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IPv6 for decision makers:
Future trend in the Internet and business

APNIC36, Xi'an, China, 28/08/2013

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Overview

- About the Internet
- Environmental scan
  - From where the growth is coming?
- Impact of the growth
- Fundamental ingredients to capture customers
- How to achieve business goals?
- Conclusion
- Supplement

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About the Internet

About the Internet

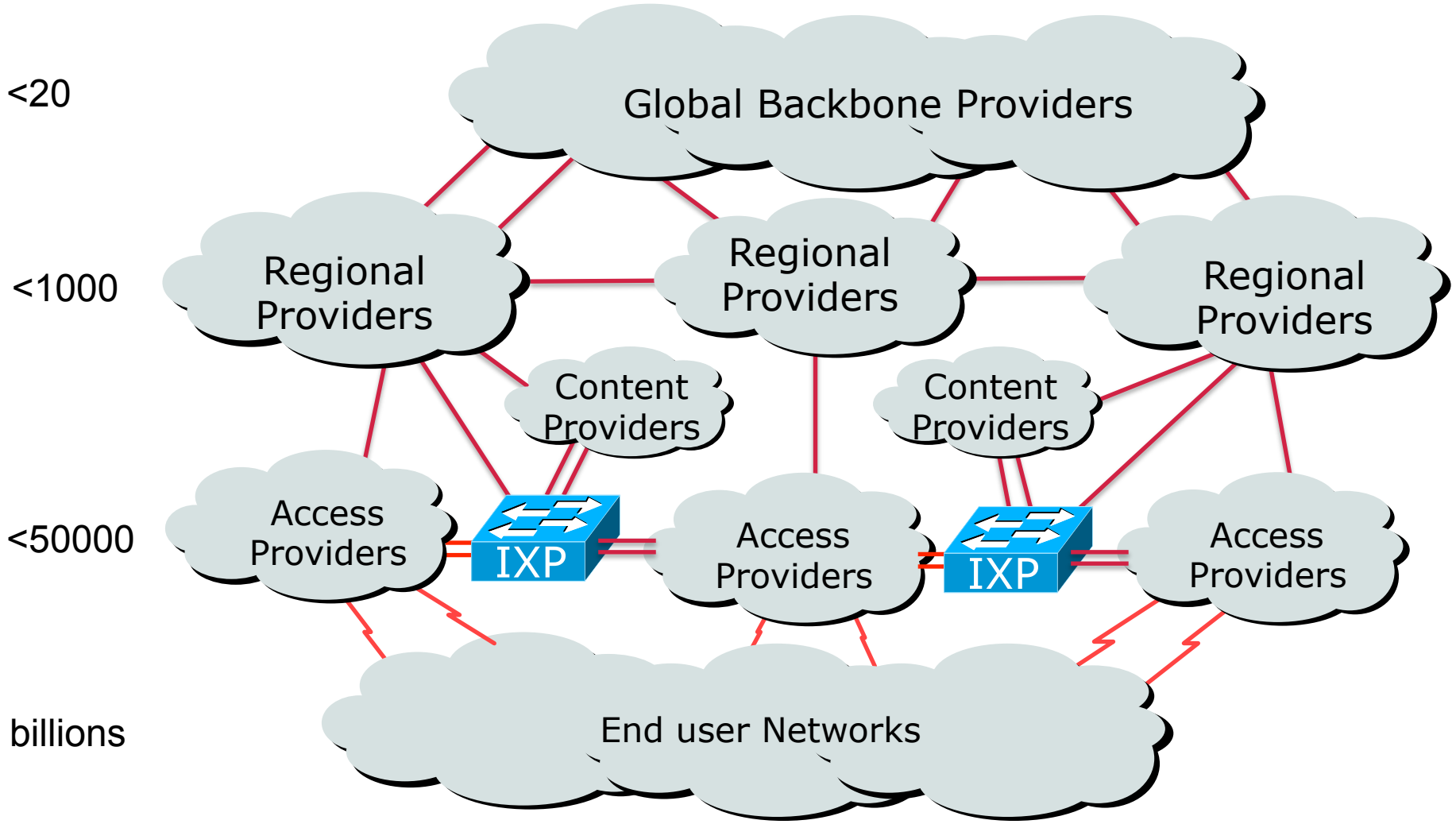
- The Internet is a global system of interconnected computer networks that use the **standard Internet protocol suite (TCP/IP)** to serve several billion users worldwide.
- It is **a network of networks** that consists of **millions of private, public, academic, business, and government networks**, of local to global scope, that are linked by a broad array of electronic, wireless and optical networking technologies.
- The Internet carries an **extensive range of information resources and services**, such as the inter-linked hypertext documents of the World Wide Web (WWW), the infrastructure to support email, and **peer-to-peer** networks.

http://en.wikipedia.org/wiki/Internet

About the Internet

- Open, decentralised, peer to peer (end-to-end) network
  - No single organisation operates or controls the Internet
- No single point of failure
  - If one path stops working, an alternative path will be found autonomously (if the path exists)
- Intelligence of the network lives at the edge not in the core
- Which is why the Internet works so well in the way it does

Hierarchy of the Internet



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Environmental scan

From where the growth is coming?

Internet business growth
Where is it coming from?

- Internet is also growing at a tremendous rate in aspiring economies, but with distinctly different growth paths from those seen in developed economies.
- So from where is the growth is coming? The following charts show part of the answer.

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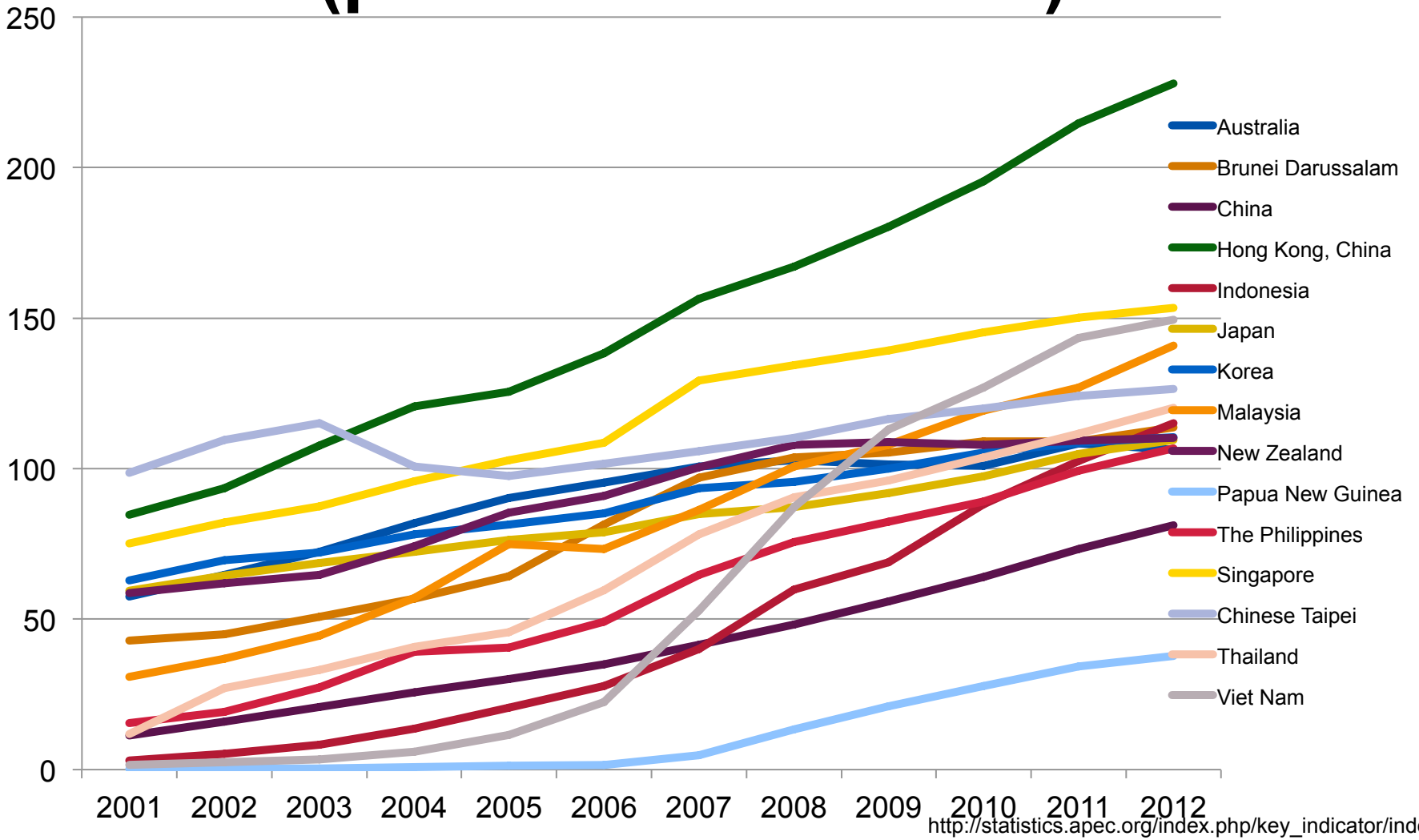
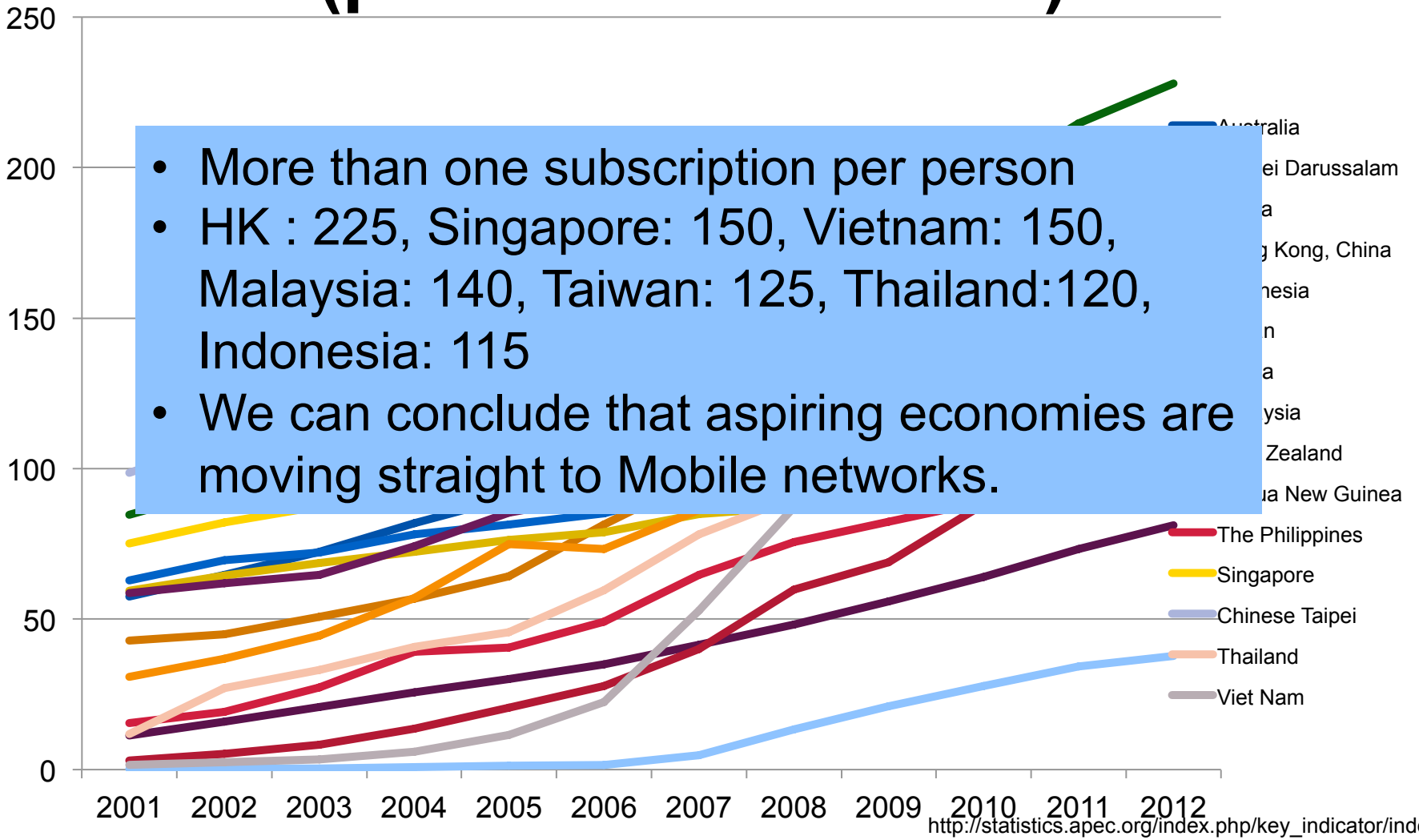
Mobile cellular subscription (per 100 inhabitants)



http://statistics.apec.org/index.php/key_indicator/index

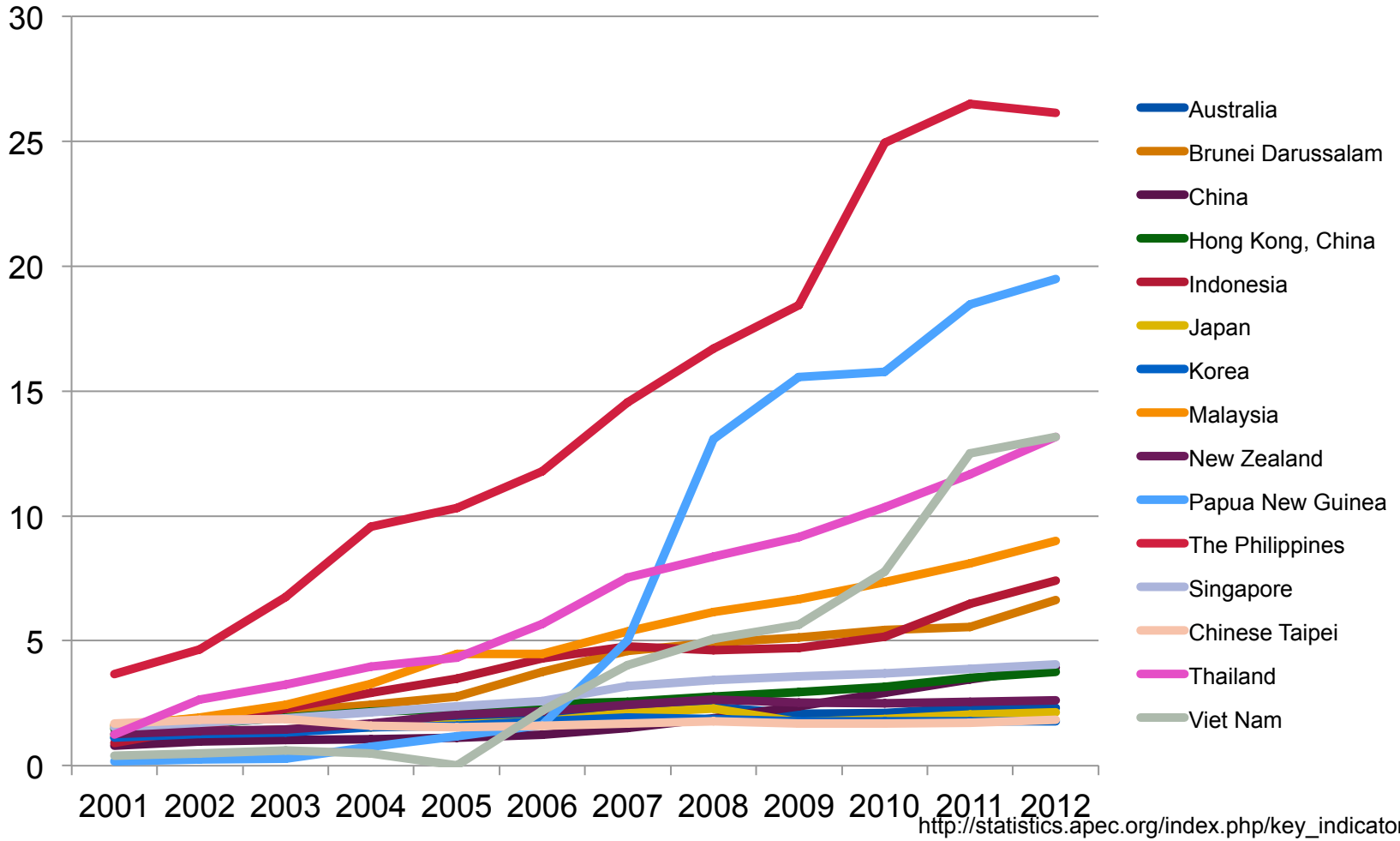
Mobile cellular subscription (per 100 inhabitants)



- More than one subscription per person
- HK : 225, Singapore: 150, Vietnam: 150, Malaysia: 140, Taiwan: 125, Thailand:120, Indonesia: 115
- We can conclude that aspiring economies are moving straight to Mobile networks.

http://statistics.apec.org/index.php/key_indicator/index

Mobile Cellular Subscriptions (ratio to fixed telephone lines)



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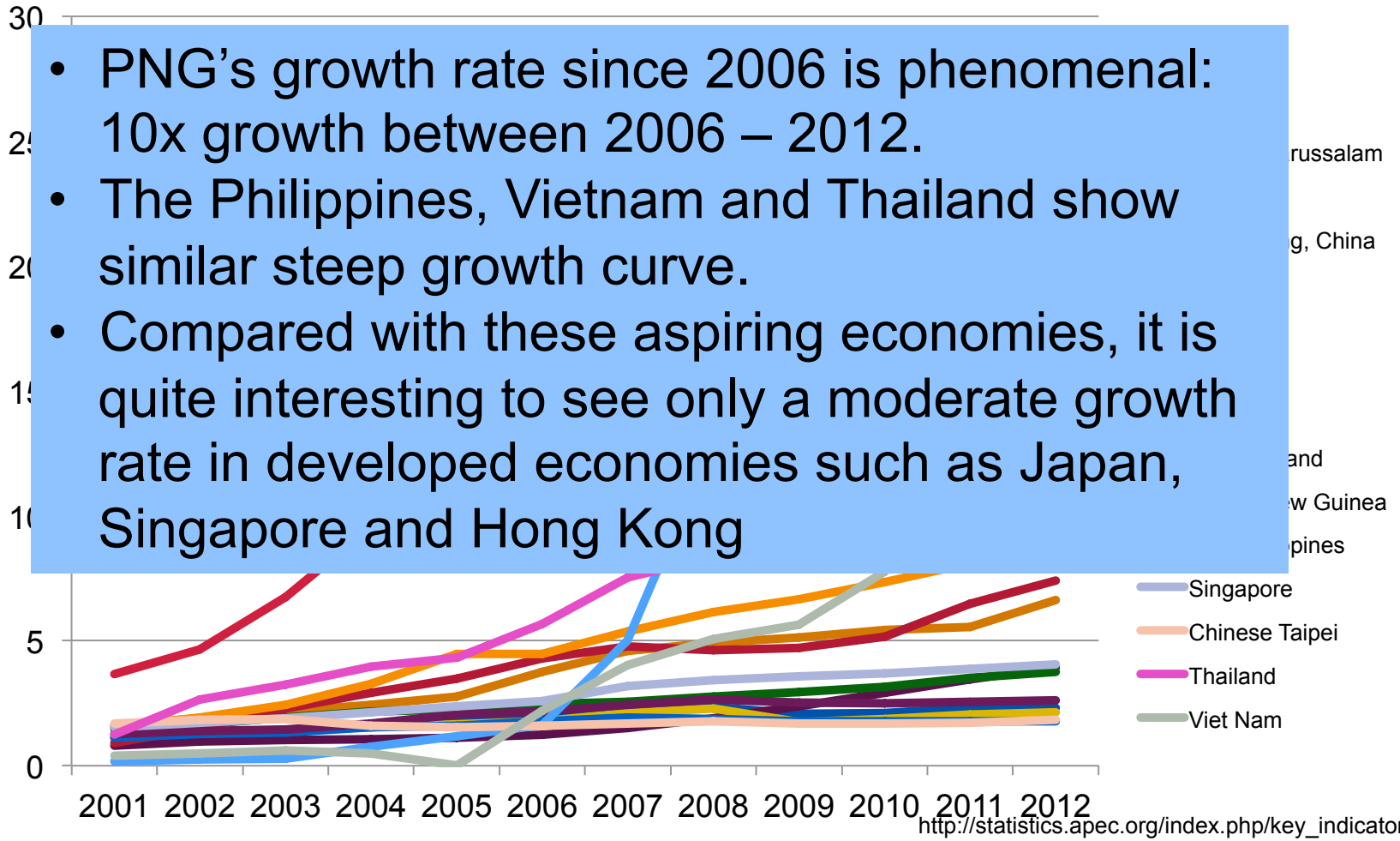
Mobile Cellular Subscriptions (ratio to fixed telephone lines)

- PNG's growth rate since 2006 is phenomenal: 10x growth between 2006 – 2012.
- The Philippines, Vietnam and Thailand show similar steep growth curve.
- Compared with these aspiring economies, it is quite interesting to see only a moderate growth rate in developed economies such as Japan, Singapore and Hong Kong



http://statistics.apec.org/index.php/key_indicator/index

Growth path in aspiring economies

- Given the recent robust increase in mobile devices such as smart phones and tablets, it is quite obvious that many Internet users in growing economies are accessing the Internet through mobile devices:
  - Most likely solely from mobile devices, compared with Internet users in developed economies.
- Mobile devices are a much lower cost to obtain than personal computers, and cellular networks are free from the high cost of cable installation on land.

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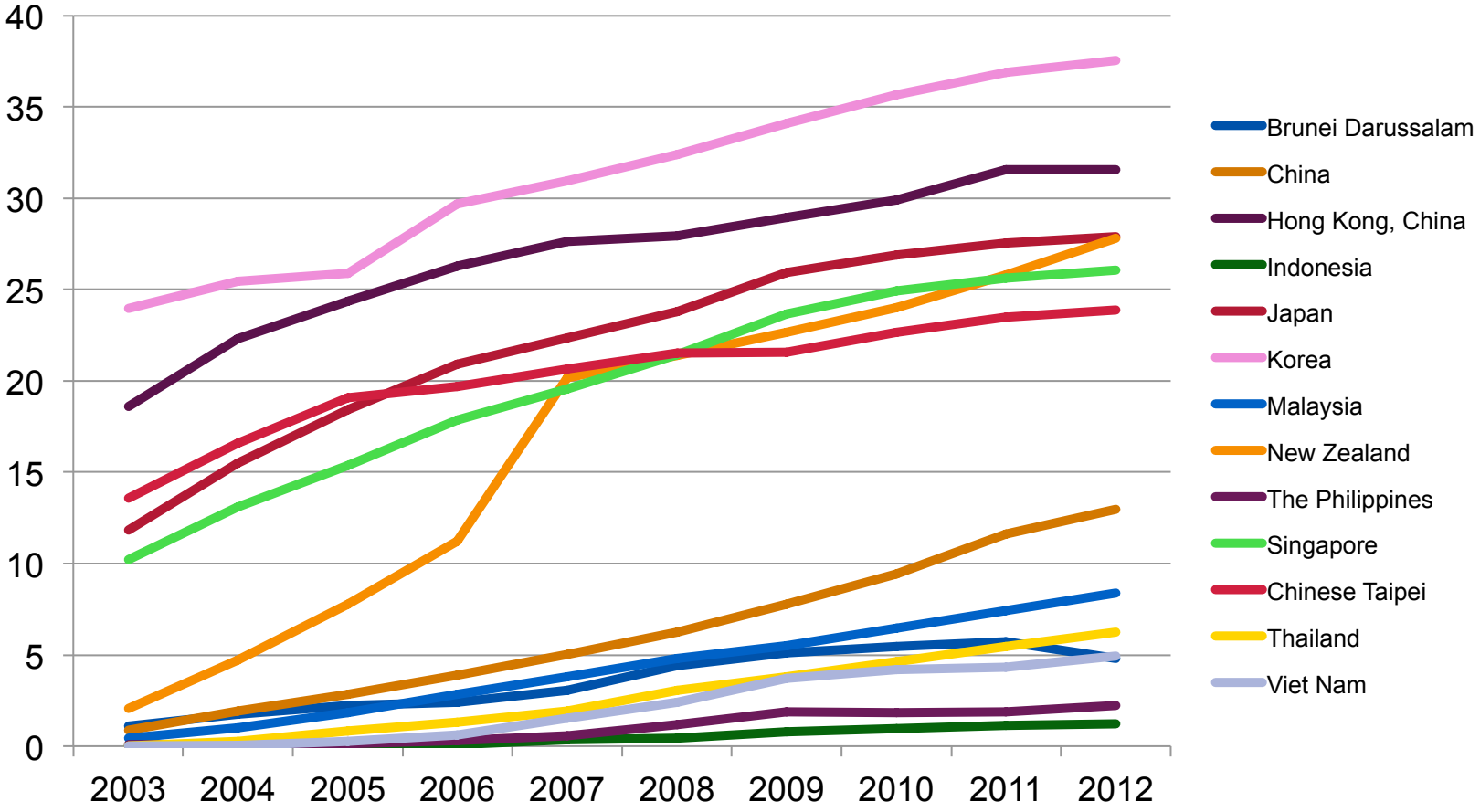
Internet subscriptions, Broadband (per 100 inhabitants)



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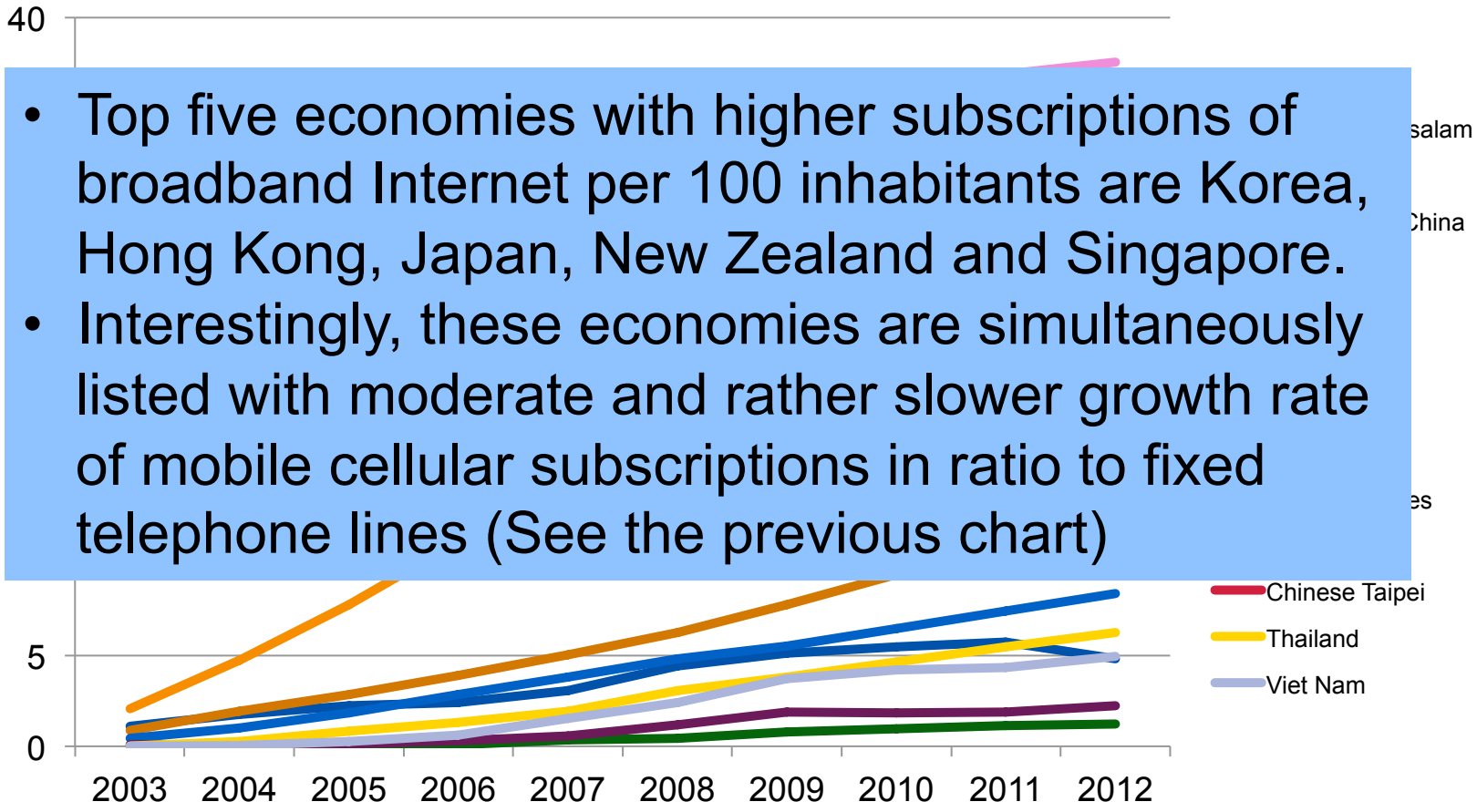
Internet subscriptions, Broadband (per 100 inhabitants)



- Top five economies with higher subscriptions of broadband Internet per 100 inhabitants are Korea, Hong Kong, Japan, New Zealand and Singapore.
- Interestingly, these economies are simultaneously listed with moderate and rather slower growth rate of mobile cellular subscriptions in ratio to fixed telephone lines (See the previous chart)

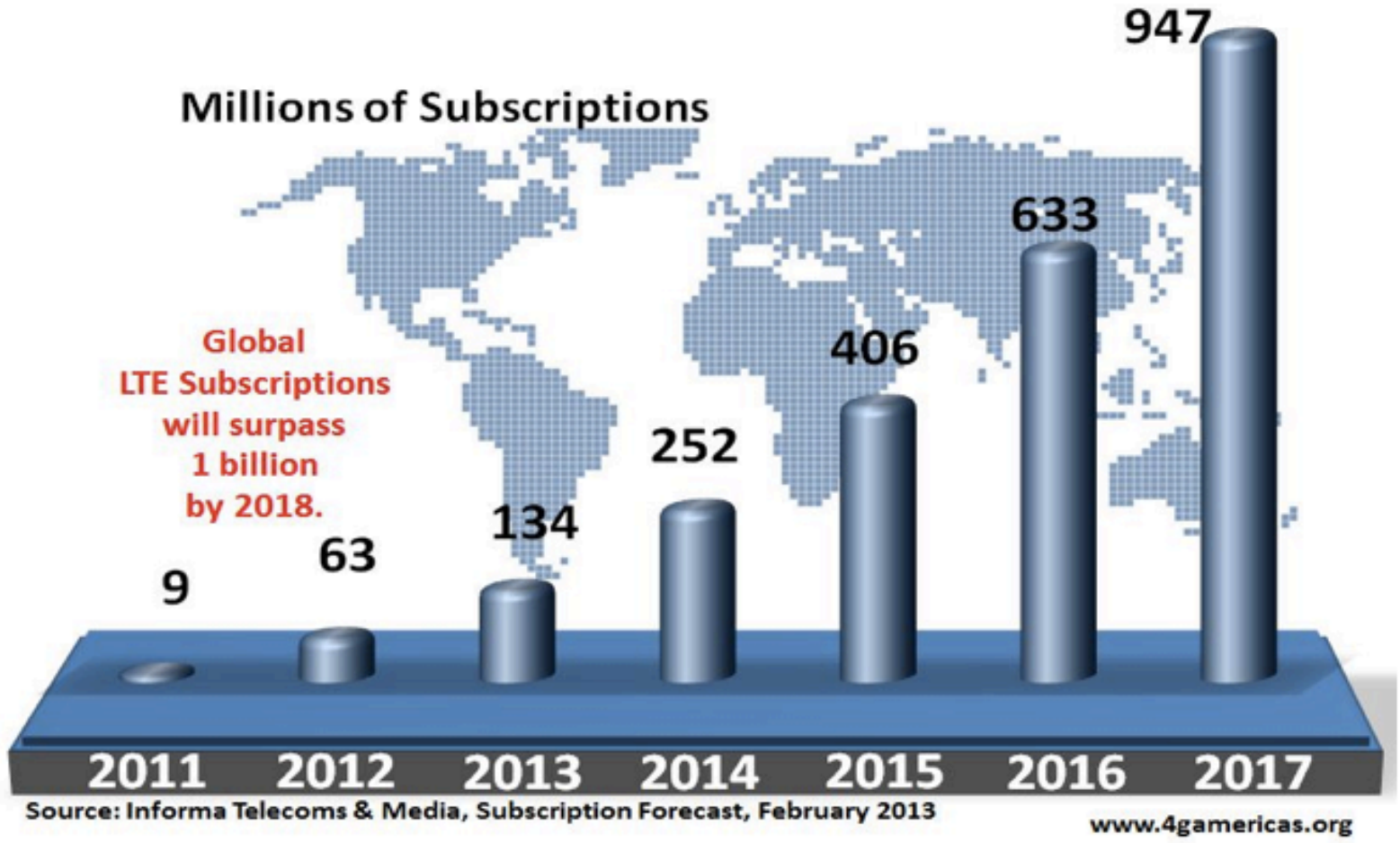
http://statistics.apec.org/index.php/key_indicator/index

Growth path of the Internet

- While fixed network broadband still provides an important base for Internet users in developed economies, mobile network access to the Internet has became a major foundation for both currently growing economies and developed economies
  - Mobile networks' role in currently growing economies is phenomenal.
- Such dynamic changes induced by rapid evolution of the infrastructure will bring in so many new Internet users into the market place.
- According to the McKinsey&Company's report:
  - In 2010, 310 million mobile devices were used to access the Internet in 30 aspiring economies out of 800 million worldwide.
  - It's almost 40% of the total and it is easy to imagine this trend will continue in the foreseeable future.

https://www.apnic.net/community/ipv6-program/ipv6-for-decision-makers

Global LTE growth focus



www.4gamericas.org/index.cfm?fuseaction=page&pageid=1781

Rapidly increasing mobile devices

- The business competency of mobile network operators is shifting from being a traditional voice and messaging provider to a mobile broadband service provider
  - Services on voice, messaging, and data are converging on IP-based services
- Given the rapid increase in the number of mobile devices, rich media applications and content, investing in techniques just to extend the lifetime of IPv4 is ultimately limited from a business continuity point of view
  - IPv6 will sustain a future business model

IPv6 in mobile networks

- Significant growth in mobile devices accessing the Internet
  - Entry of mobile devices into the Internet is largely impacting the demography of Internet users and their behavior
  - Sustaining end-to-end connectivity will lead to innovative use of these tools
  - We have not seen the largest growth of the Internet yet!
  - And it's coming!!
- For example, Internet of Things, new applications using Machine-2-Machine (M2M) connectivity in areas of:
  - Energy and utilities, financial services and banking, government, healthcare, travel and transportation, etc.

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Impact of the growth

From where the growth is coming?

Operating in exponential growth time

- Smooth, fast and reliable Internet access has been a fundamental requirement of customers of SPs
- Such demand will only increase in intensity.
- This is even more critical for enterprise customers of SPs that build their business model and/or deliver user-pay services via mobile devices.
- There may come a day when enterprise customers who are able to choose will shift to that SP that can guarantee smooth, fast and reliable end-to-end Internet access.

So what does Internet user growth mean for the SP?

- Significant growth in Internet users simply means a matching parallel growth in demand of Internet Protocol (IP) addresses.
- On top of meeting the demands of IP addresses from the existing fixed networks, SPs need to cope with additional demand for IP addresses coming from wireless networks and mobile cellular phone networks.
  - At the time of IPv4 address exhaustion
- If IP addresses are fundamental to the SP's business model, what does this restriction mean to you?

Fundamental ingredients to capture customers

Fundamental ingredients to capture customers

- What are the fundamental ingredients for SPs in the Internet industry to capture customers during the times of exponential growth?
  - **Cost effective and high quality Internet access**
  - **Scalable deployment of mobile broadband networks and Wi-Fi offload networks**
  - **Faster and reliable retrieval of content**
    - Sustaining customers on content sites longer than competitors improves the possibilities of enhancing online advertisement revenue.
    - Content providers need to carefully monitor the service level of their hosting providers, datacentres, content distribution networks etc.

How to achieve business goals?

The Situation Today

- Public IPv4 Address space is running out
  - APNIC and RIPE NCC are in their “austerity” phases
  - ARIN and LACNIC are about one year away from running out
  - AfriNIC still has about 7 years of IPv4 left
- The Internet infrastructure operators have 3 simple choices facing them:

1. **Do Nothing**
2. **Prolong IPv4**
3. **Deploy IPv6**

Recap
IP version history

	Internet Protocol version 4 (IPv4)	Internet Protocol version 6 (IPv6)
Deployed	1981	1999
Address Size	32-bit number	128-bit number
Address Format	Dotted Decimal Notation: 192.149.252.76	Hexadecimal Notation: 2001:DB8:0234:AB00:0123:4567:8901:ABCD
Prefix Notation	192.149.0.0/24	2001:DB8:0234::/48
Number of Addresses	2^{32} = ~4,000,000,000	2^{128} = ~340,000,000,000,000,000,000,000,000,000,000,000,000

Choice 1: Doing Nothing

- Advantages:
  - Business as usual, they have enough IPv4 for the foreseeable future
  - Easiest strategy – no investment needed
- Disadvantages:
  - Depends on IPv4 address availability
    - /22 (1024 addresses only from APNIC and RIPE NCC)
    - Limited transfer market activity
    - Address transfer costs
  - Customers have no access to IPv6-only content
    - If/when IPv6-only content is available
  - Lagging behind early adopters
    - Lacking operational experience in the new protocol

Choice 2: Prolonging IPv4

- This means:
  - Deploying NAT more widely
  - IPv4 address trading/market
- Advantages:
  - Continues what is known
  - Public addresses still available for ISP public infrastructure
- Disadvantages:
  - Customers forced to use NAT
  - Investment in large NAT devices
  - Rearchitecting network infrastructure around NAT
  - Address reputation (NAT as well as traded addresses)

Choice 2: Prolonging IPv4

- NAT issues:
  - Restricts provision of services to those with public addresses
  - Reputation of shared addresses
    - Behavioural, security, liability
  - Lawful intercept
  - Tracking and logging association of address/port and subscriber
  - Performance & scaling of NAT devices
  - Cost of “enterprise” scale NAT devices
  - Resource demands of some applications
  - Double or even Triple NAT likely
  - “How many ports does one user need?”

Choice 2: Prolonging IPv4

- Address transfer issues:
  - Routability of transferred addresses
  - Reputation of transferred addresses
  - More rapid growth of Internet routing table
  - Risk to integrity of routing system if transfers are unregistered
  - Cost to acquire addresses
  - Financial pressure on operators to dispose of addresses they still require

Choice 3: Deploying IPv6

- Original goal of IPv6 developers – Dual Stack
  - IPv6 running alongside IPv4
  - Public addresses for both IPv4 and IPv6
  - Once IPv6 universally deployed, IPv4 would be turned off
- Now:
  - Dual stack with public addresses still possible in some places
  - In other places, Dual Stack means public IPv6 and NATed IPv4
  - Not all network operators have deployed IPv6
  - Not all infrastructure devices can support IPv6
  - Meaning “transition” techniques required to “bypass” those

Choice 3: Deploying IPv6

- Advantages:
  - Network runs both IPv4 and IPv6
  - Once IPv6 universally available, IPv4 is simple to turn off
- Disadvantages
  - Depends on Public IPv4 address availability, or NATs
  - New protocol, staff training
  - New protocol, updated/new equipment
  - Extra resources on existing equipment (eg RIB/FIB limits)
  - Protocols are incompatible: IPv6 cannot talk to IPv4 and vice-versa
  - Updating end-user CPE

Choice 3: Deploying IPv6

- In addition to Dual Stack, Transition Techniques maybe also be required:
  - Means of getting IPv6-only to talk to IPv4-only

    NAT64
  - Transport IPv6 over IPv4-only infrastructure

    Tunnels & 6rd
  - Transport IPv4 over IPv6-only infrastructure

    DS-Lite, 464XLAT

Review of indicative business costs

- Do nothing
  - No additional cost today but may incur substantial costs in the future
- Prolonging IPv4 and Deploying IPv6
  - CAPEX and OPEX will vary depending on SP size, customer-base size, the specific business model, geographic region of operation and economy of operation etc.
  - One size does not fit all
  - Some interesting research comparing costs
    - Deploying CGN only vs deploying of both CGN and IPv6
- APNIC36 IPv6 Plenary 1 and 2
  - 28/08/2013 (Wed)

Which choice will you make?

- Doing nothing
  - Costs nothing
- Prolonging IPv4
  - Impact of taking IPv4 addresses back from customers?
  - Economics of deploying NAT?
    - e.g. Lee Howard's (Time Warner Cable) whitepaper on the economics of NATs
  - Operational impact, depending on regulatory requirements
    - Lawful intercept, logging, user tracking, reputation
  - Address transfer costs and address reputation
    - Routing system integrity – may have addresses but are they routable?

Which choice will you make?

- Deploying IPv6
  - Apparently easiest option
  - Most network infrastructure devices support both IPv4 and IPv6
  - Devices not supporting IPv6 need upgrading/replacing
  - Staff training?
  - Operational management tools?
  - Last mile infrastructure impacts (especially if contracted)
  - Transition technologies needed (eg NAT64, 6rd, 464XLAT…)

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Conclusion

Your business and the Internet

- The end-to-end Internet principle allows many stakeholders to interact directly, and provide foundation for innovation
  - The Internet is a highly diverse and flexible amalgam of many components
  - The speed of innovation is rapid
- SPs are at a critical turning point and some may be left behind if their organisation does not learn how to provide both IPv4 and IPv6 services.
  - Choosing technologies that support the current business model, while establishing a foundation for a future business model is no simple task – there is no one strategy that fits all.

Making informed decisions

- Business decision makers of SPs should begin by seeking input from their own technical and business development units
  - Their analysis and recommendations including actual ongoing annual costs and one-off costs for each option
  - Also need to examine competitors' behaviour as part of the process of making an informed decision
  - Business planning needs to consider current and future Internet connectivity demand in arriving at a business model that makes sense today and tomorrow

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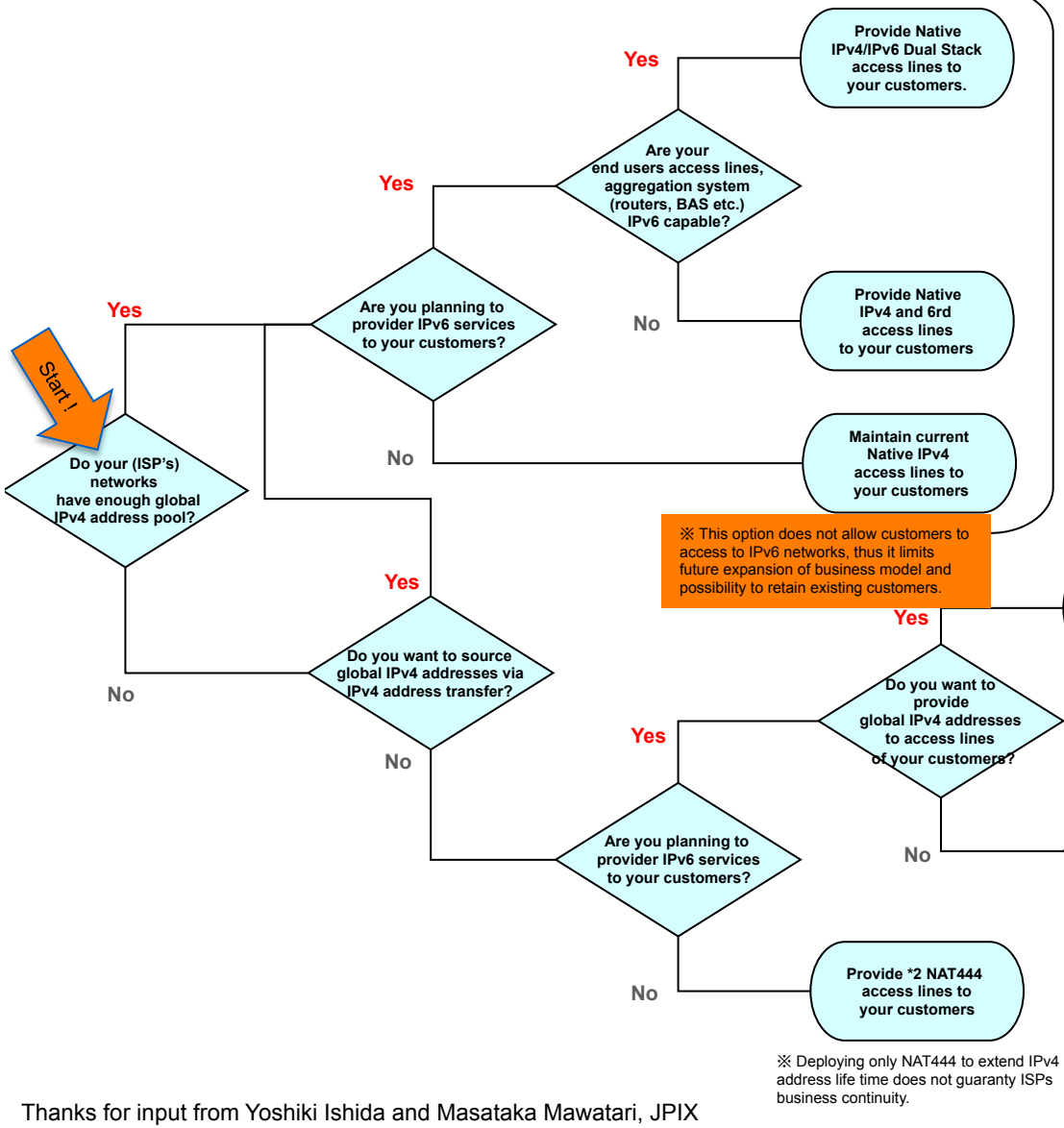
Information for CTOs

http://www.apnic.net/community/ipv6-program/ipv6-cto



This part of the flow chart represents following circumstance:

ISPs have sufficient global IPv4 address pool within their networks, so they do not need to deploy strategies to cope with IPv4 address exhaustion.

Such ISPs can consider about IPv6 deployment strategies by reviewing their business continuity strategies.

This part of the flow chart represents following circumstance:

ISPs do not have enough global IPv4 address pool, so they have to share global IPv4 addresses among several customers.

Such ISPs need to consider two strategies, if they want to grow their business:
1. extending IPv4 address life time.

2. deploying IPv6 networks

Thanks for input from Yoshiki Ishida and Masataka Mawatari, JPIX