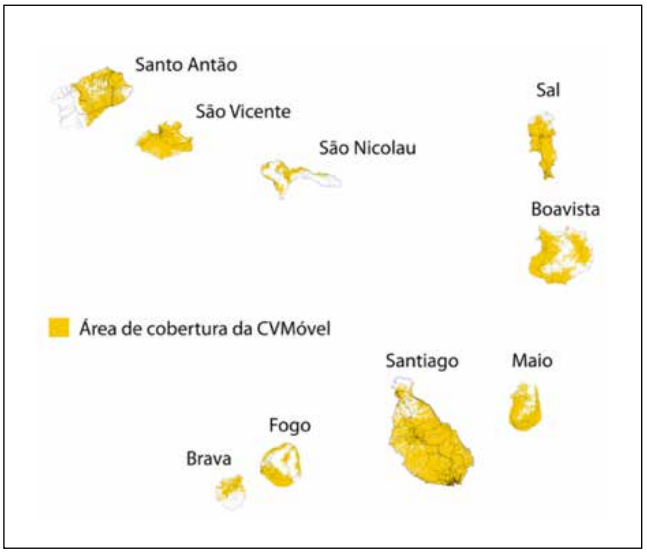

Figure CS 1.4. CV Movil's Mobile Data Coverage
(Source: https://www.cvmovel.cv/nacional-gsm-3g-edge-e-gprs)

[11] http://www.uniteltmais.cv.

[12] http://cabocom.cv.

Pricing data

As a triple-play provider, CV Telecom Multimedia (CVM) offers the following complex set of different services and bundles:[13]

- ZAP TV (CVM's bundled ADSL-based TV and broadband package) costs US$79 per month for 25 TV channels and 12 Mbps broadband, or US$86 for 40 channels and 12 Mbps broadband.
- A business ADSL broadband connection costs US$141 per month for 24 Mbps downstream and 1 Mbps upstream. A symmetric 2 Mbps connection costs US$2,046 per month.
- CVM's triple-play offering, ZAP 3P, includes TV, mobile, and Internet. The low-end package of 12 TV channels, 6 GB of data, and free on-net calls costs US$16.7 per month. Forty-five channels and 18 GB costs US$54 per month; 45 channels plus unlimited data and free on-net calls costs US$74 per month.
- With no TV, the unlimited broadband package costs US$64 per month.
- The lowest package—no TV, free on-net calls, and 5 GB of data—costs US$9.8 per month. A package with no Internet, but free on-net calls and 12 TV channels also costs US$9.8 per month.
- Off-net calls to T+ (the other mobile operator in Cape Verde) cost US$0.25 cents per minute. In contrast, calls to the United States, Canada, and China only cost US$0.08 cents per minute. From T+ to CV Movil calls cost US$0.44 cents per minute.
- All mobile Internet services are offered at speeds of 12 Mbps downstream and 1 Mbps upstream.

Figure CS 1.5. Map of Cabocom's Coverage (Source: http://cabocom.cv)

T+ charges US$5 per month for 2 GB of data and unlimited on-net calls and text messages.

Cabocom offers a 3 Mbps wireless connection with a 4 GB cap at US$39 per month, 6 GB is US$59 per month, and 9 GB is US$88 per month.

CV Telecom is required to provide access to its facilities for other operators, and the details of the facilities leasing fees and requirements are published by ANAC.[14] Wholesale prices for Ethernet circuits on CV Telecom's national infrastructure have also been determined, and are also published[15].

[13] http://www.cvmultimedia.cv/zap-3p.

[14] http://anac.cv/images/orall_precos.pdf.

[15] http://anac.cv/images/deliberacaocaretificacao.pdf.

Public sector networks

The government-owned network, *Rede Tecnológica e Privativa do Estado (RTPE),* is operated by the state's ICT agency NOSi. RTPE consists of leased cable and RTPE-owned wireless links interconnecting the islands and dozens of buildings. The network has about 2,500 users (Figure 1.6).

A radio station, *Rádio Educativa,* is dedicated to distance education and is operated by the Ministry of Education.

Private networks

Little information is available on private networks in Cape Verde, although it is known that NOSi also provides services to private companies and that a VPN service is available.

NGO networks

No independent nonprofit networks appear to be operating in Cape Verde.

Figure CS 1.6. Map of the Government Network in Cape Verde (RTPE) (Source: NOSi)

Interconnection and hosting

NOSi operates a carrier-neutral data centre.[16] Detailed prices for services are published.[17] Currently, there are no IXPs or related caching facilities.

Capacity-building infrastructure

Mobile operator CV Móvel is working with the Ministry of Education and Sports, the Ministry of Higher Education Science and Innovation, and the Ministry of Infrastructure and Maritime Economy to provide low-tariff connectivity and access equipment to students, teachers, and university staff. The project is part of the national broadband strategy and aims to do the following:

- Promote literacy and digital inclusion in schools and universities.
- Boost e-learning and the implementation of the virtual learning environment.
- Stimulate the production of open educational resources developed in Cape Verde.
- Provide free Internet access in educational venues.
- Ensure that the educational community has access to tablets and smartphones, as well low-cost Internet access.

Currently Cape Verde is not participating actively in the West and Central African Education and Research Network (WACREN), a regional network for the academic and research sector that provides access to global research networks.

Power supply infrastructure

Continued economic growth has left Cape Verde with both a power supply deficit and relatively high electricity tariffs (approximately EUR 0.25 per KWh). To address this constraint, the country has made ambitious plans to harness more renewable energy.[18] From its investment in wind and solar energy, the country achieved a 25% renewable energy base by 2014.

Applications and Content

E-government

NOSi has developed a range of ICT applications for government administration, including:

[16] http://www.nosi.cv/index.php/servicos1/data-center.

[17] http://www.nosi.cv/index.php/servicos1/tabela-de-precos/send/18-tabela-de-precos/8-preco-de-venda-ao-publico-servicos-over-the-counter.

[18] http://www.ecowrex.org/system/files/documents/2011_summary-of-cape-verde-renewable-energy-plan_ecreee.pdf.

- The National Identification and Civil Authentication System, one of the first parts of the administrative modernization strategy, with an associated National Identification Card
- The Electoral Information System, available as a smartphone app[19]
- MKonekta *(Serviçus Públicus na Bu Mô),* a platform for the provision of government services, including payments, on mobile devices.

Banking and e-payments

Banks in Cape Verde are generally all online. Pagali.cv provides an open electronic payments platform.

Media

ZAP TV[20] is a streaming IP-TV product provided by the ISP CVMultimedia over ADSL. It offers packages with 12 to 40 TV channels, as well as premium sport, cinema, and adult channels.

The state broadcaster is RTC *(Radio Televisão Caboverdiana).*[21] It operates one national television channel (TCV) and two radio channels, RCV and RCV Mais/RCV+ (youth-oriented). All three broadcasts are also streamed live on the Internet.

TIVER *(Televisão Independente de Cabo Verde)*[22] is the sole private TV broadcaster since 2007. Its programming is available online, and it operates a streaming radio station, RadioDIA.[23] CV Multimedia and Boom-TV are the only two operators with pay-TV licences.

Of particular note is the extensive use of community radio on the islands. There are 13 registered community stations[24] operated by a diverse range of local civil society groups, including farmers, cultural or musical associations, and municipalities.

There are 12 private or nongovernmental radio broadcasters, including Rádio Comercial, a private station; Rádio Educativa, which is dedicated to distance education and operated by the Ministry of Education; and Rádio Nova, which is run by the Catholic Church. Almost all the stations in Cape Verde are streamed live.[25]

An online Portuguese listings service, Sapo, operates an extensive portal in Cape Verde.[26]

In August 2015, ANAC selected Thomson Broadcast to oversee its analogue-to-digital switchover process, which should be relatively straightforward considering there is only one free-to-air station.

Local services

Education and health

NOSi has assisted with the development of a number of online applications in the education and health area,[27] including:

- The Integrated School Management System *(Sistema Integrado de Gestão Escolar, SIGE)* provides secondary and basic education schools with a networked information system designed to reduce administrative costs and enable schools to engage with students, parents, and guardians.
- The System for Integrated Management and Monitoring of Higher Education Students (SIGAE) is a management tool designed to improve the allocation of jobs and scholarships, financial management, registration of fellows, and the tracking of fellows in Cape Verde and the diaspora.

[19] http://www.nosi.cv/index.php/solucoes/eleicoes.

[20] http://www.cvmultimedia.cv/servi%C3%A7o-zap-tv-0.

[21] http://www.rtc.cv.

[22] http://tiver.cv.

[23] http://tiver.cv/index.php/radio-dia.

[24] http://www.dgcs.gov.cv/index.php/operadoras/sector-da-radio.

[25] http://muzika.sapo.cv/radios.

[26] http://www.sapo.cv.

[27] http://nosi.cv/index.php/solucoes/saude-seguranca-social.

- The Integrated Health System *(Sistema Integrado da Saúde, SIS)* is a set of modules that support the management of daily activities at health facilities.

Local government

The Municipal Information System *(Sistema de Informação Municipal)* was developed with NOSi, and includes infrastructure for local networks, access to NOSi's data centre, and an ICT system that covers municipal management—specifically, financial and human resources management, taxes, licensing, and land ownership.

Emergency services

Cape Verde's previous emergency communication systems were inefficient and based on obsolete radio technology. When the volcano on the island of Fogo erupted in 2014, it was close to two communities and left many homeless. The government took the opportunity to extend the use of ICTs for emergency response. Coordinated by ANAC, mobile operators provided improved access to the Internet in the affected areas, as well as free voice communications (including traffic priority) for those working there. Satellites and drones were used to monitor the status of the volcano, and modelling tools predicted the lava's path and speed.

The coverage of the event spread among social networks, and resulted in significant fundraising and international support. Going forward, there are plans to monitor water temperature, the weather, and volcanic activity in order to identify imminent hazards; an ICT system will be developed to manage evacuations efficiently; and smartphones will be used to warn the public of potential danger. In addition, there are plans to provide remote medical and psychological assistance to disaster victims while they are waiting for rescue teams, as well as international cooperation in emergency communications. (Cape Verde has recently approved its accession to the Tampere Convention.)

To organize emergency communications, the government created a Task Force with the following three main roles:

- Implement an Emergency Coordination Centre to operate the emergency number 112.
- Develop a new national emergency communication plan that includes ICT-based procedures.
- Implement a new national emergency communication network.

Outlook

Cape Verde's government has made consistent and forward-looking efforts to improve the country's connectivity and use of ICTs. These efforts have paid off in the relatively high levels of broadband adoption, extent of use by government, and availability of local online services. However, relatively high Internet usage fees remain, as most services are metred. This indicates that some parts of the value chain are not sufficiently competitive, but also may to be partly a result of the limited economies of scale due to the small population scattered across numerous islands.

It is likely that further reductions in the cost of access will be necessary before the full benefits of widespread adoption are obtained. Ideally, an additional operator would enter the market at both international and retail levels. In addition, special efforts would be made to ensure that plans for any submarine cables passing nearby include Cape Verde—an obvious example is Ellalink,[28] which is currently planned to run from Brazil to Portugal and is due to enter service in 2018.

References

African Development Bank (AfDB). 2014. Cabo Verde Country Strategy Paper. http://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/2014-2018_-_Cape_Verde_Country_Strategy_Paper.pdf.

Instituto Universitário de Lisboa. 2015. A Regulação da Comunicação Social em Cabo Verde na Era Digital. http://www.portaldoconhecimento.gov.cv/bitstream/10961/4789/1/%C3%9Altima%20vers%C3%A3o.pdf.

[28] http://www.islalink.es.

2 • Comoros

Key Features[1]

The Comoro Islands are located in the Indian Ocean, off the east coast of Africa and northwest of Madagascar. The archipelago consists of four islands: Anjouan (Ndzuwani), Moheli (Mwali), Grande Comore (Njazidja, where the capital Moroni is located), and Mayotte. The first three islands comprise the Union of the Comoros; Mayotte is an overseas department of France (Figure 2.1).

The population of the three islands of Comoros was estimated at 788,000 in 2015, ranking the nation 165th in the world. But, since that the population is spread over a small area, the population density is 424 people per km^2, 26th in the world. According to the 2003 Census, just over half (52%) of the population reside on Grande Comore, 42% on Anjouan and 6% on Moheli. People living in rural areas account for 72% of the population. The average household is large with 5.4 persons.

Three principal languages are in use. Shikomor is the local and official language spoken by nearly the entire population. It is written using either Arabic or Latin alphabets, but its use is primarily oral due to the lack of a stable script.[2] Arabic and French are national languages used in the educational system, and Comoros is a member of both the Arab League and the Organisation Internationale de la Francophonie. According to a 2012 survey, 63% of women and 77% of men between the ages of 15 and 49 are literate.

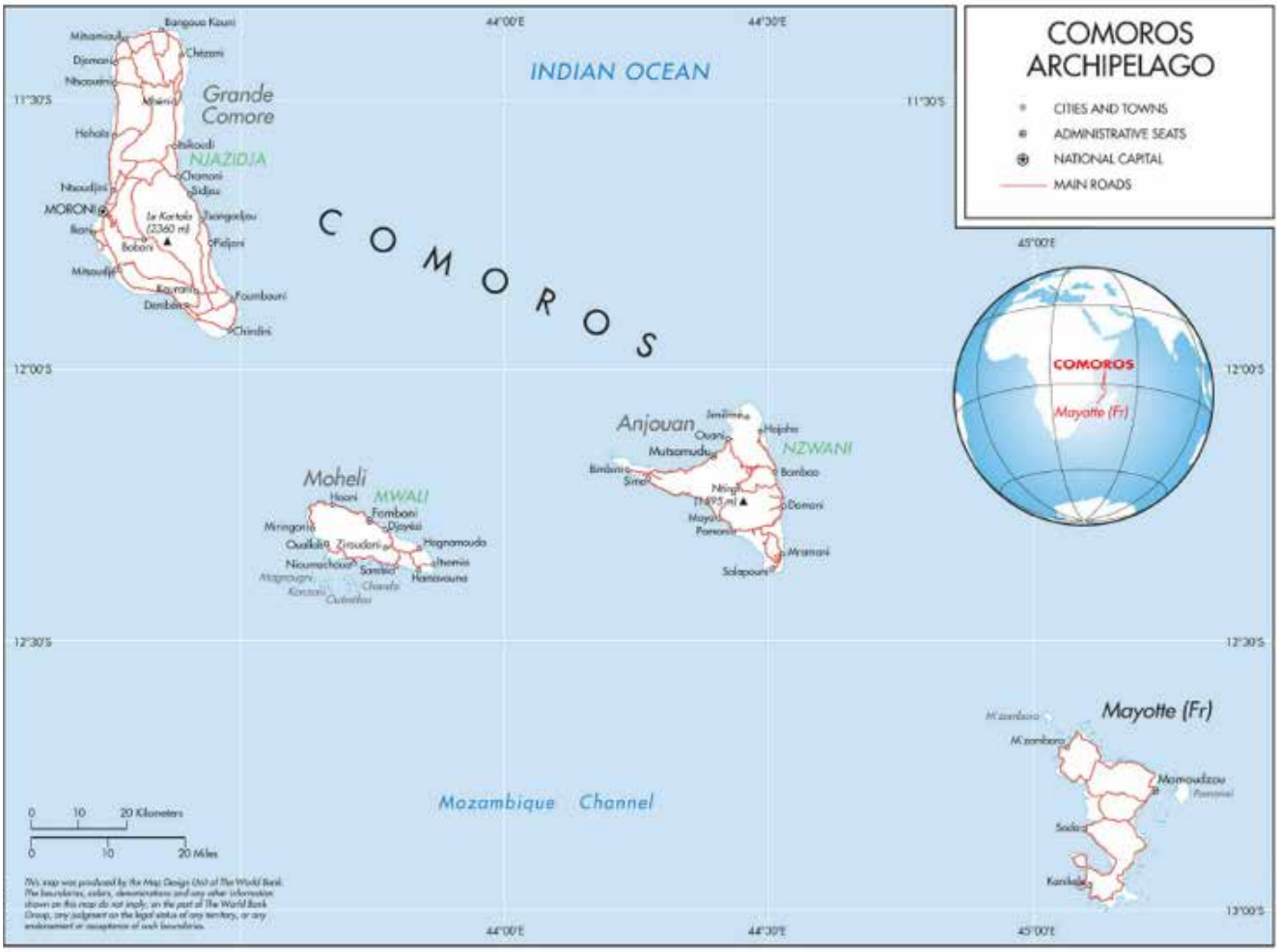

Figure CS 2.1. Map of Comoros (Source: World Bank)

[1] This section largely draws on DGSP and ICF 2014 and IMF 2015, and UN and World Bank data.

[2] UNICEF. 2016. Comoros - The Impact of Language Policy and Practice on Children's Learning: Evidence from Eastern and Southern Africa. http://www.unicef.org/esaro/Comoros LR.pdf.

Comoros is classified by the World Bank as a low-income economy, and by the UN as an LDC. GDP per capita was US$791 in 2015. Agriculture is significant, contributing just over one-third (34%) of the economy in 2014, however that number has dropped by five percentage points since 2010, in part due to price competition from larger producers. According to a 2012 survey, agriculture employed 29% of men and 23% of women. The country's export base is narrow, and includes three crops that account for approximately three quarters of exports: vanilla, cloves, and ylang. Fishing is also important, engaging 8,500 people.[3] Tourism receipts were reported at just over US$50 million in 2014, or around 8% of GDP.[4] Agriculture, fishery, and tourism are seen as the sectors with the highest growth potential. Remittances, mainly from diaspora in France, are significant and account for over a quarter of GDP. The sale of passports provided a lucrative source of income between 2011 and 2014, but the scheme ultimately foundered.[5]

Since achieving independence from France in 1975, Comoros has gone through a number of governments and considerable political instability, including several coups. That said, the last two changes of government were peaceful, the most recently in April 2016.

Comoros has classic SIDS characteristics: a remote location, no close neighbours (Moroni is over 300 km from the east coast of Africa and over 500 km from Madagascar), a small population, and a limited economic resource base. However, the country is less susceptible to natural disasters than many SIDS.[6]

Status of Internet Use

Two ISPs provide Internet services: the incumbent Comoros Telecom and new entrant Telma Comoros, which launched at the end of 2016 after receiving a licence in December 2015 following a competitive tendering process. Telma was initially unable to interconnect to EASSy. It achieved this by persuading other members of EASSy consortium to cut off the island from the Internet on 16-17 November 2016. After 18 hours of isolation, the government ordered Comores Telecoms to interconnect with Telma.

Internet is available via ADSL, leased lines, wireless CDMA dongles (using the MPESSI technology), 2G and 3G, and public Wi-Fi. Fixed broadband is generally only available in urban areas. The 3G network was launched in 2013 by Comoros Telecom, and currently covers only the main cities.

Fixed telephone penetration is only 3.4% of the population, and the number of subscriptions (including fixed CDMA wireless) dropped by over 4,000 in 2014. In contrast, the mobile market grew by 23% in 2014, and mobile penetration was 49 subscriptions per 100 people. The level of Internet access is higher—a 2012 household survey found that 73% of homes had a mobile phone.[7] By 2014 there were 35,730 mobile Internet users accessing the Internet using both 2G (GPRS/EDGE) and 3G technologies. Despite a more than twofold growth since 2010, fixed broadband is extremely limited, with only 1,102 ADSL subscriptions in 2014. It would appear that users are substituting MPESSI dongles for fixed broadband, with 9,816 subscribers in 2014.

There are no official surveys of Internet usage conducted in the country. According to Comoros Telecom, it had 137,000 Internet subscribers in 2015 (including fixed and mobile)—equivalent to 17 subscribers per 100 people. However, some of these are likely to

	Total	Penetration (% of population)
Fixed telephone subscriptions (including fixed CDMA wireless)	26,316	3.4
Mobile subscriptions (SIM cards)	378,047	49.1
Mobile data subscriptions	35,730	4.6
ADSL subscriptions	1,102	0.14
Mobile dongles (MPESSI)	9,816	1.3

Table CS 2.1. Market Statistics for Comoros, 2014 (Source: Central Bank of Comoros)

[3] See "Comoros and FAO", http://www.fao.org/3/a-ax422e.pdf.

[4] UNWTO. 2016. Tourism Highlights.

[5] Abrahamian, 2015.

[6] See "INFORM Country Risk Profile for Comoros", http://www.inform-index.org/Countries/Country-profiles/iso3/COM.

[7] DGSP and ICT, 2014.

be duplicate subscriptions (e.g., a person having both a mobile and fixed subscription) and, as supply-side figures, do not accurately reflect Internet use in the country. Given the absence of demand-side data on Internet use, Facebook usage statistics can be used as proxy. The social media application has grown in popularity in Comoros over the past five years: in March 2011 there were 6,660 Facebook users, by September 2016 this had grown nearly tenfold to 65,000, or 14% of the population aged 15 and older. There is a significant gender difference in usage of Facebook: 20% of men aged 15 and older use it, but only 9% of women do. In addition, male Facebook penetration is ~8 percentage points higher than the proportion of men with a complete secondary education or higher. For females, Facebook penetration is the same as the percentage of women with a complete secondary education or higher, suggesting that education is more of a barrier to online application usage for women than men.

Internet service prices are high, its speeds are low. There are four ADSL options, with speeds ranging from 512 kbps to 4 Mbps. ADSL prices have not changed for the last few years, despite the availability of bandwidth from the EASSy cable that arrived in 2011. The monthly price for a 512 kbps connection is KMF 18,500 (US$42), equivalent to over 60% of the average per capita income. There are different price options for wireless that depend on the period of the data plan and the amount of data. A monthly 1 GB 3G data plan costs KMF 7,500 (US$17), or a quarter of per capita income. This is clearly beyond the reach of most Comorians, and it is likely that most access the Internet using cheaper access plans with less inclusive data and constrained use. Speeds are relatively slow, with various sources reporting similar average speeds of 2 Mbps downstream and 1 Mbps upstream in September 2016.[8]

ICT Policy and Regulatory Framework

The government has taken steps to liberalise the telecom sector. Privatization of Comoros Telecom has been considered since 2005, but was recently given additional impetus due to structural reforms recommended by international development partners. The International Finance Corporation (IFC) identified several potential bidders and established a data room. However, the IFC was hesitant to move forward without the passage of a new law, which was rejected by Parliament in March 2015.[9] This opposition was partly due to the expected impact on the large number of staff employed by Comoros Telecom, despite evidence suggesting that overall employment in the telecom sector would rise because of competition.[10] Comoros Telecoms successfully lobbied to have the privatization process dropped until after the April 2016 elections, and in return agreed to cover some of the debts of MAMWE, the state-owned electricity utility. The new government has indicated that privatization may be back on the agenda.

A second mobile licence was awarded in 2007 to Twama Telecom but, due to opposition from the incumbent, it never launched and its licence was cancelled in 2012. A new bid for a full-service operator was started in 2015 via a competitive selection process funded by the World Bank. In December of that year, a licence was awarded to the Telma consortium from Madagascar for KMF 7,010 billion (US$16 million).[11] Telma started operations in December 2016, but had difficulty in reaching an agreement on interconnection, although this was part of the licence agreement.

The World Bank is spearheading a major ICT project under the fourth phase of the Africa Regional Communications Infrastructure Program (RCIP4). According to the 2013 Project Appraisal Document, the US$22 million grant has three components: one supports an enabling environment via market liberalisation and sector reform, as well as capacity building; a second revolves around connectivity, including the financing of submarine cables to Mayotte and Madagascar; and a third consists of project management, including monitoring and evaluation. The Comoros government fulfilled conditions relating to the release of funds (US$12 million) for the submarine cable in early 2017, some four years later than originally planned.

Institutional structures

The government department responsible for the ICT sector is the Ministry of Posts and Telecommunications, Promotion of New Information and Communication Technologies, charged with Transport and Tourism *(Ministre des Postes et Télécommunications, de la Promotion des nouvelles technologies de l'information et de la Communication, chargée des Transports et du Tourisme).*

The regulator of the sector is the National ICT Regulation Authority (*Autorité Nationale de Régulation des TIC, ANTRIC).* It was established by decree N°065/PR of 23 May 2009, and is charged with developing ICT policy, including creating a competitive

[8] http://testmy.net/list?q=comoros and http://opensignal.com/networks/comores/comoros-telecom-couverture.

[9] "Comores Télécom Privatisation: Summary of Advisory Services Project Information", http://ifcextapps.ifc.org/ifcext/spiwebsite1.nsf/a24f910d8d23aa078525753d-00658ca8/d7a5d27d2a21d36785257a80007055c0?opendocument.

[10] World Bank. 2016. "Renforcer la performance du secteur telecom en s'attelant a transformer Comores Telecoms."

[11] ANTRIC. 2016. "Union Des Comores: Un Processus D'attribution De Licence De Communications Electroniques Réussi." *Actualité.* http://www.anrtic.km/articles/union-des-comores-un-procesus-d-attribution-de-licence-de-communications-electroniques-reussi.html.

environment, managing scarce resources, and defending consumers by ensuring that tariffs are cost-oriented and that there is good quality of service. It is also responsible for developing a Universal Service policy and representing Comoros at relevant international organizations.

ICT Policies and Regulations

The Electronic Communications Law was adopted in 2014.[12] ANRTIC has also issued regulations relating to equipment standardization, frequency pricing, operator fees, licensing, interconnection, and the national numbering plan. Legislation covering e-commerce, data privacy, and computer security have not yet been enacted, although a draft law has been prepared.[13]

Network Infrastructure

Backbone connectivity

Historically, Comoros relied on satellite connectivity for international communications. But in 2010, the EASSy submarine cable landed in Grande Comore, and in 2011 it was put into operation. Comoros Telecom was one of the investors in the project. The amount of international bandwidth used has increased from 15 Mbps in 2010 to 600 Mbps in 2015. Although wholesale prices dropped from US$5,500/Mbps/month before the cable, they were still steep at US$2,500 prior to the entry of Telma.[14] It is not clear why the price was so high, other than the fact that Comoros Telecom still held a monopoly until December 2016. Since then, Telma has contracted for 10 Gbps of capacity on Eassy, and international capacity prices have come down to US$35/Mbps per month.

As a comparison, in Nairobi, IP transit prices were over US$70 Mbps per month in mid-2015.[15] So it would seem that the transport costs that Comoros Telecom was paying on EASSy to get traffic to a landing point on the African mainland were high (its traffic lands in South Africa and Djibouti). Comoros Telecom was not a member of the original Western Indian Ocean Cable Consortium (WIOCC) that forms the main membership of EASSy. Instead, the spur from the main cable to Comoros was fully financed by Comoros Telecom, using funds from Orange set against future payments of international mobile termination rates from France. Because of Comoros's late entry, the price paid for the cable was much higher than the market rate.

There are plans for two other international submarine cables—AVASSA, the interisland network, and FLY-LION3 to Madagascar—to be built under the auspices of the World Bank's RCIP4 project. This will also leverage the proximity of Mayotte, which already has a link to the LION cable (Figure 2.2, next page).

A domestic submarine cable connecting the three islands was completed in December 2011. Comoros Cables will likely manage this—it has suffered some recent cuts, but is currently functional. In addition, Comoros Telecom has accepted a loan of US$31 million from China EXIM Bank, paid directly to Huawei for work on a fibre backbone network on each of the islands, plus submarine fibre from Anjouan to Mayotte, and from Chindini to Moroni. Unlike the World Bank credit, for which payment is postponed for 40 years, the China EXIM Bank payment must be repaid immediately, with interest payments made over 30 years.

Interconnection and hosting

There has not been a need for an IXP in Comoros due to the dominance of the ISP market by Comoros Telecom. Presumably, the incumbent is using traffic management routines to keep local traffic within Comoros, rather than using expensive international bandwidth for the traffic. The need for an IXP will be dependent on the degree of future market liberalisation. The World Bank's RCIP project contains a subcomponent on establishing a carrier-independent IXP.[16] In March 2014, in cooperation with the Internet Society, a workshop was held to plan for a future IXP.[17]

Comoros Telecom is responsible for the .km ccTLD[18] and offers hosting in connection with that. After market liberalisation, plans exist to pass responsibility for managing .km to ANRTIC.

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[12] http://www.anrtic.km/uploads/gallery/578737f08b7af.pdf.

[13] http://www.wipo.int/wipolex/en/profile.jsp?code=KM.

[14] http://documents.worldbank.org/curated/en/903931468000027290/Africa-RCIP4-Regional-Communications-Infrastructure-Program-APL-4-RI-P118213-Implementation-Status-Results-Report-Sequence-05. IN practice, given that Comores Telecom's only wholesale customer is itself, these prices are purely notional.

[15] http://isoc-ny.org/afpif2015/AfPIF2015_Teleography.pdf.

[16] World Bank, 2013.

[17] http://www.Internetsociety.org/events/axis-workshop-comoros-bp.

[18] http://www.domaine.km/index.php.

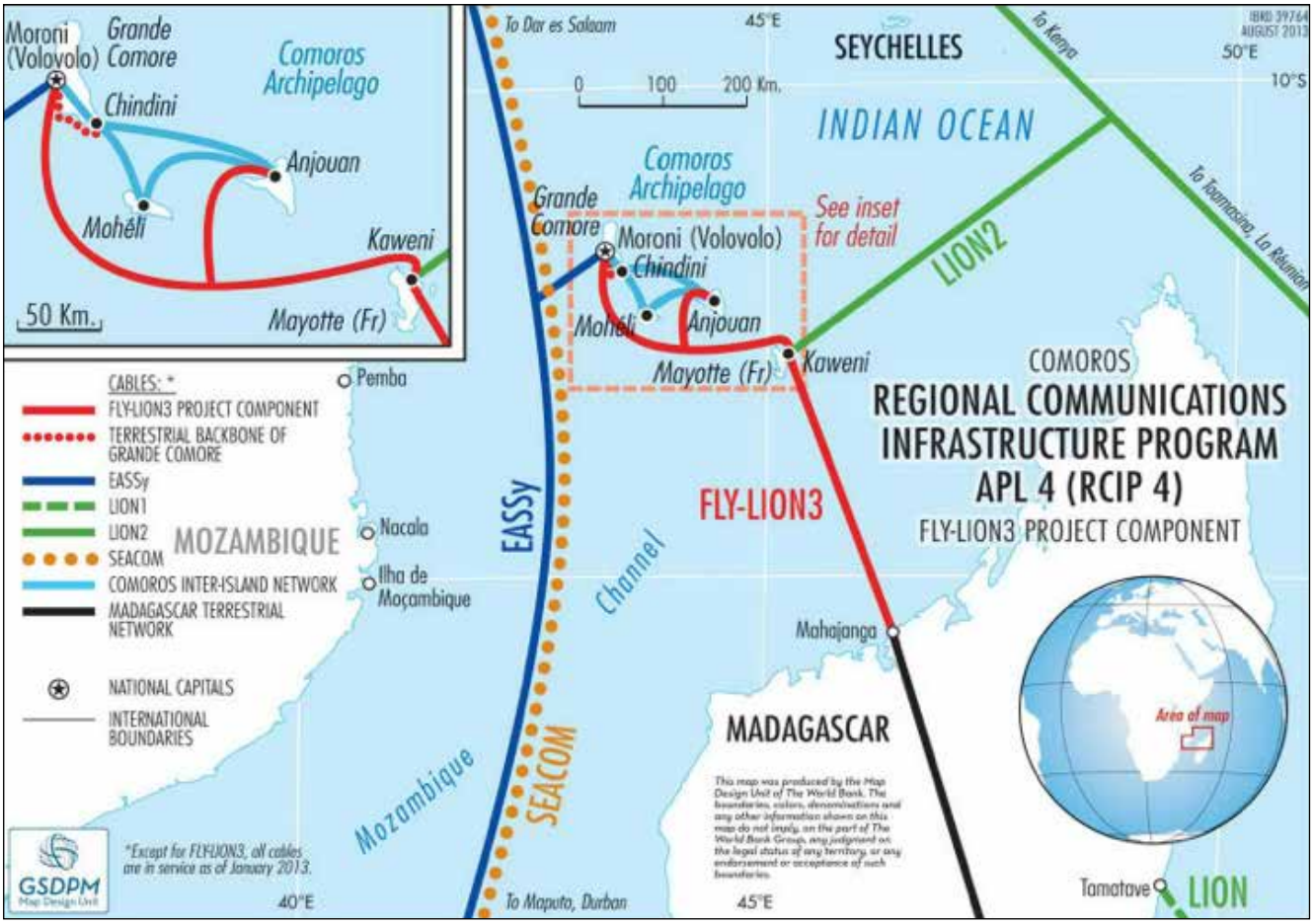

Figure CS 2.2. Current and Planned Submarine Cables in Comoros (Source: World Bank)

Capacity-building infrastructure

The University of the Comoros offers some programmes in informatics, notably through the Institut Universitaire de Technologie (IUT). The Network of French-Comorian Alliances *(Réseau des Alliances franco-comoriennes)* offers courses in office applications to approximately 900 students per session.[19]

There is a limited start-up community—most educated young people pursue careers in politics, working for others, or informal work.[20] Under the RCIP4 programme, there are plans to establish a coworking space at the IUT, as well as other measures to encourage entrepreneurship and digital literacy. In November 2016, Comoros hosted the Indian Ocean WebCup, a competition for application developers and designers from the region.[21]

Power supply infrastructure

The availability of adequate power is a challenge in Comoros.[22] The electricity sector suffers from unreliable distribution and losses of up to 40%. Electricity shortages cause blackouts lasting for hours. It takes an average of four months for a business to get a connection.[23] Several projects funded by the African Development Bank and World Bank are underway to alleviate these issues.

[19] http://www.comores.campusfrance.org/site/le-reseau-des-alliances-franco-comorienne.

[20] http://comorestoday.com/770-2/.

[21] http://comores.webcup.fr.

[22] http://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Comoros%20-%20Energy%20Sector%20Support%20Project%20-%20Appraisal%20Report.pdf.

[23] http://www.doingbusiness.org/data/exploreeconomies/comoros/#getting-electricity.

Nevertheless, the availability of electricity at the household level is relatively high for an LDC. The proportion of households with electricity was 69% in 2012, thanks in part to the relative high population density (Table 2.2). However, lack of electricity is not a strict barrier to ICT access: there is a higher penetration of mobile phones in rural households than there is electricity, implying that users find ways to charge their cell phones (e.g., away from the household or using car batteries).

Electricity			Mobile Phone		
Total	Urban	Rural	Total	Urban	Rural
69.3	85.1	61.4	73.0	86.6	66.3

Table CS 2.2. Availability of Electricity and Mobile Phones in Households in Comoros (% of households), 2012 (Source: Direction Générale de la Statistique et de la Prospective (DGSP) et ICF International, 2014: Enquête Démographique et de Santé et à Indicateurs Multiples aux Comores 2012)

Applications and Content

Despite the demonstrated impact of ICTs in areas of particular importance for development, currently there are very few significant uses of ICT across the economy. This is partly due to low take-up and historically high prices that have discouraged use, experimentation, and creation of a relevant market. There were a number of one-off projects to implement ICTs in different areas, but, in general, they didn't scale.

E-government

The use of ICTs in public administration is limited; only a few government agencies have an online presence. At the time of this report, the national portal was under construction.[24] According to the UN, the country's 2016 E-government score was 0.2155, ranking it 176 out of 193 countries.[25]

Banking and e-payments

According to the IMF, approximately 10% of the population has a bank account. There is no formal mobile money implementation in the Comoros, although it is expected that Telma Comoros will introduce one similar to its MVola product in Madagascar. Deployment of mobile money would strengthen financial inclusion and facilitate financial transactions. In 2014, the country had only 27 ATMs and five bank branches in the country.[26] Despite the lack of a formal mobile money system, it appears that airtime credit is being used to transfer funds. According to the Global Financial Inclusion Database, 4% of the population aged 15 and older received money via a mobile phone in 2011.[27] The Central Bank recently issued guidelines that acknowledges electronic payments, but also creates a number of restrictions, including types of payments and amounts that are allowed.[28]

As noted, remittances are significant to the economy, amounting to US$129 million in 2015.[29] Evidence from other countries suggests that the use of mobile money for international remittances is often cheaper and more direct than other methods.

Media

The national broadcaster, *Office de Radio et Télévision des Comores (ORTC),* offers clips from new programmes on its website,[30] and has a site specifically targeting diaspora in France.[31] Radio Comores is also available on several streaming services. One of the national newspapers has a website.[32]

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[24] http://beit-salam.km according to the United Nations Public Administration Country Studies. [Accessed 30 September 2016].

[25] https://publicadministration.un.org/egovkb/en-us/Data/Country-Information/id/38-Comoros.

[26] http://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C&sId=1460043522778.

[27] http://datatopics.worldbank.org/financialinclusion//.

[28] Central Bank of the Comoros. 2016. "III. Nouvelle règlementation relative aux moyens et systèmes de paiement." Bulletin trimestriel de la Banque Centrale des Comores, March. http://www.banque-comores.km/DOCUMENTS/Bulletin_BCC_n9_Mars_2016.pdf. [29] http://data.worldbank.org/indicator/BX.TRF.PWKR.CD.DT.

[30] http://www.radiocomores.km/index.php/historique-de-l-ortc.

[31] http://www.ortc.fr.

[32] http://www.alwatwan.net.

Education

The Ministry responsible for education has a website with information about the education sector.[33]

Created in 2003, the University of the Comoros is the country's only university.[34] In the 2014/15 school year, there were 8,350 students enrolled across campuses spread throughout the archipelago. There is no national education research network, although the Arab States Research and Education Network (ASREN) is keen to support this.[35] This Francophone organization has developed a "digital Francophone campus" in Moroni. Part of the National Centre for Documentation and Scientific Research *(Centre National de Documentation et de Recherche Scientifique),* the Moroni campus offers access to the Internet, video conferencing, distance learning, and the production of content.[36]

According to UNESCO, there is no national strategy or plan in the Comoros for ICT in education.[37] Only 13% of primary schools and 22% of lower secondary schools had electricity in 2013. Only 21% of upper-secondary schools have computer laboratories—a ratio of 131 students to each computer.

ITU is supporting increased computers and Internet access for remote, rural, and underserved schools as part of the "Connect a School, Connect a Community" project. The project also aims to train teachers and provide ICT access to local community members during off-school hours.[38] Three schools are connected on Anjouan, and each received 10 PCs, a laptop, and a server.[39] However, a recent visit (November 2015) found two of the three computer rooms locked and only one functioning. The lack of reliable electricity services, and the high cost of Internet access from Comoros Telecoms, is partly to blame.

Health

According to the World Health Organization (WHO), ICT initiatives in health are virtually zero.[40] There is no e-Health policy or strategy, although there is a strategy for developing a Health Information System (HIS). But there is some use of text messages to promote health and to issue emergency announcements.

Agriculture

Given the importance of agriculture and fishing to both the economy and individual livelihoods, the use of ICTs is very relevant. Like other sectors, however, the application of ICTs is limited. The Food and Agriculture Organization (FAO) is supporting a project that includes a component to create a food safety database and a food security monitoring system.[41]

Tourism

The government tourist office has a website with information for visitors to the country.[42] Mobile roaming is theoretically available, but in practice is very limited for tourists, who must purchase a local SIM card.[43]

Outlook

Connection to the EASSy submarine cable, plus the recent addition of two more cables, the creation of an interisland fibre-optic backbone, and the launch of 3G services have provided a solid connectivity platform for the Comoros. However, tariffs remain high in relation to the low incomes in the country, and discourage take-up. It is expected that a new operator will intensify competition at both the wholesale and retail levels, and lead to more widespread adoption of the Internet in the country.

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[33] http://www.mineducomores.gouv.km.

[34] http://www.univ-comores.km.

[35] http://asrenorg.net/?q=content/comoros-0.

[36] https://www.auf.org/actualites/comores-inauguration-de-leco-campus-numerique-fran/.

[37] http://www.uis.unesco.org/Communication/Documents/ICT-africa.pdf.

[38] http://www.itu.int/net4/ITU-D/CDS/projects/display.asp?ProjectNo=2COM15001.

[39] http://www.anrtic.km/articles/suivi-du-projet-connecter-une-ecole-connecter-une-communaute.html.

[40] http://www.who.int/goe/publications/atlas/2015/com.pdf?ua=1.

[41] http://www.fao.org/3/a-ax422e.pdf.

[42] http://www.tourisme.gouv.km.

[43] http://maps.mobileworldlive.com/network_info.php?nid=539&org_id=10584&cid=54#dvroaming.

Although connectivity is improving, low levels of literacy constrain online usage and, given the small market size, discourage development of e-businesses. The lack of e-payment options to monetize innovative ICT products and services is an obstacle to the wider application of ICTs across the economy, and the ICT expertise to develop applications and services is lacking. For these reasons, Comoros is missing the benefits that ICTs can deliver for development, particularly given its remoteness and limited human resources.

Considering the lack of financial resources, there is a role for the international community in promoting the wider application of ICTs both across the economy and in key sectors, including agriculture, education, and health. The RCIP4 project has set aside US$5 million for demand-stimulation programmes, but much more is needed. Interventions must be able to scale for ICT to have a lasting and sustainable impact.

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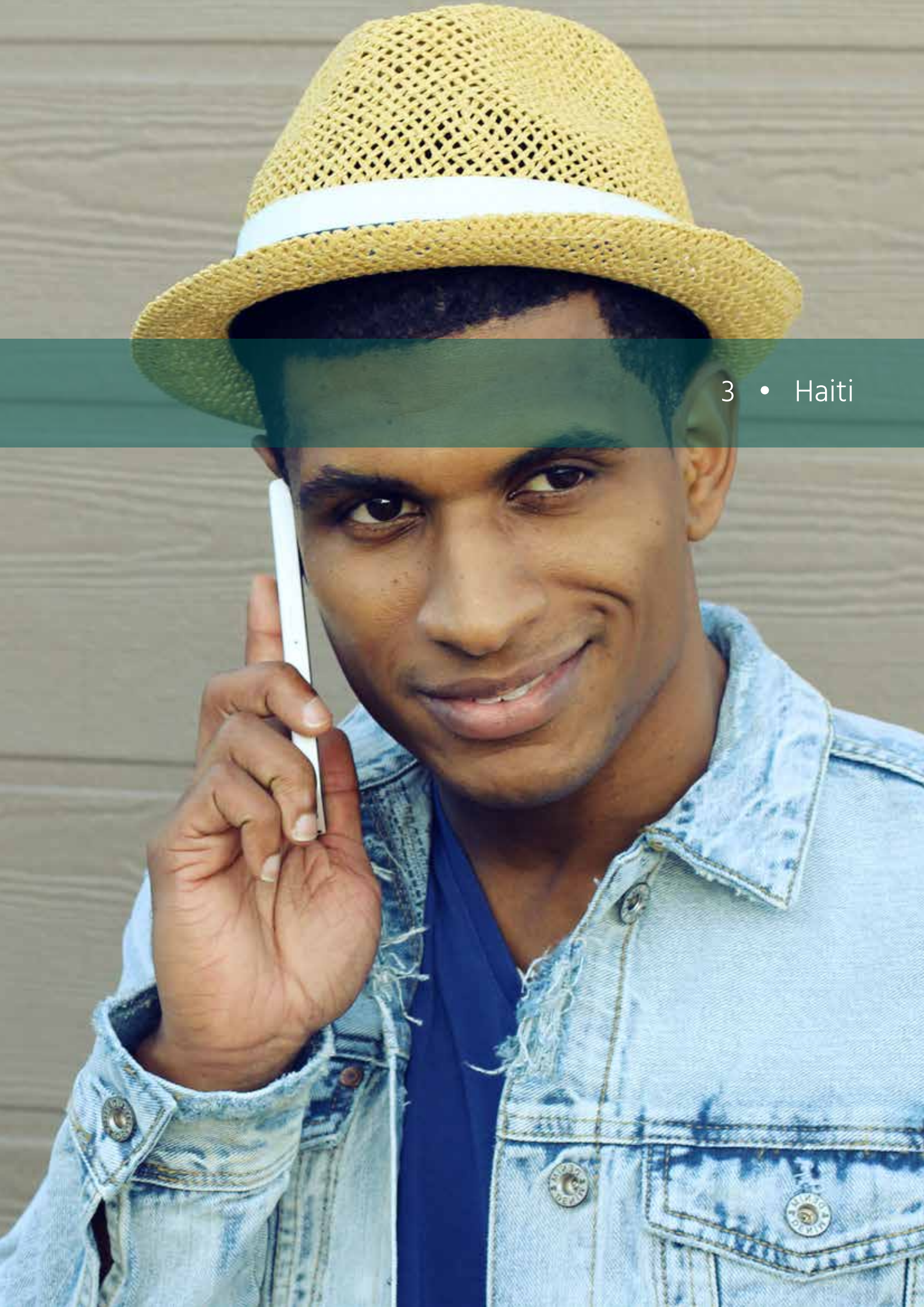

3 • Haiti

Key Features

The Republic of Haiti is located on the island of Hispaniola, in the Greater Antilles archipelago of the Caribbean. Haiti shares the island with the Dominican Republic, and alone covers an area of 27,750 km^2. At its closest point, it is 83 km away from Cuba. Haiti also comprises various inhabited offshore islands, notably Tortuga (Île de la Tortue) on the coast of northern Haiti, La Gonave, Île à Vache, and Île d' Anacaona.

Figure CS 3.1: Map of Haiti (Source: Ministere des Affairs Etrangeres, http://www.diplomatie.ht/le-pays)

With a population 10.7 million people (2015), Haiti is the most populous country in the Caribbean Community (CARICOM), and the second-most populous country in the Caribbean as a whole. The capital, Port au Prince, has a population of about 1.3 million. The population is relatively young, with a median age of 22.5, and more than 50% of the population is below the age of 25. Haiti has an unemployment rate of more than 40%, a literacy rate of approximately 60%.

During the last century, Haiti has suffered from long periods of political instability. The UN Stabilisation Mission (MINUSTAH) was establishing after the 2004 coup d'état, and it remains in the country to the present day. In February 2016, Michel Martelly stepped down as president without a successor after a deal was reached for a provisional government, leaving Prime Minister Evans Paul in power until an interim president is chosen by both chambers of Parliament.

The unstable political situation, combined with the impact of hurricanes, environmental degradation[1], and the 2010 earthquake (which left over 310,000 people dead), has resulted in Haiti having the lowest Human Development Index in the Americas. With a GDP of only about US$9 billion and a per capita GNI of US$1,760.[2] It is the only country in the region classified as low-income, and an estimated 1 million people are dependent on humanitarian aid.

In September 2009, Haiti met the conditions set out by the IMF and World Bank's Heavily Indebted Poor Countries (HIPC) programme to qualify for cancellation of its external debt. The largest donor is the United States, followed by Canada and the European Union; significant support for the government's budget has also come from an agreement with Petrocaribe, the Venezuelan government-led oil alliance that has assisted a number of Caribbean states through the provision of subsidized oil. Neighbouring Dominican Republic has also provided humanitarian aid to Haiti.

Remittances are a primary source of foreign exchange, equivalent to 20% of GDP and representing more than five times the earnings from exports in 2012.[3] Tourism revenues from cruise ships and resort hotels is increasing.

The two official languages of Haiti are French and Haitian Creole (Kreyol). French is the principal written language and is spoken by about 40% of Haitians.

Status of Internet Use

At about 0.5% penetration, Haiti's fixed-line teledensity is amongst the lowest in the world, partly as a result of the damage resulting from hurricanes and the 2010 earthquake. While there is extensive use of mobile voice telephony and broadcast radio, Haiti's use of the Internet is still at an early stage of development. Considering the country's very low income levels, mobile use is relatively high—about 70% penetration and 100 million minutes a month of traffic (Figure 3.1). In addition, there are more than 350 licenced radio stations and 347 unauthorised stations operating across the country. Due to recent investment, fibre to the premises is also now available in the major urban areas. 4G services are in test phase by the incumbent operator (now partially privatised), while a variety of 4G wireless broadband fixed and mobile technologies are offered by ISPs.

	Total	Penetration (% of population)
Population	10,711,067	-
Mobile subscriptions (SIM cards)	7,300,964	68%
Mobile broadband subscriptions	1,634 (TBC)	0.16%
Broadband subscriptions, fixed	(TBC)	-
Mobile broadband coverage	-	58%
International capacity in use	TBC (Gbps)	TBC (Kbps/capita)
AS numbers	11	-
IP addresses (v4/v6)	159744/?	-
ccTLD domain names registered	2820	-
Facebook subscribers	1,300,00	-
.ht Web pages indexed by Google	860,000	-

Table CS 3.1. Market Statistics for Haiti
(Sources: http://conatel.gouv.ht/sites/default/files/TABLEAU_DE_BORD%20%281%29.pdf, http://www.nirsoft.net/countryip/ht.html, http://research.domain-tools.com/statistics/tld-counts, http://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.17-2016-PDF-E.pdf)

[1] Haiti's forests covered 60 percent of the country fifty years ago, but today less than one percent of the country is forested. http://www.lambifund.org/programs_reforestation.shtml.

[2] http://data.worldbank.org/indicator/NY.GNP.PCAP.PP.CD.

[3] https://www.cia.gov/library/publications/the-world-factbook/geos/ha.html.

Haiti: Maintaining Connectivity During an Earthquake

The details of how communications functioned during and directly after the 2010 earthquake are of interest for any location that is vulnerable to severe environmental events. At the time, Haiti had three cellular companies and one landline company. Teleco, the incumbent fixed-line operator, had fewer than 100,000 lines, of which only about 30% were working before the earthquake. The country's only submarine cable landing station, operated by Teleco and connecting to the Bahamas, was destroyed by the earthquake.

The high fees charged for international capacity by Teleco meant that most communications (from the other private mobile operators and ISPs) used satellite links or microwave to access fibre in the Dominican Republic (which remained functioning). At the time of the earthquake, about 1 Gbps of wireless traffic was being exchanged with the Dominican Republic.

Right after the earthquake, the only operator that was still almost fully operational was Haitel, one of the smaller networks. It remained online mostly because it used almost exclusively 30- to 60-metre towers that were built to withstand hurricanes and earthquakes. Due to its small size, however, Haitel's network was quickly overloaded.

There were two major ISPs—Access Haiti and Hainet—that obtained their service through the Dominican Republic and were quickly able to restore local services. They both offered free VoIP lines for people to call relatives in the United States, Canada, and the Dominican Republic during the crisis. The core Internet infrastructure and the IXP survived the earthquake, although aftershocks temporarily cut two of the ISPs' fibre links to the IXP. Because of the extensive use of wireless technologies, telecommunications were quickly restored. ISPs initially only lost about 40% of their subscribers, and subsequently regained about 20%.

Satellite communications were also a vital part of the relief efforts. To accommodate needed bandwidth, Inmarsat reallocated spot beams from its I-4 satellites to Haiti. In the two weeks after the earthquake, more than 100 humanitarian organizations relied on satellite connectivity to coordinate and manage their work. Figure 3.2 shows Internet traffic before and after the earthquake.

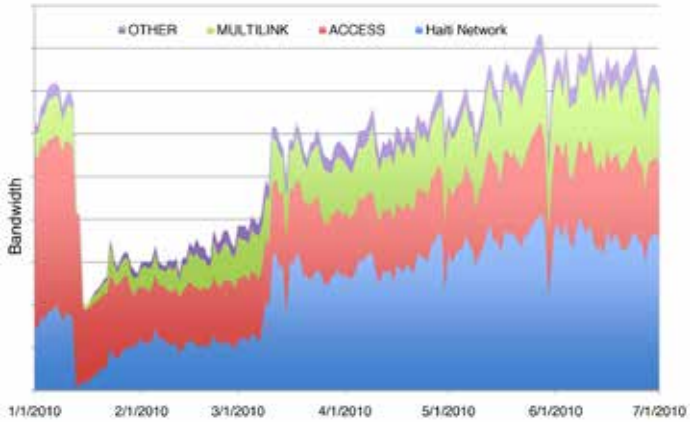

Figure CS 3.2. Internet Traffic before and after the 2010 Earthquake in Haiti
(Source: Internal Google Data, https://www.google.org/docs/Haiti.pdf)

ICT Policy and Regulatory Framework

Institutional structures

The Ministry of Public Works, Transport, and Communications *(Ministère des Travaux Publics, Transports et Communications, MTPTC)* is responsible for the ICT sector. It is regulated by the National Council of Telecommunications *(Conseil National des Telecommunications,* CONATEL), which was established in 1969 and is also responsible for the regulation of spectrum and broadcasting.

In 2013, CONATEL announced plans for establishing a Universal Service Fund that would focus on ensuring local government offices obtain connectivity. The fund would be financed from a 2% levy on licenced operator revenues.[4]

ICT policies and regulations

With the focus on reconstruction and political stability, little attention has as yet been paid to developing a national ICT policy or formulating a broadband plan. The current Telecommunications Law[5] dates from 1977; a new telecom act has been in the process of development since 2012 and is expected to be passed in 2017.

Haiti is part of an ITU initiative called Harmonization of ICT Policies, Legislation, and Regulatory Procedures in the Caribbean (HIPCAR),[6] with the objective of supporting ICT policy development in the region with financial assistance from the European Commission, in collaboration with CARICOM and the CTU. HIPCAR assessment of Haiti indicated that it has yet to adopt any of the following basic regulatory instruments:

- Cost-oriented, transparent, nondiscriminatory licensing regime
- Method of determining dominance
- Regulated process for negotiation
- Reference interconnection offer (RIO)
- Infrastructure sharing
- Local loop unbundling
- Mobile termination rates (MTR)
- Dispute resolution
- International gateway access

The current Law does not mention licensing procedures, except that the State has a monopoly over telecommunications services and may grant licences or authorizations for certain activities.

Regionally, the BIIPAC project, launched in February 2013 with support from the Inter-American Development Bank (IADB) and the Caribbean Association of National Telecommunications Organisations (CANTO), established the initiative Broadband Infrastructure Inventory and Public Awareness in the Caribbean (BIIPAC). BIIPAC comprises the following four key components:

- Broadband diagnosis and preparation of infrastructure maps
- Review of regulatory and institutional frameworks and current sector trends
- Implementation of ICT awareness and capacity building in the Caribbean
- Regional public policy recommendations for the design of national broadband strategies[7]

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[4] http://conatel.gouv.ht/node/44.

[5] http://conatel.gouv.ht/sites/default/files/loitelecom.pdf.

[6] https://www.itu.int/en/ITU-D/Projects/ITU-EC-ACP/HIPCAR/Documents/FINAL%20DOCUMENTS/ENGLISH%20DOCS/interconnection_assessment.pdf.

[7] IADB (2012). Technical Cooperation Document, pp.. 3-6. Retrieved from: http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=37562583.

Eight countries—Barbados, Belize, Dominican Republic, Guyana, Haiti, Jamaica, Suriname, and Trinidad and Tobago—participated in BIIPAC. The project ended in 2015, and the final reports were recently published.[8] The report on Haiti proposes that an ICT committee be created, headed by both the Prime Minister and an ICT agency set up by the government of Haiti and tasked with "coordinating and alignment of activities of nonprofit organisations, foreign government aid, and the Haitian public and private sectors". The report recommends developing digital literacy programmes and investing in e-government applications. Focussing on the upcoming Telecommunications Act, it proposes that the Act be updated in the context of a broader upgrade to the legal and regulatory framework covering electronic transactions, privacy, data protection, and other recent technical developments.

At the same time, the regulator CONATEL is drawing up plans for 4G spectrum auctions and licensing, following LTE trials by the incumbent operator. Number portability is also expected to be introduced shortly.

Government ICT programmes

Haiti's ICT development activities have primarily focussed on reconstruction work. As part of the government's strategic plan, Emerging Country 2030, a number of initiatives are in place to improve access to infrastructure, including ICTs. These initiatives are primarily implemented through the incumbent operator, Natcom, in which the government has a 40% shareholding.

Network Infrastructure

International connectivity

International connections with Haiti are made by satellite, terrestrial microwave, and optic fibre to the border of the Dominican Republic; and via two submarine cables: the Bahamas Domestic Submarine Network (BDSNi), which has onward links to the United States, and Fibralink, which connects Haiti to Jamaica and the Dominican Republic (Figure 3.3). BDSNi runs the length of the Bahamas with a spur to Haiti, and has a capacity of 50 Gbps, although its end-of-life design capacity is 2.4 Tbps. Fibralink connects Haiti with Jamaica and the Dominican Republic; it has a current capacity of 40 Gbps and an end-of-life design capacity of 7.2 Tbps.

The two submarine cables have been part of the network of Columbus, then Cable & Wireless Networks, and now Liberty Global. Digicel operates the Fibralink landing station, Natcom operates the BDSNi one. On the east side of the island, in the Dominican Republic, in addition to FibraLink, four other cables land: Antillas 1, ARCOS, AMX-1 and East West (EWC). These provide alternative routes for traffic via the microwave and terrestrial fibre links.

It is unclear to what extent Natcom and Digicel's terrestrial infrastructure to the Dominican Republic border is used to transit Haitian traffic to international destinations. It appears that both operators have obtained fibre links to the submarine landing stations in the Dominican Republic.

Dominican carrier BW Telecom owns a fibre-optic network to the Haitian border, where it connects with the networks of Digicel and NATCOM. It then provides links to Puerto Plata in the Dominican Republic. Puerto Plata has multiple submarine links to the United States and elsewhere, including AMX-1, ARCOS-1, and Fibralink. Digicel has one dark fibre pair from BW Telecom on this route, which gives it a terrestrial alternative to the Fibralink submarine cable in which it is part owner for traffic from anywhere in Haiti to the Puerto Plata submarine network gateway. As Fibralink also lands in the Dominican Republic, Digicel can make use of its own capacity from there, as well. Natcom apparently used to lease a similar service from BW Telecom, but recently let the agreement lapse.

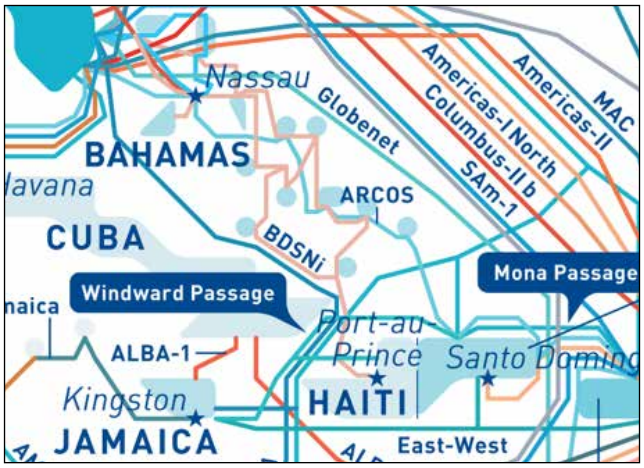

Figure CS 3.3. Map of the Submarine Cable Networks in and around Haiti (Source: PCCW Telegeography cable map, http://submarine-cable-map-2016.telegeography.com/)

[9] http://canto.org/canto-projects/cantoidb-biipac-project/final-biipac-component-reports.

[10] http://licensing.fcc.gov/myibfs/download.do?attachment_key=1089872.

Other carriers in the Dominican Republic such as Trilogy (owners of Viva), Claro (America Movil), and other small ISPs provide microwave links between Haiti and the Dominican Republic.[9]

Pricing data

Data on wholesale international capacity prices has yet to be confirmed.

International outgoing calls range in cost from US$0.075 to US$0.22 per minute, depending on the provider.[10] Incoming international calls cost about US$0.24 per minute to fixed lines, while calls to mobiles cost US$0.37 per minute (compared to US$0.12 to fixed and US$0.21 to mobile in nearby Jamaica, and US$0.08 and US$0.14 in the Dominican Republic).

Public network operators

Two operators dominate the retail market for voice and 3G mobile broadband: the previous incumbent Teleco (now called Natcom following partial privatisation in 2011)[11] with 4.7 million customers, and Ireland-based Digicel[12] with about 2.6 million customers in December 2015. The Vietnamese operator Viettel acquired a 60% share in the state-owned operator, which was transformed into the new entity Natcom; 40% of the shareholding was retained by the government. Viettel's bid for Teleco/Natcom included a commitment to build a 2,000 km fibre-optic cable to provide Internet access in particular to remote areas. According to Natcom, it has exceeded this commitment and the cable is over 6,500 km long. Digicel has also continued to invest in national fibre, and both Digicel and Natcom have national backbones that extend to the border with the Dominican Republic in the north of the country.

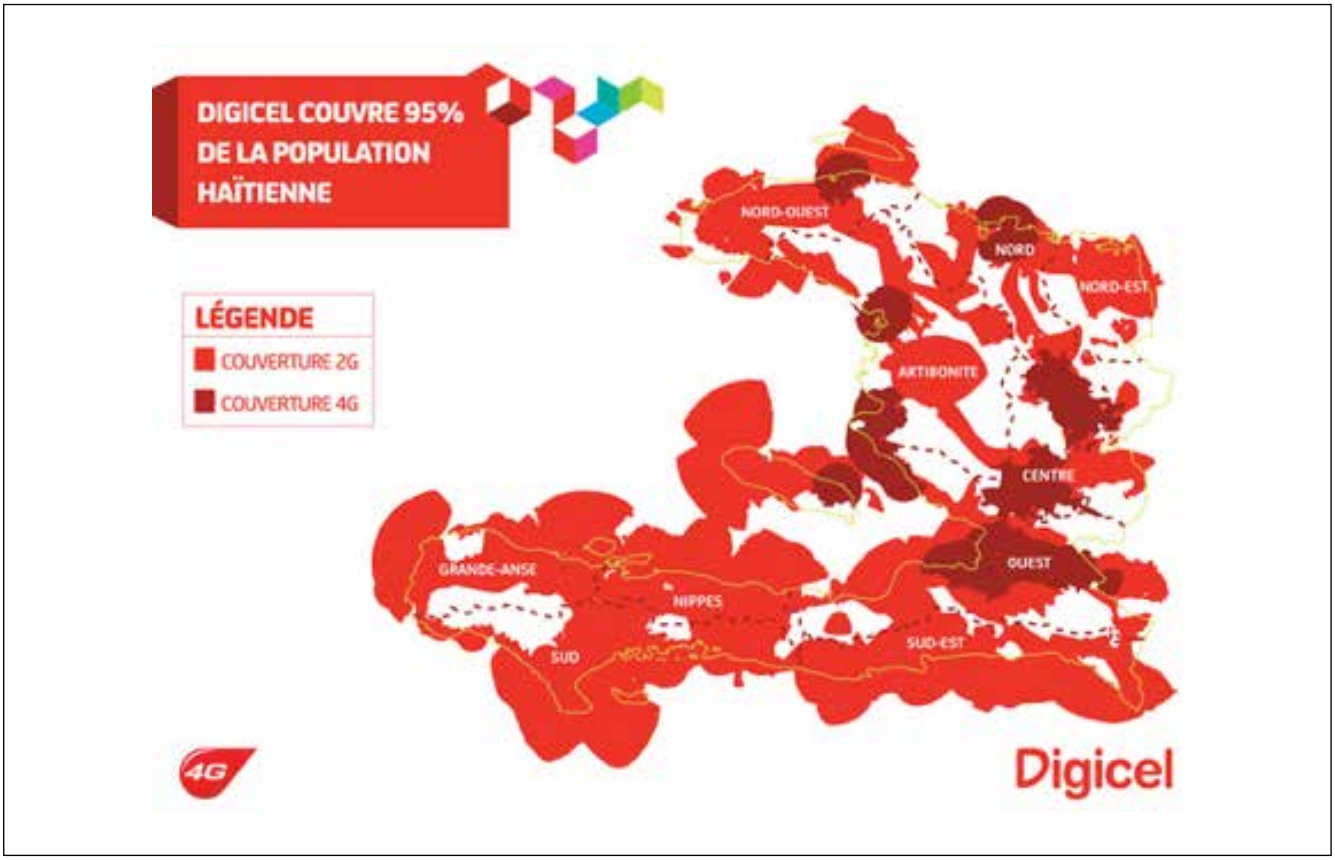

Figure CS 3.4. Map of Digicel's Mobile Coverage in Haiti (Source: http://www.digicelhaiti.com/fr/coverage_roaming/coverage_map)

[10] http://conatel.gouv.ht/sites/default/files/TABLEAU%5B2%5D.pdf.

[11] http://www.natcom.com.ht.

[12] http://www.digicelhaiti.com.

Natcom is currently the sole operator in Haiti with a (temporary) 4G concession covering six metropolitan areas of the capital Port-au-Prince: Delmas, Petionville, City Centre, Carrefour, Tabarre, and Plaine du Cul-de-sac. The operator announced in June 2016 that it will soon start trials of LTE; further developments are awaiting CONATELs announcement of a plan for auctioning 4G spectrum.

Digicel entered the market in 2006, winning 1.4 million subscribers in the first year after making the largest investment ever in the country by an international company (US$260 million). Figure 3.4 shows the coverage of its mobile network in Haiti.

In the fixed-line broadband market, Access Haiti[13] is the largest dedicated Internet provider in the country, providing both fixed wireless, mobile broadband (via 4G WiMAX dongles), and fibre to the premises. It has also begun providing telephony services.

Hainet[14] is the other major ISP operating in Haiti, offering a range of fixed wireless and satellite broadband services.

Pricing data

On-net and off-net domestic calls cost between US$0.06 and US$0.075 a minute.

Natcom offers a variety of broadband pricing options; the most indicative are the following:

- 3G off-peak use costs US$0.30 from 11pm to 5am.
- A 7GB 3G data bundle costs US$12 and is valid for 30 days.
- A 4 Mbps FTTH link with contention (i.e., shared with other users) costs US$220 per month, while a 4 Mbps dedicated link costs US$2,295 per month.

Digicel charges US$3.80 for a 1.25 Gb data bundle and US$15 for a 7 Gb bundle, valid for at least 30 days.

Access Haiti charges US$30 per month for 1 Mbps downstream/256 kbps upstream, US$86 per month for 3 Mbps downstream/ 1 Mbps upstream, and US$249 per month for 10 Mbps downstream/ 1.2 Mbps upstream. Hainet's pricing structure is very similar, although the prices are about 10% higher.

Public sector networks

Education

The education sector in Haiti has substantial challenges, partly due to the destruction of infrastructure. Although education is compulsory, many children do not go to school because their help is needed at home. Others do not complete their studies due to poor facilities and a lack of qualified teachers. It is estimated that only 50% of children between the ages 7 and 12 attend school.

Except for the sole public university—the State University of Haiti (UEH)—private universities predominate. The majority of universities are located in Port au Prince. Most of Haiti's higher education institutions were impaired or completely demolished during the earthquake in 2010, and have been rebuilding their premises and networks since then. A Research and Education Network (REN) for Haiti has been under discussion since 2011. It aims to establish an urban and rural regional network infrastructure connecting clinics, schools, and universities in the country at speeds between 100 Mbps and 1 Gbps.

Natcom says it has been providing free Internet access to 1,309 schools nationwide since 2011. From late 2014, the incumbent has had an agreement with Ministry of Education to provide 200,000 free 'Nat-Edu' SIM cards for people working in education, and to offer SIMs for communications at US$4 per month from 2015 to 2025.

Surtab[15] designs and sells computer hardware and consumer electronics, most notably tablets and mobile classrooms targeted at improving Haiti's education system. In 2014, the firm received an order from Venezuela for 10,000 tablets.[16]

Healthcare

Natcom provided free Internet connections to more than 400 medical centres in a project that was completed in 2014.

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[13] http://www.accesshaiti.com.

[14] http://hainetgroup.com.

[15] http://surtab.com.

[16] http://www.reuters.com/article/2014/03/16/us-haiti-tablet-idUSBREA2F0B020140316.

Government

Since 2011, Natcom has sponsored 35 connection points for a high-definition videoconferencing system, to facilitate decision making across the country. This project also helps the government to implement an e-government programme to bridge the digital gap between rural and urban areas.

Private networks

Little information is available on private networks that have been authorised in Haiti. A number of banks and other corporate institutions either use satellite links or wireless networks provided by the ISPs.

NGO networks

Arising from emergency work to restore communications in Haiti after the 2010 earthquake, United States-based social enterprise Inveneo began development of a rural wireless network being built as part of the Haiti Rural Initiative and designed to provide Internet access in six key rural regions, starting with Leogane, east of Jacmel and Mirabelais. The project receives support from the IADB and the EKTA Foundation. Also known as both the Haiti Connected Cities project and the Haiti Rural Broadband Network (HRBN), it is a collaborative programme involving Haitian ISPs, ICT entrepreneurs, and nonprofit organizations that will benefit from access to reliable and affordable broadband Internet. By late 2012 a backbone had been built comprising hundreds of radios at 31 tower sites and connecting 65 clients.

Inveneo has also established a framework, called BATI, in which young Haitians with ICT skills provide the first line of support, followed by the Haitian telecom company Haicom,[17] which has taken over responsibilities for the Network Operations Centre while the firm Transversal handles physical installation and maintenance of the equipment. As of April 2012, the broadband network covers 20.72% of the Haitian population.

Interconnection and hosting

There are no carrier-neutral data centres in Haiti. Digicel recently set up a Tier 3 data centre that is both hurricane-proof (able to withstand a Category 5 event) and earthquake resistant (classified as a Category 3 structure). Natcom also has its own data centre.

The AHTIC IXP[18] has been operational in Port au Prince since 2009. The IXP is a result of cooperation between the Network Startup Resource Center (NSRC) at the University of Oregon and the local Haitian Association for the Development of ICTs *(Association Haitienne pour le developpement des Technologies de l'Information et de la Communication,* AHTIC), a neutral, nonprofit organization representing the interests of ISPs, telecom operators, academic institutions, and end-users.

Nine members have been connected to the exchange; some are connected via fibre-optic links, others using radio links, and a few via Ethernet cable (because of their proximity to the IXP switch fabric). D- and F-Root DNS servers are present at the exchange, along with a Google Global Cache (GGC). Aggregated traffic through the IXP peaks at about 1 Gbps.

Haiti NIC[19] is the registry for the .ht ccTLD.

Capacity-building infrastructure

As indicated, there is no national education and research network yet in Haiti, although a regional initiative—C@ribNET—is underway that will have a major regional node in the Dominican Republic. This should provide the potential for a terrestrial link to Haiti. A strategy for the development of Haiti's NREN has already been developed as part of the C@ribNET project.[20]

With government support, about 20 cyber centres providing public access facilities have been installed across the country in Dame-Marie, Pétion-Ville, Delmas, les Cayes, and Port-de-Paix. Young people have been trained to manage these centres.

In 2013, ten eLearning centres were installed in schools and women's centres, as part of a project between Camara Haiti and Haven Partnership. Haiti's Centre for Professional Training (CFPH) provides professional ICT training.

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[17] http://www.haicom.ht.

[18] http://ixp.ht.

[19] http://nic.ht.

[20] http://www.ckln.org/home/sites/default/files/Haiti__NREN_Blueprint_-_B_&_F_1.pdf.

Power supply infrastructure

Grid power in Haiti is generally only intermittently available. According to USAID, Haiti faces two energy challenges: "a broken electricity sector and dependency on charcoal."[21] Even before the 2010 earthquake, only about a quarter of the population had access to electricity, and half of these were connected to the grid illegally. More than 90% of Haitians' energy needs are met through the use of firewood and charcoal.

There is no national grid; the national power utility, Electricité d'Haïti (EDH), operates one urban grid serving the Port-au-Prince area, plus a small number of isolated power grids for the rest of the country. Even for those with access to grid power, quality, and reliability are an issue: in Port-au-Prince, for example, there is an average of just 10 hours of service per day. In addition, the cost of grid power is an issue for businesses: although residential electricity tariffs are relatively low compared with other fossil-fuel-dependent countries in the region, commercial and industrial tariffs are amongst the highest. As a result, many home owners and businesses, especially operators and others dependent on ICTs, install generators.

The lack of grid power has created demand for suppliers of solar/photovoltaic systems such as Re-Volt,[22] which is an off-grid utility company aiming to provide affordable, reliable electricity.

The Improving Health Facility Infrastructure (IHFI) project was a multiyear effort funded by USAID and created to increase the energy supply to underserved healthcare facilities in several Caribbean countries. As part of the project, Tetra Tech was contracted to improve energy services for critical healthcare facilities in Haiti. The project focused on installing hybrid energy systems using solar, diesel, and off-grid energy, as well as energy-efficiency upgrades at small- and medium-sized health facilities. Sixteen small-scale, solar photovoltaic systems and approximately 30 battery and inverter backup power systems were installed with complete electrical rewiring and installation of energy-efficient devices in some of Haiti's largest hospitals.

Applications and Content

E-government

An e-Governance Unit has been established in the Office of the Prime Minister. The Unit is responsible for the implementation of the Integrated Platform of the Haitian Government (PIGH), which aims to establish basic ICT infrastructure in central government. A forum on standardization and harmonization of government ICT infrastructure was organized last year.

With support from USAID, the Secretary General of the Primature has been planning the establishment of a government electronic administration platform called X-Road, a component of the IFMS (Integrated Financial Management System), in order to facilitate the exchange of interinstitutional data and the decision-making process. The pilot phase in 2015 set up an electronic data exchange platform comprising 12 public institutions in collaboration with the Office of Management and Human Resources (OMHR).

A mapping system with georeferenced information on public institutions is under development. The system aims to help citizens find the location of public institutions. In addition, the MapHaiti pilot application will enable citizens to access information on projects executed by the Fund for Economic and Social Assistance (FAES).

Banking and E-payments

Most of the major banks, including UniBank and Capital Bank, have online banking facilities. The National Payment Processing Project (PRONAP), which was scheduled to come online in 2017, aims to improve access to financial services via the development of nonbank networks, electronic money, and digital finance.[23]

It is estimated that Digicel's TchoTcho mobile payment platform serves two million subscribers. Last year, Natcom developed a similar service called Lejan Cash.

[21] https://www.usaid.gov/documents/1862/haiti-energy-fact-sheet-2016.

[22] http://www.re-volt.com.

[23] http://www.brh.net/discours_gouv_006.html.

Media

Haiti has a vibrant radio broadcasting sector with more than 700 stations, although only about half have licences. CONATEL recently intervened in the country's North West department, and five pirate radio stations were forced to suspend broadcasts.

Several analogue TV stations are available, including a government-owned cable TV subscription service. The analogue-to-digital switchover is underway, and CONATEL has been planning trials of digital broadcasting since mid-2015. It was expected that testing of digital broadcasts of the national TV station (TNH) would take place before the end of 2016.[24] However, plans have not been made public for the use of the digital dividend (the spectrum made available after the transition).

Local services

Education and health

An agreement was made in 2014 between the Ministry of Education and Microsoft to improve the access and use of technology in the Haitian educational environment.

The MIT-Haiti Initiative was launched in 2013 to provide technology-enhanced resources in the national language of Kreyol that would improve science and math education. The memorandum of understanding (MoU) signed between the Haitian government and MIT-Haiti Initiative comprises a total of US$1,310,811, including $1 million from the US National Science Foundation and donations from the faculty and staff at MIT and members of the Haitian government.

The Health eVillages NGO has partnered with Haiti's leading hospital, the Mirebalais, to train nurses in use of technology, content, and apps provided by Health eVillages and available in French by its partners. Founded in 2011 in partnership with RFK Human Rights and Aptus Health, Health eVillages provides a handheld device and support for each of the hospital's wards.

CommCare, an application developed by Dimagi, is deployed on Android smartphones and locally produced tablets called Surtabs. The app enables health workers to improve referrals between the community and medical facilities, where more highly trained medical staff reside. In addition, the app is a job aid that reinforces counselling via Creole audio messages[25].

Emergency services

In response to the post-hurricane damage, specifically the extensive damage to telecom infrastructure in the departments of Grande Anse, Nippes, and South, CONATEL established an emergency unit to involve the telecom sector in emergency operations. This unit is working on the development of a national emergency communication plan for the Ministry (MTPTC).

Given both the importance of radio communications in times of emergency and the current level of dysfunction of many the country's radio stations, the emergency unit formed an association with the network of amateur radio operators to facilitate radio-communication in severely affected regions.

Technical services

The Caracol industrial park, the largest industrial park in the Caribbean, was launched in 2015 and cost US$300 million. The project includes a 10 MW power plant, a water-treatment plant, and worker housing to accommodate an expected total of 65,000 jobs. According to the IDB, the park employed over 7,620 workers by the end of 2015; its goal is to reach 20,000 positions by 2020. In January 2016, the bank approved a US$41 million grant for the final phase of the park.

To take advantage of the industrial park, Avasant Foundation is launching its Business Process Outsourcing (BPO) training programme to ensure that BPO firms in Haiti do not run short of a talent pool. Known as "Employment: Digital Youth", the programme was first launched in Jamaica. In Haiti, Avasant plans to train as many as 50 youths in call centre services every six months over the coming years.

[24] http://conatel.gouv.ht/node/103 http://www.haitilibre.com/en/news-18963-haiti-technology-soon-a-digital-tv-pilot-channel.html.

[25] https://www.usaid.gov/news-information/frontlines/foreign-aid-impact/life-clouds-boosting-haitian-health.

Outlook

Haiti is likely the last large Caribbean nation to come online. Considering recent growth in backbone network deployment and broadband use, the country is already benefitting from rapid technological change by having avoided large investments in older technologies. Mobile and fixed broadband infrastructure is now available in large parts of the country, it has redundant submarine cable infrastructure, and enjoys terrestrial fibre capacity to neighbouring Dominican Republic, where many other cables land.

Haiti and the Dominican Republic have a combined population of approximately 19.5 million—48% of the Caribbean's population. As a result, the two countries have an opportunity to establish the largest telecom market in the region.

With improvements in ICT infrastructure, the government has high expectations for outsourcing and related industries, which have been estimated to have the potential to generate as many as 13,000 Haitian jobs (5,000 direct and 8,000 indirect jobs) over the next five years.[26] Haiti hopes to leverage its trilingual capabilities, pushing the fact that there is talent in English, Spanish, and French within the country.

Nevertheless, the cycle of environmental disasters and recovery, political change, combined with a low level of literacy, lack of grid power, and generally low levels of development, pose major challenges for improving connectivity, particularly outside the major urban centres.

At the policy and regulatory levels, special efforts likely will be needed to ensure an enabling environment that supports the maximum coverage of affordable broadband. As indicated in the BIIPAC study, development of regulations to limit the market power of the dominant operators will be necessary in order to ensure affordable prices.

In terms of future expansion of connectivity to submarine cables, linking Haiti and the Dominican Republic to Puerto Rico would consolidate the three countries as a significant market. Both Puerto Rico and the Dominican Republic have carrier-neutral data centres, and the inclusion of Puerto Rico could create a stronger interest from the United States. A new submarine cable landing in Haiti is also possible—the Columbus Networks system was designed with a nearby branching segment. This branch would provide Haiti with greater connectivity. But direct connectivity to the United States via Miami is even more desirable, as this would offer access to the US Internet backbone, which would deliver even greater cost reductions. For that reason, a new submarine cable to Miami may ultimately be the most cost-effective solution, if the islands collaborate to consolidate their demand.

Increased collaboration with the Dominican Republic has been discussed for some time. In 2011, the creation of a joint fibre-optic backbone and the establishment of a virtual network to link government agencies, schools, health centres, and municipalities was proposed in a workshop organized by the Dominican Institute of Telecommunications (Indotel), with financial support from the IDB and the World Bank, and in collaboration with the Ministry of Labour and CONATEL.[27]

In April 2016 the Dominican Republic announced that it will invest millions of dollars in a programme aimed at stimulating the digital economy, including laying 500 km of fibre-optic cable and providing access to 70% of the population.

Domestically, given Haiti's mountainous topography, a festoon (chain) network of submarine cables linking the coastal areas may be an option worth considering for improving backbone connectivity. If cable segment lengths can be kept under 100 km, low-cost, energy-efficient equipment can be used instead of traditional equipment. Google Foundation has proposed a design for such a middle-mile festoon network, as shown in Figure 3.5 (next page).

In addition to improved backbone connectivity, increased domestic competition is necessary in order to drive down prices and improve coverage. This is only likely to take place after the new Telecommunications Act has been adopted and there is clarity on the spectrum assignment strategy, specifically once the analogue-to-digital switchover takes place. Then, the market should be able to support more than two mobile operators and more fixed-line providers. Bahamas Telecommunications Company (BTC) has already indicated that it has an interest in the cellular market in Haiti.[28] In 2014, a representative stated: "In 2005, we negotiated building the fibre submarine cable into Haiti [...] We had made an offer to work with Teleco de Haiti [now Natcom] and looked at

[26] http://www.nearshoreamericas.com/haiti-lays-groundwork-welcoming-global-outsourcing-firms/.

[27] https://www.haitilibre.com/en/news-2445-haiti-technology-major-Internet-project-for-haiti-and-the-dominican-republic.html.

[28] https://www.telegeography.com/products/commsupdate/articles/2014/08/04/btc-planning-to-enter-haitis-telecoms-market/.

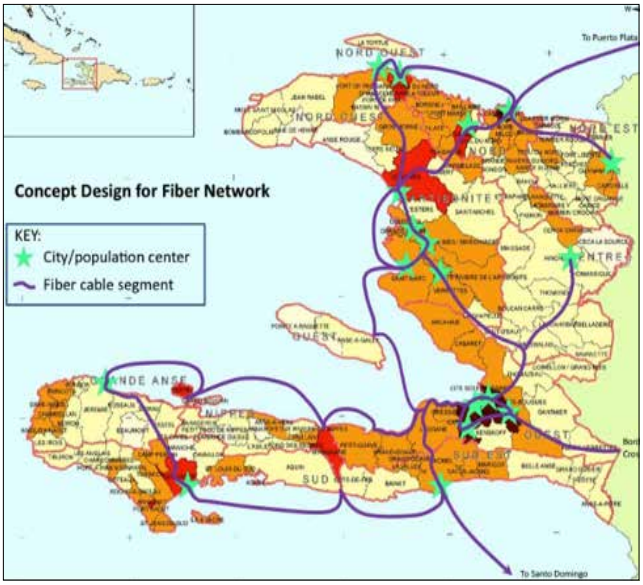

Figure CS 3.5. Map of Google Foundation's Proposal for Domestic Submarine Cables in Haiti (Source: https://www.google.org/docs/Haiti.pdf)

the possibility of a GSM licence, an Internet service provider (ISP) licence, and a cable licence. We did not capitalise on it and there was a change of administrations in 2007, so nothing happened with Haiti [...] We still have the cable there, it is working, it is underutilised and certainly BTC would like to go back into Haiti and see what the possibilities are."

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EKTA Foundation. 2012. Haiti Rural Broadband Programme http://www.ektafoundationusa.org/main/images/partners/haiti-rural-broadband-initiative.pdf.

Google. 2010. Ideas for Haiti's Internet Reconstruction. http://www.google.org/docs/Haiti.pdf.

4 • Saint Vincent and the Grenadines

Key Features

The Caribbean islands of Saint Vincent and the Grenadines (SVG) are located in the southern portion of the Windward Islands, where the Caribbean Sea joins the Atlantic Ocean. The nation had a total estimated population of 109,460 in 2016, of which 15% are concentrated in the capital city of Kingstown on the main island of Saint Vincent, where 92% of the total population reside. With a total area of 392 km^2, the country is relatively densely populated (over 300 inhabitants per km^2). The Grenadines include 32 islands, nine of which are inhabited; the largest islands are Bequia, Mustique (privately owned), Canouan, and Union. Bequia is the second most populated island, with about 10,000 people.

Most Vincentians are descendants of Africans brought to the island to work on British plantations. As a result, English is the official language, although most Vincentians speak Vincentian Creole. SVG is a parliamentary democracy and constitutional monarchy. As such, Queen Elizabeth II is head of state.

SVG is classified as a lower-middle-income economy, with a GNI per capita of US$6,670.[1] The GDP for 2016 was estimated at US$1.23 billion. Agriculture, dominated by banana production, is the most important sector; the services sector, based mostly on a growing tourist industry, is also important.

While overall literacy is relatively high, a national literacy survey (2002) revealed limited literacy among people with only a primary education; only 67.3% of people with a primary education can demonstrate basic literacy competencies.

Figure CS 4.1. Map of Saint Vincent and the Grenadines (Source: U Texas, http://www.lib.utexas.edu/maps/islands_oceans_poles/st_vincent_rel96.jpg)

Status of Internet Use

Domestic and international connectivity infrastructure is relatively well developed in SVG, and consequently there is a fairly high penetration of Internet use and telephony. With over 100% mobile penetration (due to multiple SIM cards in use by single subscribers), and 20% fixed-line penetration, as well as pay TV, the uptake of mobile and fixed broadband is substantial. The national regulatory authority, NTRC, estimates that 65% of the population were Internet users in 2015, a significant jump from the 47.5% in 2012.

Although the ICT sector is open to competition in all segments, following the merger of Cable & Wireless and Columbus fixed-line services are now a monopoly provided by Flow. This operator also competes in the mobile market with the only other licenced operator, Digicel, which is also beginning to move into fixed-line services—particularly fibre—in its nearby markets. To provide Internet services, the operators make use of 3G (EDGE), 4G (LTE), ADSL on copper lines, cable TV (coaxial) connections, and fibre to the premises (Table 4.1, next page). Of note is the relatively high number of fixed broadband subscribers—nearly 20% of the population has a fixed broadband subscription.

The relatively high number of domain name registrations compared to other countries in the region is due to the appeal of the .vc domain to venture capital enterprises around the world; the registration rules do not require a local presence in the country, resulting in the majority of domains being registered offshore.

[1] http://data.worldbank.org/country/st-vincent-and-the-grenadines.

	Total	Penetration (% of population)
Population	109,460	–
Licenced operators	1 mobile, 1 fixed/mobile	–
Mobile subscriptions (SIM cards)	110,070	100.3%
Data subscriptions, mobile (EDGE/3G/4G)	50,957	47%
Fixed broadband subscriptions	19,654	18%
Fixed lines in use	20,331	19%
International capacity in use	TBC (Gbps)	TBC (kbps/capita)
AS numbers (ASNs)	2	–
IP addresses (v4/v6)	30,208	–
ccTLD domain names registered (DNS)	49,687	–
Facebook users	59,000	54%
Web pages indexed	3,400,000	–

Table CS 4.1. Market Statistics for Saint Vincent and the Grenadines, 2016
(Sources: http://www.ntrc.vc/general/telecommunications-statistical-data, http://www.nirsoft.net/countryip/vc.html, http://research.domaintools.com/, statistics/tld-counts/, http://bgp.he.net, http://www.facebook.com, http://www.google.com)

ICT Policy and Regulatory Framework

Institutional structures

The Ministry of Foreign Affairs, Foreign Trade, Commerce, and IT is responsible for ICT. It has appointed a Minister of Information.

The National Telecommunications Regulatory Commission (NTRC),[2] is the regulatory authority for the sector. The NTRC was established by the 2001 Telecommunications Act,[3] and is also responsible for spectrum and the Universal Service Fund.

ICT policies and regulations

The Telecommunications Act (Cap 418) of the Revised Law of Saint Vincent and the Grenadines of 2009 governs the ICT sector. The government established a national ICT Strategy and Action Plan during the years 2010-2015[4] that focussed on actions recommended by the World Summit on the Information Society (WSIS) and set a number of priority areas, including cyber security, e commerce, an IXP, e-government, cloud computing, ICT training, public access facilities, and streamlined licensing procedures.

Parliament is currently debating the introduction of the Cybercrime Bill,[5] modelled on the regional template developed during the ITU's HIPCAR project.[6] SVG was an active participant in HIPCAR, which aimed to support ICT policy development in the region with financial assistance from the European Commission and in collaboration with CARICOM and the CTU. The HIPCAR assessment indicated that, except for local loop unbundling, SVG provided most of the desired regulatory instruments (such as infrastructure sharing, electronic transactions, and data privacy) required to effectively administer the sector.

This process has been assisted by SVG's membership in ECTEL, which has been working to support policy and regulatory development and harmonisation in the sector among its five member states: Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, and SVG. Of particular note is that ECTEL has now completed draft regulations in the following key areas:[7]

[2] http://www.ntrc.vc.

[3] http://ntrc.vc/docs/about/telecom_act_2001_SRO_NO_1.pdf.

[4] http://caribbean.cepal.org/content/st-vincent-grenadines-national-ict-strategy-and-action-plan-2010-2015.

[5] http://www.assembly.gov.vc/assembly/images/stories/cybercrime%20bill%202016.pdf.

[6] Harmonization of ICT Policies, Legislation and Regulatory Procedures in the Caribbean- https://www.itu.int/en/ITU-D/Projects/ITU-EC-ACP/HIPCAR/Documents/FINAL%20DOCUMENTS/ENGLISH%20DOCS/interconnection_assessment.pdf.

[7] http://www.ntrc.vc/consultation-on-adoption-in-ectel-states-of-regulations-addressing-guidelines-for-market-analysis-access-to-network-infrastructure-and-wholesale-services.

- Guidelines on market analysis and the assessment of significant market power in Eastern Caribbean Telecommunications Authority member states for electronic communications networks
- Access to network infrastructure and wholesale services
- Infrastructure-sharing
- International access to essential facilities at cable landing stations
- Retail pricing
- Consumer protection (including specific rules on consumer protection in the electronic communications sector)

In 2016, at its 34th regular meeting, ECTEL approved new legislation aimed at boosting competition in the region.[8] The new regulations address issues including consumer protection, submarine cable access, network infrastructure access, and wholesale services rules. A particular focus is on addressing access issues regarding networks owned by dominant operators and publishing guidelines on conducting market analyses. This was partly stimulated by the impact of Cable & Wireless's acquisition of Columbus International—the new legislation was introduced after ECTEL was unable to reach an agreement over market performance obligations with Cable & Wireless following the acquisition. ECTEL's members would otherwise have insufficient legal standing to stop or impose remedies on the companies involved.

The World Bank's Caribbean Regional Communications Infrastructure Programme (CARCIP) is currently supporting the development of a national broadband plan for SVC.

Government ICT programmes

Through an agreement reached with the Taiwan International Cooperation and Development Fund (ICDF), the government of SVG has been building an ICT Centre, a focal point for national e-government strategy, while also providing network facilities, equipment, and expertise for the implementation of cybersecurity measures. A new governmentwide web portal is also being constructed, through which citizens will be able to access online government services.[9]

The National Centre of Technological Innovation[10] provides technical ICT training and certification. It was initially set up in 2002 as a department under the Ministry, then established as an independent company in 2008.

Network Infrastructure

International connectivity

SVG currently has direct access to two cable systems: the Eastern Caribbean Fibre System (ECFS) and the Southern Caribbean Fibre (SCF[11]), which both land on the main island of Saint Vincent. ECFS provides connectivity to other islands in the region and to global backbones via a terminating point in the US Virgin Islands, a hub where many other submarine cables land. Similarly, SCF has connectivity to the cable hubs in Puerto Rico, the British Virgin Islands, and additional Caribbean islands. It also provides redundancy of links to neighbouring islands and global hubs in the event of a major outage on ECFS.

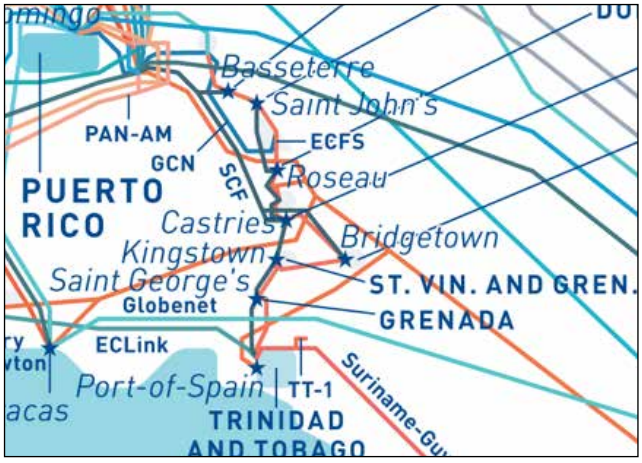

Figure CS 4.2. Map of Submarine Cable Infrastructure Connecting SVG
(Source: PCCW Telegeography cable map, http://submarine-cable-map-2016.telegeography.com/)

[8] https://www.ectel.int/ectel-telecommunications-ministers-approve-new-legislation.

[9] http://www.icdf.org.tw/ct.asp?xItem=8784&CtNode=29823&mp=2.

[10] http://www.svgncti.org.

[11] http://www.southern-caribbean.com/.

ECFS is a festoon system, a repeaterless submarine cable that interconnects 14 Eastern Caribbean islands. The six-pair cable is 1,730 km in length and runs from Anguilla to Trinidad. ECFS was first installed in 1995, and a system upgrade was carried out in 2014–15 by Xtera, which upgraded the cable to support 34 100 Gbps channels—even on the longest unrepeated segments of up to 400 km—thereby providing a total capacity of 3.4 Tbps. Prior to the Lime/Flow merger, C&W/Flow had a 72% ownership in ECFS, with the remainder divided among LIME, Digicel, and several other carriers.

The SCF is also a repeaterless system, about 3,000 km in length and with a total system capacity of 5 Tbps. SCF began service in September 2006 as the southern part of the Global Caribbean Network (Figure 4.3). The system comprises 4-8 fibre pairs, depending on the segment, and the architecture is based on two main elements: an omnibus leg connecting Trinidad to Saint Croix and Puerto Rico (implemented by Alcatel Submarine Networks) and an express leg linking Barbados to Saint Lucia and Saint Croix as a repeated system with two-fibre pairs (implemented by Tyco).

Leucadia National Corporation and the Loret Group were the owners when the Regional Council of Guadeloupe awarded the company a contract for a submarine cable linking Guadeloupe, Saint Martin, and Saint Barts to Puerto Rico. For resilience, a branching unit between Puerto Rico and Saint Martin connected that cable to the US Virgin Island hub at Saint Croix. As a result of the ACP Numérique conference held in Guadeloupe in May 2005, member states of the Organization of Eastern Caribbean States (OECS) extended the cable to Martinique and Dominica, which laid the foundation for further extension to the remaining islands all the way to the southern-most point at Trinidad and Tobago. At the time of the project, ECFS was the only submarine capacity to Saint Kitts, Saint Lucia, Saint Vincent, Grenada, and Antigua, and redundancy on this route was a further motivation for the cable.

The two companies (Leucadia and Loret) created Global Caribbean Fibre (GCF) to be the operating company responsible for the different key parts of the network—namely SCF, the Middle Caribbean Network (MCN), and Antilles Crossing. In late 2013, mobile operator Digicel acquired MCN, SCF, Antilles Crossing, and a number of related assets from GCF. This provided Digicel with a wholly owned submarine cable of approximately 2,100 km stretching from Trinidad to Guadeloupe. Digicel also contracted with GCN to provide capacity from Guadeloupe to Puerto Rico, with onwards connectivity to the US mainland.

With only two cables serving most of the Eastern Caribbean states, it is anticipated that demand for additional submarine cables will drive further deployment in order to both increase resilience and as a response to the lack of competitive pressure on capacity prices. In addition, with routes to the south via Trinidad, as well as new cables being planned between South America and Europe, Africa, and Asia, there is likely to be increased interest in routing traffic south from the rest of the Caribbean along the cables connecting SVG.

Figure CS 4.3. Map of the Global Caribbean Network (GCN) Submarine Cable System (Source: http://www.southern-caribbean.com)

SVG, Saint Lucia, and Grenada are in the early stages of deploying a cable to link to themselves (and the smaller islands among them), with financial support from CARCIP[12]. The expression of interest (EOI) for the project was announced in May 2016. It required that the cable must land "at a minimum" at the following nations:

- Bequia
- Canouan
- Carriacou
- Mustique (private island)
- Saint Vincent and the Grenadines
- Union Island

[12] https://www.worldbank.org/projects/procurement/noticeoverview?id=OP00037674.

In addition, in September 2016 Denis O'Brien, founder and chairman of Digicel, announced a "personal project" to invest up to US$450 million in a submarine cable linking 30 to 40 countries in the Caribbean region.[13]

Pricing data

The NTRC publishes data on domestic retail prices,[14] but information on wholesale pricing is not yet available, although providing this data is expected to become a requirement for operators in ECTEL countries. As a result, the only data on international capacity prices that are publically available[15] in the region are for GCN, which quotes EUR24,650 per month for an STM-1 link (155 Mbps) from Saint Barths to Paris (about US$170/Mbps/month). An E1 link (2 Mbps) costs EUR1,475 and an STM-16 costs EUR98,600. Commissioning charges are EUR7,000 for an STM-1 and EUR14,000 for an STM-16. There is a 15% discount for signing a five- year contract, and installation fees are waived. Alternatively, a 25-year IRU on two fibre pairs with a maximum capacity of 2 x STM-16 can be purchased for about EUR2 million with an annual maintenance fee of EUR108,000.

For transit to the international IP backbones, an additional transit charge of EUR50 per Mbps is levied, as is an installation fee of EUR7,000 for capacity between 100 Mbps and 1 Gbps.

Public network operators

The dominant operator is Flow. It provides fixed, mobile, and cable-TV services following the merger of its parent company (Cable & Wireless Communications) with the parent of competitor Flow/Karib Cable (Columbus International) for approximately US$1.85 billion. Shortly after the merger, the new group was bought by US-based Liberty Global, one of the world's largest international TV and broadband companies, which boasts nearly 30 million subscribers and operations in more than 30 countries across Europe, Latin America, and the Caribbean.[16] Liberty Global's purchase of the merged group, which was finalised in May 2016, has made it the dominant operator in at least 12 countries in the Caribbean.

The merger means that Flow operates a mix of coaxial cable and copper fixed-line networks. On the island of Saint Vincent, the company's core network infrastructure is constrained by the rugged terrain that inhibits the use of ring-type architectures, due to a lack of available roads circumnavigating the island. The infrastructure only supports point-to-point topologies that make the network more prone to failure, as there are no alternative network paths.

Flow also operates a microwave network to the larger Grenadine Islands, including Bequia, Mustique, Canouan, and Union. The network is configured in a ring structure for backup in case of link failure. Canouan and Mayreau have more limited bandwidth.

In addition, Flow provides MPLS/Metro Ethernet services, although coverage is limited to a small area around Kingstown due to lack of demand from either government (which operates its own network) or large commercial clients.

Digicel SVG, part of the global telecom group founded by Irish entrepreneur Denis O'Brien, is the only other competitor of Flow in SVG. The company claims to cover 98% of the population of SVG with a footprint in the five main islands (Figure 4.4). In neighbouring countries, Digicel has launched a triple-play offering called Digicel Play, and is likely to do so in SVG shortly. This fibre-based product includes voice telephony, pay TV, and broadband Internet, and has so far been rolled out in Anguilla, Barbados, Dominica, Jamaica, Trinidad and Tobago, and the Turks and Caicos Islands, with plans to add Saint Kitts and Nevis.

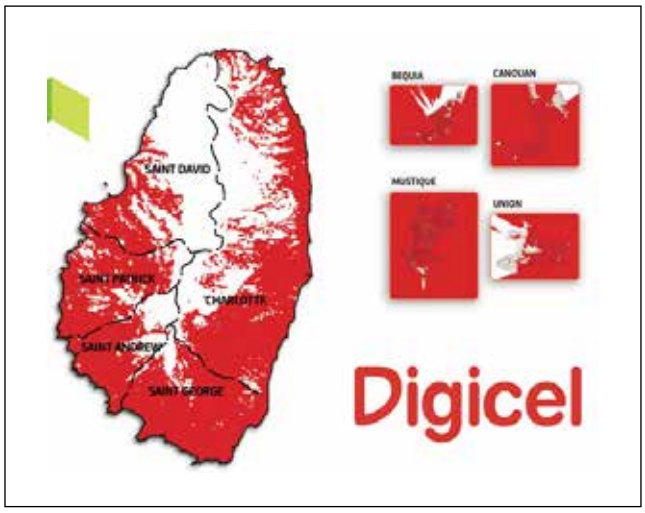

Figure CS 4.4. Map of Digicel's Mobile Coverage in SVG
(Source: https://www.digicelgroup.com/vc/en/mobile/explore/network/coverage-map.html)

[13] http://www.independent.ie/business/denis-obrien-to-invest-up-to-450m-on-network-of-undersea-telecom-cables-in-caribbean-35065044.html.

[14] http://www.ntrc.vc/general/telecommunications-statistical-data.

[15] http://www.globalcaribbean.net/media/pdf/Offre-de-reference-GCN-Saint-Barthelemy-fevrier-2015.pdf.

[16] https://www.libertyglobal.com/about-us.html.

Digicel's core network was upgraded to 4G (HSPA+) in June 2014, and also provides Metro Ethernet and other commercial services using short-haul microwave links operating in shared spectrum bands (there are no 'free' ISM bands defined in ECTEL countries). Digicel's backhaul network is primarily microwave-based. It protects its core network in SVG by using multipath radio diversity and self-healing rings along the South-Western coast of the island for network resiliency and redundancy. Core switching services for SVG are performed in Grenada. The main microwave links to the other Grenadine islands are not redundant.

Both Flow and Digicel are using existing utility poles owned by Saint Vincent Electricity Services Ltd. (VINLEC).

Pricing data[17]

Prepaid calling rates on Flow (off-net and on-net) average US$0.89 per minute.

Flow's fixed broadband services cost US$33 per month for 2 Mbps downstream/1 Mbps upstream, and US$126 per month for 100 Mbps downstream/15 Mbps upstream.[18] Flow's 3G/4G mobile broadband offering is US$18.4 per GB (valid for a month) for the first gigabyte, US$46 for 5GB per month, and US$0.26 per megabyte thereafter. Flow bundles Wikimedia sites at no cost to subscribers. TV + Internet bundles are available, for example TV plus 2 Mbps/1 Mbps broadband is US$64 per month.

On Digicel, a 1 GB bundle costs US$14.8, valid for 30 days; 5 GB costs US$44 per month.

While mobile broadband costs are similar across the region (Figure 4.5), SVG has fixed broadband services that are relatively low compared to some of the other countries in the region.

The pricing data was taken from the operators listed in Table 4.2, and show how Flow can leverage its presence in so many markets—it provides broadband services in 12 out of the 18 countries surveyed, compared to just five for Digicel.

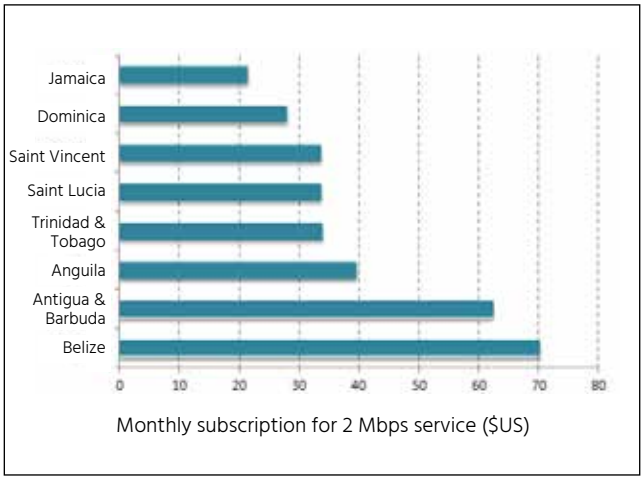

Figure CS 4.5. Costs of 2 Mbps Fixed Internet Services in the Eastern Caribbean, 2016 (Source: ICT Pulse, http://www.ict-pulse.com/2016/05/snapshot-2016-update-Internet-speeds-pricing-caribbean)

Government networks

The principal operational ICT organisation in the SVG is the Information Technology Services Division[19] (ITSD), a department of the Ministry of Foreign Affairs, Foreign Trade, Commerce, and Information Technology. ITSD is responsible for the implementation and operation of computer systems for all government agencies, and it operates a Government Wide Area Network (GWAN) that serves most government-owned and government-leased buildings in downtown Kingstown. Thanks to the GWAN, almost all government buildings in Kingstown are now connected with fibre. VoIP is used among government offices, while videoconferencing facilities are more limited and mainly used for regional meetings. Agencies using the system include:

- Ministry of Finance and Planning
- Treasury Department
- Inland Revenue Department
- Ministry of Education
- Social Welfare Department
- Prime Minister's Office
- Police Department
- Ministry of Health and the Environment
- Kingstown General Hospital
- Ministry of Trade
- Ministry of Agriculture
- Ministry of Communications and Works
- E.T. Joshua Airport

[17] Pricing data converted from EC Dollars @ 1 = 0.37US$.

[18] https://discoverflow.co/saint-vincent/Internet/plans.

[19] http://www.gov.vc/images/stories/pdf_documents/svg%20e-gov%20network%20services%20strategy%20report.pdf.

ITSD also operates a data centre that hosts servers and other equipment for its users. It is in the process of planning a fixed wireless network to extend connectivity to other institutions and to schools. It is also developing a strategy to implement public key infrastructure and develop a disaster recovery centre.

The government has made connecting schools to its network a high priority. At the writing of this report, 34 educational institutions have Internet connectivity via computer labs, including 18 primary schools and 12 secondary schools. While most institutions have Internet access, the number of students per PC is over 50. To address this, the NTRC, via the Universal Service Fund, installed Wi-Fi hotspots at all SVG educational institutions and various community centres and tourist sites.

The Ministry of Health, Wellness, and the Environment maintains a Health Information System that is used in approximately 45 locations across Saint Vincent. There are over 200 end-users of the system, using approximately 120 workstations. All Ministry of Health facilities have Internet access. The clinics and district hospitals at Bequia, Union Island, Chateaubelair, Mesopotamia Valley, and Georgetown are interconnected using VPNs over 8 Mbps cable modem connections to the Internet using Flow's network. The Milton Cato Memorial Hospital and the clinic at Mayreau both have an 8 Mbps connection from LIME.

Saint Vincent introduced the One Laptop Per Child (OLPC) programme in 2011. To date, 30,000 laptops have been distributed, significantly supplementing the availability of digital access devices throughout the country. In support of the OLPC initiative, each school has an 8 Mbps Internet connection that is provided by LIME under contract.

Private networks

Little information is available about private networks that have been authorised in SVG. A number of banks and other corporate institutions use the fixed networks, satellite links, or wireless networks provided by the two operators.

NGO networks

Most likely due to the relatively extensive commercial infrastructure present, no independent networks have been set up by NGOs or other civil society organizations.

Interconnection and hosting

Although there is no data centre yet in SVG, an IXP was launched in January 2016 by the NTRC. It is hosted at the cable landing station in Arnos Vale, where the operators Digicel and Flow interconnect. The IXP was established with support from the World Bank-funded CARCIP project that provided institutional capacity building and equipment, such as servers and racks, while Packet Clearing House (PCH) provided initial formation work and training.

Country	ISPs Surveyed
Anguilla	FLow, Caribbean Cable
Antigua and Barbuda	Flow
Aruba	Setar
Bahamas	BTC, Cable Bahamas
Barbados	Digicel, Flow
Belize	Belize Telemedia
British Virgin Islands	Flow, CTT
Cayman Islands	Flow, Logic
Curaçao	Flow, UTS
Dominica	Digicel, Flow
Grenada	Flow
Guyana	eNetwork, GT&T
Jamaica	Digicel, Flow
Saint Kitts and Nevis	Flow
Saint Lucia	Flow
Saint Vincent and Grenadines	Flow
Trinidad and Tobago	Digicel, Flow, TSTT
Turks and Caicos Islands	Digicel, LIME

Table CS 4.2. Survey of Internet Service Providers in the Caribbean
(Source: ICT Pulse 2016[20])

Capacity-building infrastructure

As yet, there is no national education and research network in SVG, although the country has been included in the planning and assessment for the development of the Caribbean Research and Education Network (C@ribNET) and the agreement establishing the Caribbean Knowledge and Learning Network Agency (CKLNA) to operate C@ribNET, which aimed to connect all CARICOM countries to the world's research and education community via AMPATH to North America, Géant to Europe, and RedCLARA to Latin America. C@ribNET operates an STM-1 (155 Mbps) backbone between Jamaica, Trinidad and Tobago, Dominican Republic, and Florida that can later be upgraded to an STM-4 (622 Mbps). C@ribNET also connects the Dominican Republic to Géant (Paris) with an STM-1, and Ja-

[20] http://www.ict-pulse.com/2016/05/snapshot-2016-update-internet-speeds-pricing-caribbean.

maica to RedCLARA in Panama with a DS3 (45 Mbps). The network was financed by a contribution of EUR10 million by the European Union.

The government of SVG has recently instituted a one-month programme to enhance the capacity of over 700 secondary school teachers in the use of ICT tools in the classroom.

Power supply infrastructure

Electricity generation at SVG is largely dependent on imported petroleum, with a small amount (3%) of hydro power. Tariffs for electricity have increased, and the government has a national Energy Plan that was published in 2009[21] and indicates that many of the diesel generators are old, inefficient, and in need of replacement by newer engines or other means of electricity generation. This is seen as an opportunity to move toward new sources of energy and exploit a higher proportion of renewable energy sources.

Geothermal power offers particular promise on Saint Vincent, with potentially sufficient capacity to supply the other islands as well. SVG made an agreement with the Abu Dhabi Fund for Development (ADFD) for a US15 million loan to set up a 15 MW geothermal power station in the country. The project is being funded as part of the US$350 million ADFD/IRENA project that was set up in 2012 to provide concessional financing for renewable energy projects in developing countries affiliated to the International Renewable Energy Agency (IRENA). Exploratory drilling is now expected to commence in 2017, funded by a STG4 million grant from the UK's Department for International Development.[22]

Applications and Content

E-government

SVG was one of the three CARCIP countries which participated in the US$2.4 million World Bank's Electronic Government Regional Integration Project (EGRIP). The project's overall objective was to promote the delivery of regionally integrated e-government applications in order to take advantage of economies of scale and resource sharing. Project outcomes included the following:

- Regionally harmonized legislation related to e-government.
- eID cards for persons under 18 years of age; 559 Vincentians registered and 551 cards were issued by June 2016.
- Reduction in the average time to complete a VAT tax filing from one day to 30 minutes.
- About 7,700 taxpayers—60% of the taxpayer base—submitted 23,325 e-tax filings by June 2016.
- The eProcurement system conducted six tenders with a total value of US$27 million.

As part of the project, a Multi-Purpose Identification (MPID) system was set up in the three CARCIP countries. The system, which is to be interfaced with the existing Civil Registry and the Election systems in each country, is at various phases of implementation. The project also includes applications in the public finance area and a pilot project for e-government in health. The project is to be expanded to cover other sectors including tourism, agriculture, health, and education.

The government uses the Standard Integrated Tax Administration System (SIGTAX) to manage tax collection. ASYCUDA is used in customs. Justice software and the Judicial Enforcement Management System (JEMS) has been adopted to facilitate the administration of the Courts, including cases, payments, warrants, sentencing, docket scheduling, and the generation of forms and reports.

Banking and e-payments

All of the main banks have online services. The banks include two subsidiaries of Canadian banks (CIBC and Scotia Bank), as well as LoyalBank and the Bank of Saint Vincent and the Grenadines. The Caribbean Credit Card Corporation processes card transactions through its network.

The government of SVG and some island banks have begun investigating the creation of an intraisland banking network.

[21] http://www.oas.org/en/sedi/dsd/Energy/Doc/SVG_NEP_SEP.pdf.

[22] http://www.caribank.org/news/st-vincent-grenadines-receives-funding-geothermal-energy-development.

Media

All the major SVG news media are online, including *Caribbean News Now, CIBS News Network, The Herald, I-Witness News, News 784, Prensa Caribe, Searchlight, SVG Express, The Vincentian* (Saint Vincent), and *The VincyView.*

There are about three local TV channels that are available from the single national station: SVGTV, which broadcasts its own signal, and two stations (IKTV and VC3) available on cable TV and broadband. In addition, there are over 100 international channels, as well as Flow's TV channel and video-on-demand service. Spectra, a Saint Lucian company, was granted a cable-TV licence in 2014. No data is available on the status of SVG's analogue-to-digital switchover process.

Local services

Education and health

There is no curriculum covering ICTs at primary or secondary schools in SVG—formal education relating to ICT or computer science is only available at the tertiary level. However, incorporation of ICTs into teaching was part of a EUR13.3 million project funded by the European Commission that was completed in 2013.

The National Health Information System, is expected to restructure and reengineer the business processes at hospitals and clinics. A new fibre-optic cable was laid to connect the Ministry of Health with the Milton Cato Memorial Hospital (MCMH), where tele-medicine is being used.

As part of the national ICT strategy, SVC plans to launch a Health Information System (HIS) to track patient records, diagnostic tests, discharges summaries, medications, medical supplies, laboratory results, and health statistics.

Emergency services

SVG has two emergency services agencies: the Royal Saint Vincent and Grenadines Police Force (RSVGPF) and the National Emergency Management Organization (NEMO). The Fire Service and the Coast Guard are units of the RSVGPF. Maritime emergencies are handled by an active Global Maritime Distress Safety System hosted by Flow and operated and managed by the Coast Guard.

NEMO's primary communications are managed via a series of internal radio networks and connections to the fixed and mobile telephone networks of Flow and Digicel.

Agriculture

The SVG government has plans to introduce an agricultural management information system (NAPMIS) to train farmers and extension staff in the use of information systems and ICT in agriculture.

Outlook

SVC and other countries in the Eastern Caribbean have benefitted from relatively widespread infrastructure and an enabling policy and regulatory environment for ICT services, in part fostered by ECTEL, which in 2000 became the world's first multicountry regulatory telecom agency.

The breakup of the Cable & Wireless telephone monopoly, the entry of Digicel, and the creation of ECTEL have facilitated more-affordable and pervasive broadband services. However, an already fairly concentrated market with only three players (Lime, Flow, and Digicel), has now been reduced to just two operators by the merger of Lime and Flow. This is likely to put a heavier responsibility on ECTEL and the national regulatory authority NTRC to ensure the country continues the trend toward improved connectivity and is not disadvantaged by the duopoly environment. In this respect, the adoption and implementation of the new draft ECTEL regulations is likely to be a key step.

Nevertheless, with 50% of SVC's population living in rural areas, some of which are dispersed across small islands, it is not a simple matter to extend affordable connectivity services to everyone. It will likely require a concerted approach that addresses all of the elements in the value chain—from encouraging passive infrastructure sharing, local loop unbundling, wholesale price regulation, provisions for MVNOs, and more spectrum availability to increased international submarine cable connections.

Considering that international capacity is a major part of the cost of providing local broadband services, the plans for additional submarine cables bodes well. However, the scope of the planned CARCIP cable may need to expand beyond ECTEL members to include additional islands to the north and/or south in order to gain the most benefit from the investment. Saint Lucia, SVG, and

Grenada already have direct links among them via two different cables, so the new cable is unlikely to confer much advantage, unless it is also used to extend connectivity to the nearby islands that have access to multiple additional cables, namely Trinidad in the south and Martinique in the north. This could be implemented using low-cost repeaterless technology, as the distance between Carriacou/Grenada and Trinidad is only 200-250 km, and from Saint Lucia to Martinique is less than 100 km.

Regarding the country's ability to withstand the hurricanes that are common in the region, SVC's core infrastructure is relatively well able to deal with these events. The backbone fibre-optic networks were deployed using two different methods: one being primarily aerial and the other mostly underground via a duct system. These deployment methods provide for a level of resiliency, such that the chances of failure of both networks within the same geographical area are low; the aerial infrastructure is susceptible to winds and flying debris, while the underground infrastructure is vulnerable to landslides and road washouts during heavy rains.

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ECTEL, 2016. Regulations on International electronic communications access to essential facilities at Cable Landing Stations. http://ntrc.vc/Annex%20D%20-%20International%20electronic%20communications%20access%20to%20essential%20facilities%20at%20Cable%20Landing%20Stations%20regulations.pdf.

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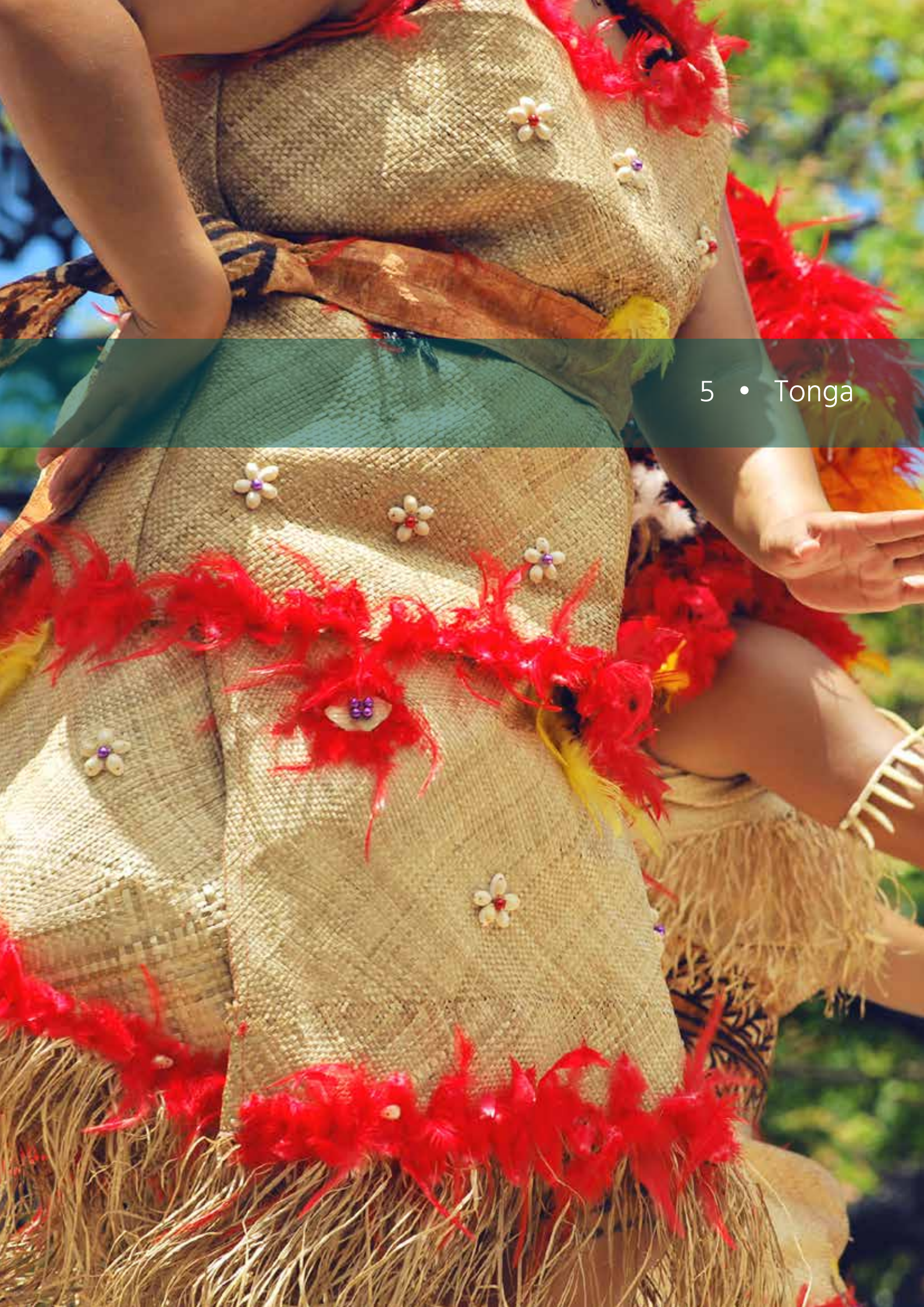

5 • Tonga

Key Features

The Kingdom of Tonga, the only constitutional monarchy of the Pacific Island countries and the only one to have never been colonized, is spread across 171 islands, of which 48 are inhabited. According to the 2011 Census, the population was 103,252, an increase of 1.2% from 2006; the population in June 2012 was estimated at 103,219. The island of Tongatapu is home to 73% of the population. Some 24,229 people (23%) make up the urban population, living in the capital of Nuku'alofa and surrounding areas. Tonga is divided into five administrative island groups: Tongatapu, Vava'u, Ha'apai, 'Eua, and the Niuas.

Tonga's GDP per capita was US$4,427 in 2013, qualifying it as an upper-middle income economy.[1] A significant number of Tongans live abroad, and in 2013 overseas remittances were US$61 million, accounting for 13% of GDP.[2] Tourism is the largest foreign exchange earner; in 2011-12 there were 47,967 visitors, and in 2013 tourism receipts came to TOP75 million (10% of GDP).[3] Agricultural exports, including fish, make up two-thirds of total exports, and the agricultural sector contributes almost 20% of GDP.

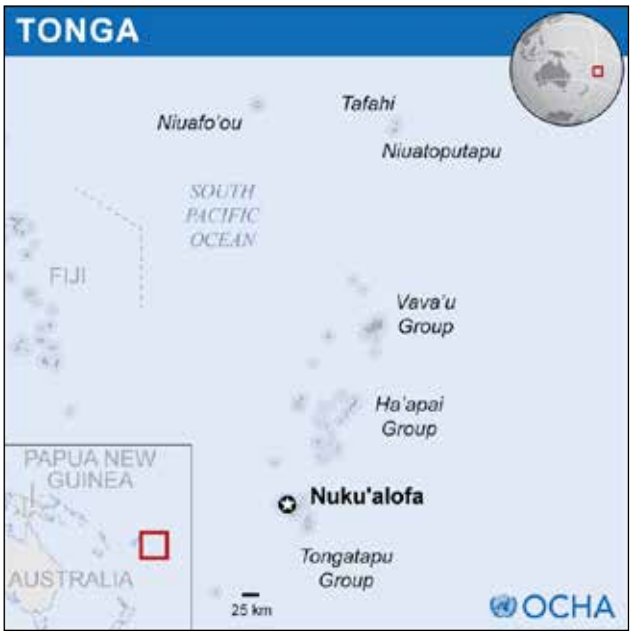

Figure CS 5.1. Map of Tonga (Sources: UNCS, ESRI.)

Note: The boundaries and names shown and the designations used on this map do not imply official endorsementor acceptance by the United Nations. Map created Sept 2013.

Status of Internet Use

There are two main ISPs: TCC, providing both wireless and fixed broadband access, and Digicel, providing wireless access. The Danden Group provides Internet access over satellite (VSAT). Several wireless technologies (WiMAX and 3G) are offered, and TCC provides fixed broadband using ADSL2+ in some areas.[4] Tonga launched mobile broadband relatively late compared to other South Pacific nations: TCC deployed its 3G+ network in December 2013, and Digicel in July 2014. According to the Ministry of Environment, Energy, Climate Change, Disaster Management, Meteorology, Information, and Communications (MEECCDMMIC) there has been rapid take-up of 3G services, with over 50,000 users by the end of 2014 (Table 5.1). Both operators provide Wi-Fi access throughout the Nuku'alofa Central Business District, and TCC also offers narrowband dial-up services.

Retail broadband prices have dropped and shifted from speed-based to data caps. In 2008, TCC offered a 256 kbps download package for TOP1,840 per month. In 2014, a 3 GB data plan using WiMAX was T$49 and fixed broadband was T$99. A 1GB 3G mobile broadband package was TOP24, with 60-day validity. Mobile broadband download speeds averaged 1.6 Mbps in November 2014.[5]

2G Mobile		Fixed Broadband		Mobile Broadband	
Active SIMs 2014	Active SIMs per 100 Inhabitants	ADSL Subscriptions	Coverage (% of population)	Subscriptions	Coverage (% of population)
71,000	67.4	1,400	1.5	>50,000	50
Digicel, TCC	Digicel, TCC	TCC	Digicel, TCC	Digicel, TCC	Digicel, TCC

Table CS 5.1. Summary of ICT Market in Tonga, 2014 (Sources: ITU/World Development Indicators 2014, MEECCDMMIC)

[1] http://data.worldbank.org/about/country-and-lending-groups.

[2] http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTDECPROSPECTS/0,,contentMDK:22759429~pagePK:64165401~piPK:64165026~theSitePK:476883,00.html#Remittances.

[3] National Reserve Bank of Tonga, Quarterly Bulletin, June 2014.

[4] ADSL2+ provides a minimum download speed of 16 Mbps. See "ITU-T G.992.5 (01/2009)", http://www.itu.int/ITU-T/recommendations/rec.aspx?id=9653&lang=en.

[5] Based on six speed tests conducted by the authors.

According to the 2011 Census, 9.3% of Tongan households had access to the Internet at home, and 45% had access outside the home (figures refer to total number of households, rather than respondents or household members). Fuelled by sharply dropping Internet access prices, the number of Facebook users skyrocketed between March 2011 and December 2014: from 7,000 to 30,000 users, with penetration among the population aged 13 and older rising from 10% to 43% (Figure 5.2). This can be interpreted as a minimum estimate of the country's Internet users since not all Internet users are using Facebook.

Tonga is close to most of the 2015 targets established by the Broadband Commission for Digital Development (Table 5.2). Although it does not have a specific broadband plan, Internet penetration is just below the target. If mobile broadband pricing and the percentage of households with Internet access are used as indicators, the affordability and connectivity targets have been reached.

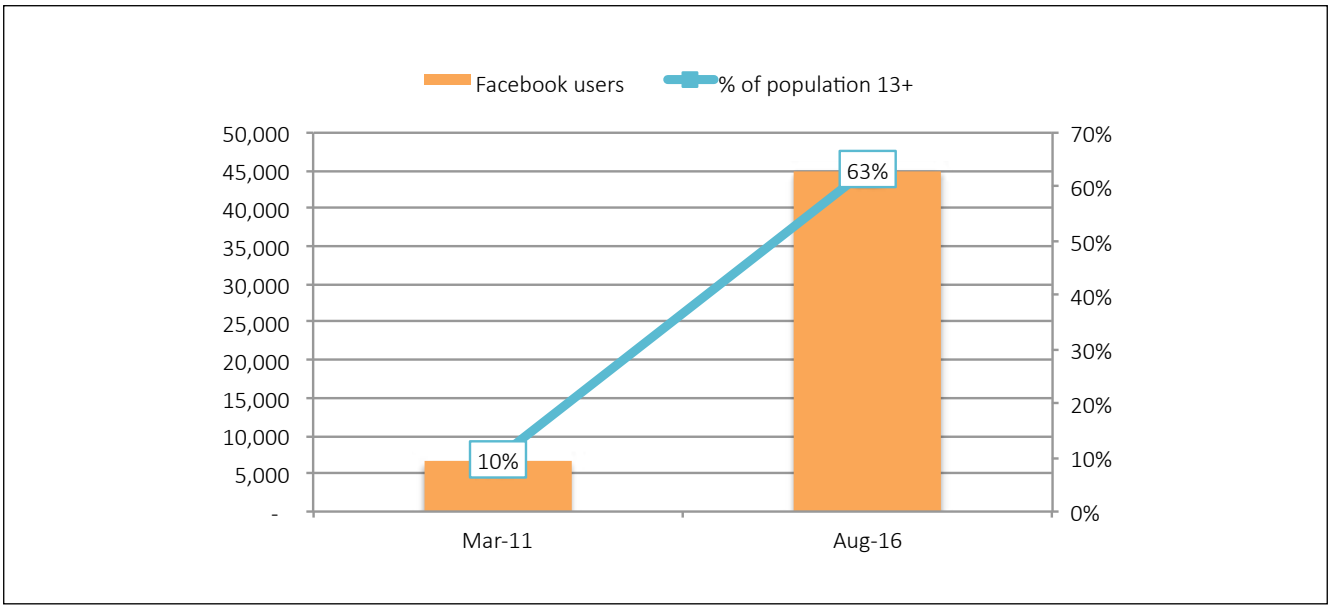

Figure CS 5.2. Facebook Users in Tonga (Source: Adapted from Facebook.)

Goal	Broadband Commission Target	Tonga's Status
Making broadband policy universal	By 2015, all countries should have a national broadband plan or strategy or include broadband in their universal access/service definitions.	None
Making broadband affordable	By 2015, entry-level broadband services should be made affordable in developing countries via adequate regulation and market forces (e.g., such services should cost less than 5% of average monthly income).	An entry-level fixed broadband plan costs 15% of per capita monthly income. An entry-level 3G mobile broadband package costs 3.6% of monthly income.
Connecting homes to broadband	By 2015, 40% of households in developing countries should have Internet access.	In 2011, 9.3% of households had an Internet connection, 45% could access the Internet outside the home.
Getting people online	By 2015, Internet user penetration should reach 60% worldwide, 50% in developing countries, and 15% in the least developed countries.	In 2014, 43% of the population aged 13 years and older used Facebook.

Table CS 5.2. Tonga's Progress and the Broadband Commission Targets
(Source: "Broadband Targets for 2015", http://www.broadbandcommission.org/publications/Pages/bb-targets.aspx)

ICT Policy and Regulatory Framework

Tonga Communications Corporation (TCC), the country's incumbent operator, was formed in 1978 to operate domestic telecom services, with Cable & Wireless of the United Kingdom operating international services. In 2001, the assets of Cable & Wireless were purchased and merged with TCC. TCC is a state-owned enterprise with around 300 employees in 2014. It reports a 100% market share for landlines, 70% for fixed Internet access, and over 50% for mobile services.[6]

The 2000 Communications Act established the basis for the introduction of competition in the telecom market. A second provider, Shoreline Communications Ltd., entered the market in 2002, offering various services including mobile (through the TonFon brand). In 2007, Irish-owned Digicel entered the market through its purchase of TonFon. Digicel had 100 full-time employees in 2014.

The Ministry of Environment, Energy, Climate Change, Disaster Management, Meteorology, Information, and Communication (MEECCDMMIC) is responsible for sector policy and, for now, regulation (there are plans to create a separate regulatory unit). In conjunction with that, new legislation is being prepared, including amendments to the Communications Act, a Communications Commission Act, and a new Cybercrime Act, as well as amendments to the Copyright Act and a new Electronic Transactions Act.

Government ICT programmes

Major infrastructure projects have been implemented over the last few years, including the deployment of the Tonga–Fiji submarine cable and launch of mobile broadband networks. These projects have depended on funding from development partners to a significant extent due to their large scope, need for concessional financing, and the limited availability of private sector funding.

Donor	Project	Amount (US$m)	Year	Comment
IFC	Digicel Tonga	6.8	2009	Funding for Digicel's mobile network[7] [this is a commercial investment]
World Bank	Pacific Regional Connectivity Program	17.2 (grant)	2011	Funding for roll-out of Tonga-Fiji cable[8]
ADB	Tonga–Fiji Submarine Cable Project	9.7 (grant)	2011	Funding for roll-out of Tonga-Fiji cable[9]
PRIF	Tonga–Fiji Submarine Cable Project	0.5 (grant)	2011	Funding for regulatory support in relation to roll-out of Tonga-Fiji cable

Table CS 5.3. Assistance from Development Partners for Key ICT Projects in Tonga, 2003–13 (Source: Pacific Regional Connectivity Program, http://projects.worldbank.org/P113184/pacific-islands-regional-connectivity?lang=en)

Given the widespread mobile coverage in Tonga, possibly the highest in the South Pacific, there is no need for public sector involvement in basic connectivity. There are, however, other areas where support could be important, including establishing mechanisms to enhance broadband connectivity in areas lacking suitable and affordable access. The most feasible approach would be to incentivize operators to cover remaining areas that are not within a mobile broadband footprint. The planned construction of a domestic fibre backbone will likely require public assistance, since it will be partly funded by savings from construction of the cable to Fiji. However, this will be dependent on government obtaining the remaining funding (e.g., from sale of TCL shares or mobilization of concessional funds from other partners).

Other areas that the public sector could support include development of online government services (both citizen-facing and back-office applications), as well as funding and expertise for developing applications in health, education, and agriculture. The educational sector could benefit from a structured approach to deploying computers in schools; providing training in digital

[6] "About Us", http://www.tcc.to/index.php/aboutus/. Accessed 1 May 2015.

[7] "IFC ICT Sector Investments, FY03- FY10", https://ieg.worldbankgroup.org/Data/reports/chapters/appf.pdf.

[8] http://web.worldbank.org/external/projects/main?Projectid=P113184&theSitePK=40941&piPK=64302772&pagePK=64330670&menuPK=64282135&Type=Financial.

[9] http://adb.org/projects/details?page=financing&proj_id=44172-022.

literacy for both teachers and students; applying e-learning; and developing higher-level computer and network skills for those who have completed secondary school. The latter is particularly important for enhancing the country's software sector, which is nascent at best but critical for developing applications that could generate meaningful socioeconomic impacts.

Network Infrastructure

International connectivity

An 827 km submarine cable linking Tonga to Fiji was commissioned in August 2013. From Fiji, onward connectivity is provided via the Southern Cross cable to Australia and the United States. The new cable provides an initial capacity of 10 Gbps. TCC, Digicel, and the University of the South Pacific (USP) are connected to the cable. International bandwidth has grown almost 17-fold, from 37 Mbps in July 2011 to 620 Mbps by February 2015 (Figure 5.3).[10] The cable is owned and operated by Tonga Cable Limited (TCL), whose shareholders are the Kingdom of Tonga (83%) and TCC (17%).

Pricing data

Previously, satellite connectivity was US$3,600/Mbps/month, whereas the cost with the new cable is US$475/Mbps/month (can be lower, depending on volume purchased). This is still almost twice the price of international bandwidth in Fiji, and results in higher retail Internet prices in Tonga. The wholesale price of the Tonga-Fiji cable is linked to the current capacity use. This is intended to cover the cable's fixed cost, but it is not easy to identify exactly what that cost was. The final cost of the cable was US$25

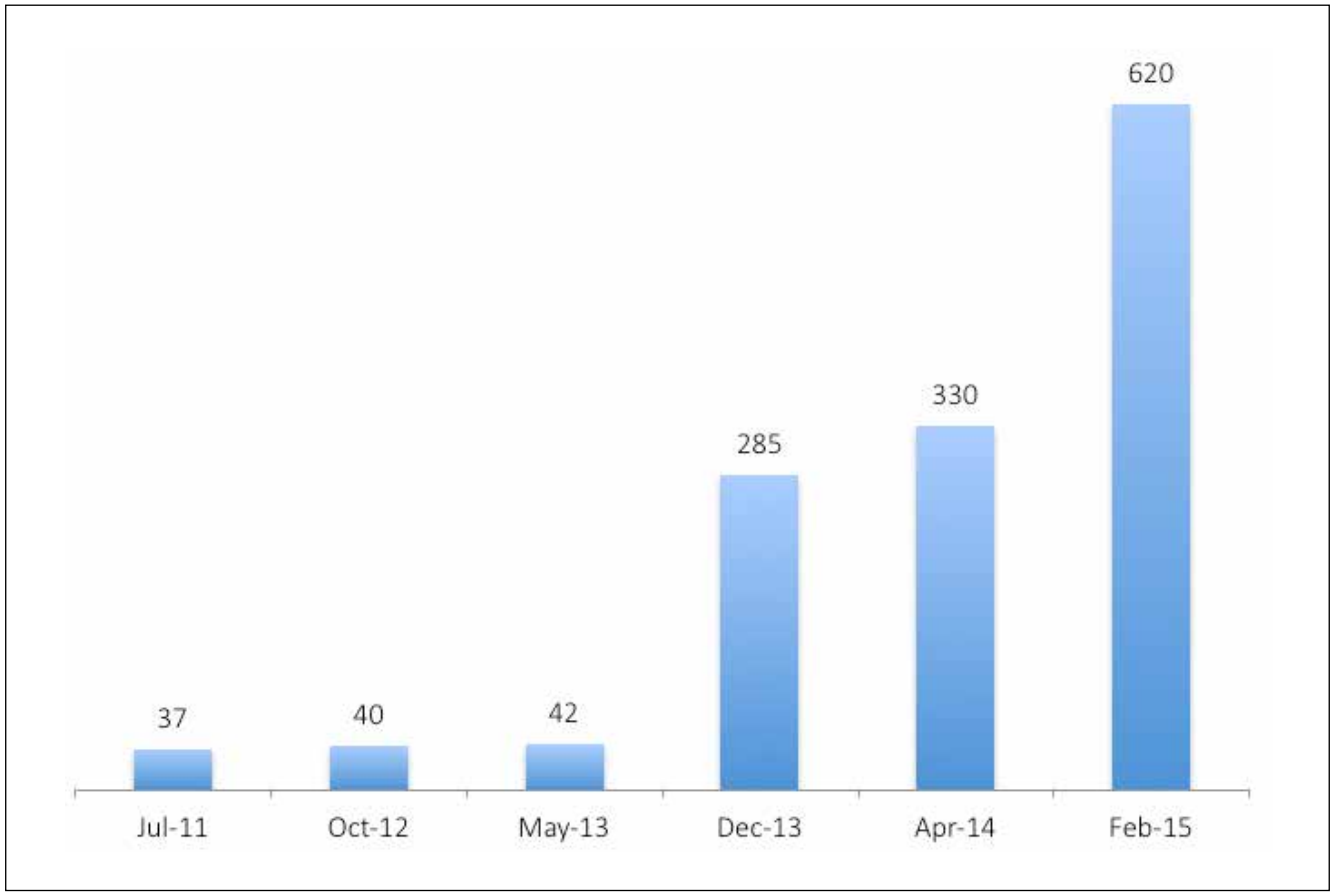

Figure CS 5.3. International Internet bandwidth in Mbps, July 2011–February 2015
(Source: Adapted from World Bank, Tonga—Pacific Regional Connectivity Program: P113184, Implementation Status Results Reports.)

[10] http://www wds.worldbank.org/external/default/WDSContentServer/WDSP/SDN/2014/09/28/090224b08278ba57/1_0/Rendered/PDF/Tonga000Pacifi0Report000 Sequence005.pdf.

million compared to an initial project estimate of US$34 million, of which 81% was provided in the form of grants by development agencies and the Kingdom of Tonga funding the remaining 19%. Plans are to use the savings to part-finance the extension of the cable to Vava'u and Ha'apai, if the government can mobilize additional funds from private or public sources.

Given the size of the market, it is unlikely there will be many more parties contracting bandwidth on the cable. On the other hand, the demand for bandwidth is likely to grow, particularly with the expansion of multimedia services delivered online.

Based on calculations carried out by the authors of this report, the cost of the cable could be recouped in a shorter period by moving to flat-rate pricing. At current prices, the original costs of the cable would recouped in 14 years,[11] with consumers paying for the approximately 90% of unused but activated capacity. One way to lower retail Internet prices is to increase the amount of bandwidth available at a fixed price that still recovers the cost of the cable. In other words, instead of pricing per Mbps, the price would be a fixed amount rising a certain percentage per year, while the amount of bandwidth supplied is increased. For example, the amount of capacity provided could be doubled each year with an annual increase in price of 25%. In this scenario, prices would initially be lowered to US$208/Mbps/month and then drop to US$24 within five years (Table 5.4). For TCL, this would provide a more stable revenue stream and would recover the costs of the cable faster than under the current tariff structure. It is the authors' opinion that this scenario would reduce international bandwidth costs, drive Internet utilization, and trigger exciting applications made possible by abundant capacity such as high-quality video streaming, ICT-enabled outsourcing, and undoubtedly new and innovative services.

	Current (Mbps)	Dec 2014 (Mbps)	Dec 2015 (Mbps)	Dec 2016 (Mbps)	Dec 2017 (Mbps)	Dec 2018 (Mbps)	Dec 2019 (Mbps)
Current Allocation Digicel	200	500	1,000	2,000	4,000	8,000	16,000
Current Allocation TCC	225	500	1,000	2,000	4,000	8,000	16,000
Current Allocation USP	100	200	200	200	200	200	200
Total Utilization	525	1,200	2,200	4,200	8,200	16,200	32,200
Cost per Mbps US$	475	208	142	93	60	38	24
TCL Total Revenue per Annum in US$	$2,992,500	$2,992,500	$3,748,800	$4,687,200	$5,859,000	$7,323,750	$9,154,688
Increase in Revenues		0%	25%	25%	25%		
Operational Costs	1,229,000	1,229,000	1,229,000	1,229,000	1,229,000	1,229,000	1,229,000
Annual Net revenue	$1,763,500	$1,763,500	$2,519,800	$3,458,200	$4,630,000	$6,094,750	$7,925,688
Total Net Revenue		$1,763,500	$4,283,300	$7,741,500	$12,371,500	$18,466,250	$26,391,938

Table CS 5.4. Alternative Scenario for Wholesale International Internet Bandwidth Pricing (Source: Authors' calculation based on data from TCL and ADB.)

Note: Constant prices of 2014. Current lit capacity is 10 Gbps out of total design capacity of 320 Gbps. This scenario assumes that additional capacity would be lit from 2017.

[11] Based on the final cost of the cable (US$25 million) and estimated operating costs of US$1.2 million per year. "Tonga-Fiji Submarine Cable Project (RRP TON 44172), Financial and Economic Analyses", http://www.adb.org/sites/default/files/linked-documents/44172-022-ton-efa.pdf.

Public network operators

TCC has a fibre backbone on the island of Tongatapu. It uses microwave to link the island of 'Eua, while satellite is used to connect the island groups of Ha'apai, Vava'u, and Niuas. Digicel uses microwave on Tongatapu and to connect 'Eua, and satellite for connectivity to the other islands. TCL plans to use the savings from the international cable costs to construct a domestic fibre backbone linking 'Eua, Ha'apai, and Vavu'u. This would lower costs compared to current alternatives and would provide the necessary backhaul capacity to better handle broadband traffic.

Public sector networks

Government connectivity varies. Most ministries in Nuku'alofa are connected to the Internet, and each ministry makes its own arrangement with an ISP. Some use wireless networks, some ADSL, and some are connected by fibre-optic cable. Most have a website. The Freedom of Information policy website provides links to relevant ministries, describes their work, and provides contact details.[12]

The idea of creating a single government network with a data centre has been around since 2002, but remains on hold due to a lack of funding. Because there is no managed virtual government network interlinking ministries, nor standard software and data protocols, e-government applications aimed at citizens and businesses lag behind. Some effort has been devoted to digitizing documents to speed up workflows, but the ability to pay taxes or request civil records online does not exist. Obtaining documents such as birth, marriage, and death certificates entails a visit to government offices to file a request and then wait at least several days before receipt. Given the dearth of electronic public services, any formal impact study would likely show limited results.

Applications and Content

E-government

All processes for registering a business—including the business's name, certificate of incorporation, business licence, and registration with the tax authority—have been integrated into the website of the Business Registries Office, which is available 24 hours a day.[13] Payment for all related fees can be made online using a credit card. The Registrar of Companies has installed two kiosks at its offices for people who do not have access to a computer. The new integrated process reduces the time to register a firm from 16 days to less than one, placing Tonga among the countries with the fastest business registration process in the world.

Banking and e-payments

Tonga could benefit from greater financial inclusion—60% of the population did not have a bank account in 2011.[14] Digicel launched its mobile money service in Tonga in January 2011, and by September had 2,157 active users.[15] The service supports money transfer, as well as bill payment. Digicel works with domestic and overseas partners to enhance its mobile money offerings. The Development Bank of Tonga processes cash deposits and retrievals for mobile money users, and KlickEx Pacific handles overseas remittances.

In May 2012 Digicel launched its "Beep and Go" service based on near field communication (NFC) technology. It allows users to swipe their phone across a point-of-sale terminal to pay. At launch, it was available at some 50 merchants in Nuku'alofa, and there are plans to extend the service. Around 10% of Digicel's customer base was using the mobile money platform in November 2014.

Given Tonga's large overseas population, remittances are important. The 2011 Census found that over half of households in the country received overseas remittances, and according to World Bank estimates, US$61 million in remittances was received by Tonga in 2014, equivalent to 13% of GDP. The KlickEx Pacific service allows users in Australia or New Zealand to send funds to mobile phones in Tonga in less than one hour.[16] Compared to banks and traditional money transfer operators, KlickEx Pacific is the least expensive method to transfer money from New Zealand to Tonga (Table 5.5, next page).

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[12] http://www.foi.gov.to/index.php/other-agencies.

[13] https://www.businessregistries.gov.to/. See also "Tonga's Innovative Online Business Registry Goes Live – ADB." *News from Country Offices.* 2 December 2014. http://www.adb.org/news/tonga-s-innovative-online-business-registry-goes-live-adb.

[14] "Digicel and VeriFone combine to launch unique Mobile Wallet payments service in Tonga." *Press Release.* 14 May 2012. http://www.digicelpacific.com/en/media-center/press-releases/digicel-verifone-combine-to-launch-unique-mobile-wallet-payment-service.

[15] Pacific Financial Inclusion Programme. "Quarter 3, 2011 Brief Project Update for Investment Committee." http://aid.dfat.gov.au/countries/pacific/fiji/Documents/financial-inclusion-monitoring-report-investment-committee.pdf.

[16] https://www.klickexpacific.com.

	Fee (NZ$)	Total cost (NZ$)*	Total cost (%)
Bank Average	20.00	40.27	20.13
Money Transfer Operator Average	7.50	21.64	10.82
Digicel/Klickex	3.00	10.96	5.48

Table CS 5.5. Cost of Sending NZ$200 to Tonga by Different Methods, December 2014 (Source: www.sendmoneypacific.com, accessed 5 January 2015)

* Transaction fee plus margin on foreign exchange transaction.

Media

Virtually all of Tonga's leading news and information outlets are online. This includes the state-owned Tonga Broadcasting Commission, whose website features news articles and weather, as well as programming information and streaming Radio and TV Tonga[17]. In addition, there are newspaper and radio stations with websites.

Local services

Education and health

ICT in education has been focused on strengthening school administration through better collection and exchange of electronic records, as called for in the Education Act.[18] The experience of the Ministry of Education and Training in developing an Educational Management Information System (EMIS) has been trying. It has been working with a system originally provided by UNESCO, but it is hard to adapt to the local context, and the Ministry suffers from a lack of technological resources and capability. It is looking to replace the system with a cloud-based system.[19]

All secondary schools are connected to the Internet using TCC's network and receive an educational discount. Most secondary and primary schools have computers, primarily from donations. For example, a local bakery recently donated 100. This presents maintenance challenges given the variety of models and software versions. Nevertheless, the Ministry tries to staff schools with at least one person who has computer experience.

Several years ago there was a pilot project for primary schools called One Laptop Per Child. It was unsuccessful for several reasons: teachers did not receive adequate training, content was not provided in the local language (children are not normally exposed to English classes until Class 3), and after the trial it was expected that the beneficiaries would pay US$100 per laptop.

There is no formal e-learning program due to a lack of budget, equipment, and expertise. This would be very relevant for the country due to the shortage of teachers, particularly for some subjects such as physics. There is one example of using mobile phones for homework, in which students were asked to text their teacher the answers to a daily quiz. The teacher received too many texts so the experiment was ended.

Computer science is included in the curriculum in secondary schools. Post-secondary educational institutions in Tonga offering computer science courses include the University of the South Pacific and the Tonga Institute of Higher Education. Some church schools have diploma programmes, as do private companies. The Tonga Chamber of Commerce offers two-week training programmes in office applications, such as Miscrosoft Excel, Word, and so forth. This is coordinated by the Tonga Business Enterprise Centre with assistance from the New Zealand government, and aims to build up business skills in the country.

There are no impact studies available that would show, for example, how the EMIS has increased efficiency and lowered the cost of school administration, nor how access to the Internet in schools has impacted learning outcomes.

The University of the South Pacific, headquartered in Fiji, has contracted 100 Mbps of bandwidth on the Tonga-Fiji submarine cable. This will enable it to offer higher quality and enhanced functionality for its e-learning offerings to the campus in Tonga, which had around 1,300 students in 2013.[20]

[17] http://www.tonga-broadcasting.net.

[18] The Act states, "The Ministry shall establish and maintain an Information and Management System to capture all relevant data in relation to the work of the Ministry."

[19] http://triesten.com/products/iskool/.

[20] http://www.usp.ac.fj/index.php?id=usp_tonga_campus.

In the health sector, as in education, the main ICT intervention is computerizing internal processes. The introduction of ICT goes back to 1999 as part of a health system reform undertaken with Australian assistance. At that time, the Ministry of Health had three computers and two dial-up connections. The country's Health Information System (HIS), developed with World Bank support, is robust and advanced. The vendor carries out system maintenance,[21] reducing the need for skilled staff (out of 944 staff, only four are in IT). The HIS has undergone continual improvements, with the focus currently on integrating databases to reduce duplication. The system has improved health outcomes by more efficient management of patient information, but there is a lack of long-time data series and models to prove the correlation. Indirect impacts include reduced waiting times for doctors from improved scheduling.

The Ministry has a data centre located at the main hospital. All four hospitals in the country are connected to the Internet and networked to the HIS. In addition, the seven health centres in Tongatapu are connected, although it is a challenge to provide reliable connectivity to the seven other centres in the outer islands due to the expense. The Ministry makes efficient use of bandwidth by a variety of measures, including accessing radiology images on a central server instead of emailing them back and forth.

There is high interest in remote consultation, particularly with the higher bandwidth available via the submarine cable. Consultations are currently done over the telephone with specialists in New Zealand, and the Ministry is negotiating with the government for a leased line with a direct connection to the submarine cable in order to support telemedicine. A local eye surgeon says:

> *This fibre optic cable will allow our doctors to communicate more easily with health workers on other islands and with doctors overseas. We are planning live surgery with overseas partners, getting a live feed to what is happening here in Tonga, and directing the doctors in complicated surgery.*[22]

A unique identification code for each person is a prerequisite for developing health-based online services. Here Tonga has an advantage—every person is assigned a unique National Health Number at birth that is used during visits to the health system. The need for dissemination of health information via the Internet can be inferred from the 2012 Demographic Health Survey that asked respondents how they obtained contraception information—there was a choice of three media: TV, newspaper, and radio. The Internet was not an option. More than a quarter of female respondents did not use any of these three sources, rising to almost half for those aged 15-19 (Figure 5.4, left). The 15-24 age group is most at risk from unwanted pregnancies, and is the age group with the most intensive use of online social media (Figure 5.4, right). This suggests that the most relevant channel for disseminating health information to this age group is online social media.

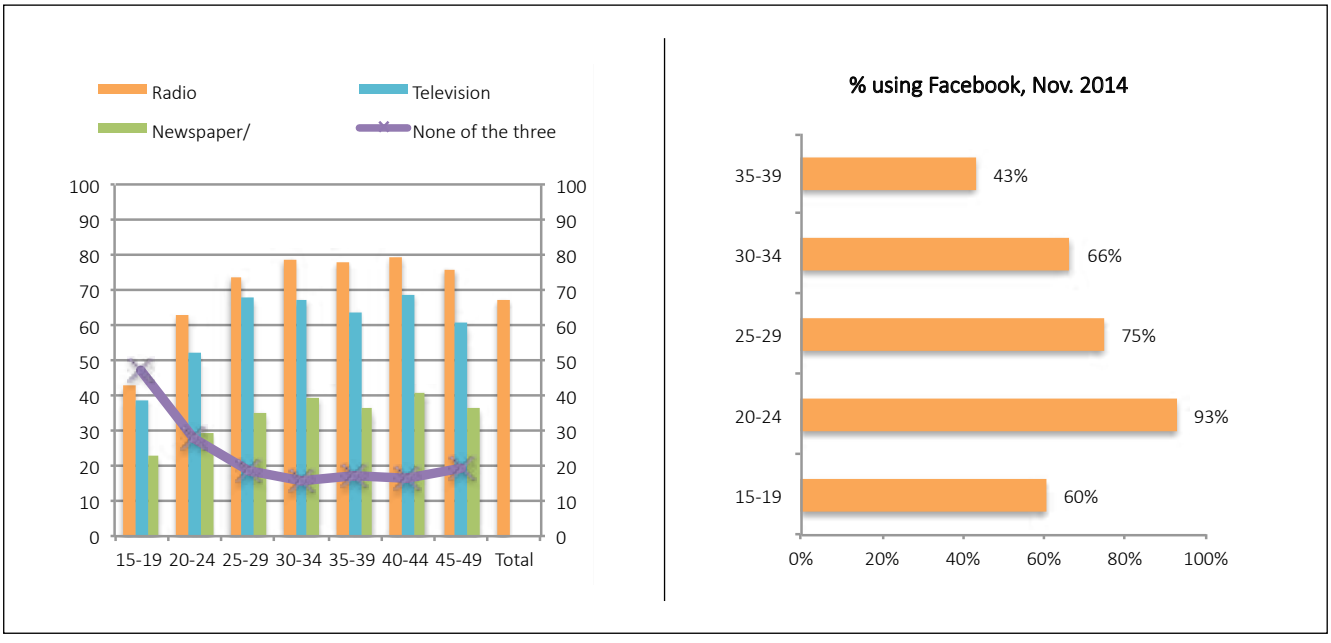

Figure CS 5.4. Source of Contraception Information (2012) and Facebook Use (2014) among Tongan Women (Source: Adapted from Demographic Health Survey 2012 and Facebook.)

[21] http://www.cse-global.com/Solutions/Healthcare.html.

[22] Faster Internet in Tonga = Better Healthcare. 2013. https://www.youtube.com/watch?v=GWclQJh2HKQ&feature=youtube_gdata_player.

Agriculture and fishery

The Ministry of Agriculture and Food, Forests, and Fisheries (MAFFF) has a website. The fisheries division also has its own website from which it disseminates a variety of information. Local firm Pasifika Solutions supports both of these sites. The Ministry receives many calls about import regulations and would like to upload relevant information to the website. However, MAFFF's main method for sharing information with farmers and fishermen is via three radio programmes a week using the Tonga Broadcasting Service, which has the country's largest broadcast coverage.

MAFFF only makes limited use of television due to its lower coverage and higher costs, even though audio-visual communication is more effective than solely audio. Experts are tapped to share knowledge in such areas as diseases, pests, growing techniques, and so forth. MAFFF would like to send staff into the field and record best practices, but budgets are restricted and the Ministry lacks both the equipment and qualified journalists required to do so.

Price information is collected by Ministry staff on a weekly basis. It is disseminated via radio, but is not available on the website. There is no data about the use of this pricing information, whether it has reduced price asymmetry, and how it might affect the welfare of those working in the agricultural sector.

There was a project to build a database of agricultural information in order to best respond to queries from farmers and fishermen. The idea was for farmers and fishermen to call or text a call centre, and to send photos if their mobile phones have that capability. The database would then be consulted for appropriate remedies. Ten mobile phones were provided to extension workers to kick-start the project, which was supported by the Secretariat of the Pacific Community Land Resources Division.[23] However, despite the high prevalence of mobile phones in rural areas, the initiative did not advance beyond the pilot stage.

In fisheries, mobile phones are used mainly for safety: fishermen are warned if there is bad weather approaching or call for help if they have a problem out at sea. Similarly, illegal fisherman use mobile phones to alert each other when they are fishing out of season and law enforcement officials are nearby. At the same time, digital cameras and GPS are used by Fisheries Rangers to police illegal fishing.[24]

Australian company Queen Fine Foods is collaborating with Digicel to deliver mobile services to organic vanilla farmers on the island of Vava'u.[25] A Queen Vanilla Growers Association was set up, grouping some 280 farmers in an attempt to revive Tonga's vanilla industry. All growers purchase mobile phones to improve communications via group messages, and to have access to mobile money so they may be sent monthly maintenance payments. Queen Fine Foods is completing certification for Fair Trade and Organics standards, and is funding this for the farmers.[26]

Tourism

Tonga Tourism Authority has both a website[27] and a Facebook page[28] that, as of 17 November 2014, had 34,025 "likes". The website lists a variety of accommodations, and provides a brief description and contact information for each. Mobile operators leverage the significant number of visitors by offering special tourist SIMs at kiosks at the international airport.

Other

Most e-services, whether aimed at businesses or the public, are developed by the private sector. Mobile alerts from the Tonga Power Limited advise customers of power outages and overdue bills, and Air New Zealand provides flight information. Some utility payments can be made using mobile money or mobile banking applications. The Electronic Funds Transfer at Point of Sale (EFT-POS) system, provided by the Australian company Westpac, uses the mobile network to offer information to merchants (sales, tax calculations, and so forth).

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[23] SPC. 2014. "Pacific agriculture and forestry leaders encouraged to embrace 'e-agriculture.'" Accessed 22 November. https://www.spc.int/fr/liste-de-diffusion/571-pacific-agriculture-and-forestry-leaders-encouraged-to-embrace-e-agriculture.html.

[24] http://www.tongafish.org/index.php?option=com_content&view=article&id=136:fafanewequipment&catid=113&lang=en&Itemid=484. [25] Tora, Iliesa. 2014. "Digicel Help Vanilla Farmers in Vava'u." *Tonga Daily News,* 31 January. http://www.tongadailynews.to/?p=3223.

[26] http://www.queen.com.au/tonga-vanilla-programs/.

[27] www.thekingdomoftonga.com.

[28] https://www.facebook.com/tonga.

Outlook

The arrival of the Tonga-Fiji submarine cable in 2013 radically altered the ICT landscape. The supply of bandwidth increased and Internet use—measured by both subscriptions and usage—dramatically increased. The cable also enabled the launch of 3G+ broadband. Mobile access is high, driven by Tonga's early introduction of competition.

Sector-wide applications leveraging the increased bandwidth and high mobile penetration are limited. With the exception of the new online business registration system, there are few government e-services aimed at businesses and citizens, and apart from ongoing computerization of administrative process, there is minimal use of ICTs in the pretertiary education and health sectors. Most software is developed abroad due to scarce domestic resources.

There are several areas in which development partners might provide assistance. For example, there is a need for government networking and applications support. Support should be as an integrated project that both connects government agencies and streamlines data sharing via common protocols and standards, and develops key online services for businesses and citizens.

Another area unlikely to develop without assistance is a local software industry. IT companies are scarce, and Tongan organizations have limited in-house ICT capability; many outsource their software needs from abroad. The country runs an ongoing deficit in trade for computer software and services. A study by the Commonwealth Secretariat reiterates the Tongan government's position that "a critical mass of ICT and knowledge-based specialists [...] will be required to sustain the growth of the information society and the information economy".[29] The domestic software and services industry needs nurturing via a partnership of telecoms firms, tertiary institutions, government, the private sector, and development partners. Until this happens, the full potential of the country's ICT fibre-optic connectivity and high mobile penetration is unlikely to be fulfilled.

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[29] Commonwealth Secretariat, 2013

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Key Features[1]

The Republic of Vanuatu comprises 83 islands in the South Pacific and a total land area of 12,281 km^2 spread out over 360,000 km^2 (Figure 6.1). Of its 83 islands, 63 are inhabited and administratively organized into six provinces. The 2015 mid-year population was estimated at 277,500, growing at an average rate of 2.3% a year. The most populated island is Efate, home to the capital Port Vila. The urban area consists of Port Vila and Luganville, the country's second largest city. These two cities account for 27% of the population, which is ethnically homogenous—98% is Ni-Vanuatu, a Melanesian race.

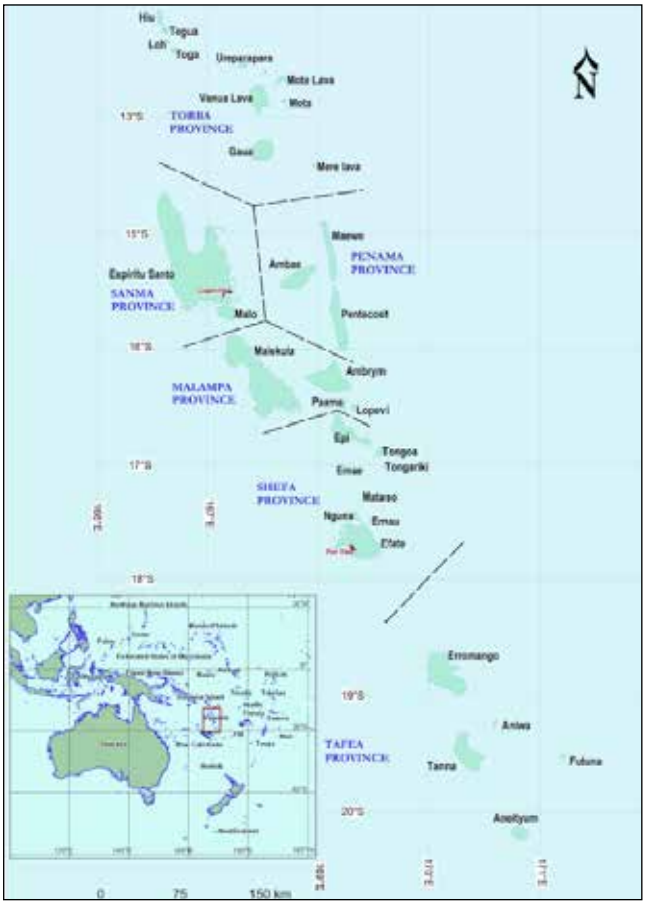

Figure CS 6.1. Map of Vanuatu (Source: Vanuatu National Statistics Office, 2009 Census, Volume 1.)

France and the United Kingdom jointly governed Vanuatu until its independence in 1980. This past is reflected in the fact that two of the country's three official languages are English and French; the third is Bislama, a Melanesian Creole. There are also more than 100 local languages.[2] The main language spoken in households is a local one (63%), followed by Bislama (34%). Only 3% of households use English or French on a daily basis. The 2009 Census indicated that 85% of the population is literate: 74% in Bislama, 64% in English, and 37% in French. There is a literacy gap between urban (98%) and rural (80%) areas. Approximately half the population aged 15 years and older has a primary education, one quarter has a secondary education and 4% have a tertiary education.

The World Bank considers Vanuatu to be a lower-middle income economy with a per capita income of US$3,148 in 2014. The UN classifies Vanuatu as an LDC, a status it is expected to graduate from in 2017.[3] Agriculture, fishing, and forestry are mainstays of the economy, reflecting the large rural composition of the population; together they accounted for 22% of GDP in 2014. Tourism is also significant: the number of visitors each year is roughly equivalent to the population (89,952 visitors arrived by air, and 197,471 by cruise ship in 2015). Vanuatu's financial sector is notable for a lower-middle income LDC, with finance and insurance contributing 6.9% of GDP in 2014. The ICT sector contributed 5.9% of GDP in 2014.

The category-5 cyclone that struck in March 2015 is estimated to have caused damage equivalent to 61% of Vanuatu's GDP, and wreaked serious consequences for medium-term economic growth due to the destruction of agricultural and tourism facilities.[4]

Status of Internet Use

In 2016, eight companies had licences to provide telecom services, including Internet.[5] Most subscriptions are with the two main operators: the incumbent Telecom Vanuatu Limited (TVL) and mobile operator Digicel. The other operators mainly offer fixed wireless access (e.g., point-to-point or VSAT) or wholesale services. TVL offers copper-based ADSL and fibre broadband, as well as mobile broadband Internet access. Digicel offers wireless Internet access using both WiMAX and its 3G/4G mobile network. Digicel

[1] This section is largely adapted from the Vanuatu National Statistics Office.

[2] http://www.ethnologue.com/country/VU.

[3] http://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=818.

[4] http://www.imf.org/external/pubs/ft/scr/2015/cr15149.pdf.

[5] http://www.trr.vu/index.php/en/telecom-industry/licences/telecommunications-licence [Accessed 15 September 2016].

launched its 3G network in December 2011,[6] and TVL followed a year later in January 2013[7]. In April 2014, WanTok launched a wireless 4G (LTE) service in Port Vila. At the beginning of 2016, Digicel announced the launch of its LTE network, with initial coverage in Port Vila.[8] Digicel reported 89 cell sites in early 2015, providing 92% population coverage using 2G (GSM) and just over half (51%) by 3G.[9]

Data from the regulator suggest there were slightly more than 80,000 Internet subscriptions as of December 2015.[10] The vast majority were wireless; there were only 4,300 fixed broadband subscriptions.[11] It is notable that, according to the GSMA, there were 27,000 mobile broadband subscriptions in 2015,[12] implying that most Internet subscriptions are using low-speed 2G (i.e., GPRS/EDGE) or fixed wireless connections. This is reflected in the relatively low average speeds of 845 kbps download and 392 kbps upload reported in September 2016.[13]

Internet use has grown rapidly over the last half dozen years, driven by greater coverage and lower prices due to increasing competition and the 2014 connection to an ICN1 submarine cable. The 2009 Census, the last official survey on Internet use for the country, reported 9,290 persons aged 15 and older had used the Internet the week before the census (6.7% of that age group). In December 2014, Facebook reported 15,400 persons aged 13 and older using Facebook. In August 2016, there were 34,000 Facebook users, equivalent to 20% of the population 15 years and older—more than three times the 2009 figure for Internet use (Figure 6.2).

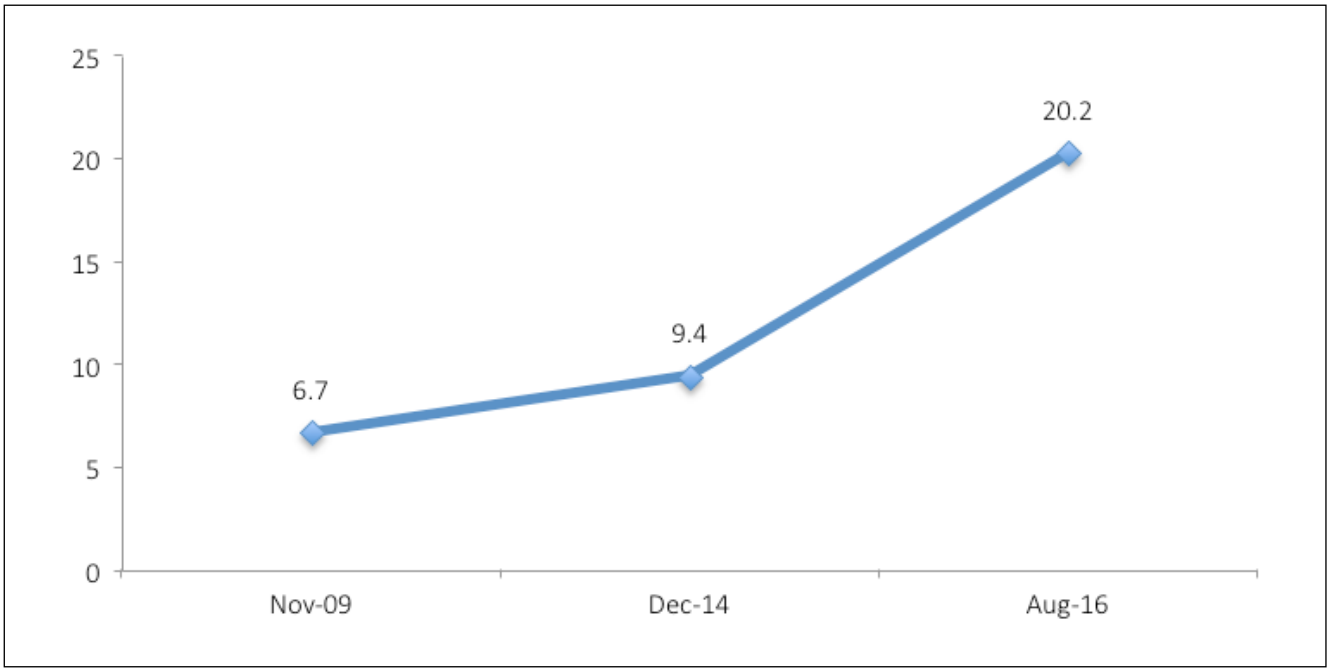

Figure CS 6.2. Internet and Facebook Use in Vanuatu (% of Population Age 15+), 2009–16 (Source: Adapted from Vanuatu National Statistical Office and Facebook Ad engine.)

[6] http://www.digicelvanuatu.com/en/about/news/digicel-launches-3g-mobile-broadband-in-vanuatu.

[7] http://www.tvl.vu/sites/default/files/events/2013-01-14_TVL%203G%2B%20launch.pdf.

[8] Digicel. 2016. "World-Class LTE Internet Has Now Arrived in Vanuatu." News, January 20. http://www.digicelvanuatu.com/en/about/news/world-class-lte-Internet-has-now-arrived-in-vanuatu.

[9] Digicel. 2015. Form F-1 Registration Statement.

[10] http://www.trr.vu/index.php/en/telecom-industry/market-and-competition/statistics/2015.

[11] http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx.

[12] https://www.gsmaintelligence.com.

[13] http://testmy.net/list?q=vanuatu [Accessed 15 September 2016].

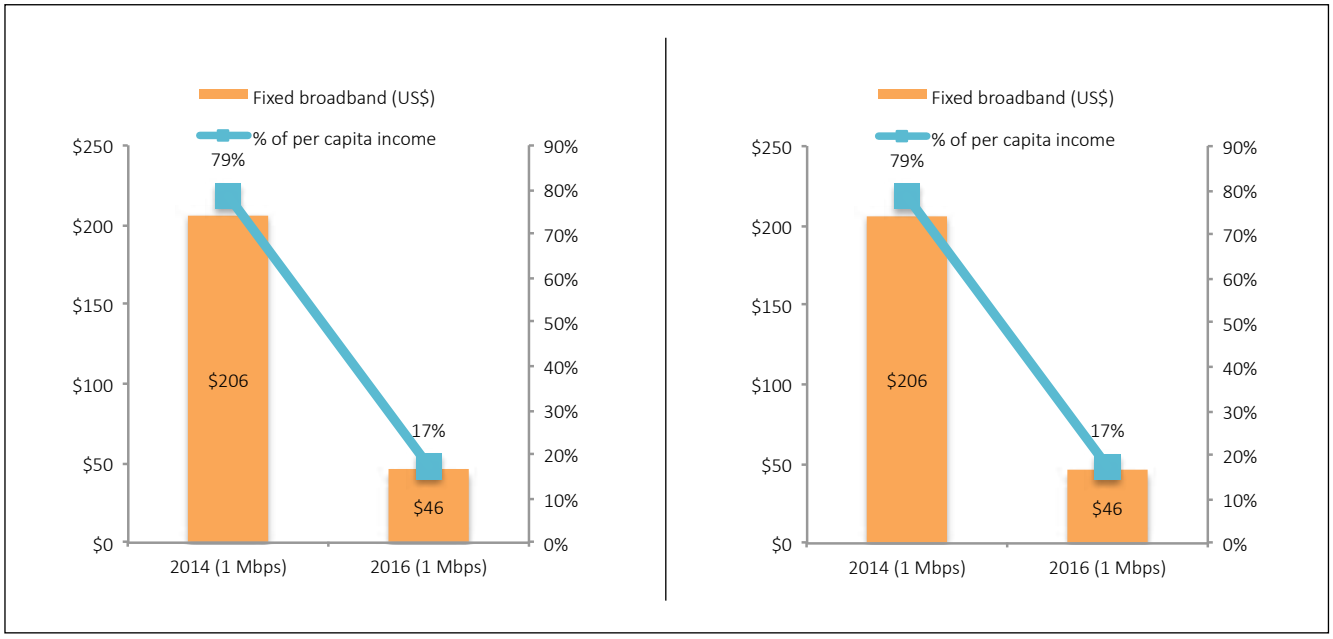

Figure CS 6.3. Monthly Internet Prices in Vanuatu, 2014 and 2016 (Source: Adapted from TVL and Digicel websites.)

Retail Internet prices have been declining sharply. The cost of a 1 Mbps monthly fixed broadband subscription dropped 78% (measured in US$) between 2014 and 2016 (Figure 6.3, left), and Digicel's cheapest price for a 30-day mobile broadband plan fell by 78% and the data allowance increased by a third (Figure 6.3, right).

Fixed broadband Internet access remains costly in terms of average incomes. A 1 Mbps fixed broadband subscription accounts for 17% of per capita income, the fastest speed (4 Mbps) is four times more costly. This is beyond the reach of most households and micro and small businesses in the country. One reason for the high prices is Vanuatu's difficult geography, another is that although wholesale bandwidth prices have come down since the introduction of the submarine cable, pricing has been far from transparent.

The Universal Access Policy (UAP) has the objective of covering 98% of the population with a minimum download speed of 2 Mbps by 2018.[14] The UAP has financed 15 computer labs in schools and for after-school use by the community. Three Information and Communication Centres have also been rolled out, where entrepreneurs operate and offer ICT services to the local population.

ICT Policy and Regulatory Framework

Telecom Vanuatu Limited (TVL) was the historic monopoly telecom service provider, owned equally by the government, Cable & Wireless of the United Kingdom and France Telecom. It had an exclusive licence until 2012, but in an effort to bring competition to the market, the Telecommunications Act was amended in 2007. As part of the liberalisation process, the government relinquished its shares in TVL to the two remaining shareholders. In 2011, Cable & Wireless sold its 50% stake to Mauritius Telecom (owned 40% by Orange and 59% by the government of Mauritius). In 2013, Mauritius Telecom increased its ownership of TVL to 90%, and in 2015 acquired the remaining 10% to become the sole owner.

In March 2008, Digicel was granted a mobile telecom licence and became the country's second mobile operator. A total of eight service providers are licenced to operate in Vanuatu,[15] although there is concern about market concentration, particularly for wholesale Internet access. One company owns the only submarine cable landing in Vanuatu, and, in the mobile market, Digicel reported a market share of 69% in 2015.

[14] This was modified from the original 21 Mbps specified in the Universal Access Policy, http://www.trr.vu/attachments/article/431/uap_implementation_update_report_20_november_2014.pdf.

[15] http://www.trr.vu/index.php/en/telecom-industry/licences/telecommunications-licence.

Institutional structures

The Office of the Government Chief Information Officer (OGCIO) is responsible for ICT sector policy, guided by the 2013 National Information and Communication Technology Policy.[16]

The Telecommunications and Radiocommunications Regulator (TRR) was established under the Telecommunications and Radiocommunications Regulation Act of 2009.[17]

The World Bank has been supporting both OGCIO and TRR via a technical assistance project,[18] as has the Australian government via its Governance for Growth project.[19]

ICT policies and regulations

Vanuatu has enacted a number of laws relevant for the ICT sector. This includes the 2006 Telecommunications Act[20] and the 2000 Electronic Transactions Act.[21] There is also a consumer protection regulation relating to telecommunications.[22] The 2013 National ICT Policy provides strategic direction for the ICT sector.[23] The 2013 National Cybersecurity Policy describes the government's strategy for promoting safety and security in the use of ICTs.[24] The 2013 Universal Access Policy lays out the direction for enhancing telecom access in unserved and underserved locations.

Network Infrastructure

International connectivity

The 1,259 km Interchange Cable Network 1 (ICN1) linking Port Vila to Suva in Fiji was launched in January 2014 (Figure 6.4, next page). The cable has been configured with an initial capacity of 20 Gbps. In Fiji, traffic is transferred to the Southern Cross cable and routed to either Australia or the United States. The ICN1 cable is owned by Interchange Limited and cost US$32 million.

The official launch of the cable was delayed by price negotiations with Vanuatu's operators, which had been ongoing since before construction of the cable. Interchange considered itself a wholesale provider offering bandwidth to all operators on equal conditions. There were initially two options for procuring bandwidth: Indefeasible Right of Use (IRU) or leased capacity, with prices varying by method, volume, and duration.

Starting in 2010, Interchange offered Early Bird IRUs for a 15-year period at a cost of US$5.7 million for an STM-1 (155 Mbps), or US$16 million (i.e., half the cost of the cable) for an STM-4. Conditions were somewhat onerous, calling for 10% due at the time of the contract and the balance due on commissioning.

The locked-in IRU price was US$204/Mbps/month for an STM-1 and US$143 for an STM-4. While this appeared relatively cheap at the time compared to other South Pacific countries, operators in Vanuatu still needed to pay transit charges from Fiji to Australia or the United States—approximately US$150 in mid-2014. Leased capacity was significantly more expensive: the Early Bird price was US$765/Mbps/month with a 10-year term.

The government of Vanuatu, FCC (a local company) and Wantok (in which Interchange has an ownership interest) purchased IRUs, and the two major operators, Digicel and TVL, as well as Telsat (an ISP), did not purchase bandwidth in advance.

As of 2014, Interchange announced it was only offering IRUs and that leased capacity would have to be procured from a reseller. Speedcast, operating as a wholesaler, leased capacity from FCC to sell on to TVL while FCC leased capacity to Digicel. The resellers

[16] http://ogcio.gov.vu/ICT%20Policy/Vanuatu-National-ICT-Policy-EN.pdf.

[17] http://parliament.gov.vu/Acts/Official%20Gazettes/Extra%20Ordinary%20Gazettes/2009%20-%20Extraordinary%20Gazettes/Extraordinary%20Gazette%20Numero%20Special%20No.%2018%20of%202009%20(dated%2027%20November%202009).pdf.

[18] http://documents.worldbank.org/curated/en/556991468317068268/pdf/AC68960ISDS0Ap00200201300Box374360B.pdf.

[19] http://dfat.gov.au/about-us/publications/Pages/governance-for-growth-mid-term-review-report.aspx.

[20] http://www.wipo.int/wipolex/en/text.jsp?file_id=197724.

[21] http://www.wipo.int/wipolex/en/text.jsp?file_id=198081.

[22] http://www.trr.vu/attachments/article/541/consumer_protection_regulation_gazette.pdf.

[23] http://www.trr.vu/attachments/category/166/vanuatu_national_ict_policy.pdf.

[24] http://www.trr.vu/attachments/category/167/cybersecurity_policy.pdf.

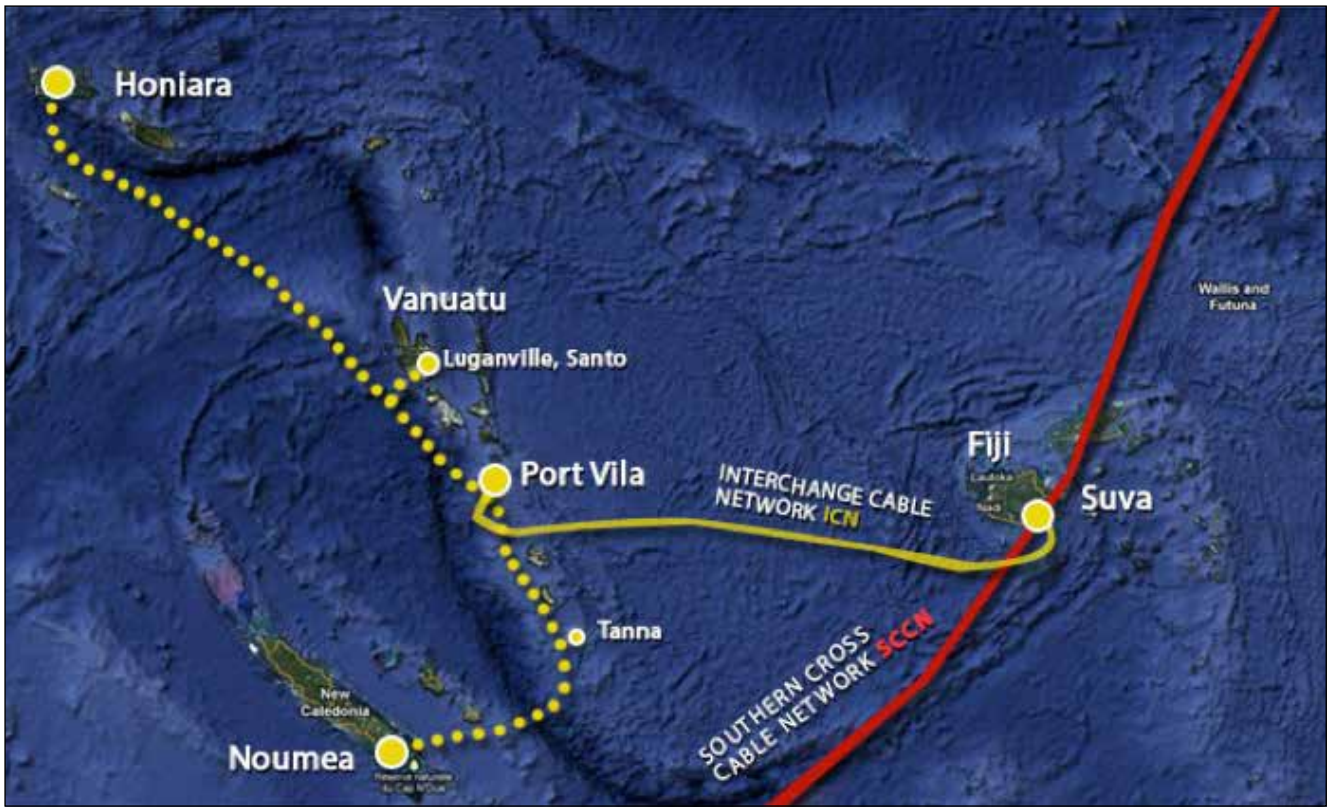

Figure CS 6.4. Existing and Planned Submarine Cables Connecting to Vanuatu (Source: Interchange Limited)

Note: The dotted yellow lines represent a second cable planned by Interchange Ltd that will go to New Caledonia and Solomon Islands and add a second landing station in Vanuatu at Luganville.

added an extra layer to the wholesale market with consequently higher prices. Meanwhile, TVL found that it could obtain a better price directly from Interchange (despite having previously stated it was no longer offering leased capacity), and it cancelled its contract with Speedcast. Consequently, in November 2014, Speedcast complained to the regulator that Interchange was engaged in false, misleading, and anticompetitive behaviour. TRR eventually issued a determination in June 2016 imposing modest fines on FCC and Interchange and finding Interchange dominant in the wholesale international Internet services market.

TRR could have established a gliding price cap, as was done in Fiji and as was requested by some of the Vanuatu ISPs, or could have called on Interchange to publish a Reference Access Offer (as was done in Samoa). Instead, TRR required Interchange to provide pricing and terms of supply (which Interchange was already obligated to do), and evidence that the prices are cost-based and not anticompetitive. TRR argues that the order will promote "cost-based pricing for access to a critical bottleneck facility."[25] According to the determination, Interchange's lease prices are US$330/Mbps/month for bandwidth less than 400 Mbps, and US$299/Mbps/month for amounts greater than 400 Mbps. This is for bandwidth to Fiji; from there, transit costs must be added to use the Southern Cross cable to either Australia or the United States. Regulated IP transit prices from Fiji to Australia were US$139 in January 2015, and US$119 to the United States. In contrast, a new submarine cable from Samoa to Fiji will reportedly have a price of US$112/Mbps/month, including IP transit in Hawaii.[26]

Roughly 155 Mbps of international capacity was being used in Vanuatu when ICN1 launched. It is estimated that this grew to 600 Mbps by the end of 2014. Interchange announced plans to build a second cable running to Solomon Islands and New Caledonia, to be known as Interchange Cable Network 2 (ICN2). According to recent news reports, its plans have changed and the cable—now

[25] TRR. 2016. "Determination and Findings Relating to the Wholesale International Internet Services Market and Speedcast's Complaint Against Interchange Limited." http://www.trr.vu/attachments/article/595/trr_final_determination_1_june_2016.pdf.

[26] World Bank. 2015. Samoa - Third Phase of the Pacific Regional Connectivity Program Project. Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/813211467999714829/Samoa-Third-Phase-of-the-Pacific-Regional-Connectivity-Program-Project.

called Melanesian Cable Solution (MCS)—will connect to the Solomon Islands and Papua New Guinea.[27] The government in the Solomon Islands is deciding whether to select MCS or a cable supported by the Asian Development Bank and World Bank.

National backbone

Each of the operators has its own domestic backbone network, mainly consisting of microwave links, plus satellite to a few areas. Both Digicel and TVL have some fibre in Port Vila. The government also has its own backbone network, with fibre in provincial capitals and microwave and satellite to other areas. Unfortunately, there is not better coordination, since the cost of three microwave networks is likely more than the cost of a fibre backbone. There could be an opportunity to leverage Interchange's proposed international submarine cable to the Solomon Islands for some domestic fibre spurs.

Public sector networks

The OGCIO is the entity responsible for government ICT. In 2008, it launched an e-government project that included construction of a government backbone network, financed by a US$29.5 million loan from China's Export-Import Bank[28] and with Huawei as the lead contractor.[29] The network connects the six provincial capitals via microwave and satellite, with local access through fibre-optic cable. There are also two data centres, as well as disaster recovery capability. The backbone is the country's third largest after the two main telecom operators. An agreement is in place for each to use one of the three networks in case of outages, and there are plans for the government to provide wholesale services over its backbone. Around half of the approximately 7,000 government employees use the network. It provides VoIP and video-conferencing services, thereby substantially reducing communications costs (no precise figures are available). Several other applications are available, mainly involving financial management. And a smartphone version facilitates access to services by staff from anywhere with mobile broadband coverage.

Interconnection and hosting

The Vanuatu Internet Exchange (VIX) began providing peering in February 2014. VIX was the South Pacific's first IXP and has six participants: Telsat, Digicel, WonTok, the government, TVL, and SPMI. There is a Google cache, including YouTube, as well as IPv6 peering. The support of the regulator and the IXP's neutral location in the government data centre are cited as critical for getting members to participate.[30]

Vanuatu's ccTLD (.vu) is managed by TVL and the Vanuatu Network Information Center (VUNIC).[31] Because TVL's management dates from when telecom services were a monopoly in the country, the TRR issued a briefing paper about future administration of the .vu domain, specifying that it would assume responsibility for policy and development, and would appoint TVL as the technical administrator.[32]

Interchange is building a technology park in order to provide colocation, data storage, and facilities for software developers and others.[33]

Capacity-building infrastructure

Opportunities for formal advanced IT education are limited. The University of South Pacific's Emalus campus in Port Vila serves 900–1200 students per semester, who study mainly law; IT is not a specific discipline.[34] The Vanuatu Institute of Technology serves 800 students,[35] and offers certificates in a variety of topics, including IT.[36] There is not a significant entrepreneurial start-up scene, nor supportive elements such as coworking spaces or incubators.

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[27] https://www.telegeography.com/products/commsupdate/articles/2015/01/09/cable-compendium-a-guide-to-the-weeks-submarine-and-terrestrial-developments/.

[28] Maya Schmaljohann and Annalisa Prizzon. 2014. *The age of choice: Fiji and Vanuatu in the new aid landscape*. London: Overseas Development Institute. http://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9172.pdf.

[29] "Huawei e-Government Cases", http://www.alphacomputer-dz.com/alphadays/galerie/presentation2/Huawei/01%20Datacom%20Solution/Solutions/Huawei_e-Government_Cases.pdf.

[30] Michaelson, George. 2014. "Success of Vanuatu's Internet Exchange (VIX)." APNIC Blog, September 16. http://blog.apnic.net/2014/09/16/success-of-vanuatus-Internet-exchange-vix/.

[31] https://www.vunic.vu/faq.php#q1.

[32] TRR. 2015. Intended Future Arrangement And Management Of .Vu Country Code Top Level Domain. http://www.trr.vu/attachments/article/454/briefing_paper_dot_vu_cctld_issues_for_trrstakeholder_pre-consultation_close_meeting.pdf.

[33] http://www.chinadaily.com.cn/world/2015-06/01/content_20976226.htm.

[34] http://www.usp.ac.fj/index.php?id=7596.

[35] http://vit.edu.vu/about-vit/welcome-from-principal/.

[36] http://vit.edu.vu/courses/it-studies/.

Power supply infrastructure

There are two main electricity operators: Union Electrique du Vanuatu Limited (UNELCO), which has concessions on Efate, Malekula, and Tanna; and Vanuatu Utilities and Infrastructure Limited (VUI), which has a concession on the island of Espiritu Santo for Luganville. The two operators had 13,885 customers at the end of 2012. Most electricity is generated by diesel, except in Espiritu Santo, where 86% is generated by hydroelectric facilities.[37] The majority of the population lives outside these concession areas, which makes supplying electricity problematic. According to one report, the concession regime should be liberalized, thereby enabling utilities to extend their grids.[38]

The proportion of households with electricity stood at just 32% in 2013 (Table 6.1), but the lack of electricity does not appear to be a strict barrier to ICT access, at least for households using mobile phones. There is a far higher penetration of mobile phones than electricity in households in rural areas, implying that users are finding ways to charge their cell phones (e.g., away from the household, using car batteries).

Electricity			Mobile Phone		
Total	Urban	Rural	Total	Urban	Rural
31.7	86.2	8.5	80.0	96.5	73.0

Table CS 6.1. Availability of Electricity and Mobile Phones in Vanuatu Households (% of Households), 2013
(Sources: Vanuatu National Statistics Office and Secretariat of the Pacific Community, 2014; Vanuatu Demographic and Health Survey, 2013.)

The lack of grid electricity outside mainly urban areas creates a challenge for base stations and backbone transmission networks, and adds to costs as expensive diesel generators are needed. Operators are mitigating this somewhat by using hybrid solar sites where feasible.

Applications and Content

E-government

There are limited e-services available; most of the government network efforts going to improving back-office processes. An online business registry was launched in August 2015 that enabled enterprises to register their firms over the Internet or at kiosks in the Vanuatu Financial Services Commission. The registry has reduced average time for a registration from three weeks to less than three days.[39]

On a smaller scale, there are several mobile applications aimed at citizens and developed by different organizations.[40] For example, the Vanuatu Ferry sends text messages advising of its schedules, and the National Provident Fund allows its 21,000 members to use their mobile phones to check balances and receive text alerts when there is a contribution to their account.

Banking and e-payments

Digicel launched its "isi Mani" mobile banking services in partnership with the National Bank of Vanuatu (NBV) in 2011,[41] which resulted in a modest take-up of 7,840 customers and 30 agents by the end of the year.[42] Users' mobile phones are linked to their NBV accounts from which online banking services are available. The service has had modest uptake mainly because it has not been successful in obtaining permission to offer international remittance transfers. In 2014, ANZ launched its goMoney mobile banking service using Digicel's network.[43]

[37] http://www.ura.gov.vu/index.php?option=com_content&view=article&id=38&Itemid=228&lang=en.

[38] http://www.ifc.org/wps/wcm/connect/ca9c22004b5d0f098d82cfbbd578891b/energyaccessreport.pdf?MOD=AJPERES.

[39] https://www.adb.org/news/vanuatu-law-reforms-culminate-launch-online-business-registry.

[40] Minges and Stork, 2015.

[41] http://www.nbv.vu/isimani.html.

[42] https://www.adb.org/sites/default/files/project-document/59824/40148-012-van-tcr.pdf.

[43] http://www.anz.com/promo/gomoney-pacific/?pid=trb-hb-hp-sep15-gomoney-vu-fr-2.

Despite a well-developed financial sector, only around half of households had a bank account in 2014.[44] There are no official data on credit cards or recent data on mobile money accounts or other forms of digital payment but the indications are they would be low, hindering the take-up of digital business in the country.

Media

Vanuatu Broadcasting & Television Corporation operates several radio stations and a television service. It has a website offering radio streaming, and a Facebook page.[45] Leading newspapers such as the Vanuatu Daily Post have websites, and there are a number of social media sites.[46]

Local services

Education

There has been limited formal government support for ICTs in schools. Internet access and computers need to be purchased from inadequate local school budgets. Connectivity is therefore uneven across schools, particularly between primary versus secondary schools, and between urban versus rural areas. A 2013 survey found 37% of schools with computer labs, 37% with a few computers used by teachers or administrators, and 26% with no computers at all.[47] The data were not nationally representative, however, being slanted towards urban areas, so it can be assumed that the majority of schools in the country do not have computers let alone Internet access. Only around 5% of students in the surveyed schools were considered computer literate, with the shortage of computers (around 1 per 200 students) being a major obstacle. Most of the respondents indicated that ICTs in education are a low priority, and that the main obstacles are a lack of electricity and trained staff. A further factor is that only around two-thirds of Vanuatu's 525 primary and secondary schools have access to electricity (grid, generator or solar/wind/water).[48]

The government has deployed Internet access and computer labs to 15 schools, and plans to distribute 350 tablet computers to students through the Universal Access Programme.[49] The initiative is supported by the Australian government's Governance for Growth programme and is implemented in coordination with the Ministry of Education, TRR and OGCIO.[50]

The University of the South Pacific has plans to use capacity on the ICN cable for its Vanuatu locations, enabling it to offer higher-bandwidth services including access to regional higher education networks. However, as of mid-2016, it was still using the USP satellite network.[51]

Health

Efforts are being made to enhance communications between health institutions across the country. There are six hospitals, one in each province. Five are linked to the government network with a minimum bandwidth of 2 Mbps. The main application is the Health Information System (HIS), for which the quality and timeliness of data should improve with better connectivity.

The mSupply software system is used for inventories of medical goods and pharmaceuticals.[52] This provides better monitoring and distribution in the provinces, and reduces the storage of drugs that have expired.

The Ministry of Health is keen to use social media and mobile phones to disseminate information to the public. Some NGOs have piloted text alerts in the health sphere but these have had limited success due to SMS prices and the reluctance of operators to provide discounts for bulk SMS services for the health sector. The mobile operators did provide free text messaging for relief organizations in the wake of Cyclone Pam in 2015 to disseminate public health alerts.

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[44] According to 2014 data from the IMF Financial Access Survey (http://data.imf.org).

[45] http://www.vbtc.vu.

[46] PACMAS 2013.

[47] OGCIO, Ministry of Education, and TRR. 2013. The First Survey of ICT Usage in the Vanuatu Schools. http://ogcio.gov.vu/images/pdf/First%20Survey%20of%20ICT%20Usage%20in%20Schools%20Final%20Final.pdf.

[48] Ministry of Education and Training. 2014. Annual Statistical Digest. https://moet.gov.vu/docs/statistics/Annual%20Statistics%20Digest%20for%20the%20Ministry%20of%20Education_2014.pdf.

[49] http://www.trr.vu/attachments/article/590/5th_trr_uap_update_report_report_to_stakeholders_30_june_2016.pdf.

[50] TRR. 2014. "A new dawn in education - ICT enabler," October. http://www.trr.vu/attachments/article/410/a_new_dawn_in_education_ict_enabler_final.pdf.

[51] http://www.pirrc.org.fj/index.php?option=com_edocman&task=document.viewdoc&id=142&Itemid=169&lang=en.

[52] https://governmentofvanuatu.gov.vu/Final%20English%20-%20Budget%20Narrative%20%20-%20March%2014th%202013e81a.pdf?download=80%3Afinal-english-budget-narrative.

Agriculture and fishery

In Vanuatu, there are no widespread mobile phone or online applications aimed at farmers and fisherman that would provide market and pricing information, weather updates, and production and pest-control tips. An e-Agriculture strategy is being developed with the support of the Food and Agriculture Organization (FAO) and the ITU.[53] In the area of biosecurity, high-quality images of plant diseases are being transmitted over the Internet to New Zealand for remote diagnosis.[54]

Tourism

The Vanuatu Tourism Office has both a website and a Facebook presence.[55] Its website provides a directory of accommodation services, including many operated by local entrepreneurs who are contacted by major global travel portals. Another initiative to encourage tourist business is provincial websites, such as the one for Malampa, which has an online form to ask about packages and bungalow stays.[56] The Department of Tourism has a website aimed at potential investors and the tourist industry.[57]

Like in other Pacific countries, the mobile operators are leveraging the high purchasing power of travellers and the strong likelihood of their bringing a mobile phone. Both have kiosks at the airport and provide tourist SIM cards. This is encouraged by high roaming fees for those without roaming plans.

For example, just over half of all visitors are from Australia and stay for an average of 11 days. Across the Oceania region, the average mobile data usage per month in mid-2016 was 1.2 GB.[58] If an Australian tourist in Vanuatu consumed the same proportional amount during the average duration of their visit, it would amount to 444 MB for 11 days. Table 6.2 (next page) shows what it costs a prepaid data user in Australia for that amount, as well as an Australian roamer in Vanuatu without and with a roaming data plan.

	Australia domestic[1]	Roaming[2]	Roaming[3]	TVL[4]	Digicel[5]
Price in national currency	40	1,332	210	400	600
Price in US$	$30	$1,002	$158	$4	$6
MB included	4,000	444	1030	600	600
Price per MB (444 MB)	$0.07	$2.26	$0.36	$0.01	$0.01
Price per MB included	$0.01	$2.26	$0.15	$0.01	$0.01
Plan	2 x 14 day	A$3 per MB	Travel pass	2 x 7 day	3 x 7 day

Table CS 6.2. Mobile Data Roaming Prices for Australian Visitors, 2016 (Source: Adapted from Digicel, Telstra, and TVL.)

[1] What an Australian prepaid user pays in Australia, [2] What an Australian visitor to Vanuatu without a roaming plan pays, [3] What an Australian visitor to Vanuatu pays with a roaming plan pays, [4] Prepaid data prices for TVL, [5] Prepaid data prices for Digicel.

Emergency services

Tropical cyclone Pam, which struck Vanuatu in March 2015, offers a number of examples of how ICTs were used to mitigate the disaster. In preparation for the cyclone, the mobile operators, OGCIO, and TRR created a plan to protect critical telecom facilities and coordinate recovery operations as part of the Emergency Telecommunications Cluster Group. Digicel and TVL provided free use of their networks to the government in order to disseminate cyclone information and warnings to the public.[59] Despite Pam being a category-five cyclone, only 11 people were killed. One of the main reasons for the relatively low loss of life was the text

[53] http://www.e-agriculture.org/events/fao-itu-e-agriculture-solutions-forum.

[54] https://www.spc.int/en/about-spc/structure/956-spc-fiji-and-new-zealand-collaborate-to-train-fiji-and-tuvalu-biosecurity-officers.html.

[55] See http://vanuatutravel.info and https://www.facebook.com/vanuatuislands.

[56] http://www.malekula.travel/.

[57] http://tourism.gov.vu.

[58] https://www.ericsson.com/res/docs/2016/mobility-report/emr-raso-june-2016.pdf.

[59] Willie, Glenda. 2015. "How has ICT contributed to Vanuatu Being resilient prior, during and after Pam?" *Vanuatu Daily Post,* 30 July 30 2015. http://dailypost.vu/news/how-has-ict-contributed-to-vanuatu-being-resilient-prior-during/article_5ae3f53e-a620-58c7-8af8-b6c2f6972153.html.

warning system in place—the first time SMS was extensively used for disaster warning in the country.[60] Text alerts were sent from the national meteorology service during the approach of the cyclone, so most of the public were aware and took preventative measures. The World Health Organization used SMS following the cyclone to send health alerts to some 90,000 people.[61] In addition, social media and crowd-sourcing were used extensively in the recovery process to identify areas where there was mobile phone coverage and public charging stations. There was also a Facebook page for posting information about missing relatives and an OpenStreetMap of the affected areas.[62]

The ITU's Emergency and Community Center Project calls for establishing four monitoring stations in the future, in collaboration with the Vanuatu Meteorological and Geohazards Department, to monitor disasters and climate change impacts.[63]

Outlook

There have been major ICT changes in Vanuatu since 2008, including the introduction of mobile competition (2008), the launch of high-speed wireless Internet access (2011), and connection to a submarine cable (2014). This has been complemented by relevant laws and policies covering telecom regulation, e-commerce, cyber security, consumer protection, and universal access. The universal access programme aims to see almost the entire population covered by Internet access with speeds of at least 2 Mbps by 2018.

But Vanuatu has not fully exploited its impressive increase in connectivity. One reason is socioeconomic: there is a significant digital divide between urban and rural areas in terms of access to the Internet, which mirrors similar divides in energy, wealth, and education. While the target of covering almost the entire population with at least 3G mobile coverage provides the potential for widespread Internet access, actual usage and impact will not significantly increase without corresponding actions to deal with affordability, availability of electricity, and digital literacy.

Another reason for the extensive divides is the limited available human resources and capacities to develop relevant applications, services, and content. There is minimal capacity at formal post-secondary institutions to train students in IT disciplines. As a result, there is no real ecosystem nurturing entrepreneurs to develop digital applications. Effort needs to be devoted toward creating additional educational opportunities to study computer science and related fields, as well as enabling a tech ecosystem.

These efforts should be made particularly for social applications that can impact the majority of the population living in rural areas, in order to improve their well-being and economic opportunities. Examples include providing farmers and fishermen with digital tools to check market pricing, weather conditions, and production techniques; public alerts and teleconsultation to improve health outcomes; and acceleration of the process of computerizing schools to expand educational resources via online content.

This will require better connectivity in rural areas, particularly higher-capacity backbones. A more-collaborative approach to national backbones merits investigation, such as developing a high-capacity fibre-optic domestic network shared using open-access principles by the government and telecom operators. This could be developed in conjunction with the expansion of grid electricity where there are mutual benefits, such as using electrical towers for fibre-optic cable.

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[60] http://www.abc.net.au/news/2015-04-01/explainer3a-why-was-the-vanuatu-death-toll-from-cyclone-pam-so/6363970.

[61] http://www.wpro.who.int/southpacific/programmes/health_sector/emergencies/health-cluster-16may2015.pdf.

[62] http://humanityroad.org/wp-content/uploads/2015/03/20150317_Humanity_Road_Sitrep4-Vanuatu.pdf.

[63] http://www.trr.vu/attachments/article/590/5th_trr_uap_update_report_report_to_stakeholders_30_june_2016.pdf.

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Glossary

Backbone
Trunk routes of a network, also used as the path for transporting traffic between different networks. Backbones can be the physical telecommunication cable infrastructure, or the circuits established over them by a particular network operator.

Bandwidth
The size or capacity of a communications channel, indicating its ability to transfer data, usually measured in the speed of data transfer, in bits per second (bps) for packet networks such as the Internet, or SDH STMs, or also often stated as the frequency range assigned to the channel, measured in Hertz (Hz).

Bit
Binary Digit—a 0 or a 1—the way information is encoded digitally.

Broadband over electric power lines (BPL)
Use of power cables to transmit data.

Business process outsourcing (BPO)
Use of a third party, often offshore, to carry out business activities for a company, such as a help desk or accounts processing.

Bits per second (bps)
The number of bits passing a point every second. The transmission rate for digital information, i.e., a measure of how fast data can be sent or received. Often expressed as Mbps (Megabits per second) or Gbps (Gigabits per second) for high-speed links.

Broadband
A high-speed (multimegabit) data connection sufficient to support streaming multimedia connections. Target speeds for broadband are continually evolving.

Byte
Eight bits of data, sometimes called a “word” or an “octet”. Used as a measure of storage capacity or traffic, e.g., a 1 Gigabyte mobile data package.

Cable landing station
The facility where a submarine cable lands on shore, housing equipment for distribution of the capacity and in most cases also for powering the cable.

Caribbean Telecommunications Union (CTU)
An intergovernmental agency supporting the development of improved telecom services in the Caribbean region.

Cloud service
A service provided via the Internet that gives access to applications and data storage facilities that are hosted on the service provider’s network and servers. Typical examples are Amazon WS, DropBox, Gmail, and MSN.

Colocation
The renting of space for housing computer server equipment, usually in specially designed buildings (called data centres, telehouses or carrier hotels).

Connection redundancy
Two or more communication links via physically separated network providers. Redundancy ensures continued operations in the event of one connection going down.

Construction and Maintenance Agreement (C&MA)
A type of detailed shareholder's agreement made between consortium members or owners of a fibre project.

Content
The data that travels over a network: traffic; any form of digitised information ranging from text to multimedia audio and video. It may include software/applications, as well as financial and gaming transactions.

Dark fibre
Optical fibre which is not yet in use, and therefore unlit.

Demand forecast
A projection of the future demand for capacity on a communications system, typically for at least ten years, taking into account market growth and competition factors.

Dense wavelength-division multiplexing (DWDM)
A technology that enables data from different sources to be transmitted simultaneously on a single optical fibre, each signal (data source) being carried on a discrete optical wavelength. Up to 80 wavelengths (and theoretically more) can be transmitted on a single optical fibre.

Detailed feasibility study (DFS)
A demonstration that a system is economically viable, based on the projected cash flow given the demand forecast and cost estimate, along with projected pricing for capacity on the system.

Domain name
A name, registered with and held on a database by a domain name registry, consisting of a name, sometimes a second level domain, and a top level domain, e.g., total.com.ng, mycompany.co.uk.

Downstream
A network's paid traffic. In contrast to upstream traffic, for which a network must usually pay transit fees, and peered traffic, which is usually settlement-free, downstream traffic is paid for by the network's users.

Digital Subscriber Line (DSL)
A technique for delivering broadband services over copper cables, traditionally used to provide fixed telephony services.

Exabyte
A billion gigabytes.

Fibre-optic cable
A technology using glass fibre for the transmission of data. The signal is imposed on the fibre via pulses (modulation) of light from a laser or a light-emitting diode (LED). International fibre cables are now usually deployed with terabit capacities.

Fibre to the home (FTTH)
The provision fibre-optic broadband communications links to domestic premises – a more generic term to include other buildings or to the kerb would be FTTx.

Gigabits per second (Gbps)
A data transfer rate of a billion bits per second.

Hosting
A term for the service of managing data servers or websites for third parties. Similar to colocation, but may be on shared equipment.

Information and communication technologies (ICTs)
Data transmission and processing technology, including applications and content.

International gateway
A facility to provide international connectivity and termination points. In practice it is a licensing term used by many government regulators that allow only licenced operators to carry international voice traffic or to lease international data circuits.

International private leased circuit (IPLC)
A physical circuit of dedicated capacity provided at two points: one inside the country and one outside the country. In many cases, the circuit is charged in two sections—each from the location to the border, or in the case of submarine cable, one local origination and one foreign origination.

International Telecommunications Union (ITU)
The United Nations intergovernmental body responsible for telecommunications.

Internet exchange point (IXP)
A physical infrastructure facility enabling many networks to exchange Internet traffic. Traffic is exchanged by peering agreements made between the ISPs connected to the Internet exchange. By peering at an Internet exchange, the connected ISPs reduce their reliance on a small number of networks (usually their upstream providers). This also reduces network latency and improves the user experience via more responsive services.

Internet service provider (ISP)
An organisation that connects end-users and businesses to the global Internet. ISPs often provide other services, as well, such as storing and forwarding email and hosting websites. They may or may not own the underlying physical infrastructure used to provide their services. ISPs that purchase bandwidth from companies with direct links to the Internet, in turn sell that bandwidth in smaller chunks to their own customers.

IP packet
A discreet datagram of Internet traffic constructed according to the Internet Protocol, between 40 and 1599 bytes long, having a source, destination (i.e., routing information) and other management information, as well as the actual user data (payload).

Indefeasible Rights of Use (IRU)
A means of purchasing long-term rights (usually 10 to 15 years) to the capacity or physical resources (optic fibre or wavelength) on a communications circuit. IRUs are treated as assets for accounting purposes, which adds to their tax advantage compared to leasing.

Leased line
A telecommunications circuit that is leased between two or more locations and rented from a telecom provider.

Link aggregation
Various methods of combining (aggregating) multiple network connections in parallel in order to increase throughput beyond what a single connection can sustain and provide redundancy in case one of the links fails.

Local area network (LAN)
A network of computers and data links spread over a relatively small physical area, often in one building and often belonging to one organization. See also metropilitan area network and wide area network.

Long Term Evolution (LTE)
A standard for 4G wireless networks.

Mbps
A data transfer rate of a million bits per second.

Median
The midpoint in a range of values.

Metropolitan area network (MAN)
Usually a fibre-optic network covering a city.

National regulatory authority (NRA)
See Regulator.

Network
Two or more interconnected computers or data communications devices. See also IP network, metropolitan area network, wide area network.

Open access
Re fibre-optic infrastructure, open-access service delivery models ensure that all operators, regardless of the size of investment or capacity purchase, have equal terms of use for access to fibre-optic cables on a capacity (Mbps), wavelength, and dark fibre basis.

Optical ribre cable (OFC)
The cable that carries data by modulating light pulses, usually in glass fibres, although plastic fibres can be used over short distances.

Optical ground eire (OPGW)
A cable that runs along high-tension electric power lines, used to provide control information for the power network. OPGW often has additional cables for use by communication network operators.

Pacific Region Infrastructure Facility (PRIF)
A multiagency coordination mechanism aimed at improving the delivery of development assistance from donors and development partners to the infrastructure sector in the Pacific region.

Packet
A discreet chunk of data traffic. See IP packet.

Peer
A network in which an operator has a peering relationship and where traffic is usually exchanged between peers at no cost.

Petabit
One thousand terabits.

Point of presence (PoP)
A location where a network has physical infrastructure to provide services to end-users or to interconnect with other networks.

Public-private partnership (PPP)
A mutually beneficial relationship between government and private sector entities, such as shared investment in a submarine cable and landing station. Not to be confused with purchasing power parity, a mechanism to compare the relative values of currencies.

Public switched telephone network (PSTN)
The traditional voice telephone system, including both fixed and mobile networks. Most networks today are migrating from a switched architecture to an IP packet based architecture.

Public telecom operator (PTO)
Usually the incumbent operator (often previously state-owned), although technically the distinction between fixed line operators, mobile operators, and ISPs is increasingly blurred (see PSTN).

Quality of service (QoS)
A measure of the quality of the service provided by a network. There are many QoS measures, depending on the nature of the traffic. Examples include ping time, packet loss, and round-trip time. Also see Service-level agreement (SLA). QoS rules can also be applied to different types of traffic passing through a router, e.g., voice traffic might be given a higher priority than email.

Regulator
A government entity with responsibility for executing national policy by establishing regulations that govern the telecom sector. The regulator is normally semiautonomous (although the state usually appoints the executive body), and it derives its income from licence fees. The regulator's main responsibility is to ensure a level playing field in the market and to curb the impact of market dominance of the incumbent operators. In some economic regions with a high level of integration, such as the EU and ECOWAS

(West Africa), a substantial amount of policy and regulatory development takes place at the regional level that the member states are obliged to adopt.

Request for proposal (RFP)
A formal request for suppliers to propose detailed solutions for provision of a system.

Rough order of magnitude (ROM) estimate
An approximation of system cost based on knowledge of route and product prices, using standard estimating practices.

Route
The path taken by IP packets of a cable or radio transmission through one or more networks. Due to the dynamic nature of routing on the Internet, packets from the same data stream may travel by different routes and reassemble at the final destination.

Significant market power (SMP)
A term used by regulators to help ensure a level playing field in the presence of an operator that is dominant in the market and able to charge uncompetitive prices (often the incumbent previously state-owned monopoly operator). An SMP determination allows the regulator to set the tariffs that may be charged and place other conditions on the operator.

Submarine line terminal equipment (SLTE)
The electronics necessary to carry traffic over an undersea fibre-optic cable.

Supply contract
A formal detailed definition of a suppliers' obligations to manufacture, install, and test a system; and a developers' obligation to pay.

Special purpose vehicle (SPV)
A company set up for a particular purpose, often with not-for-profit goals where shareholders are a mix of public and private entities, such as an open-access submarine cable landing station.

Synchronous digital hierarchy (SDH)
The traditional carrier network transmission protocol (see below), now being superseded by Ethernet and IP services.

Synchronous transport module (STM)
The International Telecommunication Union-Telecommunication Standardization Sector (ITU-T) standard for transmission over a fibre-optic network using the SDH protocol: an STM-1 link has a capacity of 155 Mbps, an STM-4 has a capacity of 622 Mbps.

Terabit (Tb)
One thousand gigabits. The latest fibre-optic cables are able to carry tens of terabits per second over thousands of kilometres.

Transit
An arrangement in which an operator sells access on its network to other networks. Transit charges are set by negotiation and often not disclosed publicly. Transit arrangements typically provide access to an array of networks not limited to one country. In many cases, one Internet transit arrangement with a large network is used to provide a small network with access to the rest of the world.

Upstream
The connection(s) to the global Internet Typically a proportion of the upstream capacity required by a network is peered away to some other networks at no cost, while the rest of the capacity required is purchased from a transit provider.

Wavelength
A carrier of data on a fibre-optic cable. See DWDM.

Weighted average cost of capital (WACC)
A measure of the financing cost of the capital used in making an investment, such as for a submarine cable.

Wide area network (WAN)
A network of computers spread over a large physical area, from regional to global. WANs may be operated and used by single organizations, or used by many. Perhaps the ultimate WAN is the Internet. See also MAN.

Abbreviations and Acronyms

2G	Second generation (of mobile telephone technology), also GSM.
3G	Third generation (of mobile telephone technology), also WCDMA, HSPA, and HSDPA.
4G	Fourth generation (of mobile telephone technology), also LTE.
AOSIS	Alliance of Small Island States
CWC	Cable and Wireless Communications
ECTEL	Eastern Caribbean Telecommunications Authority
EDGE	Enhanced Data for Global Evolution
FTTH	Fibre to the home
Gbps	Gigabits per second (Also Gb/s)
GDP	Gross domestic product
GPS	Global positioning system
GSM	Global system for mobile communication
HHI	Herfindahl-Hirschman Index
HSDPA	High-speed downlink packet access
HSPA	High-speed packet access
ICT	Information and communication technology
IMF	International Monetary Fund
IP	Internet protocol
IRU	Indefeasible rights of use
ITU	International Telecommunications Union
LAN	Local area network
LDC	Least Developed Country
Mbps	Mega (million) bits per second, also Mbps.
NRA	National Regulatory Authority
OTT	Over the top
PRIF	Pacific Region Infrastructure Facility
PSTN	Public switched telephone network
PTO	Public telecom operator
SIM	Subscriber identity module
SMP	Significant market power
SMS	Short Message Service
UN	United Nations
US$	United States dollars. All currency conversions use annual average exchange rate.
VSAT	Very small aperture terminal
WCDMA	Wideband code division multiple access

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