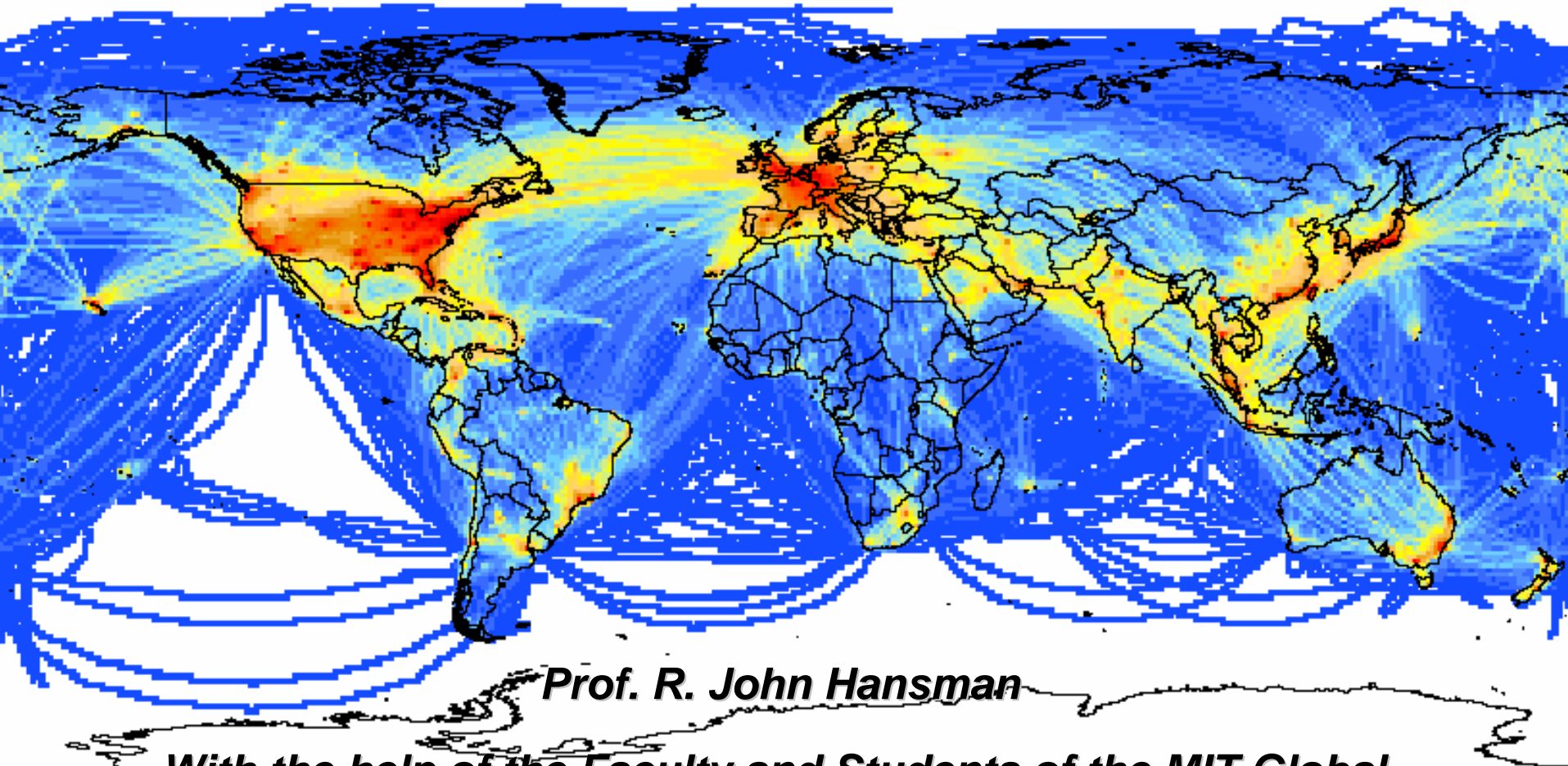




Global Aviation Infrastructure

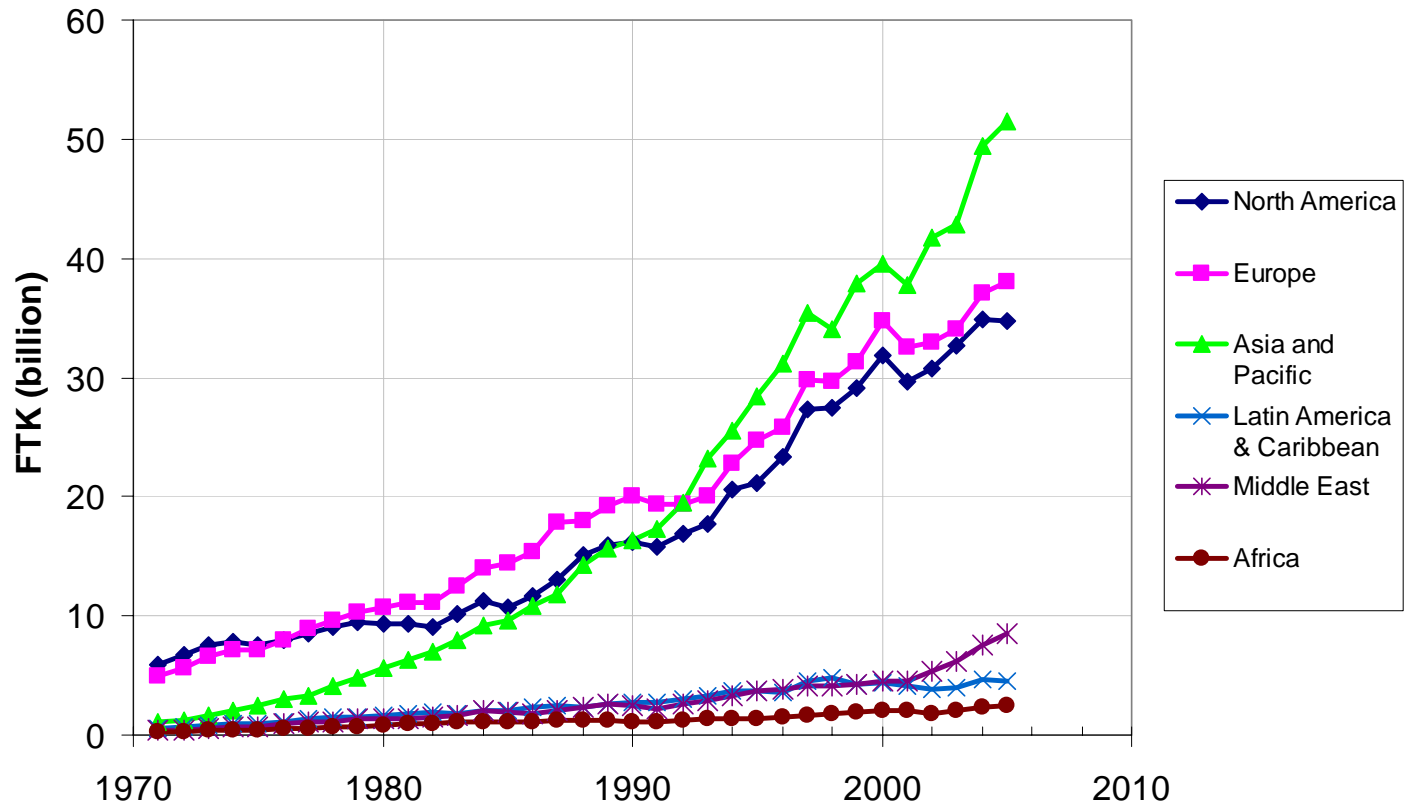


Prof. R. John Hansman

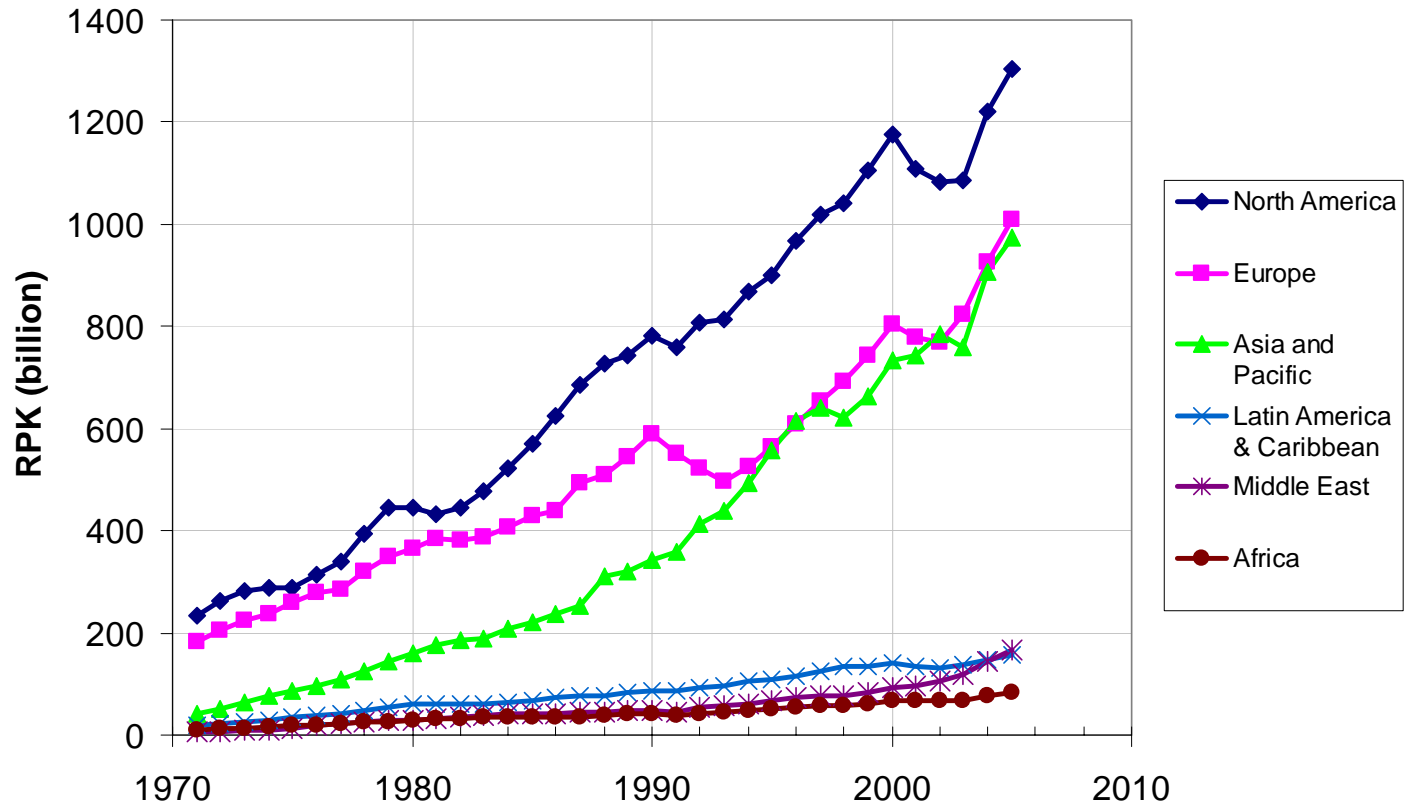
With the help of the Faculty and Students of the MIT Global Industry Study

rjhans@mit.edu

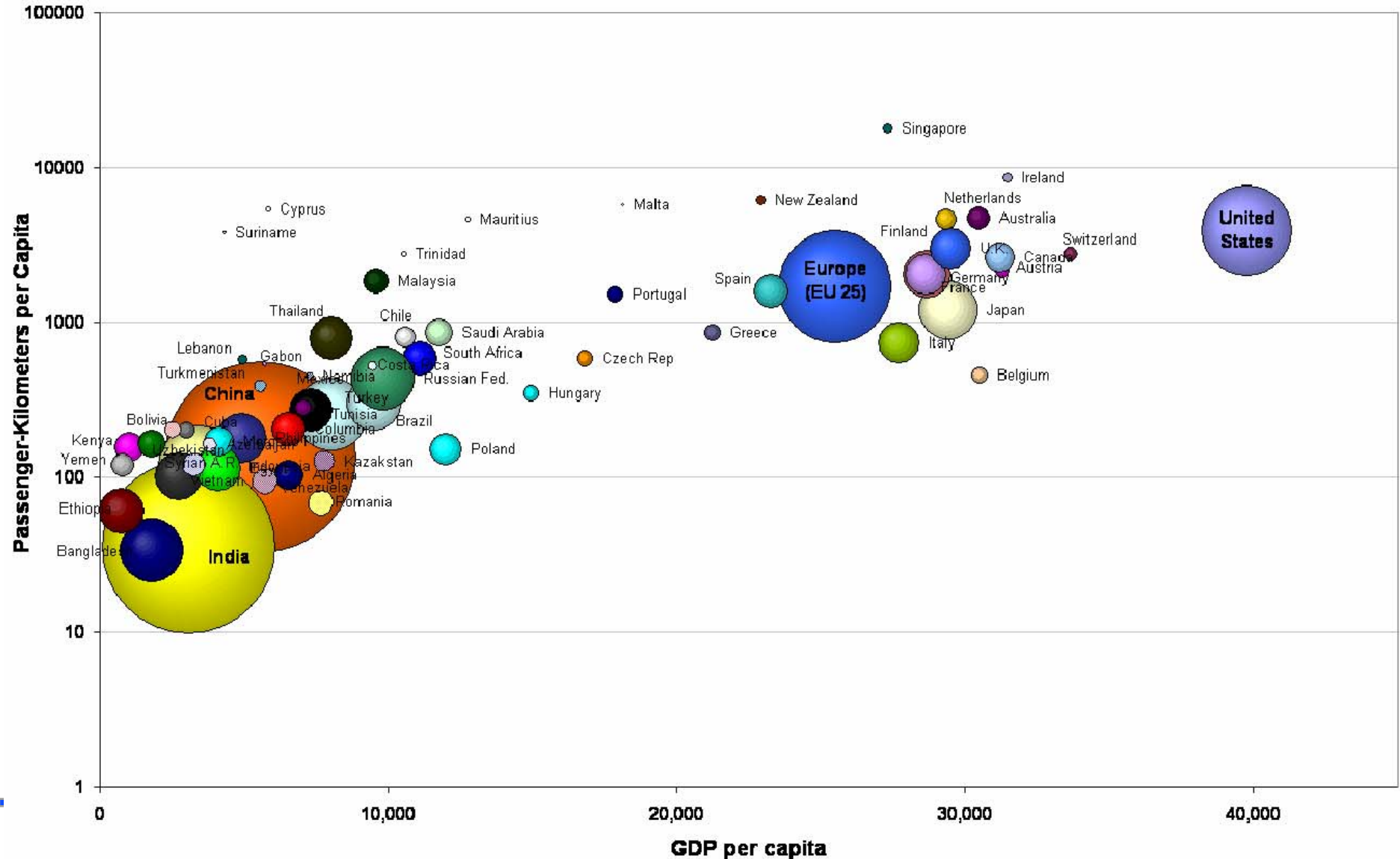
Freight Tonne-Kilometers by Region



Scheduled Revenue Passenger-Kilometers by Region



Air Transportation Markets 2004 Data



China - India Megamarkets

SOUTHWEST ASIA >>

	ANNUAL GROWTH	RANK 1-10
GDP	5.4%	2
RPKs	7.1%	2
RTKs	9.1%	1

DELIVERIES

Value, \$B	90	8
New airplanes	1,030	8
Regional jets	70	6
Single aisle	750	6
Twin aisle	200	7
747 and larger	10	8

TOTAL FLEET

2005	310	10
2025	1,140	8

CHINA >>

	ANNUAL GROWTH	RANK 1-10
GDP	6.6%	1
RPKs	7.9%	1
RTKs	7.1%	3

DELIVERIES

Value, \$B	280	3
New airplanes	2,880	3
Regional jets	290	3
Single aisle	1,840	3
Twin aisle	660	5
747 and larger	90	5

TOTAL FLEET

2005	1,030	4
2025	3,900	3

Ranked by the 10 regions discussed in detail in this section.

Source : Boeing Current Market Outlook 2006



China - India Infrastructure Approaches

India

Airline Liberalization

Marginal Infrastructure

Industry Pushing

Infrastructure

China

Airline Regulation

Infrastructure Investment

Field of Dreams

“If you build it they will come”



India

18 Bilateral MOUs last year

1. India - Russia *New Delhi, 21st February 2006*
2. India - Italy *New Delhi, 15th February 2006*
3. India - Thailand *Bangkok, Thailand, 10th February 2006*
4. India - UAE *New Delhi, 7th December 2005*
5. India - New Zealand *Queenstown, New Zealand, 19th October 2005*
6. India - Singapore *New Delhi, 24th August 2005*
7. India - Philippines *New Delhi, 21st July 2005*
8. India - Bhutan *Thimphu, Bhutan, 6th July 2005*
9. India - Canada *Ottawa, 2nd June 2005*
10. India - Germany *New Delhi, 25th May 2005*
11. India - Belgium *Brussels, 18th May 2005*
12. India - Netherlands *The Hague, 17th May 2005*
13. India - Qatar *New Delhi, 12th May 2005*
14. India - Oman *New Delhi, 27th April 2005*
15. India - USA *New Delhi, 14th April 2005*
16. India - UK *New Delhi, 13th April 2005*
17. India - China *New Delhi, 11th March 2005*
18. India - France *Paris, 23rd February 2005*

China

Battle for last US Route

Nonstop to China

Four carriers are competing for one new route to China. Here's what each carrier proposes.

Continental Airlines

Route: Newark, N.J. to Shanghai
Seats: 283
Flight Time: 14 hr.

United Airlines

Route: Washington, D.C. Worth to Beijing
Seats: 347
Flight Time: 15 hr. 15 mins.

Northwest Airlines

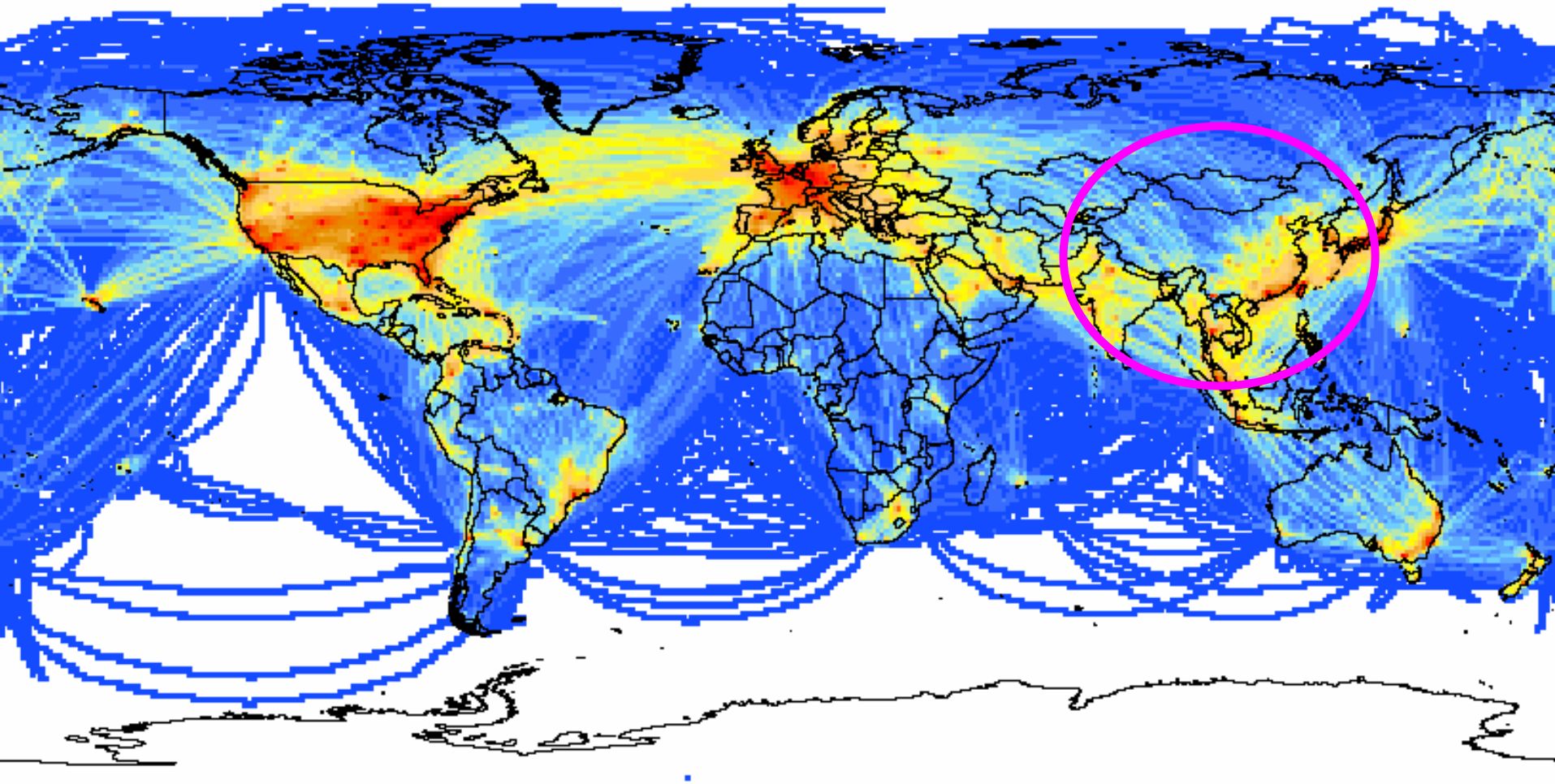
Route: Detroit to Shanghai
Seats: 335
Flight Time: 14 hr. 45 mins.

American Airlines

Route: Dallas/Ft. Worth to Beijing
Seats: 247
Flight Time: 14 hr. 30 mins.

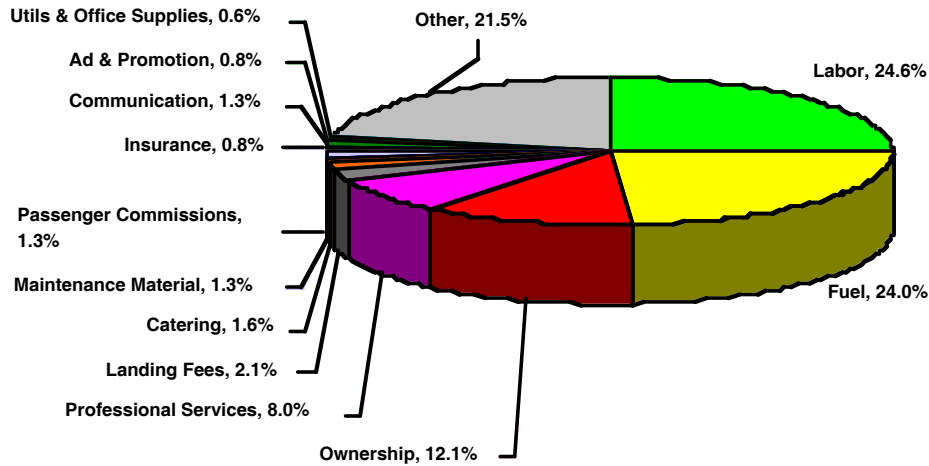
- **Current services:** from New York, Chicago and San Francisco.
- **The U.S. Department of Transportation will award one last route (until 2008) between China and the U.S. by the end of the year.**
- **Four U.S. airlines are competing for the route:**
 - United,
 - Northwest,
 - Continental,
 - American

China

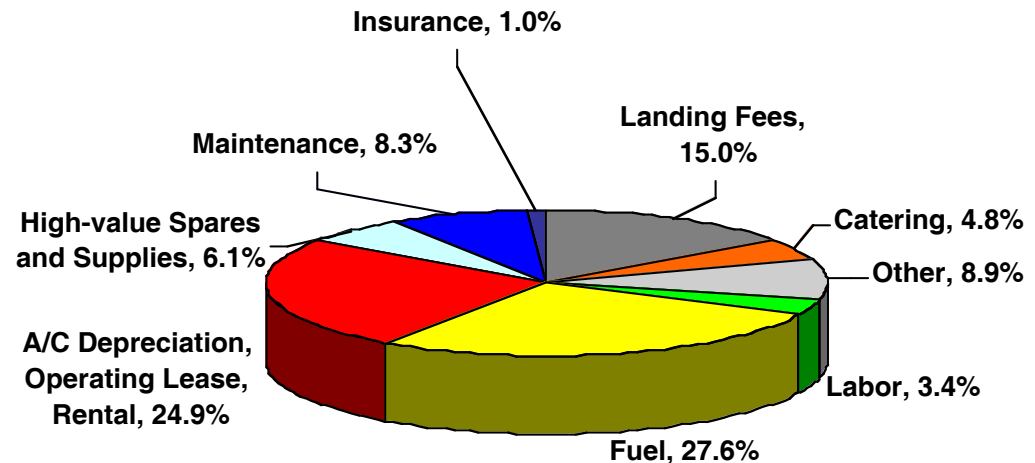


Comparison of Cost Structure Chinese vs US Airlines

U.S. Airlines, 2005

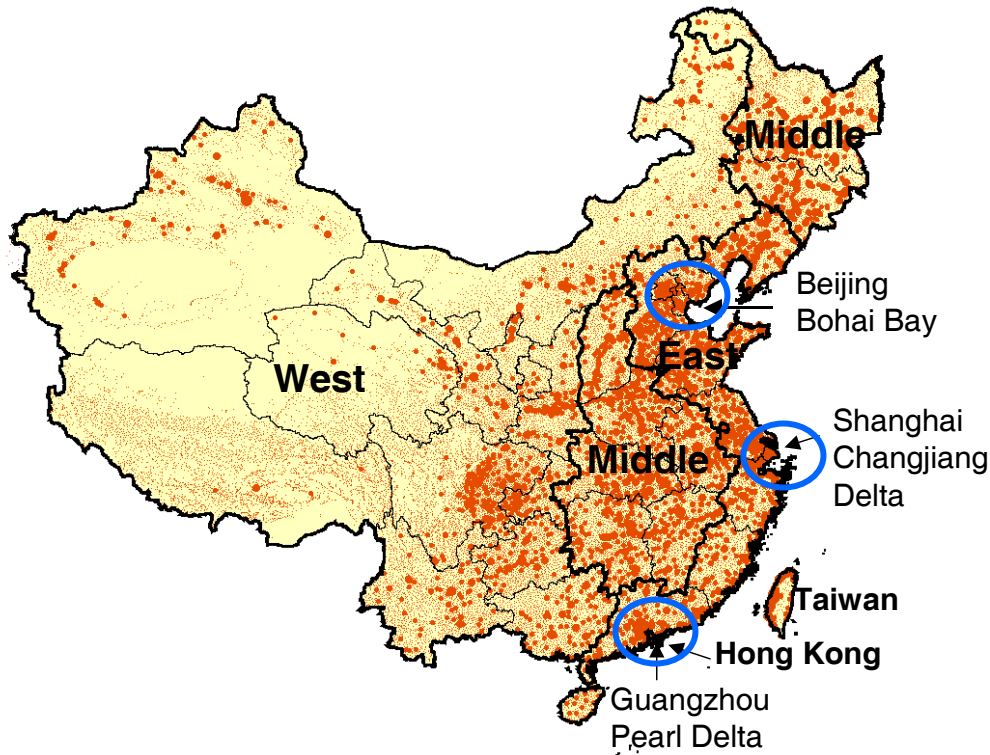


Chinese Airlines, 2001



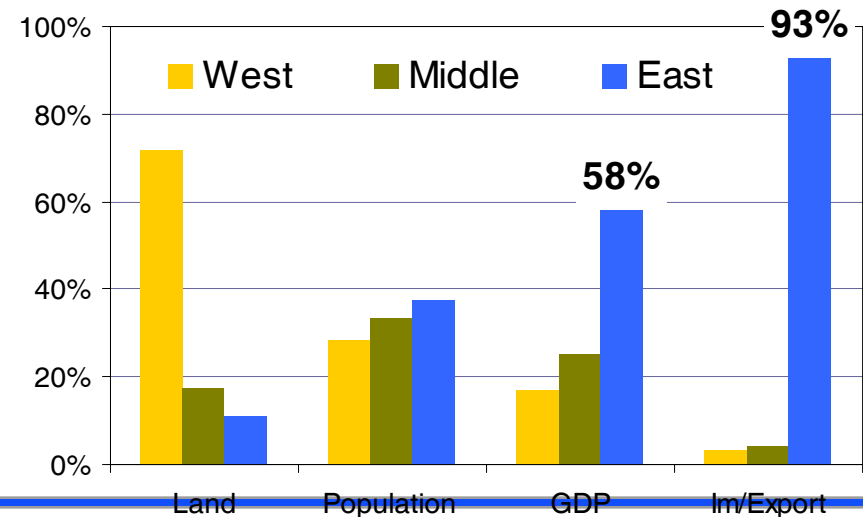
China Golden Triangle

Distribution of Cities and Towns



Land	9.6 mn km ²
Population	1,284 mn
GDP in 2002	10,240 bn RMB
Intl Trade in 2002	621 bn USD

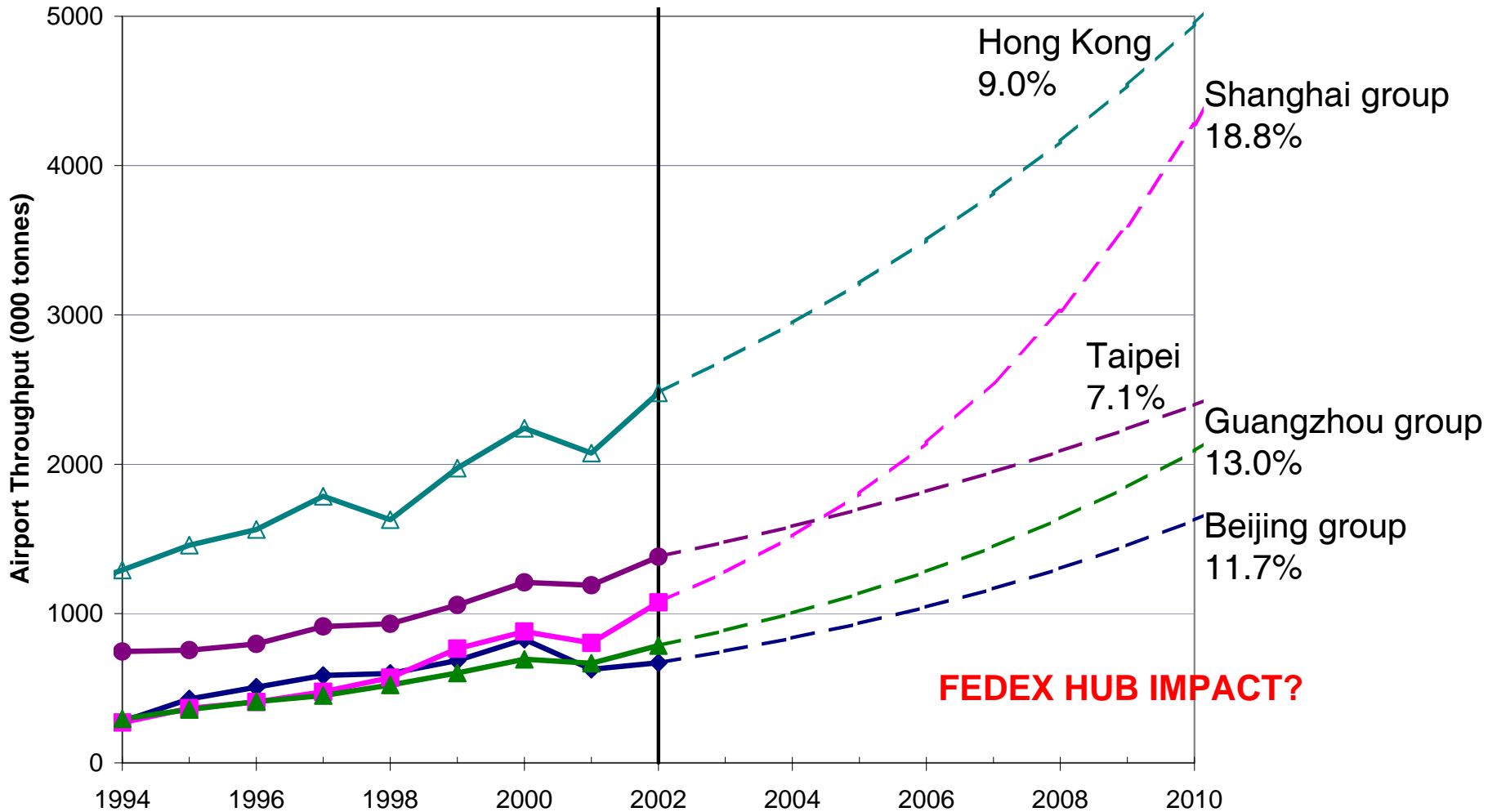
- East region dominates all economic metrics
- Three economic centers
 - Beijing
 - Shanghai
 - Guangzhou





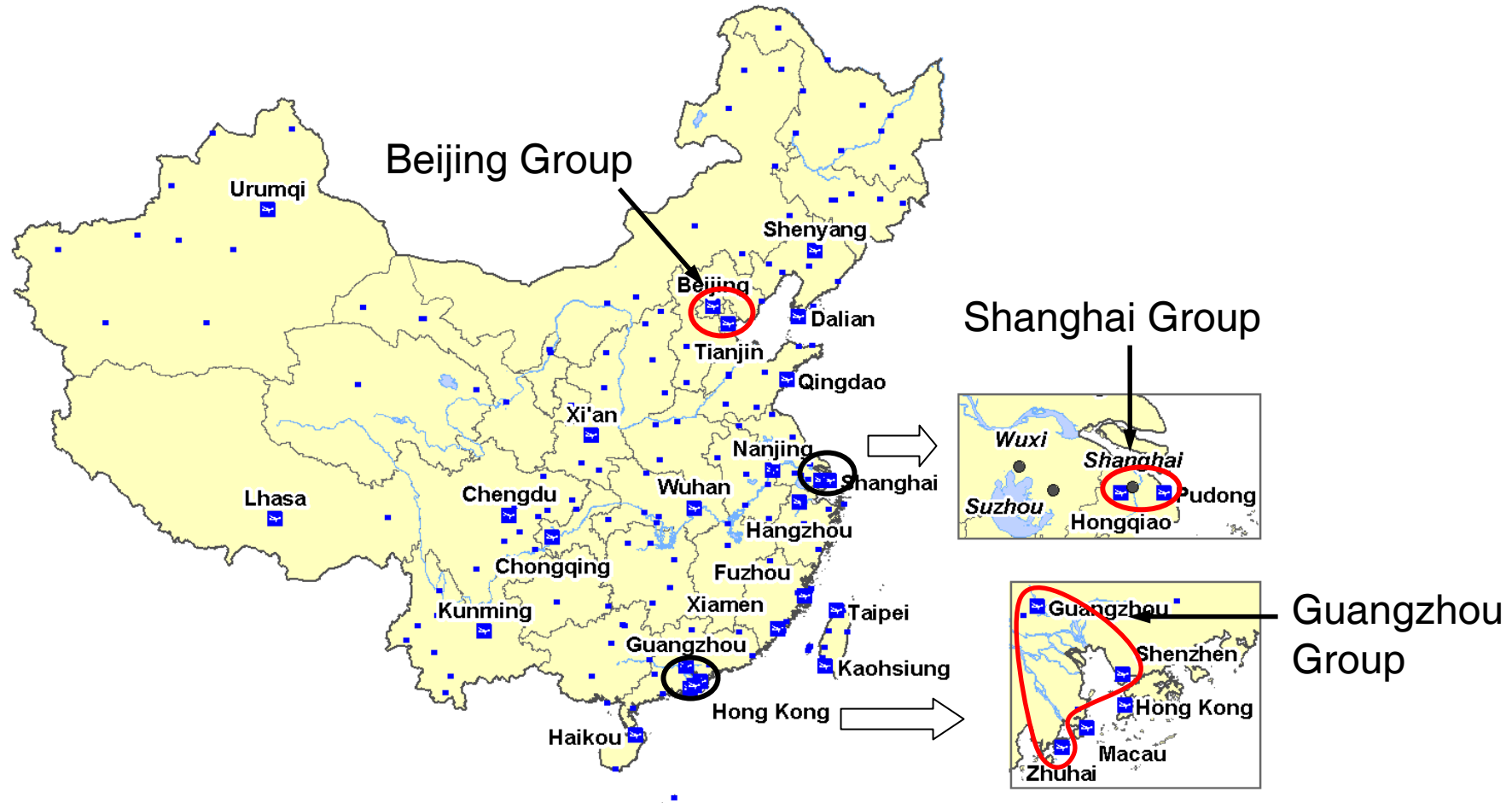
Trends of Cargo Throughput

Based on Average Historical Growth Rates
Observed in 1993-2002 (1994-2002 for Mainland)



Source: based on data from CAAC, Hong Kong Airport Authority, CAA

China Airport Development



- ~150 commercial airports operational in 2002
- 237 airports expected by 2010 (CAAC), most are regional airports



China Airport Development

- **Government Airport Spending**
 - \$14.9 B (1990-2005)
 - \$17.4 B Planned (2006-2011)
- **Planned Expansion 17.4B**
- **42 Airports**
- **2005 138M Pax,**
- **(15.5% growth rate) CAAC**
- **CAAC Projections 14%/yr through 2010 then 11%**
- **Beijing 2008 Olympics is a driver**

Beijing Airport





Liuzhou Airport “Field of Dreams”?

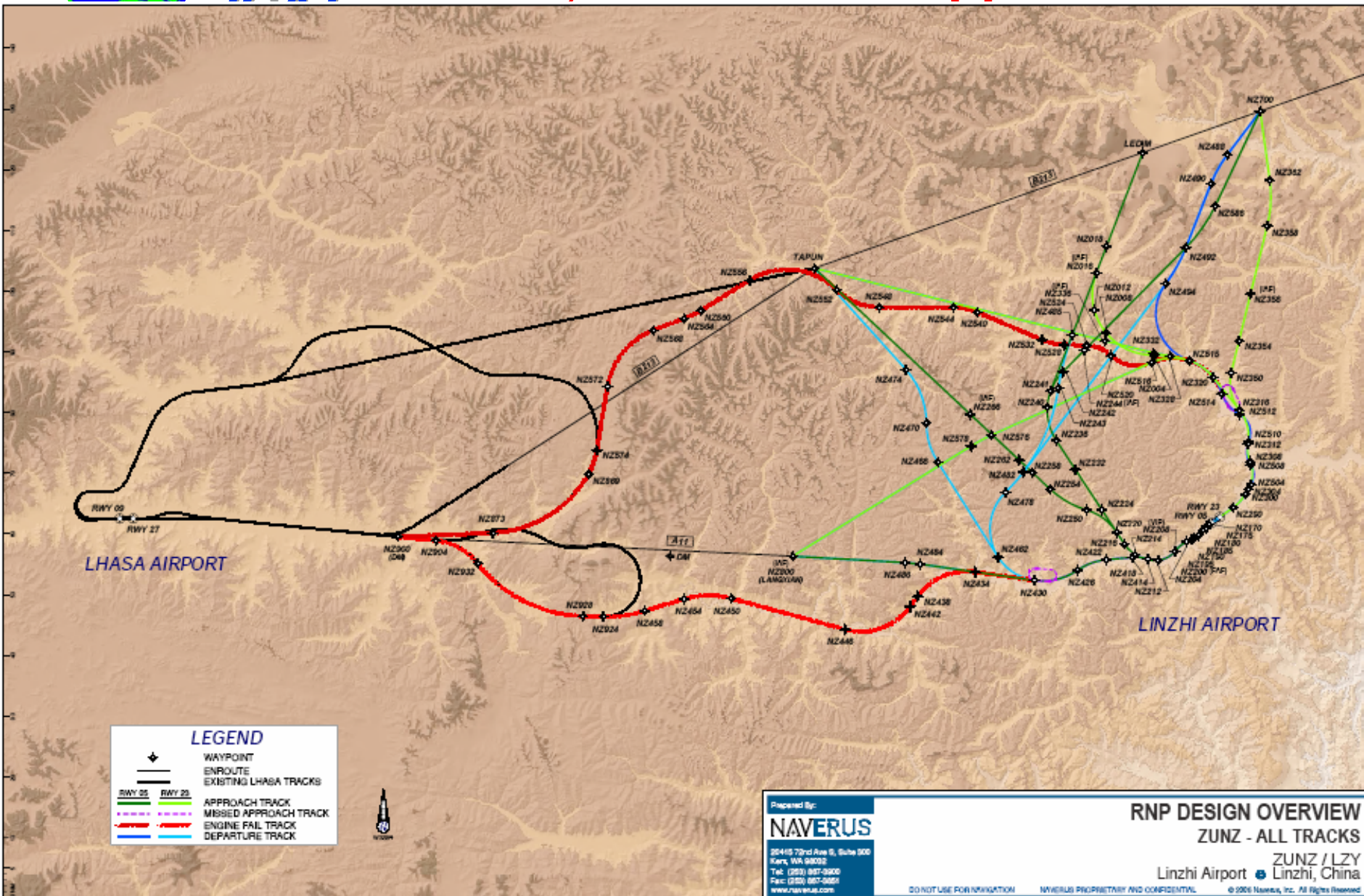




Linzhi Tibet, Lhasa, RNP Approach



Lhasa, Linzhi RNP Approach





Flight Plans Filed 24 hours in Advance (must be approved)

中国民航西南空管局管制中心飞行动态 (历史记录)

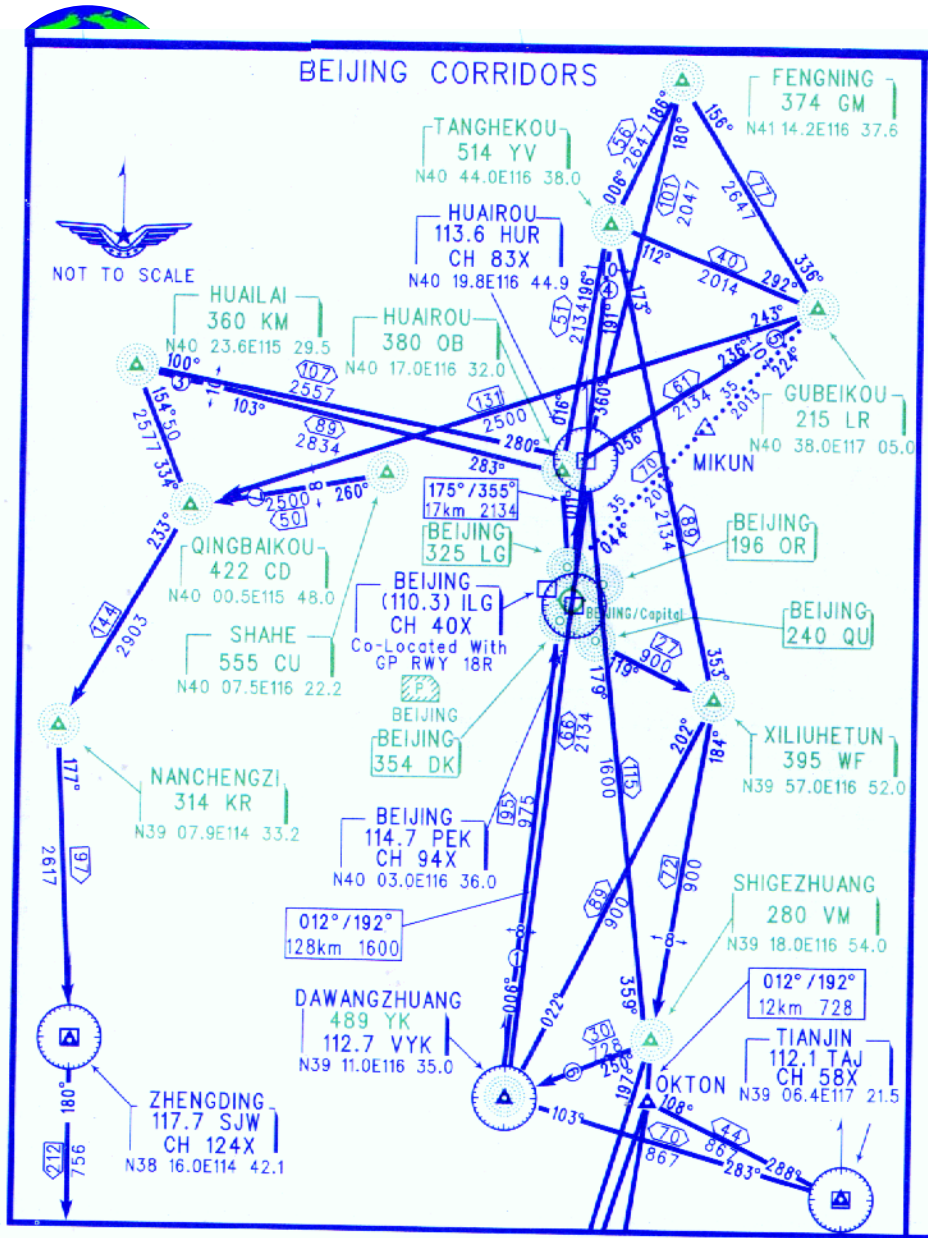
2000-10-12 星期四

ID 批号	Flight No. 航班号	SSR	Flt Type 机型	Call number 机号	Task 任务	Dep. Aerodrome 起飞机场	Dep. Time 起飞时间 ETD ATD	ATA 实落时间	Arr. Aerodrome 降落机场	Cross Day 跨日	Altitude 巡航高度	Command 指挥距离	Remarks 备注 Remarks (Company)
1	CXN431	1515	B752	B2832	正班	成都	0825	0831	曼谷	N	N 0960	312	西南
2	CXN432	0740	B737	B2599	正班	成都	1220	1305	1546	N	N 1020	275	西南
3	CXN412		A340	B2389	正班	香港	1810	1837	2030	N	N 1080	322	西南
4	CXN411	1525	A340	B2389	正班	成都	1500	1522		N	N 1020	330	西南
5	CCA1405	3062	B738	B2641	正班	北京	0845	0858	1123	N	N 1080	304	国际
6	CCA1406	1504	B767	B2641	正班	成都	1215	1227	1421	N	N 1140	279	国际 VIP
7	CCA1407	0021	B733	B2588	正班	北京	1515	1519	1750	N	N 0960	304	国际
8	CCA1408	1525	B733	B2588	正班	北京	1840	1853	2054	N	N 0900	279	国际
9	CCA1411	3047	B733	B2531	正班	北京	1340	1358	1625	N	N 0960	304	国际
10	CCA1412	1511	B737	B2531	正班	成都	1640	1714	1917	N	N 0900	279	国际
11	CCA1421		B73B	B2580	正班	天津	0820	0827		N	N		国际
12	CCA1421	4030	B737	B2580	正班	西安	1040	1112	1222	N	N 0720	304	国际
13	CCA1422	1510	B733	B2580	正班	西安	1250	1307	1406	N	N 0780	279	国际
14	CCA1422		B733		正班	西安	1510		1624	N	N		国际
17	CNW2415	6204	BA46	B2703	正班	兰州	1955	1945	2103	N	N 0780	315	西北
20	CNW2416	1507	BA46	B2703	正班	成都	2150	2141	2252	N	N 0720	282	西北
21	CNW2427	3161	BA46	B2715	正班	珠海	0855	0907	1042	N	N		西北
22	CNW2427	2350	BA46	B2715	正班	贵阳	1120	1143	1246	N	N 0600	322	西北
23	CNW2428	2252	BA46	B2715	正班	成都	1305	1346	1451	N	N 0570	330	西北
24	CNW2428	1550	BA46	B2715	正班	贵阳	1440	1530		N	N		西北
25	CSN3413	3117	B757	B2835	正班	广州	1330	1348	1531	N	N 0960	322	南方
26	CSN3414	1507	B757	B2835	正班	成都	1630	1647	1832	N	N 0900	330	南方
27	CSN3453	3140	A320	B2393	正班	深圳	1600	1610	1805	N	N 1080	322	南方
28	CSN3454	1501	A320	B2393	正班	成都	1845	1859	2044	N	N 1020	330	南方
31	CSN3403	3123	A320	B2351	正班	广州	0815	0822	1009	N	N 0960	322	南方
32	CSN3404	1523	A320	B2351	正班	成都	1115	1120	1305	N	N 0900	330	南方
33	CSN3442	1506	B737	B2921	正班	成都	2040	2051	2212	N	N 0900	195	南方
34	CSN3471	6271	B73B	B2952	正班	郑州	1240	1239	1423	N	N 0960	304	南方
35	CSN3471	2254	B733	B2952	正班	成都	1500	1511	1613	N	N 0720	312	南方
36	CSN3472	2201	B73B	B2952	正班	昆明	1655	1708	1809	N	N 0780	275	南方
37	CSN3472	1502	B733	B2952	正班	成都	1845	1912	2033	N	N 1020	279	南方
38	CSN3576		B733		正班	上海	1555			N	N		南方
39	CSN3576	6251	B737	B2921	正班	武汉	1815	1837	2008	N	N 0960	186	南方
40	CSN8847	3170	B73B	B2910	正班	汕头	1530	1543	1742	N	N		南方

实际起飞时间中，带'#'号的表示入境时间

Flight history of Sichuan Province of China

Beijing Corridors



3 Arrival Corridors

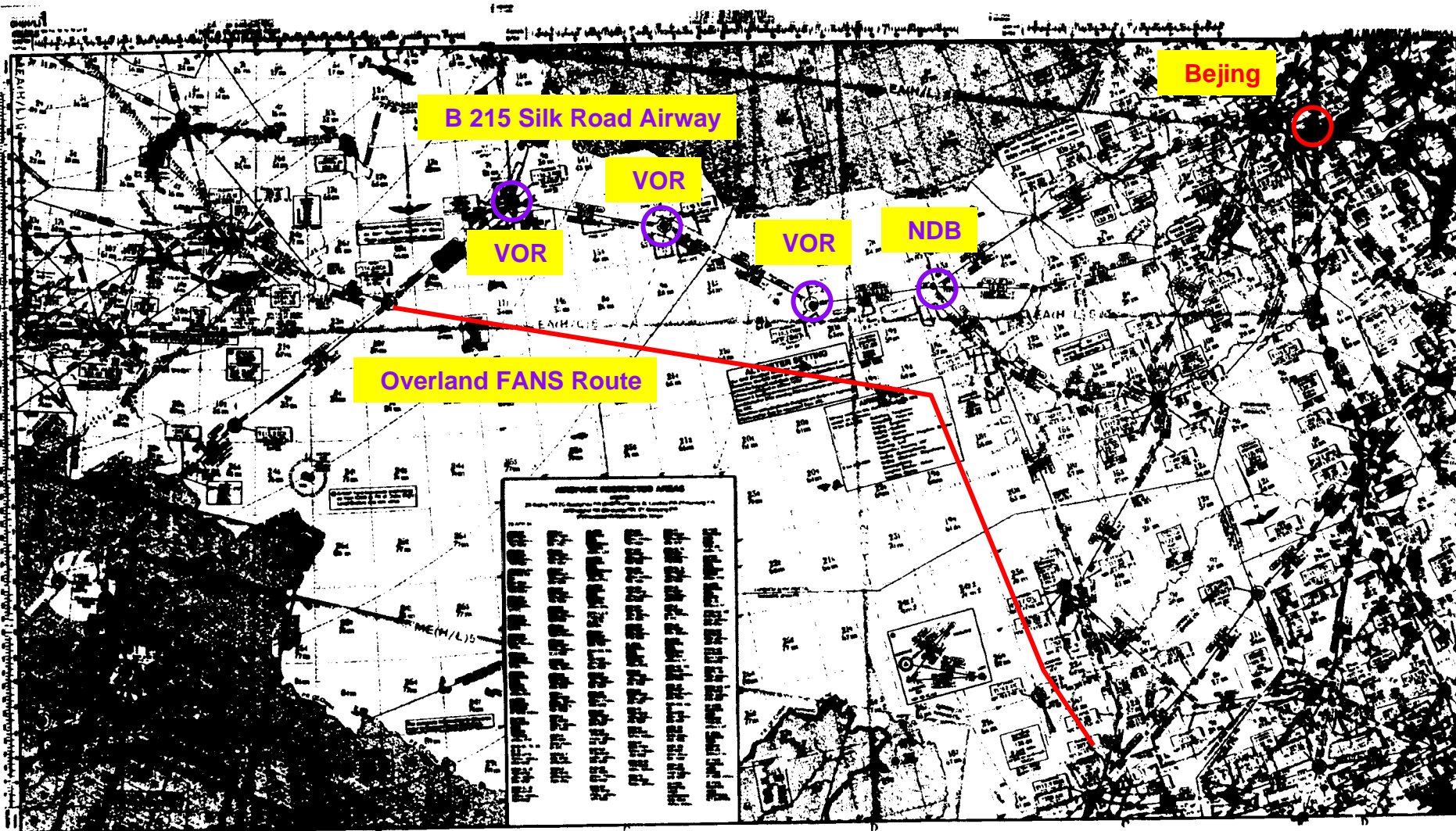
3 Departure Corridors

2 Overflight Corridors

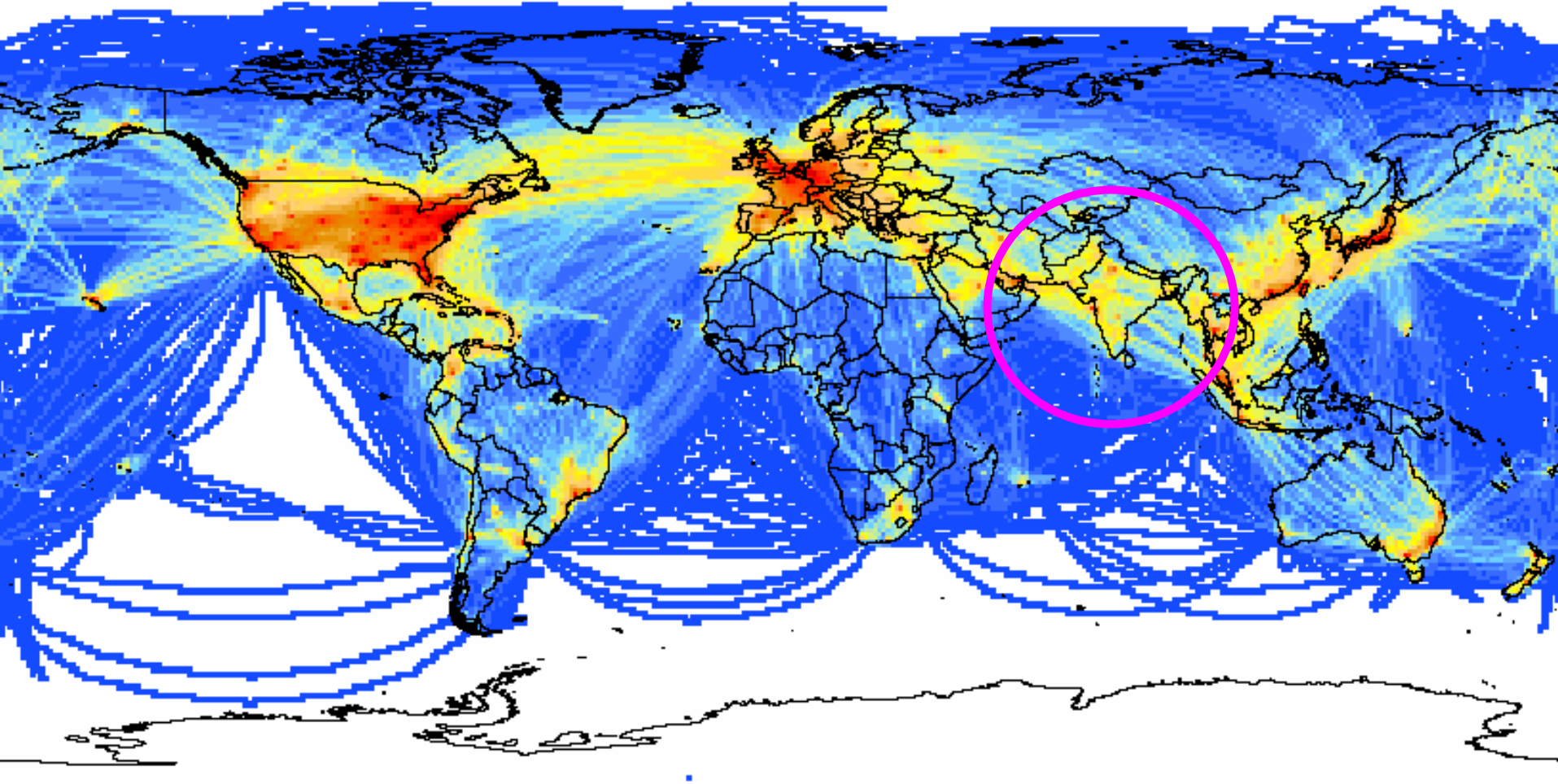


West China Airway Structure

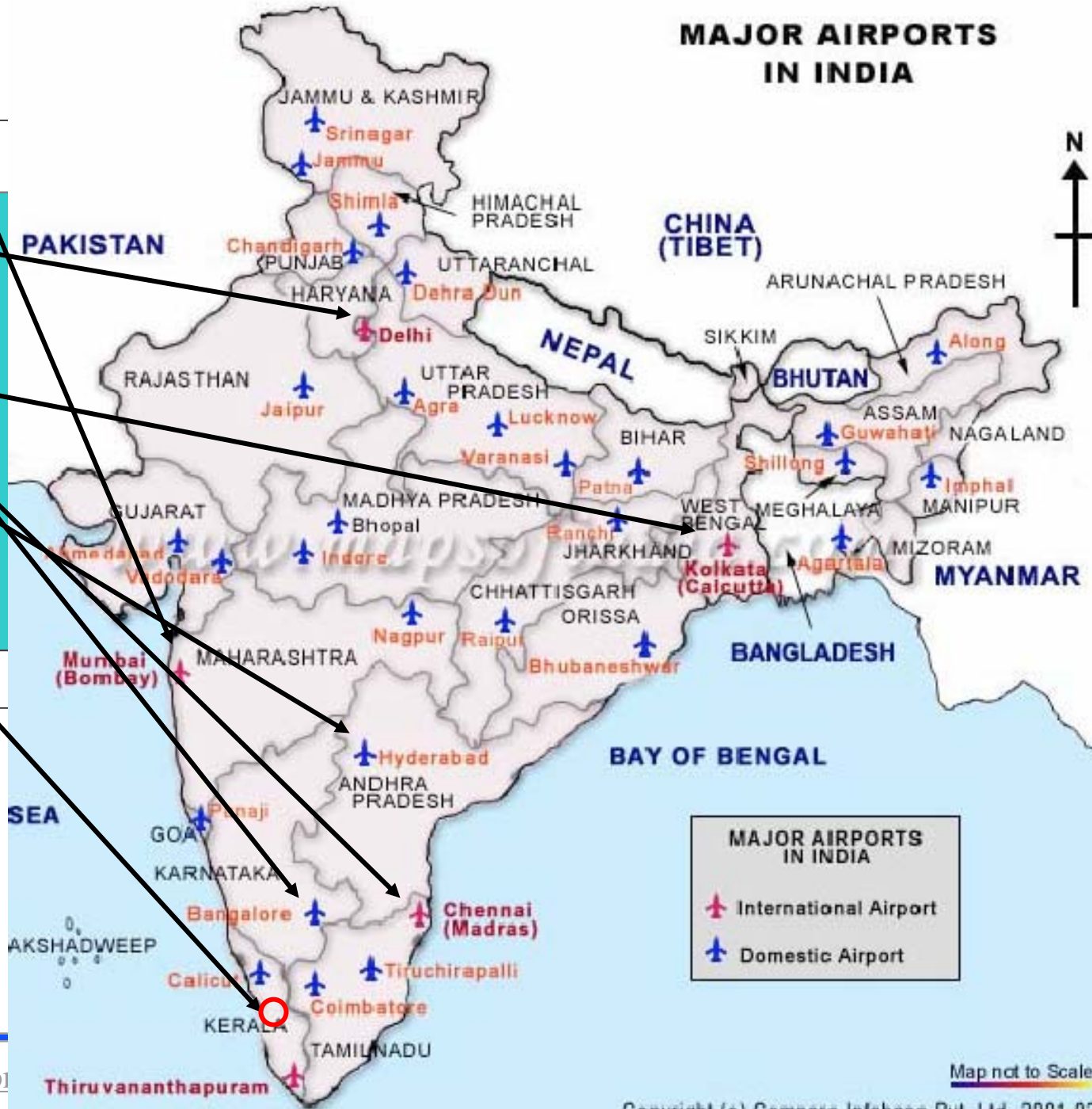
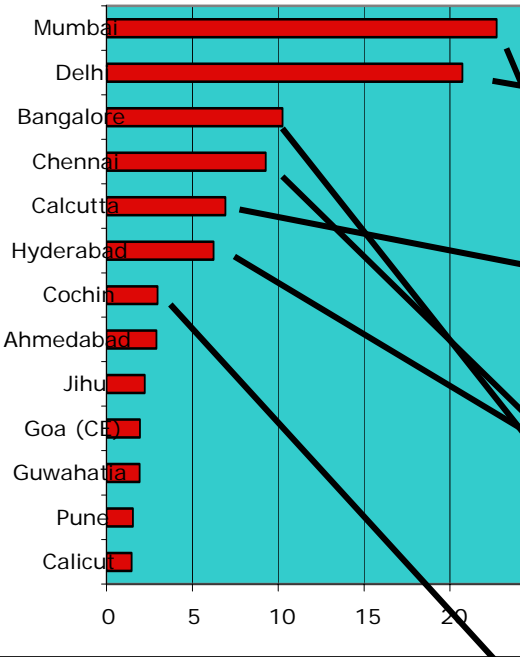
2240 nm aprox



India



Oct 05 Movemen

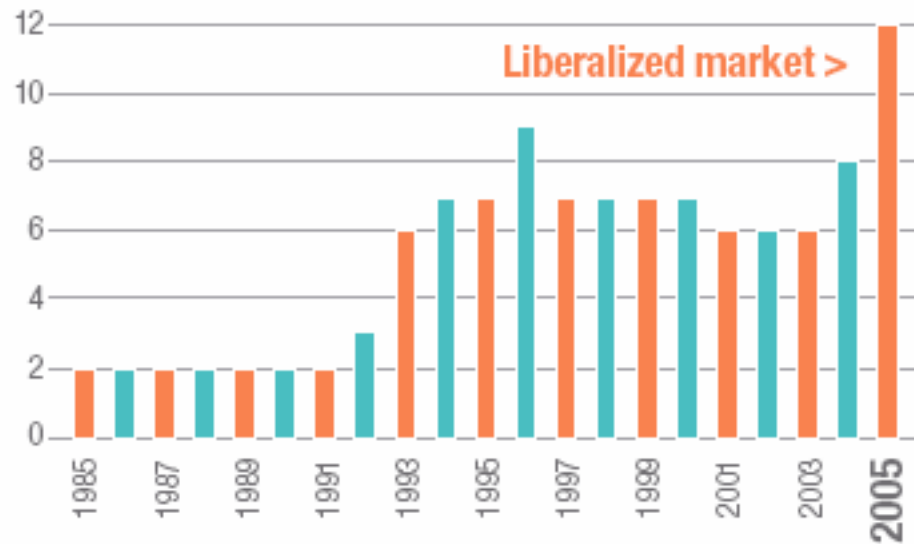




Meta-Observations

- **Significant Growth**
 - Domestic (Jet, Air Deccan stimulating the market)
 - International (Economy and Open Skies)
 - 20% expected to cool to less than 10%
 - Train and Road Infrastructure marginally functional
- **Airport Capacity/Space Problem Well Recognized and Being Addressed**
 - Most Airports have latent capacity but poor runway/taxiway setups
 - Mumbai most difficult point
 - Cochin, Hyderabad, Bangalore, greenfields in progress
- **Most critical short term constraint is trained personnel**
 - Pilots, Controllers, Mechanics, DGAC
- **ATC lacks efficiencies but not a major capacity constraint**
 - Current controller shortage (450 controllers)
 - Current staffing 1200 controllers, 6000 Technical Equipment Maintenance

NUMBER OF AIRLINES IN INDIA



MARKET LIBERALIZATION >>



Domestic Airline Liberalization and Competition

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QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

- **Indian AL**
 - Government officials
- **Air Deccan**
 - Emerging Middle Class
- **SpiceJet**
 - Emerging Middle Class
- **Jet**
 - Multi-National Corporate
- **Air Sahara**
 - Corporate
- **Kingfisher**
 - Corporate
- **IndiGo**
 - Emerging Middle Class
 - 100 A-320s?, Rakesh Gangwal (USAir)

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.





Air Deccan Market Stimulation *Destinations*

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are needed to see this picture.

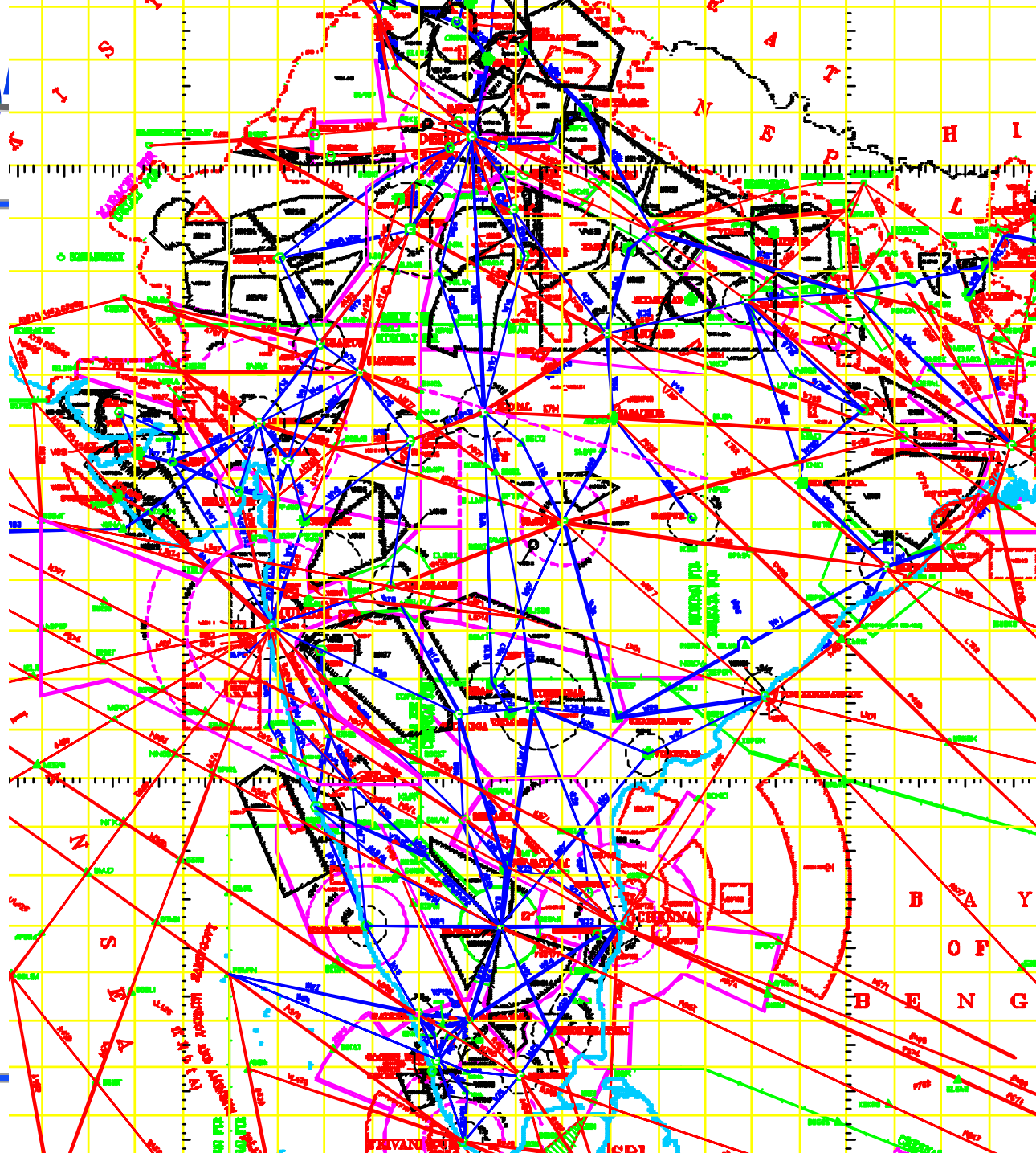
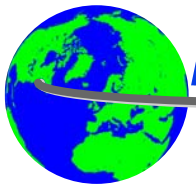
QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.



India Air Transportation Infrastructure Component Capability

- **Airports** (high capacity 25 ops/hr >> 38)
 - Runways ● 1 Runway ops. Plans for expansion
 - Terminals ● Weak, PPPs emerging
 - ◆ Ramp Parking Stands ● Major Domestic Limit (Design Criteria)
 - ◆ Ground transport interface ● Very poor but endemic
 - Servicing ● Controlled by Air India
 - Maintenance ● Limited training, Hanger
- **Air Traffic Management**
 - Communications ● HF issues, Bay of Bengal etc
 - Navigation ● Geography, need to check ILS availability & minimums
 - Surveillance ● Radar Gaps
 - Control ● Low Tempo, Controller Shortage
- **Weather**
 - Observation ● OK
 - Forecasting ● OK
 - Dissemination ● In face briefings required
- **Skilled personnel** ● Pilots, Mechanics, Controllers
- **Cost recovery mechanism** ● Weak, shifting



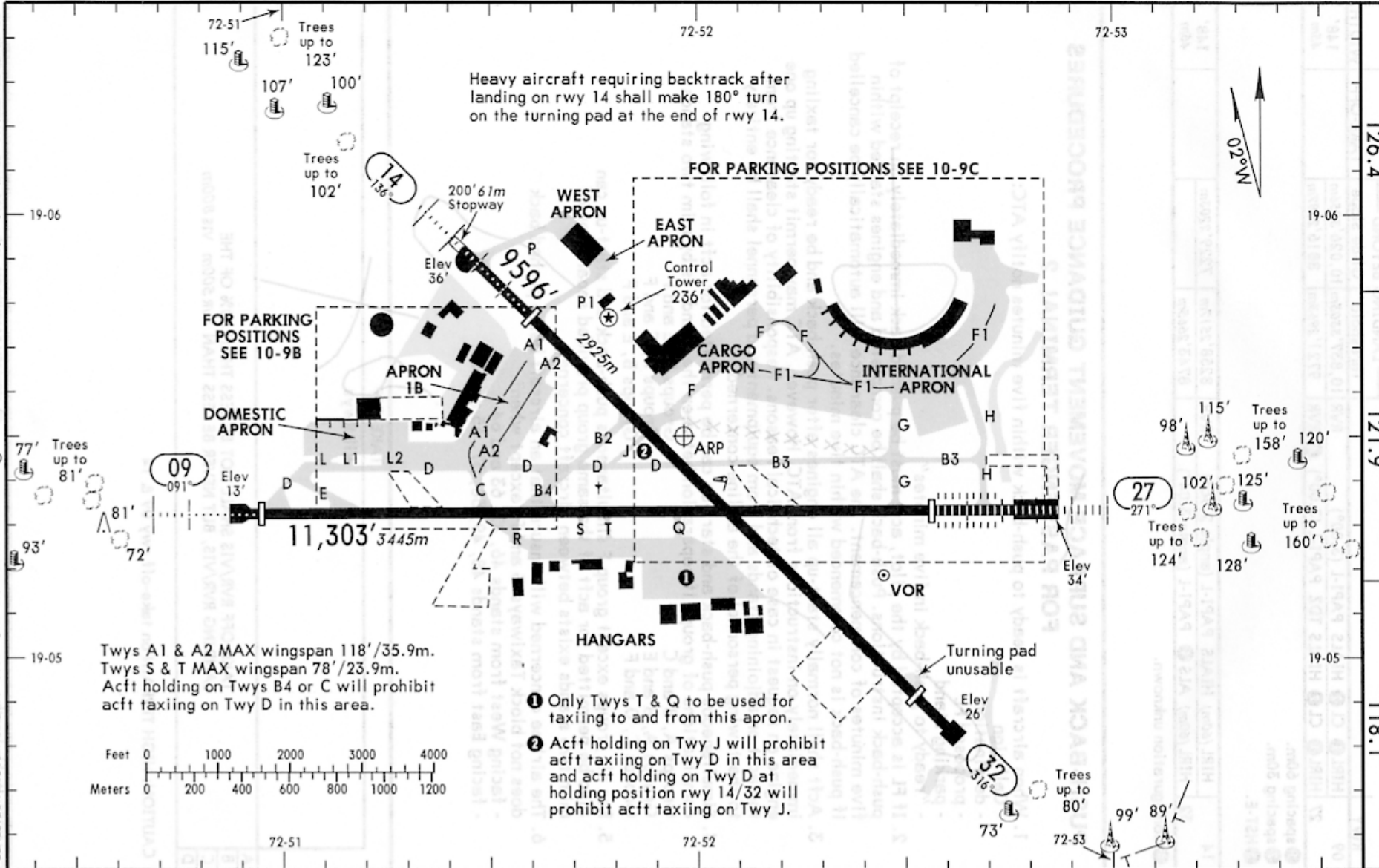
Mumbai





Mumbai

CHANGES: Airt elev, Rwy length & bearing. Notes.
© JEPPIEN SANDERSON, INC., 1999, 2005. ALL RIGHTS RESERVED.



Twys A1 & A2 MAX wingspan 118'/35.9m.
Twys S & T MAX wingspan 78'/23.9m.
Acft holding on Twys B4 or C will prohibit acft taxiing on Twy D in this area.

- ① Only Twys T & Q to be used for taxiing to and from this apron.
- ② Acft holding on Twy J will prohibit acft taxiing on Twy D in this area and acft holding on Twy D at holding position rwy 14/32 will prohibit acft taxiing on Twy J.



Mumbai



High Local Population Density Limits Expansion

Mumbai

Encroachment areas in yellow



High Local Population Density and Topography Limits Expansion

Mumbai Encroachment Issue

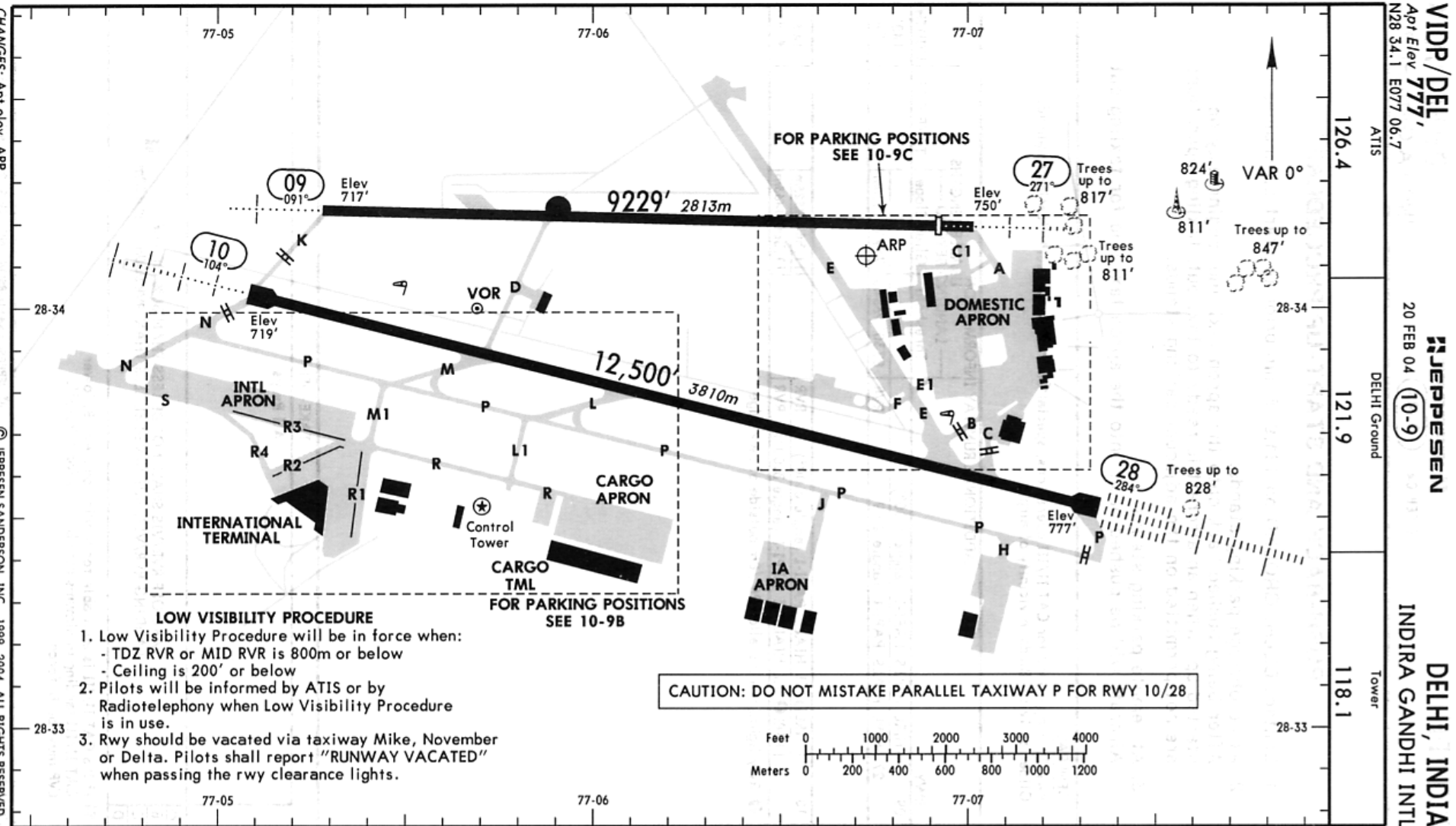


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are needed to see this picture

High Local Population Density and Topography Limits Expansion

Delhi



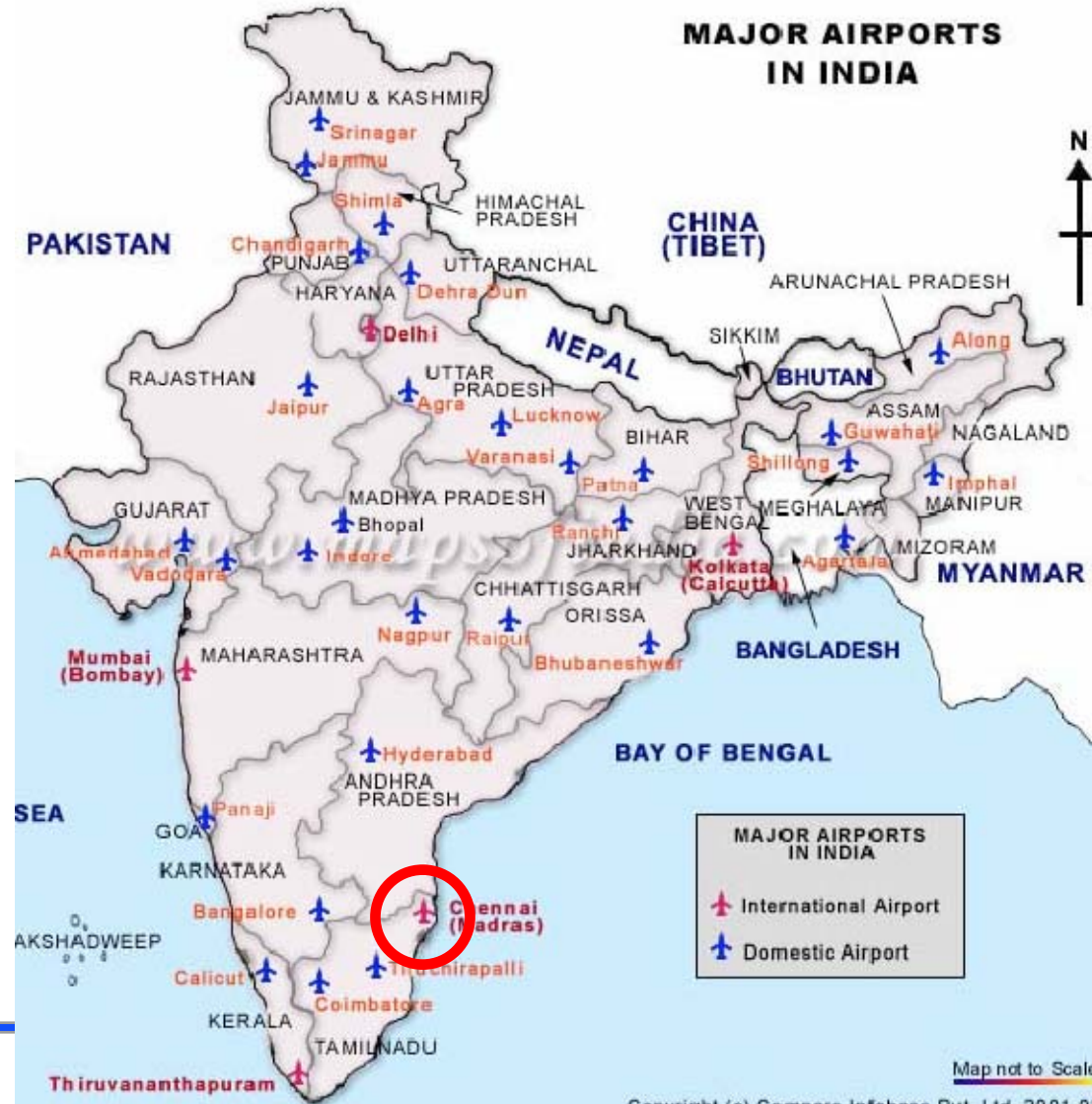






13 DEC 05 10:14:00

Chennai



Chennai ATC



Area & Approach Control



Procedural (Non-Radar) Control



Approach Control

Cochin



Cochin “Greenfield” Airport

Indigeneous



Bangalore





VOBG/BLR
 Apt Elev **2912'**
 N12 57.1 E077 39.9

JEPPESEN
 26 NOV 04 (10-9)

BANGALORE, INDIA
 BANGALORE

*ATIS	BANGALORE Tower
128.25	123.5



12-56	Stand 6 available for acft up to B747. For Radar Minimums see Terminal page ME-51 etc. Rwy 09 right-hand circuit.	12-56
77-39	77-40	77-41



Bangalore “Greenfield” Airport *PPP International Investment*

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are needed to see this picture.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

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Source: Bangalore Airport Watch <http://www.karnataka.com/watch/blr-airport/>

Airport Design: [Kaufmann, van der Meer Planer AG](#)

Leh





- **Leh (IXL)**
- **Elevation 10682 ft**
- **Runway Length 10100 ft**
- **Visual Approach Only**
- **Civil Enclave**



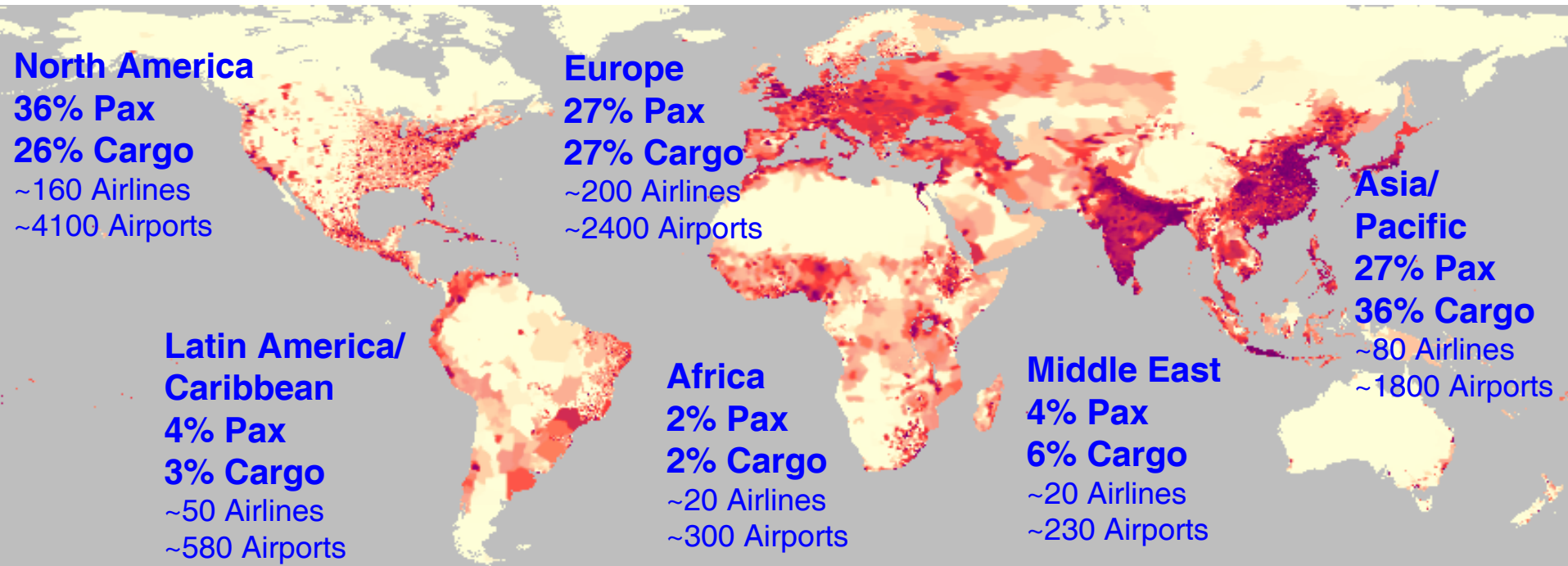








Air Transportation as Enabling Factor in Developing Regions



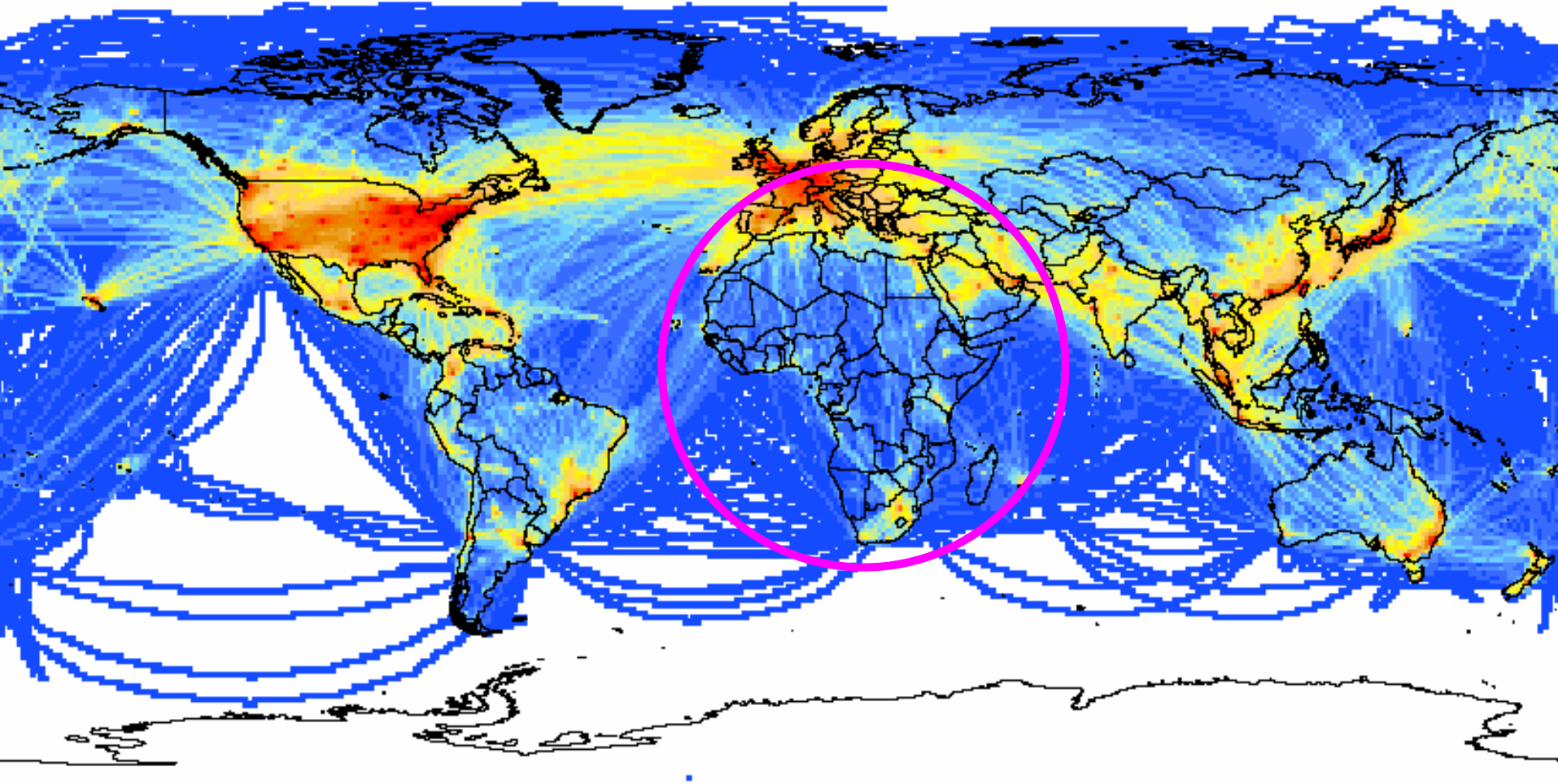
Infrastructure - Satellite Based Information Technologies have the potential to allow regions with immature air transportation infrastructure to rapidly reach parity with mature systems

The Air Transportation Industry has an **obligation to find economic models which support investment and economic development in these regions.**

Africa

TOTAL FLEET

2005	720
2025	1,030

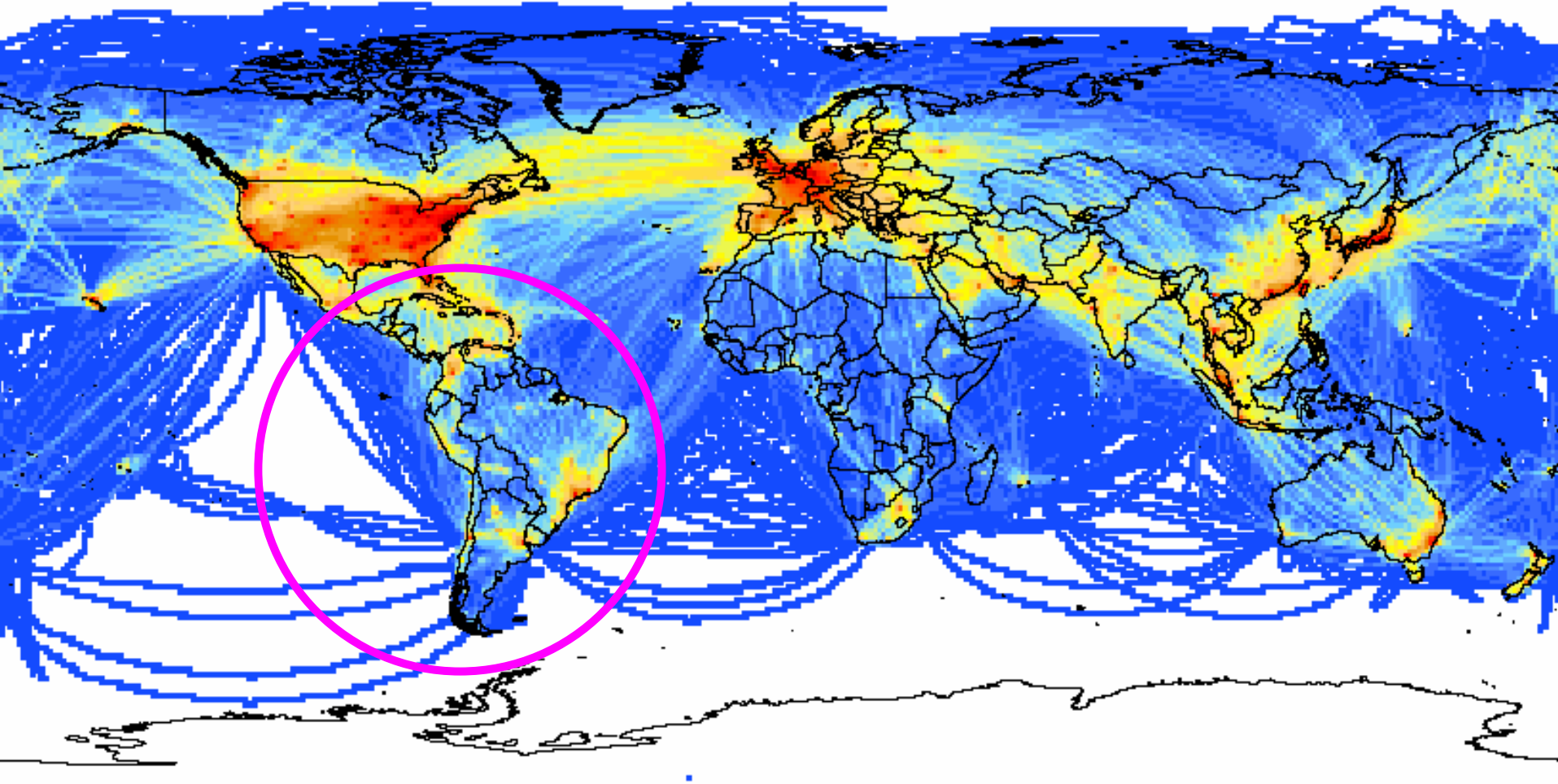




Latin America

TOTAL FLEET

2005	1,100
2025	2,720





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BMP decompressor
are needed to see this picture.