

Spectrum Management- Sea or Land?

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World Bank, Washington DC

Nov 29, 2011, SDR Forum

Outline

- **Trends**
- These trends are in Both Developed and Emerging Markets
- Economics and Physics of Spectrum Management- Technical Solution
- This is the Right Time

IP Traffic to Grow Exponentially; Wireless Key to Growth

Global IP Traffic, Forecast 2010-2015



Source: Cisco, 2011

Global IP Traffic, Wired and Wireless, Forecast 2010-2015



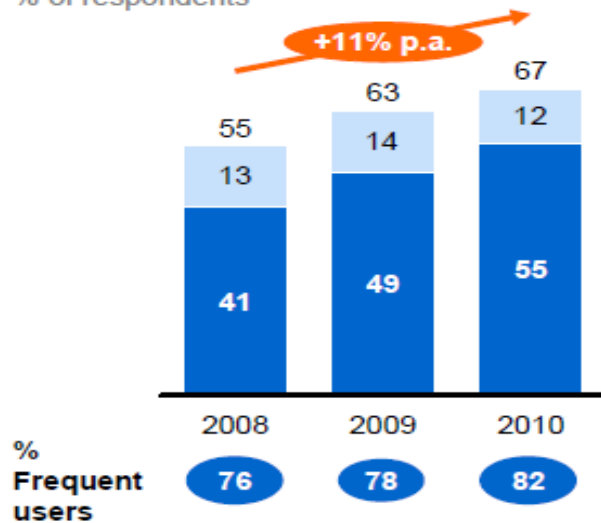
Source: Cisco, 2011

Users Perspective

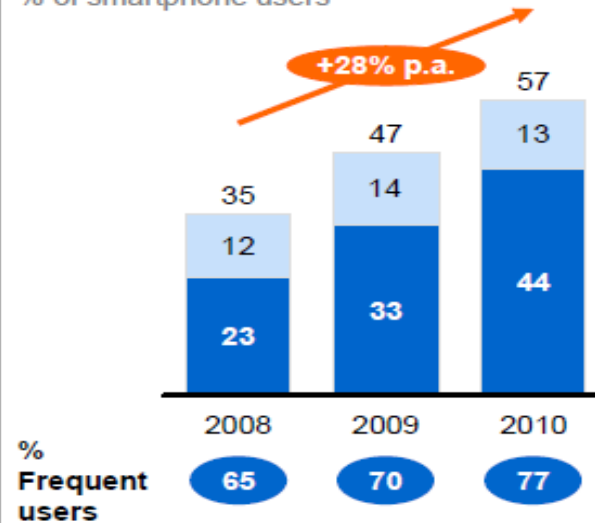
The penetration of social networks is increasing online and on smartphones; frequent users are increasing as a share of total users¹

■ Frequent user²

Social networking penetration on the PC is slowing, but frequent users are still increasing
% of respondents



Social networking penetration of smartphones has nearly doubled since 2008
% of smartphone users

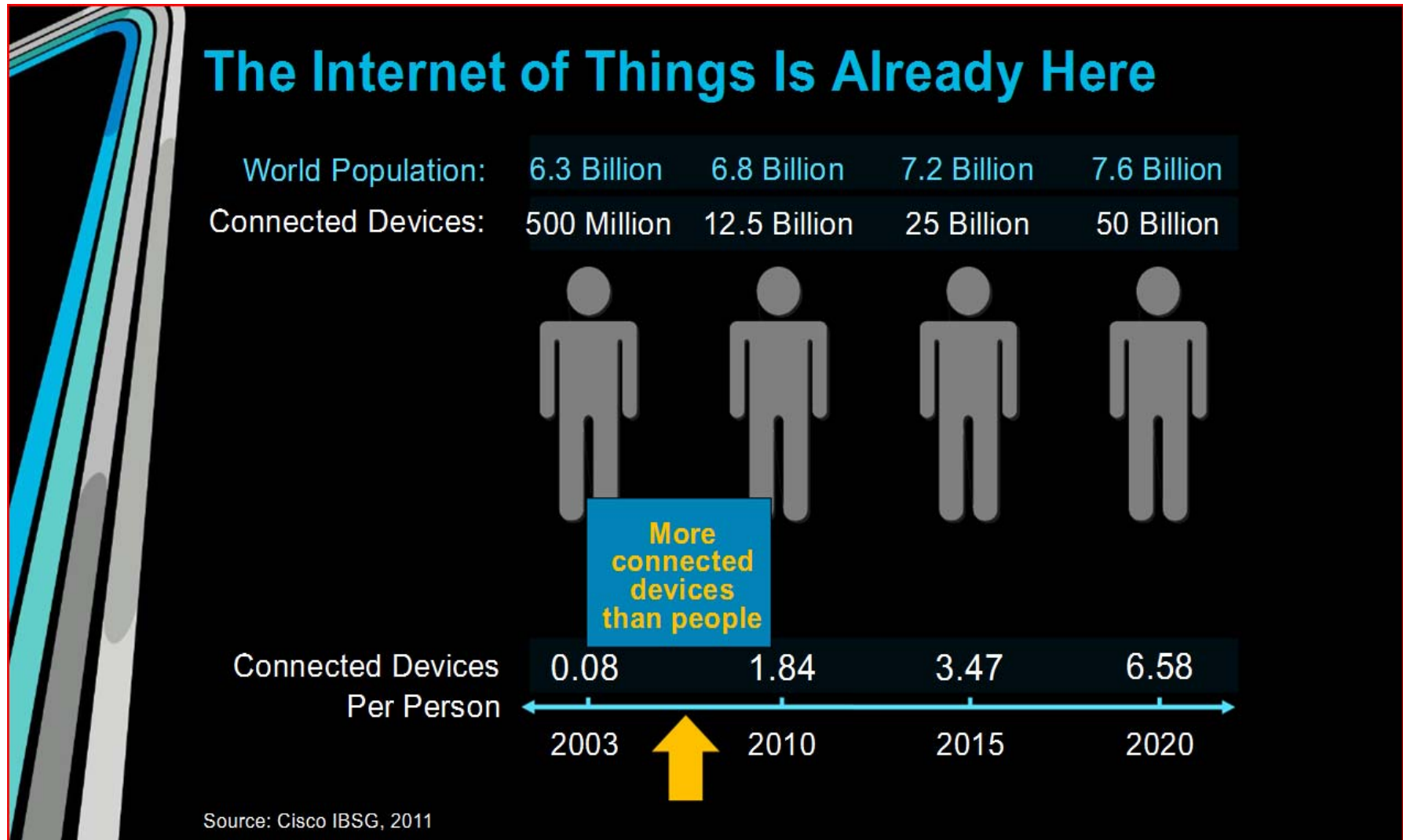


¹ Based on penetration of users who browse social network sites. For consistency, we exclude Twitter-specific questions (added to survey in 2009) and location-based mobile social networks (e.g., Foursquare, added to survey in 2010).

² Frequent users defined as those that use social networking at least once a week.

SOURCE: McKinsey iConsumer Survey

Growth Trend

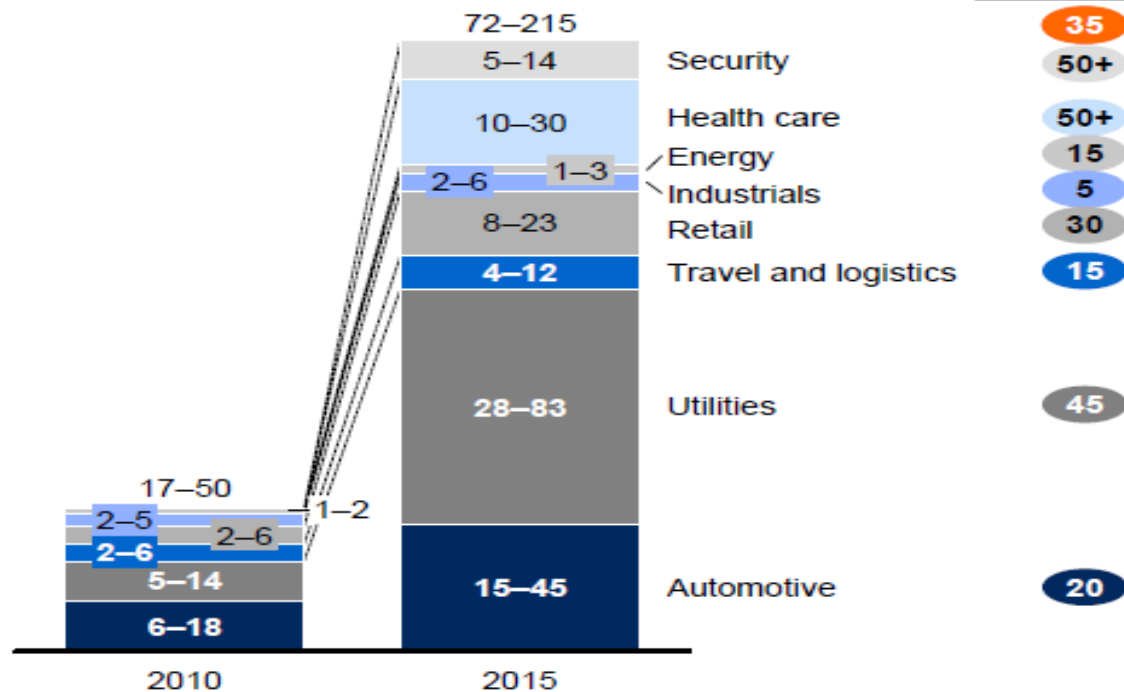


Exponential Growth of Data

Data generated from the Internet of Things will grow exponentially as the number of connected nodes increases

Estimated number of connected nodes
Million

Compound annual
growth rate 2010–15, %



NOTE: Numbers may not sum due to rounding.

SOURCE: Analyst interviews; McKinsey Global Institute analysis

This is Networking

New Internet Inhabitants

What do trees, cows, shoes, and your body have in common?



This **tree** has 3,000 followers...do you?



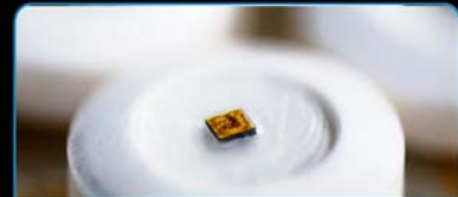
Cow transmits 200 MB per year



Connected **shoe**



Asthma inhaler cross-referenced with environmental / weather data



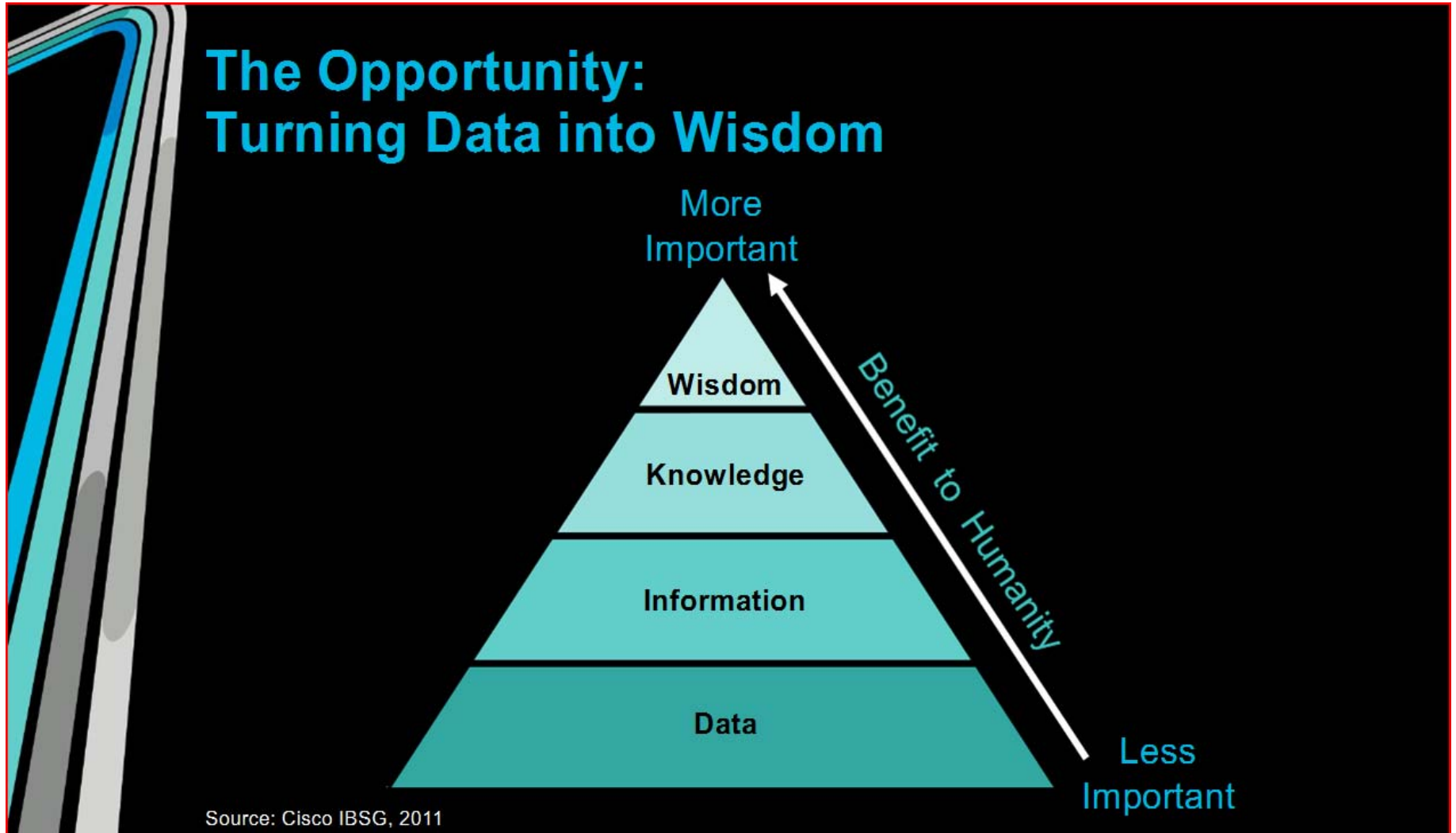
Proteus chip transmits data from your stomach

Sources: Cisco IBSG, 2011; Sparked, 2010; Nike, 2010; David Van Sickle, 2011; Proteus, 2011

Imagine the Pressure on Spectrum management



Transformative and Innovative Agenda

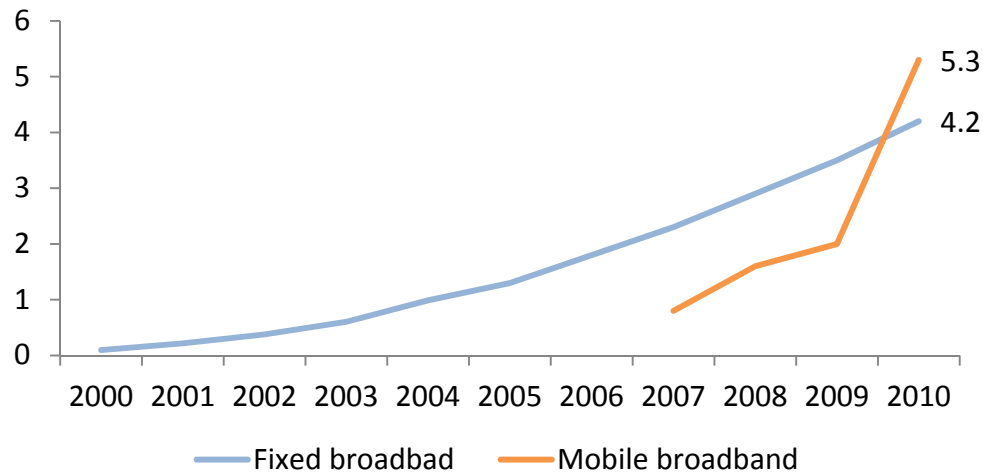


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Broadband Is Already Mobile in Emerging Countries

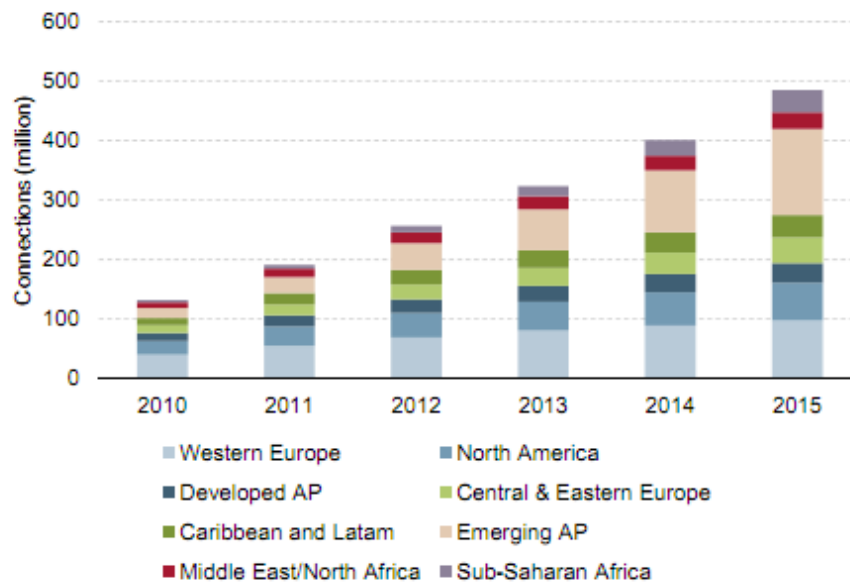
Fixed wireline broadband vs. mobile broadband in developing countries



The developed/developing country classifications are based on the UN M49, see:
<http://www.itu.int/ITU-D/ict/definitions/regions/index.html>
Source: ITU World Telecommunication /ICT Indicators database

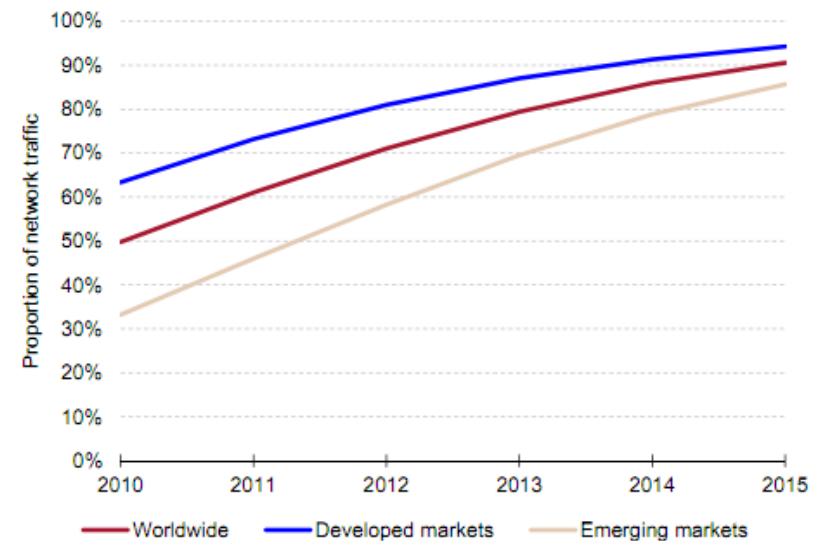
Mobile Broadband Will Expand Traffic Growth

Mobile BB Connections By Region, Forecast 2010-2015



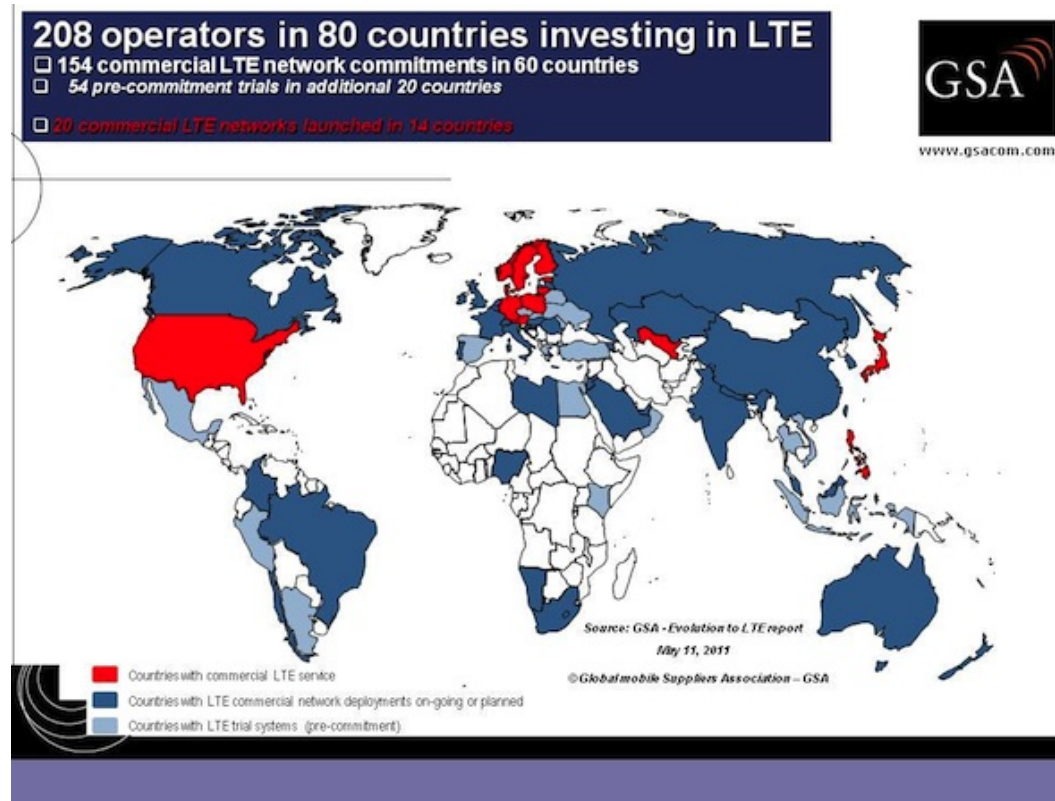
Source: Analysys Mason, 2011

Data Services as Proportion Mobile Networks Traffic, Forecast 2010-2015



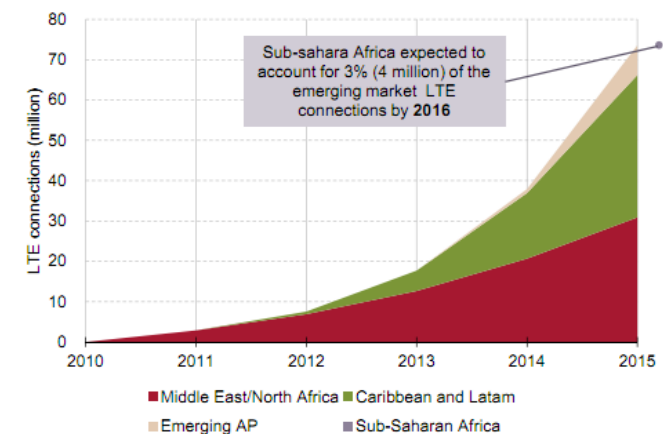
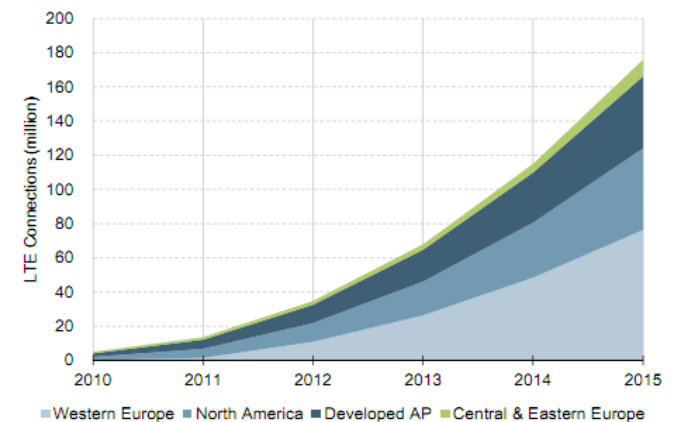
Source: Analysys Mason, 2011

Leapfrogging the Infrastructure Barrier Through Mobile



Source: GSA, 2011

LTE Connection Forecast, Develop-
Emerging countries, Forecast 2010-2015



Source: Analysys Mason, 2011

This is happening in Emerging markets

BlackBerry Bold 9790 launch sparks riot in Indonesia

Nov. 28, 2011 (4:02 am) By: [Lee Mathews](#)

 Like



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Network Economics

Figure 1: Comparison of the network economics of legacy and LTE networks [Source: Analysys Mason, 2010]

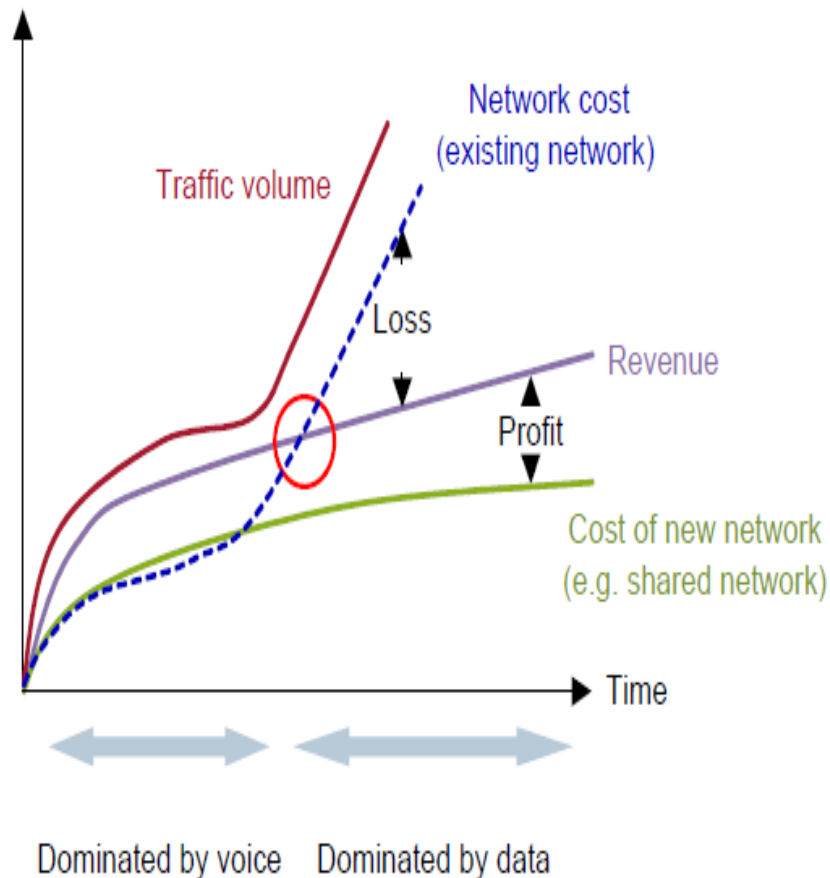
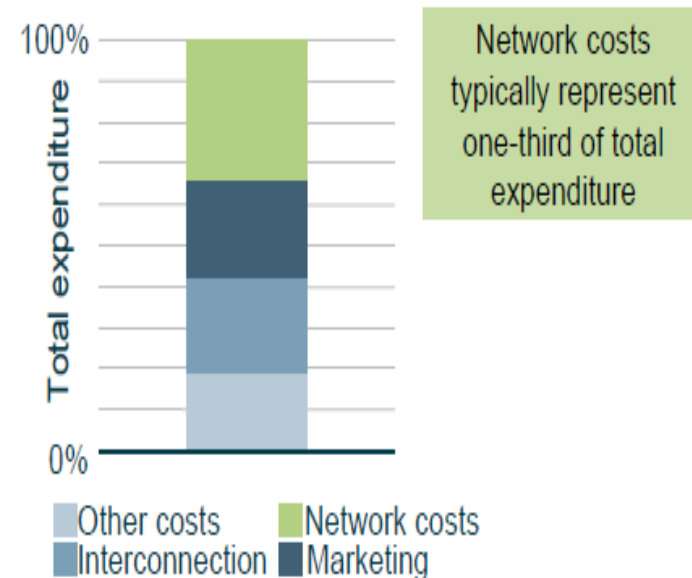
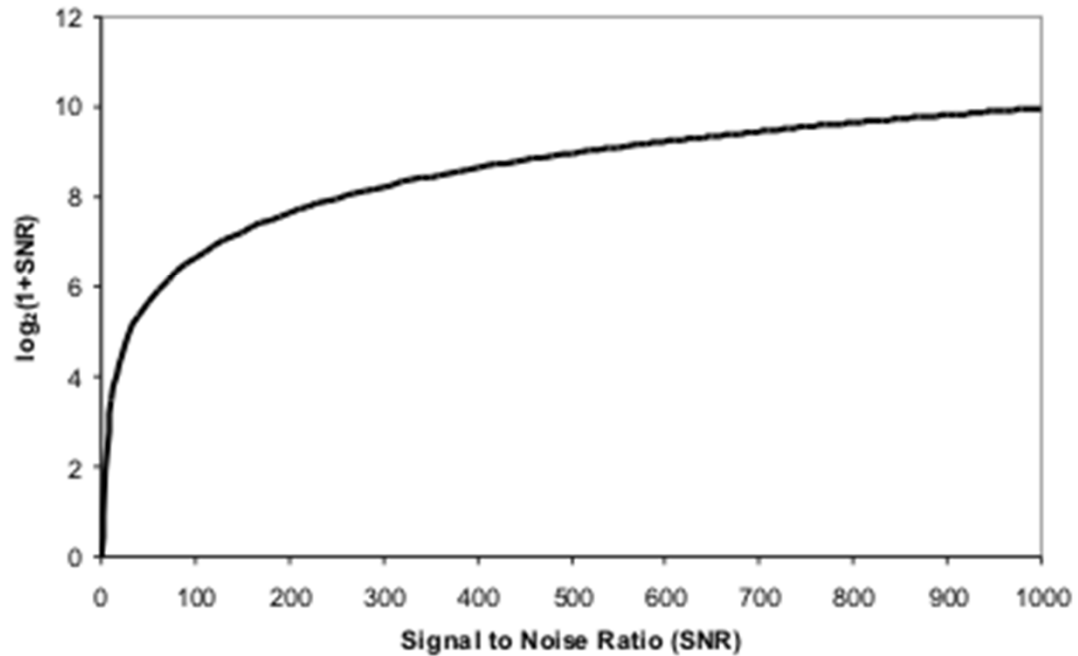


Figure 2: Typical expenditure by a European MNO [Source: Analysys Mason, 2010]



Shannon's law-What does it tell?

$$\text{Shannon's Law: } C = BW \times \log_2(1 + \text{SNR})$$

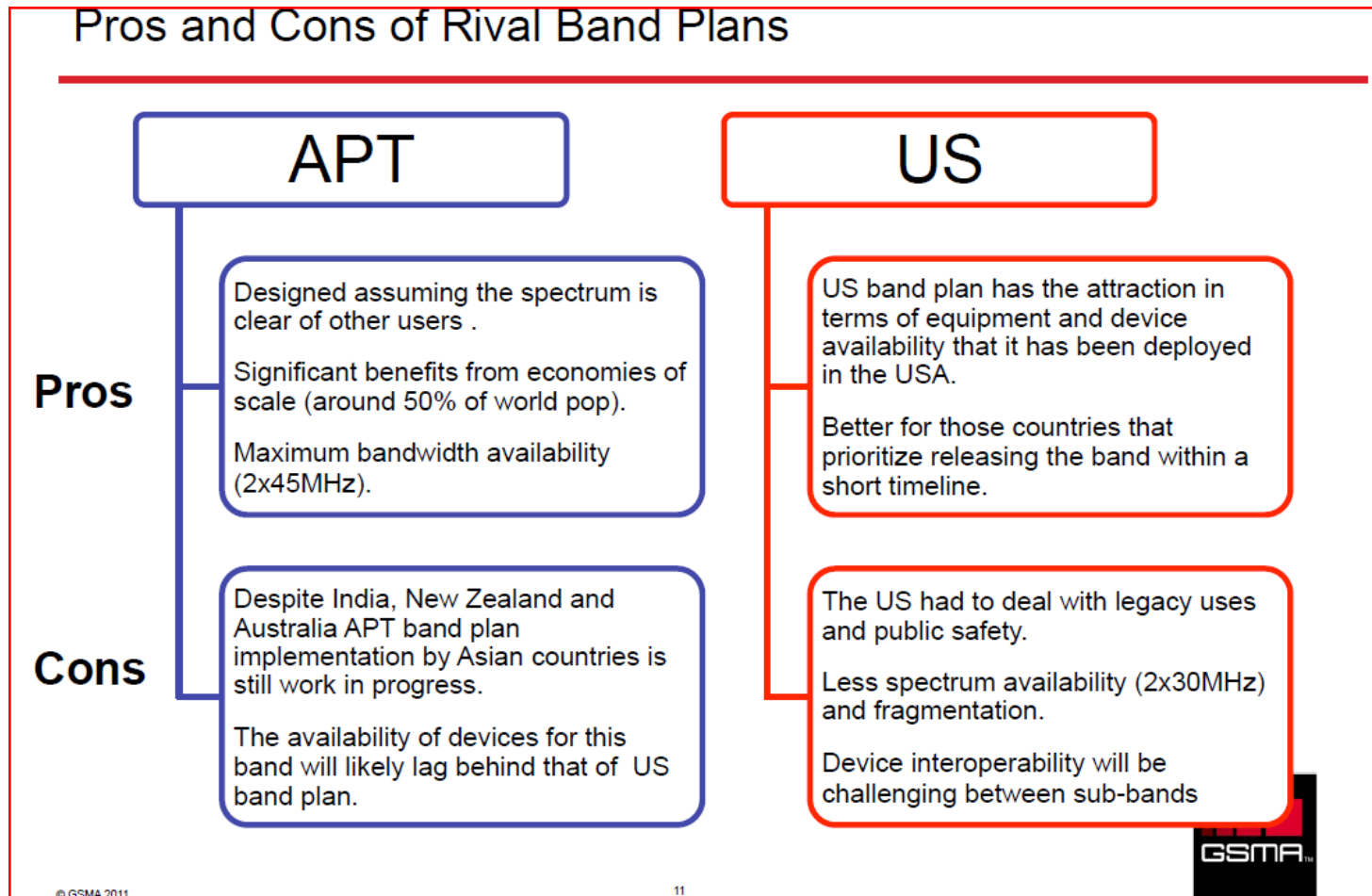


'BW' increase is the only solution to increase the 'C' beyond a limit

Choosing a Band Plan

- Harmonization
 - Reduce the cost of devices
 - Driving service uptake
 - Reduce cross –border interference
- Optimization of use of spectrum
- Increasing the coverage

Is this Comparison Necessary?



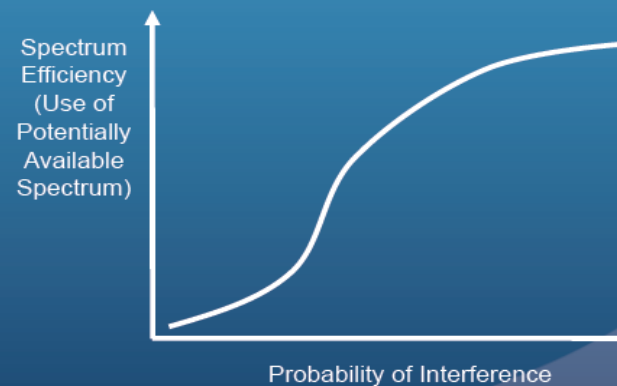
Are we using spectrum efficiently?

- NSF funded National Radio Network Research Test Bed (NRNRT) Program Sponsored Spectrum occupancy measurements in US in 30 MHz-3000 MHz frequency bands in Jan2004-Aug 2005
- The study goal was to determine the spectrum occupancy in each band (30 MHz-3,000 MHz) at multiple locations. The studies found significant available spectrum in most bands:
 - The average occupancy over all of the locations was 5.2%
 - The maximum total spectrum occupancy was 13.1% (New York City)

Spectral Efficiency

Utilization vs. Interference Risk

- As in classic detection theory, there is a trade off between efficient spectrum use and minimizing interference
- FCC decision chose to use 1966 radio propagation model this is known to be too conservative in rough terrain



Independent RAN providers

- Passive infrastructure sharing has become a common practice in mobile industry
- Just like independent tower companies, there will be independent RAN providers and different telecom operators will share their network
- RAN should work for all technologies in all frequency bands
- RAN resources are allocated and charged dynamically depending upon the requirement
- Independent clearing houses to settle financial payments
- Advancements in Cognitive and Software Defined Radio technology

Opportunity to all

- Should spectrum continue to be managed like 'Land' or it should be like 'Sea'. Only technology may change this trend.
- Is auction really a market based approach ?
May be technology gives a different answer.
- Very few operators having access to spectrum deprives other innovative entrepreneurs to access the market

Big Market Size

- World will have more mobile phones than its population in 2012
- In Broadband services still there is a big gap and this gap will be largely bridged by wireless technologies
- Spectrally efficient technologies are relevant for all countries
- Most of the telecom equipment are being supplied globally and mobile operators are international

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Two parallel Events

- Switchover from Analog to Digital TV
- Renewal of mobile operators licenses
- This is the right time to start Spectrum Management as 'Sea' and not as 'Land'
- This is where SDR Forum has to make a significant contribution