



MPLS/SDN Intersections Next Generation Access Networks

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MPLS & Ethernet World Congress 2013

Agenda



- Carrier Requirements – Current & Future
- Software Defined Networking - What does it mean?
- Challenges ahead in deploying...
 - SDN in Access Networks
 - MPLS/MPLS-TP in Access Networks
- Explore Intersections of SDN/MPLS
- SDN Next Steps & Research Activities

Carrier Requirements

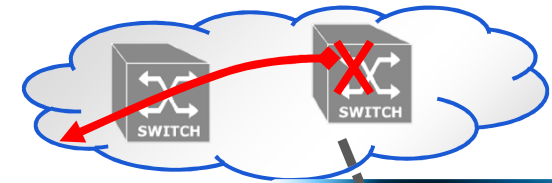
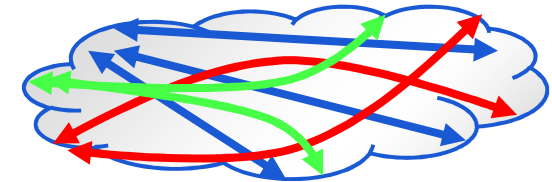


Carrier Requirements

Traditional/Current



- Path Provisioning
 - Static and Dynamic
- Scalability
- Protection/Resilience
- OAM, Fault Finding & Fault Resolution
- SLA Verification/Performance Monitoring
- Synchronization
- Security



...broadly met via Carrier Ethernet and MPLS-TP

Carrier Requirements Requested...Predicted...



- Rapid re-provisioning & Elastic Services - Cloud

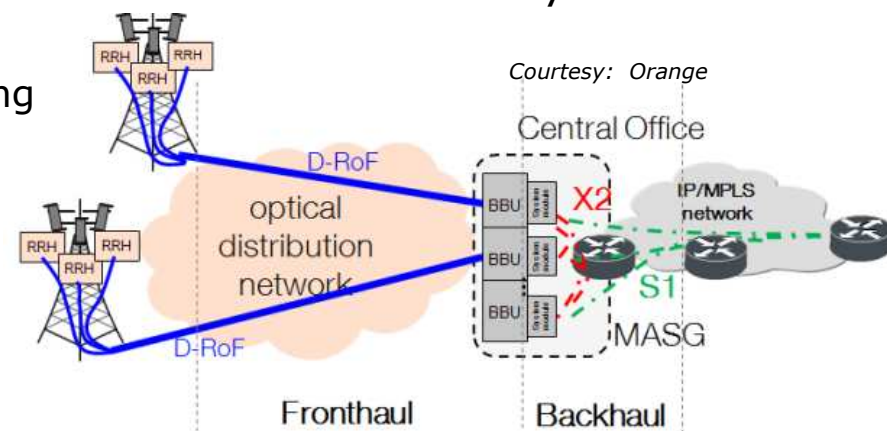


- Hybrid Models (Carrier Ethernet/MPLS)
 - MPLS interoperation at Carrier Ethernet \$\$

- Latency challenges

- LTE Backhaul and CoMP Air Optimisation - X2 channel delays
 - >1ms ~5% Hit in optimisation
 - Adoption of C-RAN and BBU Pooling

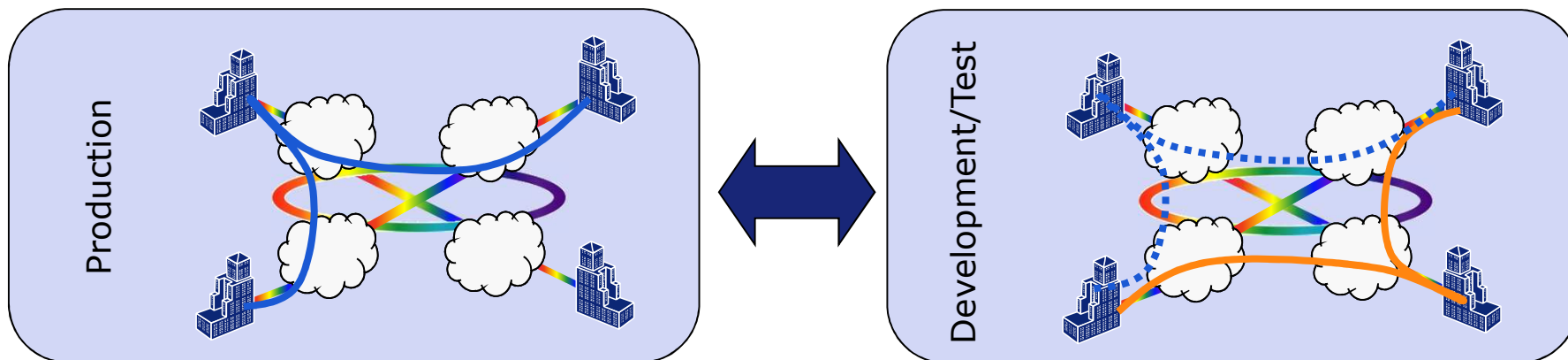
- Network Convergence
 - Converged Fixed Line and Mobile
 - Economy and Scale



Carrier Requirements Requested...Predicted...



- Virtualization
 - Slicing of the network
 - Best Effort, Premium Services, Auction (on-demand)
 - Experimental/Development on top of 'in-field' equipment
 - Virtual Functions onto common platforms
 - Allow easy roll-out and avoid vendor lock-in – ETSI NFV



- Network Simulation - VMs of Nodes, simulate behaviour at Scale

Provisioning/Flexibility/Virtualization/Simulation...Software Defined Networking

What is Software Defined Networking?



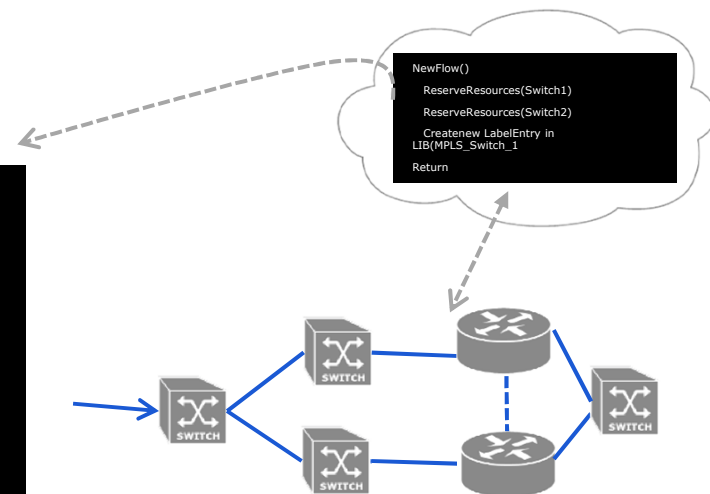
Software Defined Networking Isn't as simple as...



```
If Packet_Header(MidStr, 6, 3) = "00-80-EA"  
  then Tx_Mgnt_Port(ADVA_Packet)  
  else Tx_Network_Port(Unkown_OUI)  
Endif
```



```
NewFlow()  
  Create_ProtectionPath (Switch 1)  
  ReserveResources(Switch2, Switch 3)  
  Createnew_LabelEntry(MPLS_Switch_1)  
  Createnew_LabelEntry(MPLS_Switch_2)  
  Create_ProtectionPath (Switch 4)  
Return
```



Software Defined Networking not just code to control switch or network

Software Defined Networking

What does it mean?



Separation of data and control plane



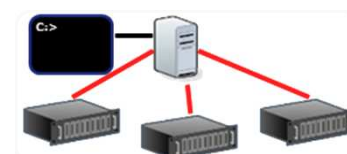
Flow oriented data plane



Centralized management & control



HW abstraction and virtualization



Network programmability

- Deterministic behaviour, predictable performance, rapid convergence
- Simplified planning, global optimization, off-line analysis
- Secure multi-tenancy & infrastructure sharing
- Better machine & service mobility
- Application-driven networking

Key SDN innovations: virtualization and application-level programmability.

Deployment Challenges



SDN in Access Networks

What are the Challenges...Technology Gaps

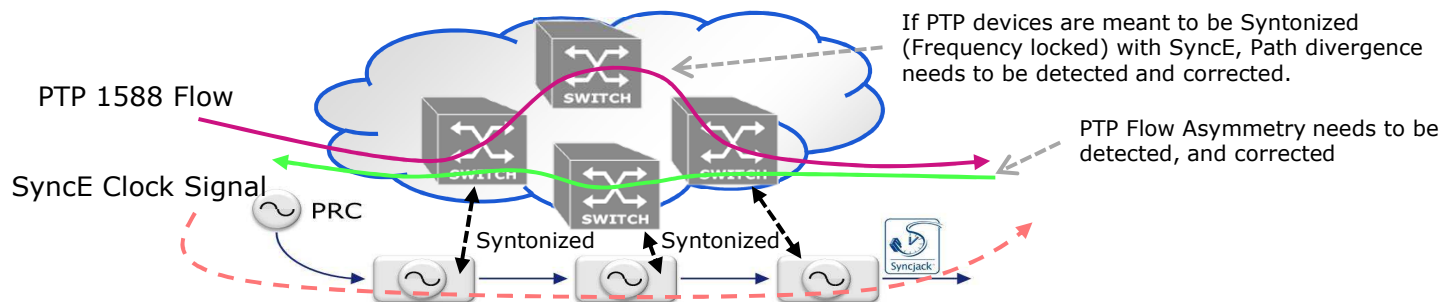


Mobile Backhaul - Programmable Synchronization layer?

- Physical & Protocol Layers
 - Capability detection
 - Discovery of clock references
 - Frequency signals & Time Protocols
 - Analogue/HW as well as protocol problem
 - Clock Budget - Performance over number of hops into Path decision making
 - Physical layer Vs Packet Layer
- **SDN to associate different layers – physical/packet**

Fixed Line – Adaptive SLA Model for Elastic Services

- Service Level Agreement
 - QoS/OAM around user defined model
 - not a topology parameter
 - OAM tools need to be adaptive, scalable, programmable
 - Avoid over-dimensioning/ Cost/Volume
 - Flow Based Fault Finding Tools need to be adaptive
 - VCCV/Connectivity Check, Loopback Reflectors compliment service demand
- **SDN to support OAM/SLA reservation and management – as well as service**



Tools like OpenFlow are beginning to consider QoS, but still some way to go...

MPLS/MPLS-TP in Access Networks

Strengths & Challenges

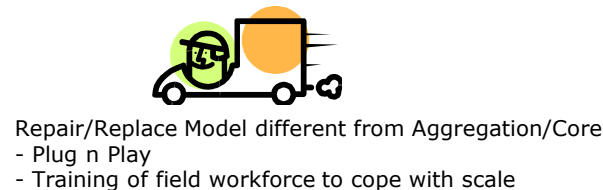


- MPLS Strengths
 - Well defined, widely adopted in other parts of the network
 - Control Planes entrenched in core
 - Unrealistic to expect/want a clean slate (SDN) approach to disrupt
- Challenges - MPLS/MPLS-TP in the Access Network

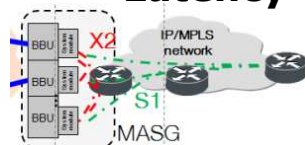
Footprint/Power/Cost



Operational Model



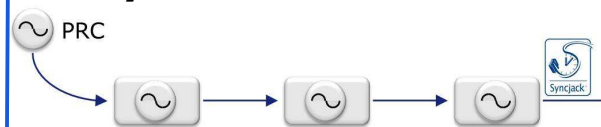
Latency



MBH Air Interface – CoMP and X2 Channel Delay – Latency sensitive

- Drive forwarding decisions on lowest layers and simple topology
- MPLS/TP sit too far into header to optimise
- Simple network unlikely to benefit from MPLS/TP

Synchronization

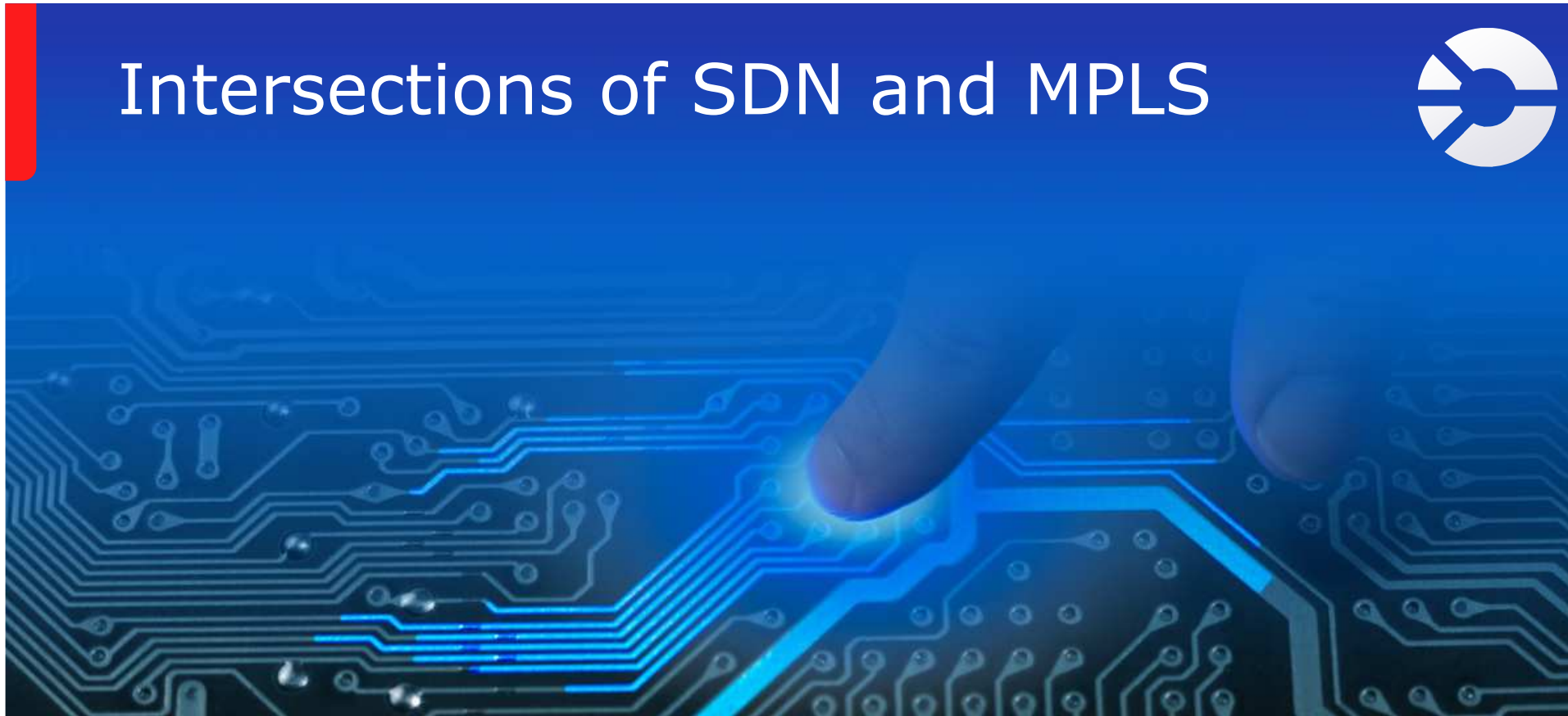


Synchronization in MPLS networks is still a challenge

- TICTOC in IETF working towards on-path support i.e. Transparent Clock
- Still not a complete solution
- Correlation of clock issues between physical and protocol layers

MPLS & MPLS-TP do not deliver all of the needs of the Access Network

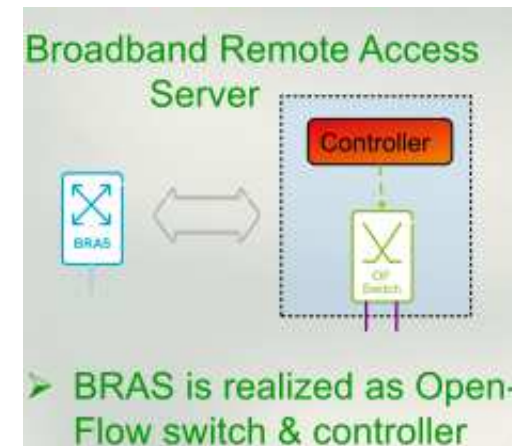
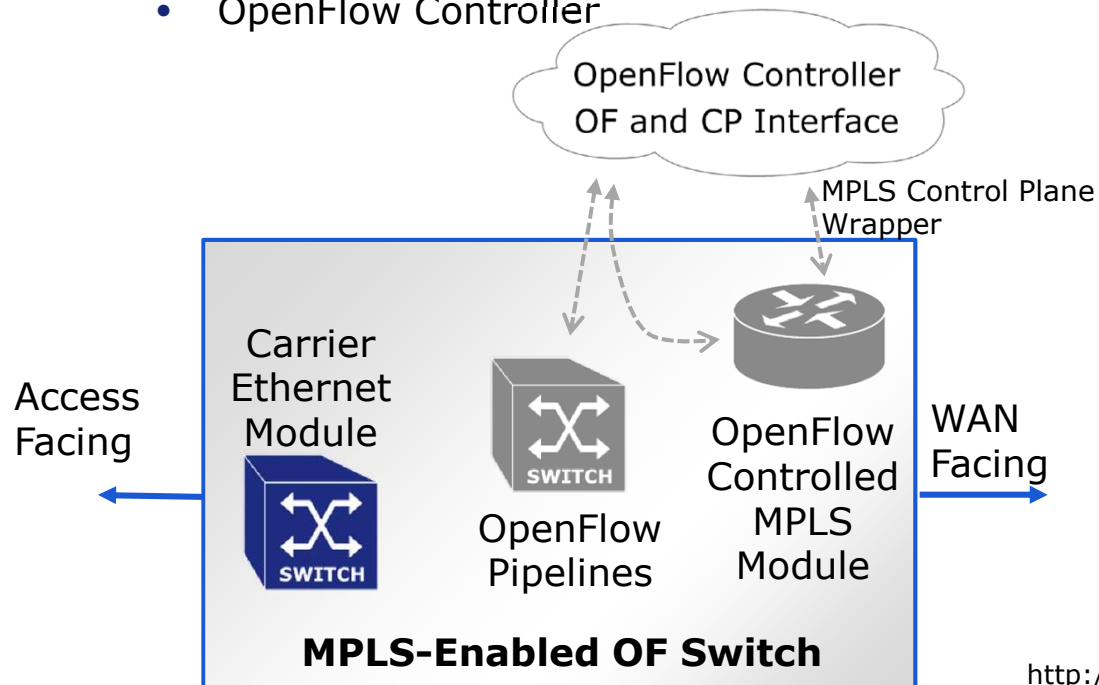
Intersections of SDN and MPLS



SDN & MPLS Intersections

OpenFlow as one implementation of SDN Concept

- MPLS-Enabled OpenFlow Switch
 - Carrier Ethernet functions & MPLS Interop at Carrier Ethernet \$\$
 - Carrier Ethernet Access facing interfaces
 - MPLS Shim layer in Hardware
 - OpenFlow Controller
- OpenFlow in WDM-PON OLT
 - OLT analogous to DSLAM
 - DSLAM as a BRAS/BNG
 - Distributed BRAS Function
 - OLT with OpenFlow & OpenBRAS

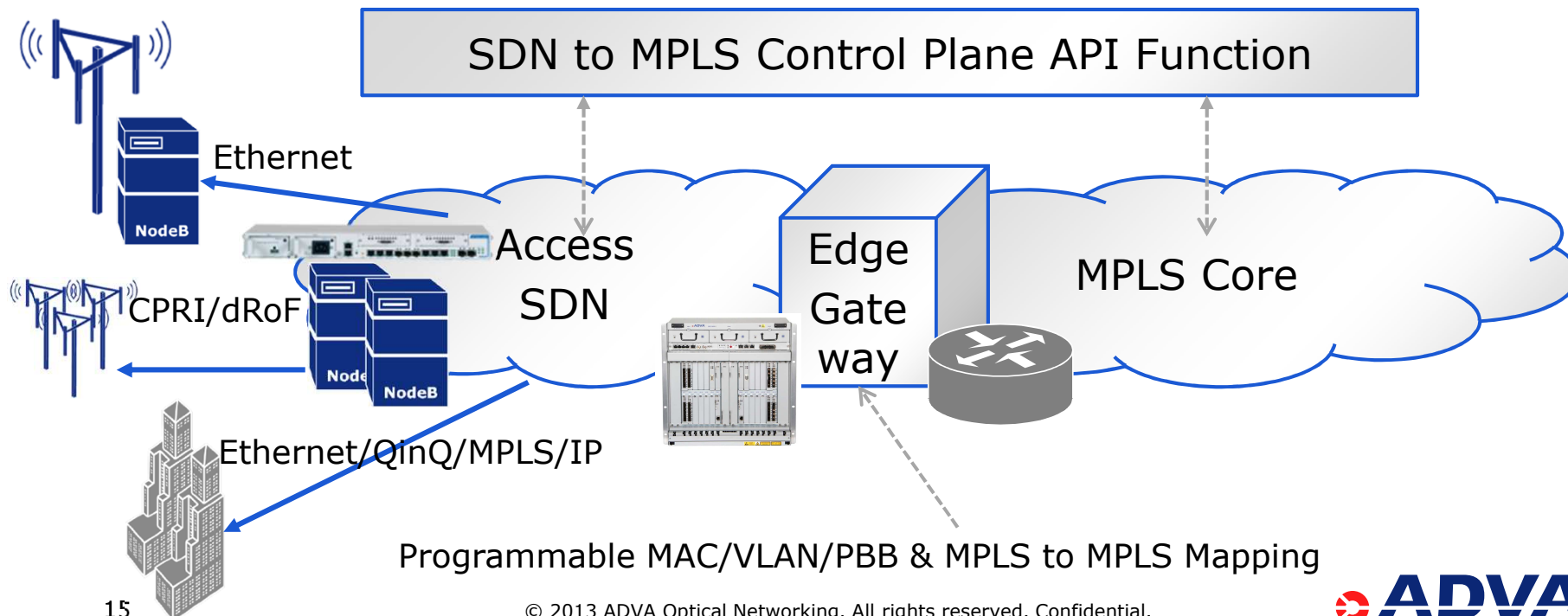


http://www.fp7-sparc.eu/assets/publications/22-ONS2012-SparcA1_ONS2012_poster_09.pdf

Where might intersections arise?



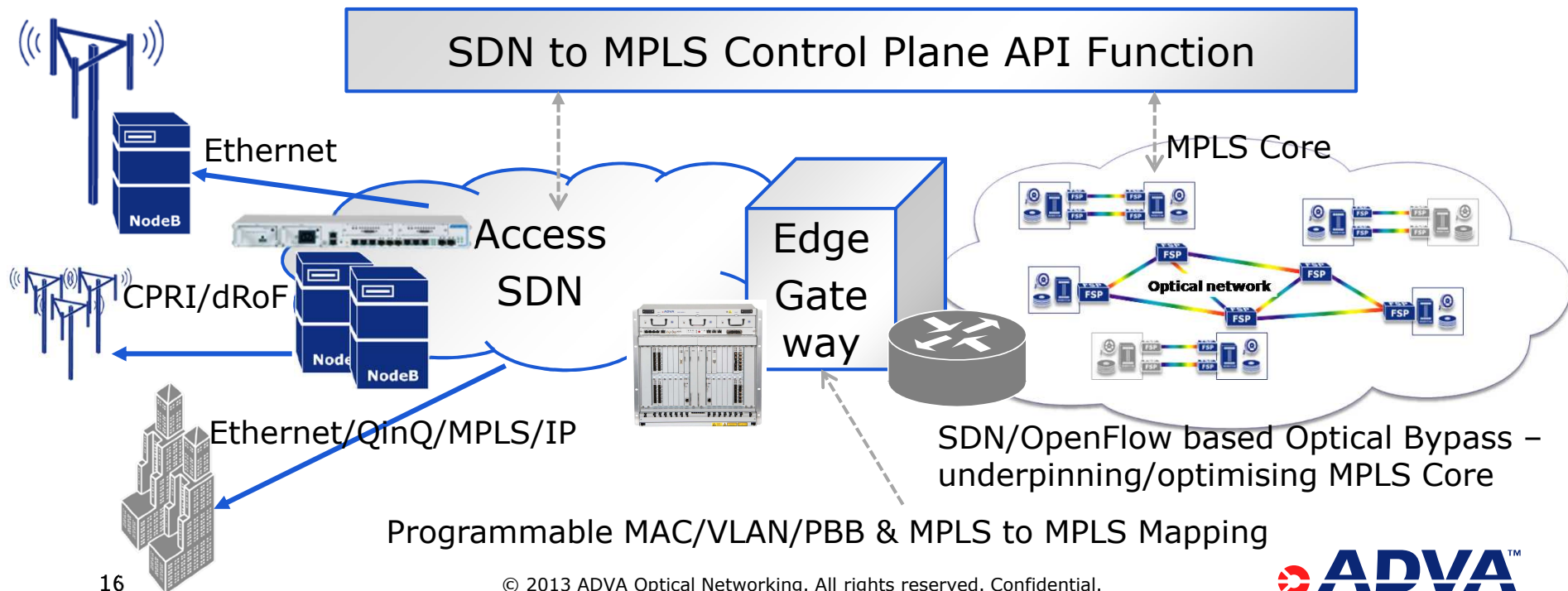
- Access Network Edge!
 - SDN Access Network – where services originate and are delivered
 - SDN management layer interaction with Control Plane
 - Path requests - Access node to remote Access node
 - SDN Path detection/provision in the access > causes MPLS path request
 - MPLS Control Plane to handle path provision across the MPLS core
 - Seamless Access SDN with MPLS Aggregation/Core
 - Results in MPLS hand-off from the Access



SDN in Access & SDN Optical Layer with MPLS on top



- SDN based Optical bypass underpinning MPLS Core
 - Proven use cases – OFELIA project – EU FP7
- SDN in Access network, SDN in Optical Layer & MPLS on top
 - Working in orchestration
- Depends on - Control Plane, SDN Controllers, APIs
 - Communication through Open Interfaces



SDN Next Steps & Research



Software Defined Networking

Steps to get there ...



Extend SDN technologies into the optical/Access domains



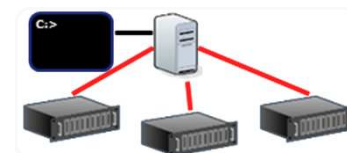
Enable interworking with IP/MPLS networks



Define open northbound interface



Provide framework for virtualization of SDN domains



**Address open architecture questions
(e.g. allocation of discovery, OAM, protection & timing)**

Software-Defined Networking

Collaboration & Research



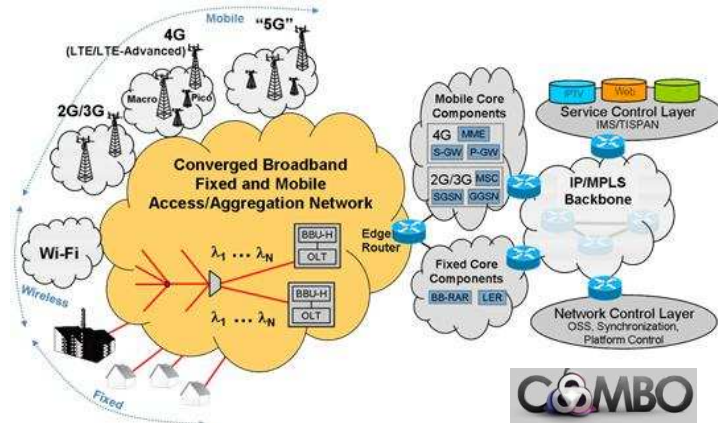
Standards



Collaborations, Trials, Ecosystem



Network Architectures/Studies



SDN Applications Emergence



Key Messages



 Access Networks – Programmability/User Defined/Adaptive

 SDN & MPLS Approach each have deployment challenges

 SDN in Access Compliments MPLS Aggregation/Core

 Key Concepts demonstrated on Optical domain - OFELIA

Software Defined Networking in the Access is on it's way...



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Thank you

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