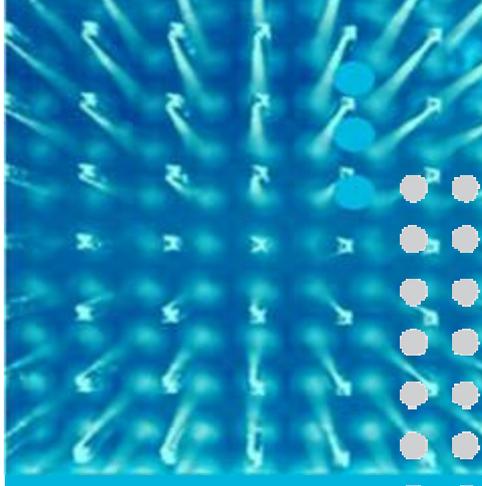




# Sharing National Broadband Networks

Regulatory Issues and Technology Choices



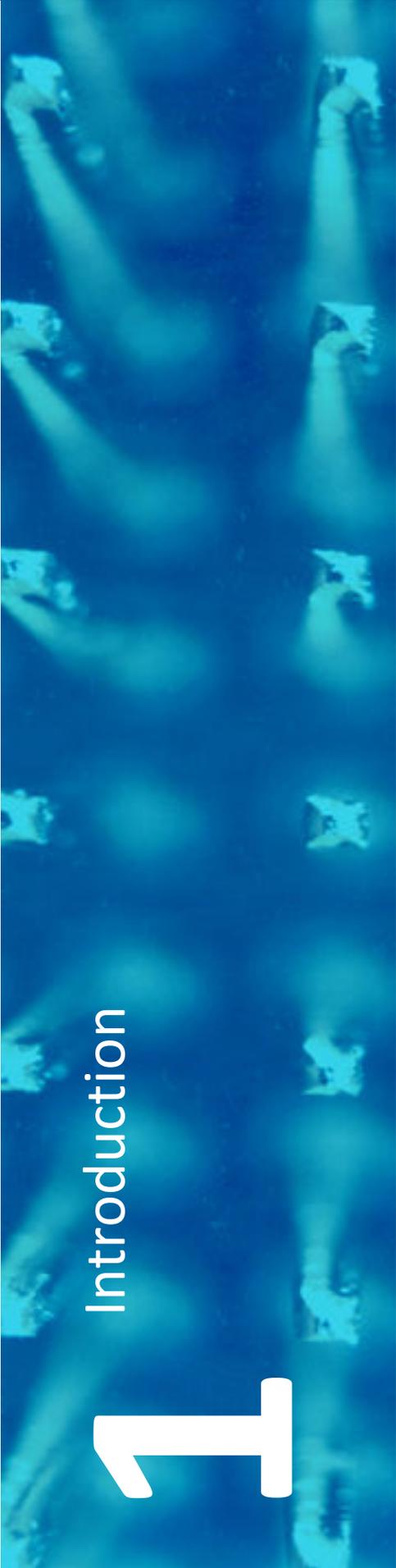
Dirk Wolter

CTO NSEA Region

September 2010

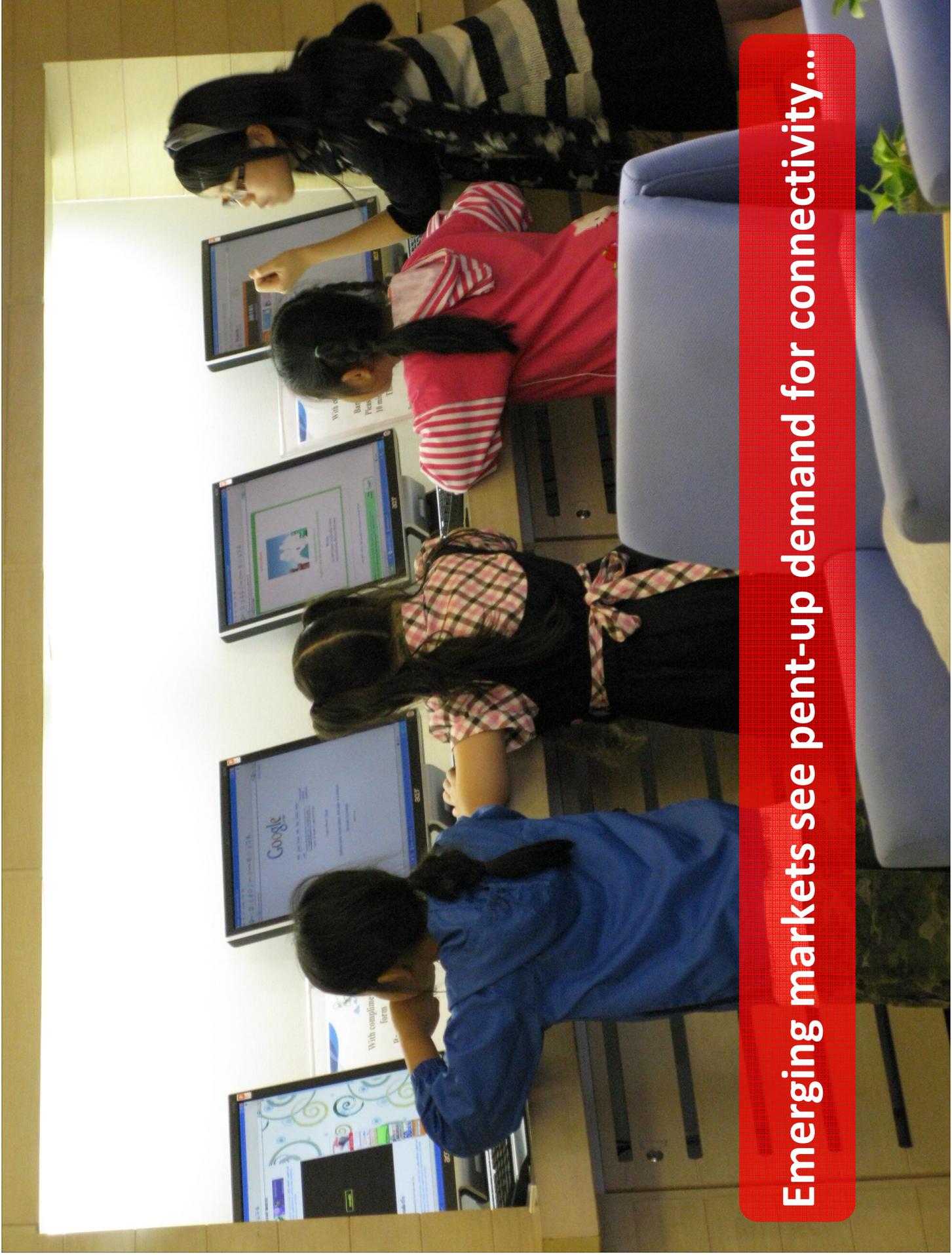
## **Agenda**

1. Introduction
2. Fixed Networks:  
Technology Choices and Infrastructure Sharing Concepts
3. Mobile Networks:  
Technology Choices and Infrastructure Sharing Concepts
4. Summary



## Introduction

# 1



**Emerging markets see pent-up demand for connectivity...**

...with current service availability woefully inadequate...

**INTERNET**

HI - SPEED

**256** KB/S

8 AM. - 11 PM.

DREAM VALLEY

RESORT.

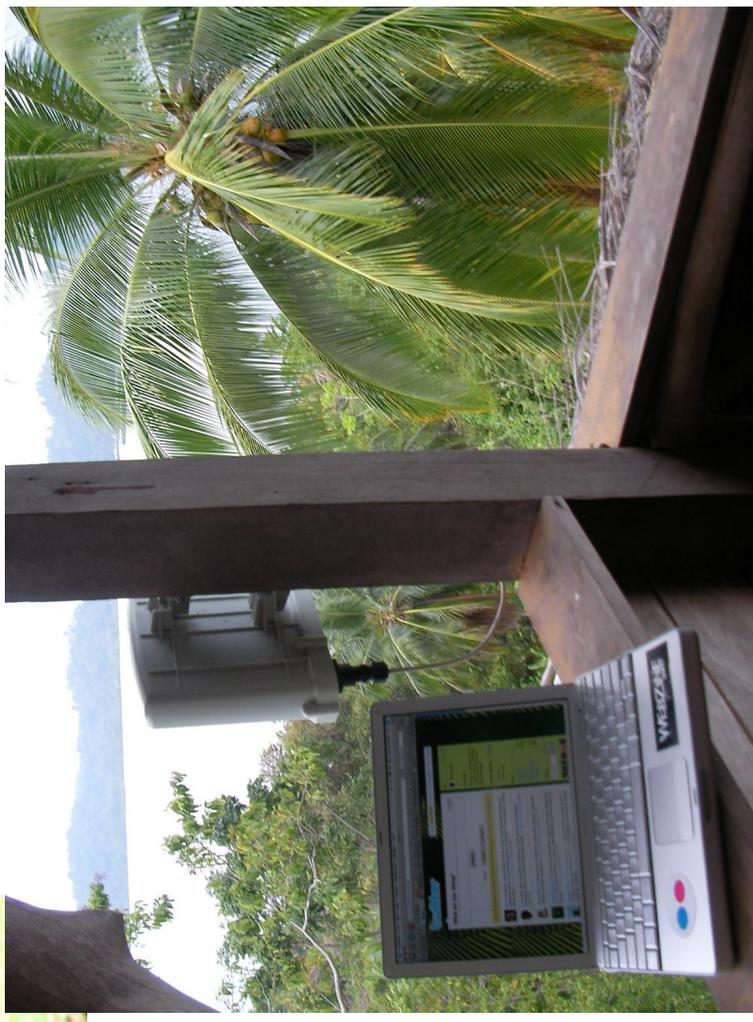


...and incumbent fixed infra being of poor quality and only available in urban areas...



...making mobile access the preferred option for users...

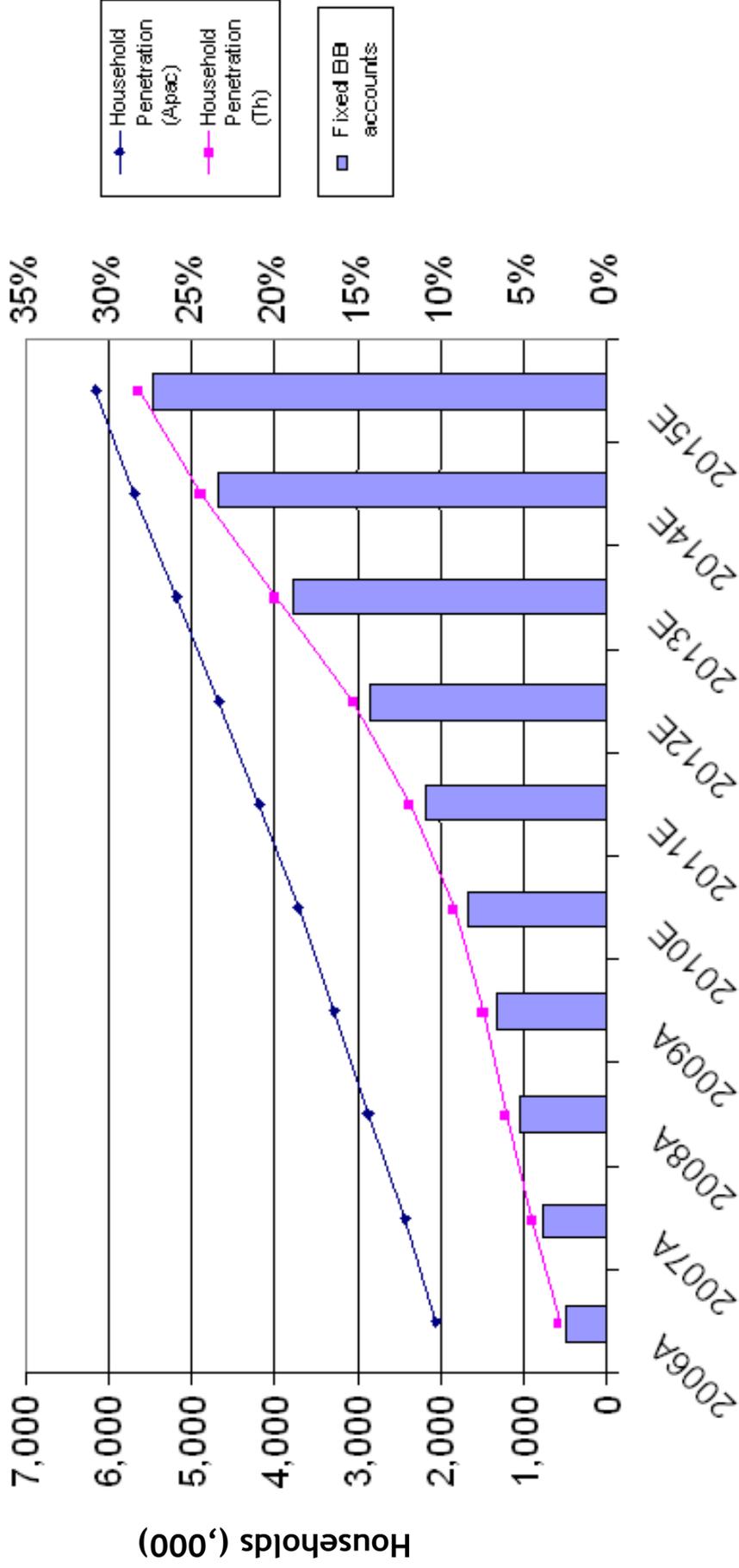
- Convenience
- Availability
- Affordable



...and for operators.

- Business case
- Roll-out speed
- Uptake

## Thailand Broadband Market - Fixed



Source: Pyramid Research, Jun 2010

# Challenges of Wireless Broadband in Emerging Markets and Solutions

## Broadband Capacity

How to improve broadband experience and QoS?

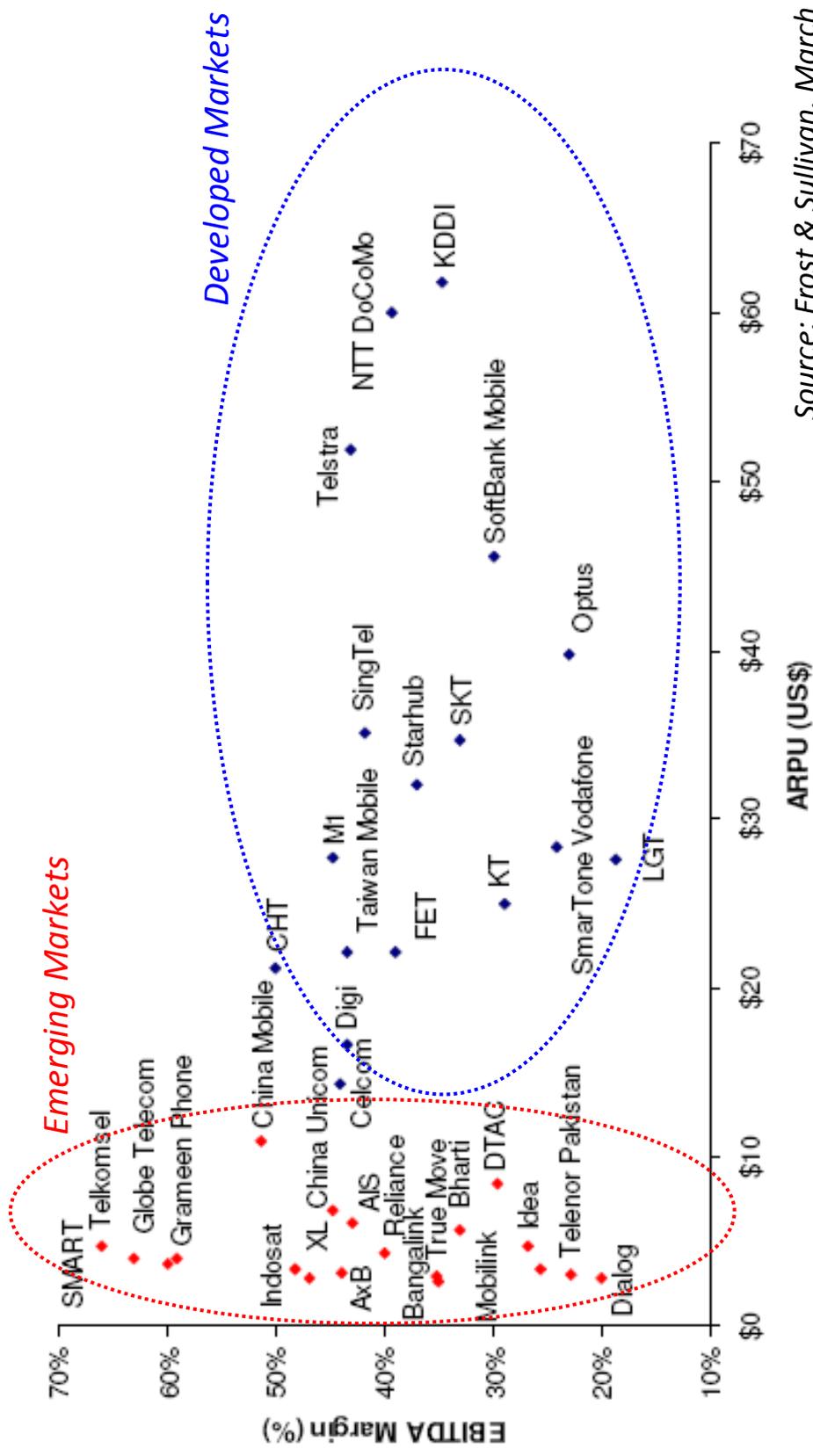
- Fixed broadband infrastructure for residential user to offload mobile networks – Mobile networks alone are not sufficient
- New deployments: Fttx technologies (GPON)
- QoS mechanisms for differentiated service offering
- Broadband optimized RAN based on HOM (16QAM, 64QAM), MIMO, IP (eg. HSPA+, LTE, WiMAX)
- More spectrum, Smaller cell sizes – micro cells
- Data centric (IP) backhauling

## Broadband Coverage

How to extend broadband coverage into rural areas?

- Cellular networks, at low frequency bands: 450/700/850/900 MHz
- Digital dividend, LTE 700 MHz
- Re-farming (e.g. UMTS900)
- Low power consumption and alternative power solutions
- Satellite backhaul or long range microwave solutions
- Government incentive programs (USO/USF)

...with strong profitability despite low ARPU.



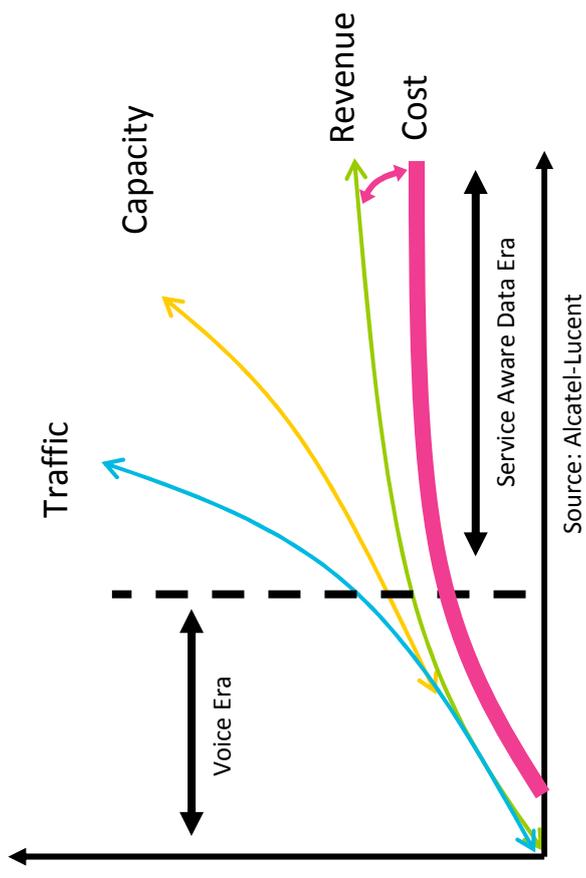
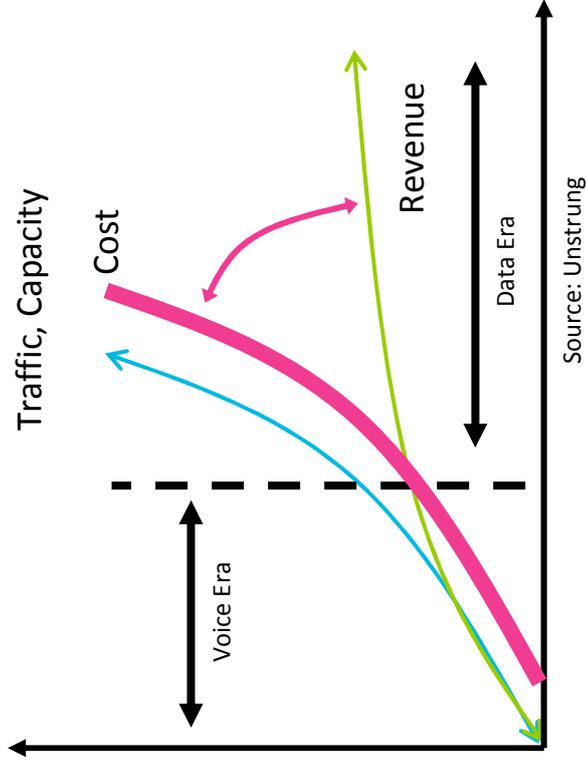
Source: Frost & Sullivan, March 2010

## Economics of broadband works against operators

- Vast increase of traffic through data applications
- Traffic increase is no longer matched by proportional revenue increase
- Drives a need to transform networks

Conventional networks not ready for data traffic:

Data Centric Networks flatten cost curve:



*Data centric networks and infrastructure sharing are the most effective cost saving measures*

## Motivation and Benefits of network sharing

**Reduce investments (CAPEX)** for rollout, densification, or coverage extension

**Reduce operational costs (OPEX)** by sharing e.g. the maintenance and rental cost, reducing power consumptions etc.

**Accelerate rollout** enabling **faster service** to a greater population

**Provide environmental benefits** with fewer towers and antennas

**Regulatory benefits** by faster time to universal service

### Key Challenge for the network operator:

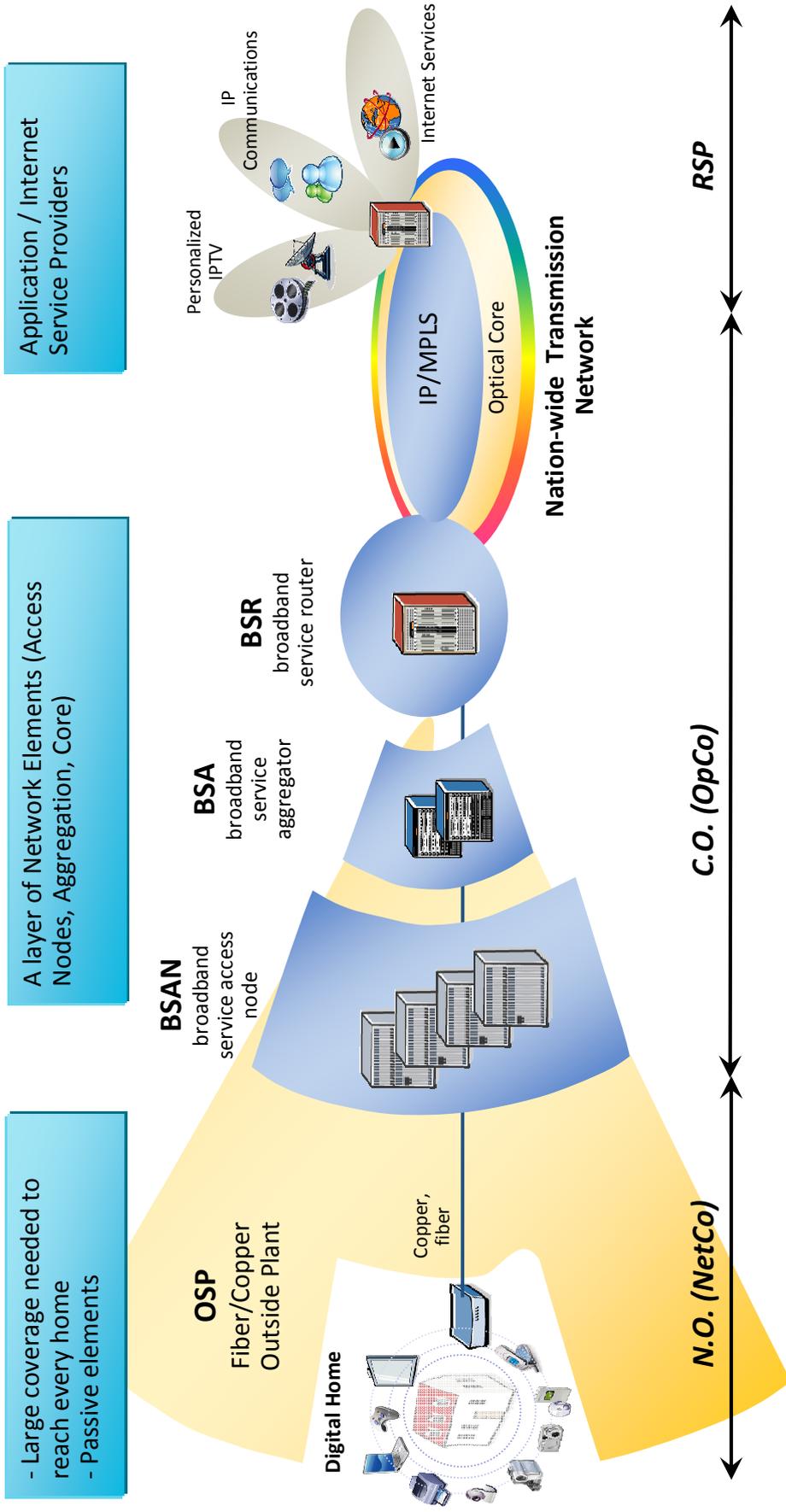
How to enjoy the economical benefits of network sharing while maintaining the service providers “identity” and differentiation?

# 2

Fixed Networks:

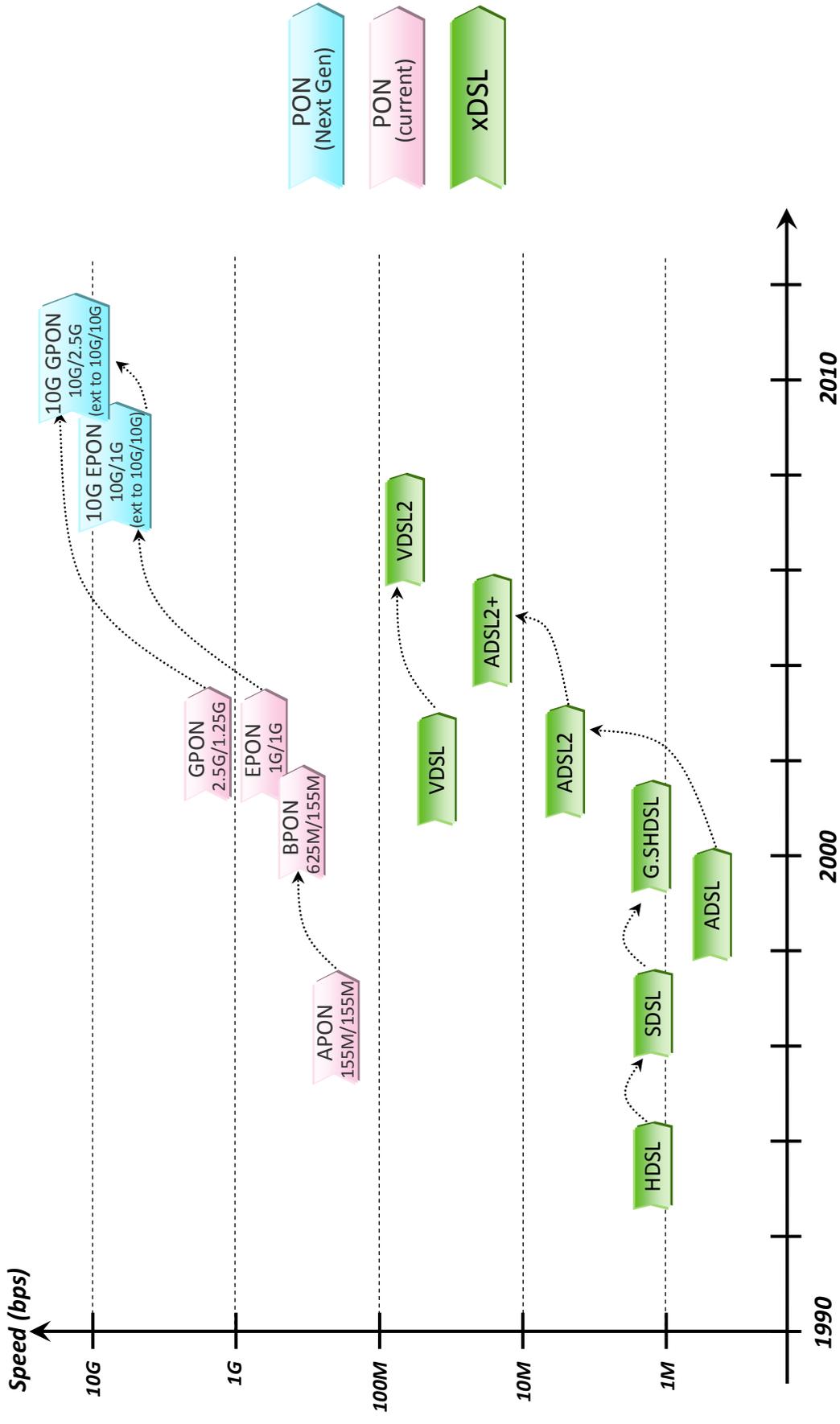
Technology Choices and Infrastructure Sharing Concepts

# Segments of the Fixed Network Infrastructure



High Cost of "last mile" slows down the availability of High Speed Broadband.  
Sharing this infrastructure greatly improves the economics

# Wireline Broadband Access / Standards evolutions

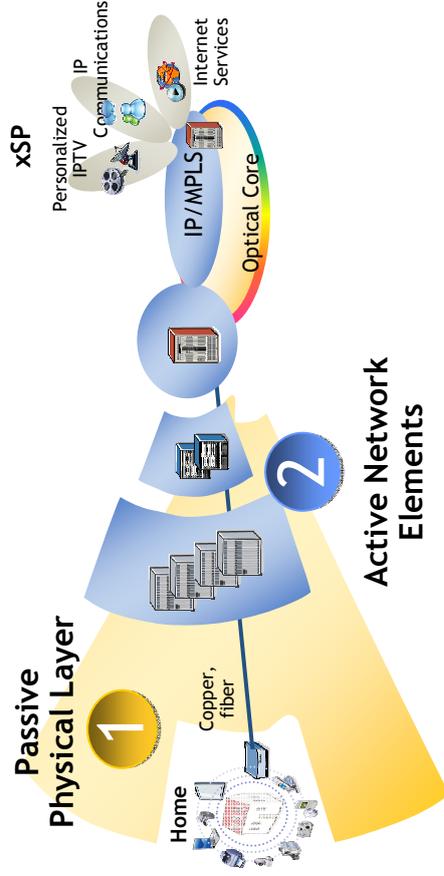


## Unbundling Options – Copper based infrastructure

1

### Passive Physical Layer

- Full unbundling, allowing the operator to lease the copper pair connecting to the end subscriber
- Shared Spectrum, the incumbent still maintain control over the copper mainly for voice service, while CLEC will use the part of spectrum for broadband



2

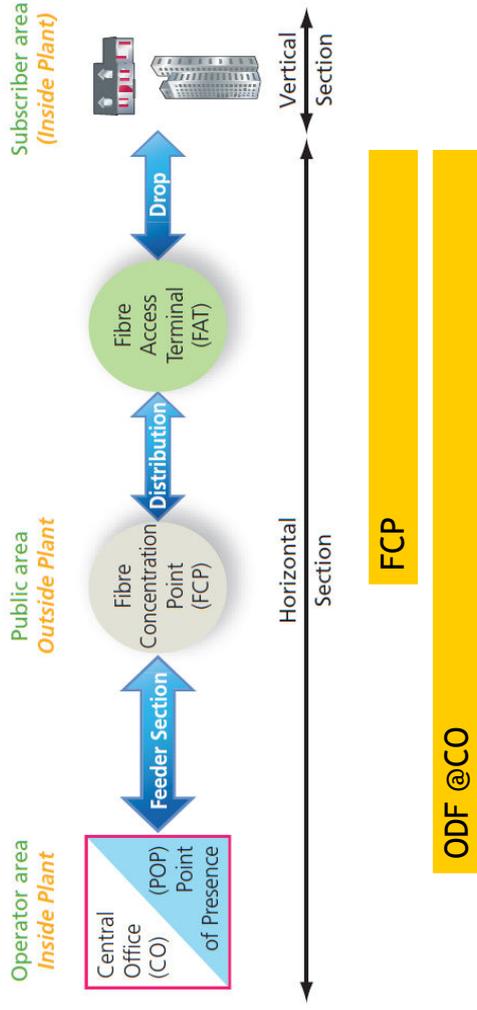
### Active Network Elements layer

- Bitstream access that are commonly deployed as wholesale of xDSL ports to the CLEC. These are mainly existing network elements from the incumbent operator.

## Unbundling Options – Fiber based infrastructure

### Diverse Topologies in a Fiber-based infrastructure

- FTTH (point-to-point splitter for GPON, EPON; or wavelength split for WDM PON)
- FTTx (to Node/Curb; to Building. Copper as last mile)



1

### Physical Layer

- At FCP (Fiber Concentration Point)
- At ODF in the Central Office
- Wavelength unbundling at ODF (in the case of WDM PON access)

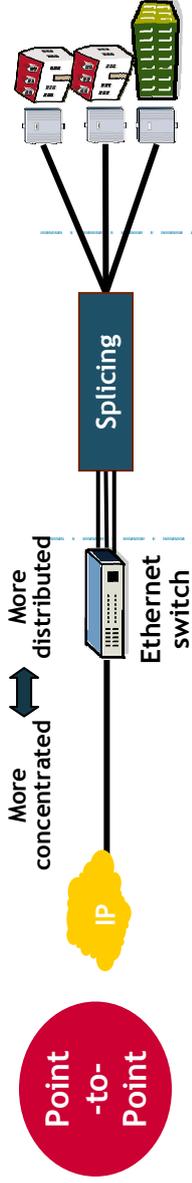
2

### Active Network Elements layer

- These are high-speed bitstream access that could be in the form of point-to-point Ethernet or PON (GPON, EPON, WDM PON). In many recent National Broadband projects (UK, Australia, Singapore, Malaysia) GPON has been chosen

# A Basic Comparison of Four FTTH Architectures

Central Office      Access loop      Home



**Efficient Outside Plant**  
 Small street/pole cabinet  
 No remote powering



**Cost-effective Feeder**  
 Smaller duct sizes,  
 CO consolidation  
 Need remote Powering



**Wavelength per user**  
 Few fibers in feeder section  
 CO consolidation



**Best Scalability**  
 Passive OSP, lowest CAPEX  
 CO scalability & Consol. (20+ km)

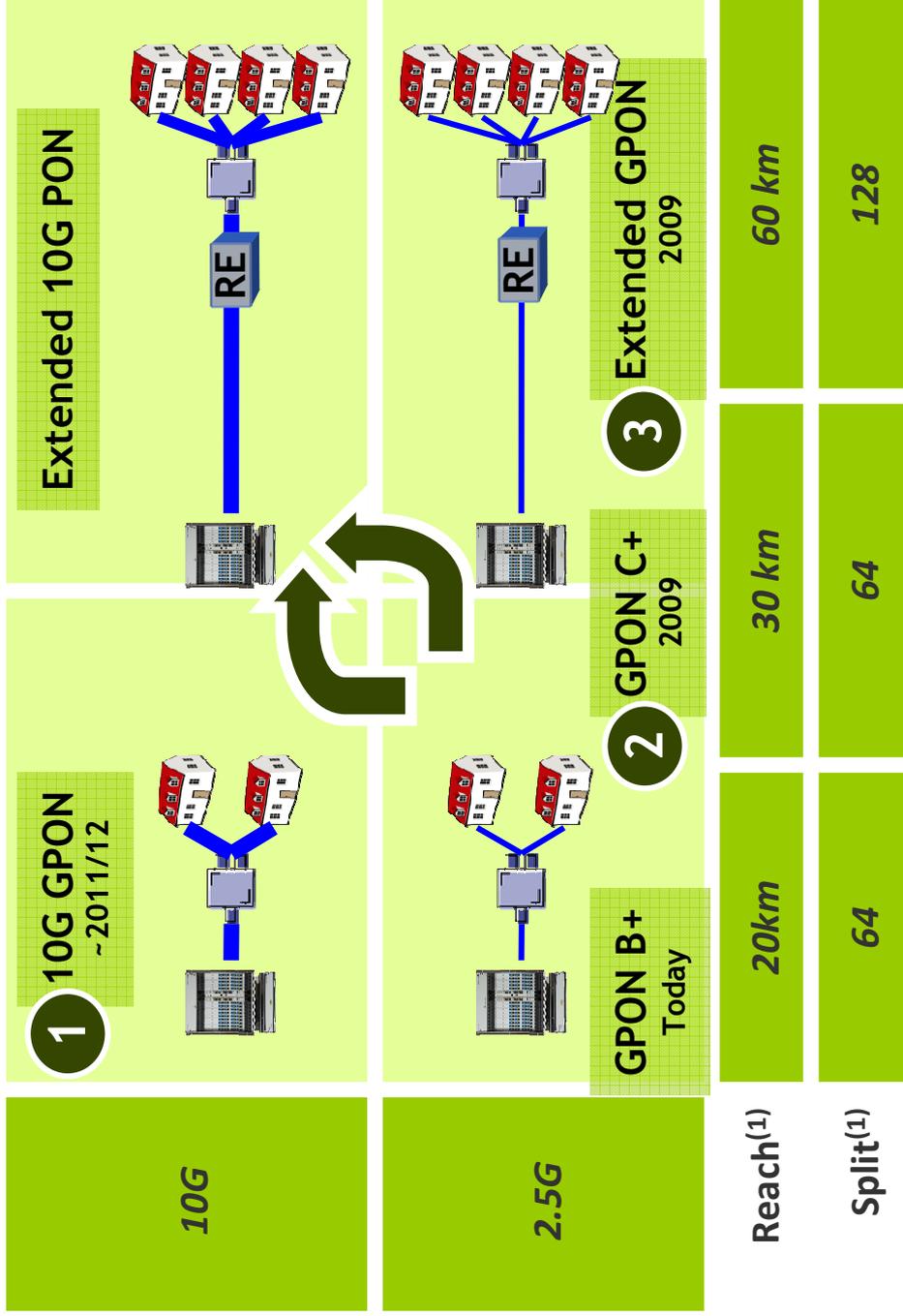


# Pushing the envelope of PON now

*Moving up Capacity, Reach & Split*



More BW for FTTB & backhaul  
 Increased split ratio  
 More BW & symmetry per subs.



(1) Reach and Split max performance not simultaneous

## Regulatory approach: Introduction

---

Governments are looking for ways to increase productivity, national competitive advantage and grow GDP.

- Within this context, Regulators are examining ways to restructure the infocomm industry to stimulate innovative service development and enable commercially viable open access high speed broadband networks.

High cost of last mile infrastructure and regulatory uncertainty are major obstacles for the wide deployment of broadband network infrastructure.

- Government projects (NBN) and long term regulatory initiatives (such as Open Access) help overcoming these issues.
- Governments often subsidize the build out of nationalize broadband infrastructure through a PPP (Public Private Partnership)

## Open Access Model

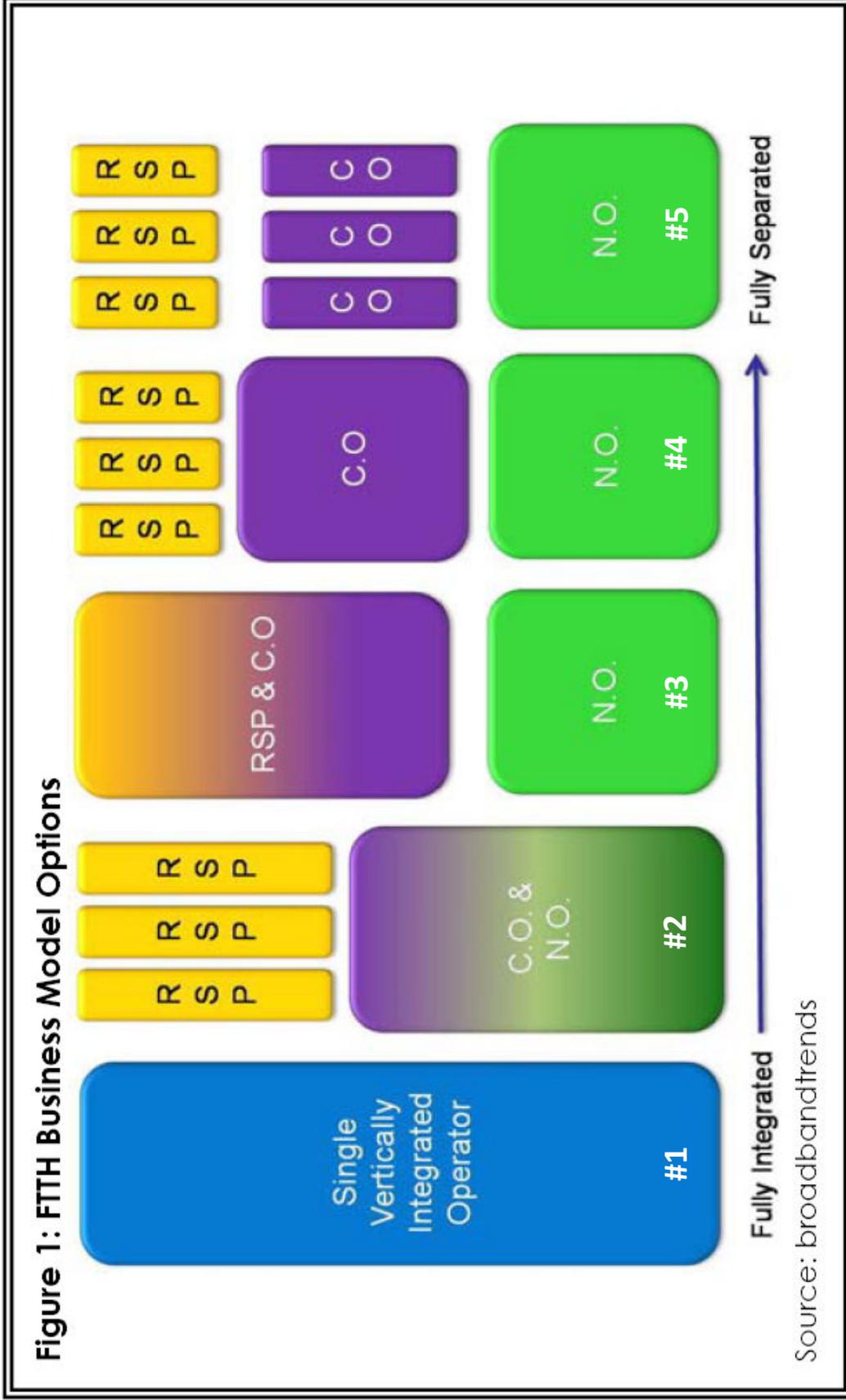
### *Principles and Economical Benefits*

#### **Open Access Model = Separation of physical infrastructure from service provisioning**

- Allows sharing of the expensive physical infrastructure across multiple operators i.e. improves cost effectiveness
- Non-discriminatory terms for service providers (equal access and charges)
- Network owner (N.O. or NetCo) focuses on infrastructure, typically aiming for a maximum of coverage
- Multiple Service Provider (Communications Operator, C.O., OpCo) “ride” on the NetCo’s infrastructure and focus solely on attractive service offering

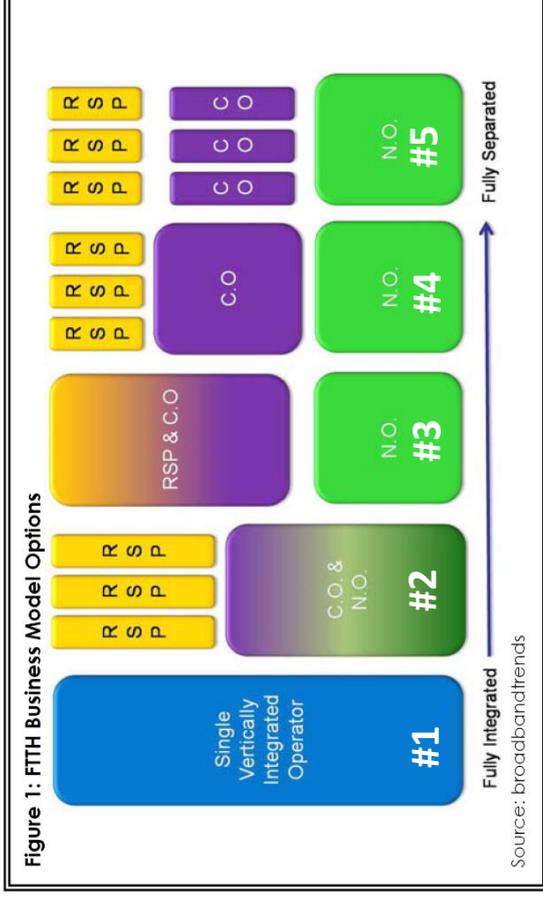
# Open Access Business Model

## Options for implementation



# Open Access Business Model

## Options for implementation



### General Observations

- No one size-fits-all model – depends on geographic complexity and state of competitiveness
- Regulators must be guided by an understanding of desired coverage, price-point and quality of service
  - o This will identify subsidy required (top-down)
- Consensus exists across all models that competition does not exist at the bottom passive layer

### Model #1

- o Status quo in most countries
- o Local loop unbundling normally a precursor to separation

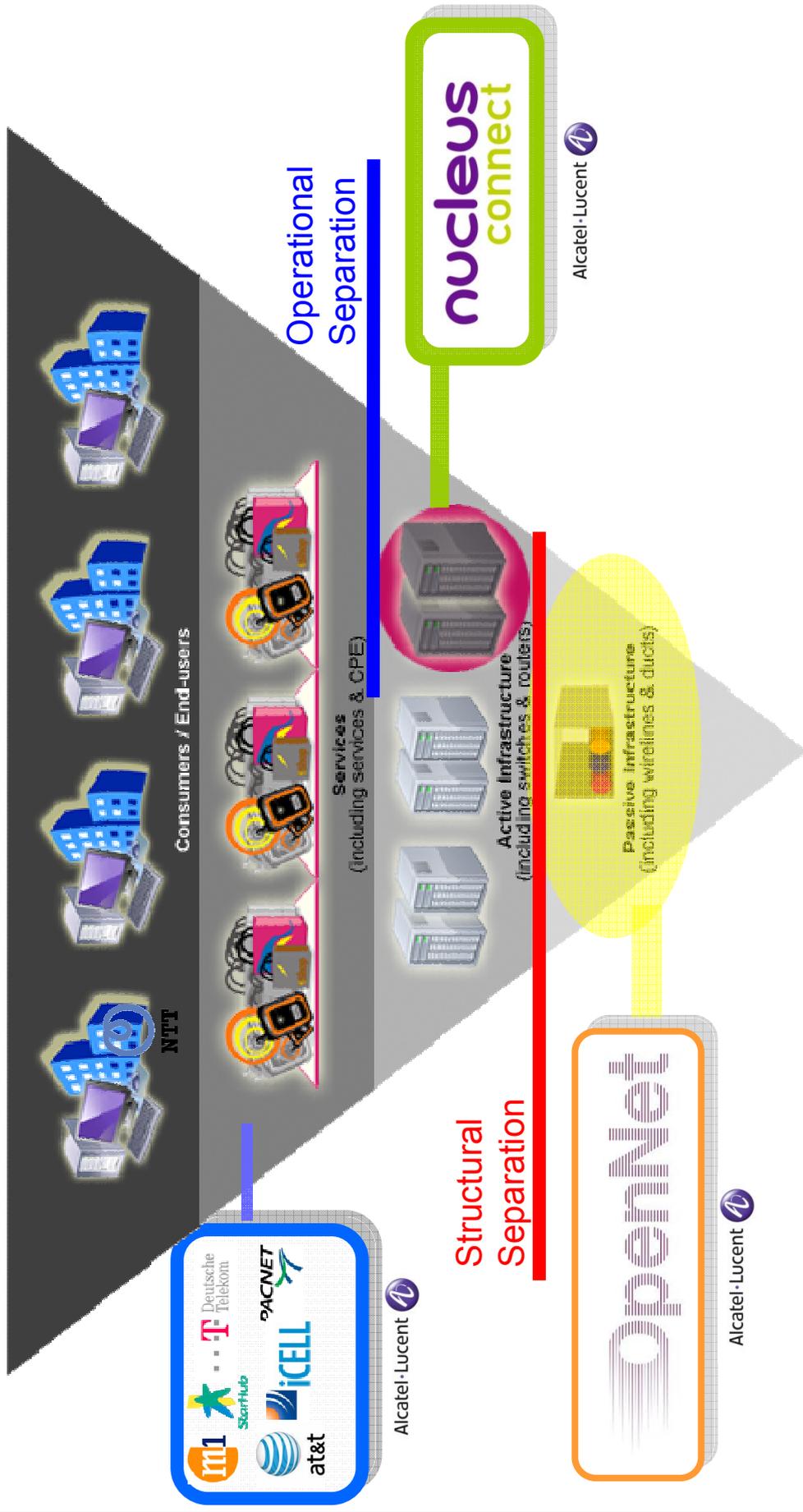
### Model #2

- o Australia's NBNCo (A\$43b)
- o New Zealand (still evolving) (NZ\$1.5b)

### Model #5

- o UK (BT has operational separation of BT Openreach (level 0,1) offering services to customers including BT Wholesale)
- o City-by-city initiatives in places like Amsterdam and Nordic countries
- o Singapore's Opennet and Nucleus Connect (S\$4b)

# Singapore Next Gen NBN Industry Structure



# Singapore's National Broadband Network ("NBN")

## The Transformation of the Telecom Landscape in Singapore

### RSPs

- Packages and sells broadband services to corporate, government & consumer end-users
- Incumbents such as StarHub are expected to become RSPs, as well as rumoured new entrants such as BT & NTT, as well as Over-the-Top players

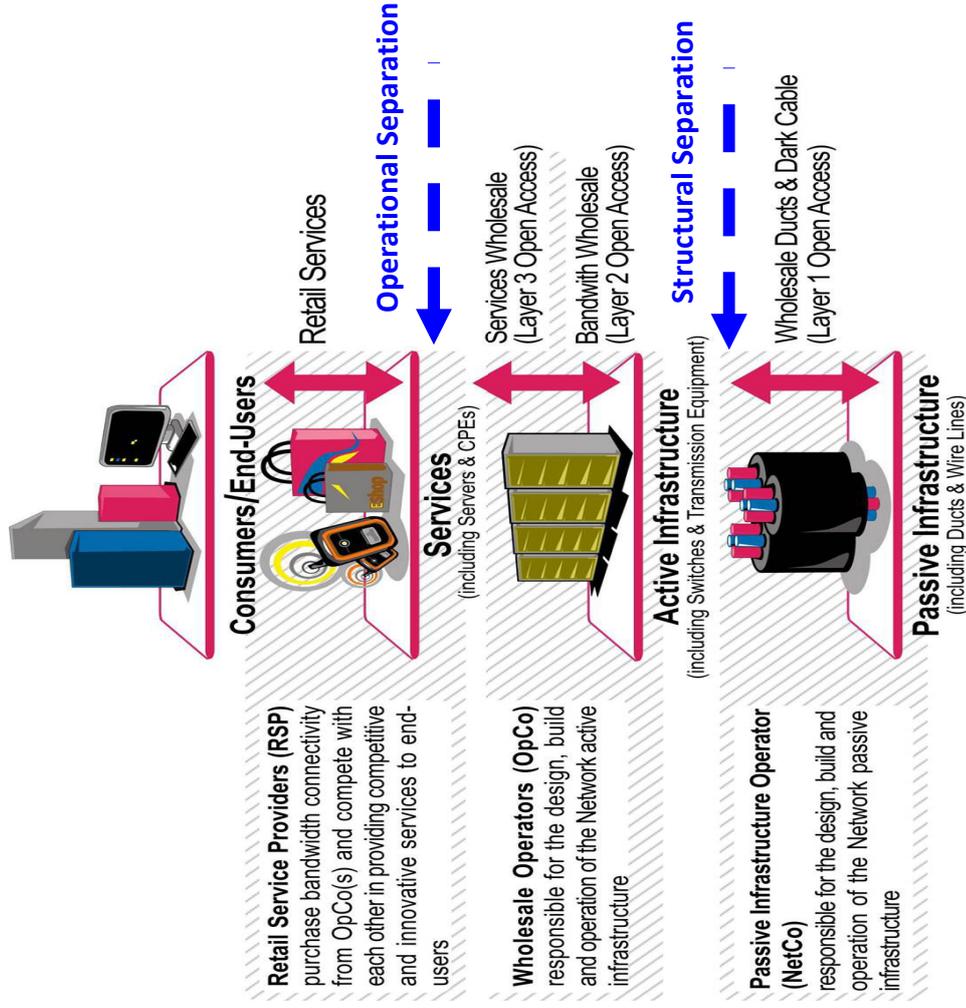
### OpCo

- License to operate and S\$250m subsidy awarded in April 2009 to StarHub's Neucleus Connect.
- Wholesale's broadband connectivity to arm's length RSPs on open-access terms
- Greenfield-build of active network comprised of FTTx (GPON, AE), optical, IP Core and OSS/BSS

### NetCo

- License to operate and S\$750m subsidy awarded in Sept 2008 to SingTel-led OpenNet Consortium, comprised of SingTel, Axta, SPH & SP Tel
- Greenfield-build of passive network comprised mostly of civil works (ducts), dark fiber and OSS/BSS system
- FTTx network rolled out starting in late 2010 through to 2013

## Singapore's New Industry Structure



## Singapore Next Generation National Broadband Network (NBN)



|                  | Residential  | Non-residential   |
|------------------|--|---|
| Retails Services | (Set by each RSP)  | (Set by each RSP)   |
| OpCo             | 100/50 Mb/s for SG\$ 21/month<br>1.0/0.5 Gb/s for SG\$ 121/month<br><i>(include NetCo Wholesale price)</i> | 100/100 Mb/s for SG\$ 75/month<br>1.0/1.0 Gb/s for SG\$ 860/month<br><i>(include NetCo Wholesale price)</i> |
| NetCo            | SG\$ 15 / month  | SG\$ 50 / month   |

- Asymmetrical offers for residential or business users with GPON
- Symmetrical offers for business users with GPON and P2P/Active Ethernet, up to 1/1 Gb/s
- Wholesale Service Offerings from OpCo to RSPs
  - Class A: real-time (video conferencing, premium VoIP, gaming...)
  - Class B: near real-time (IPTV, video streaming, gaming, video conferencing...)
  - Class C: mission critical (ATMs, data centres, control systems...)
  - Class D: best effort (Internet surfing, VoIP...)

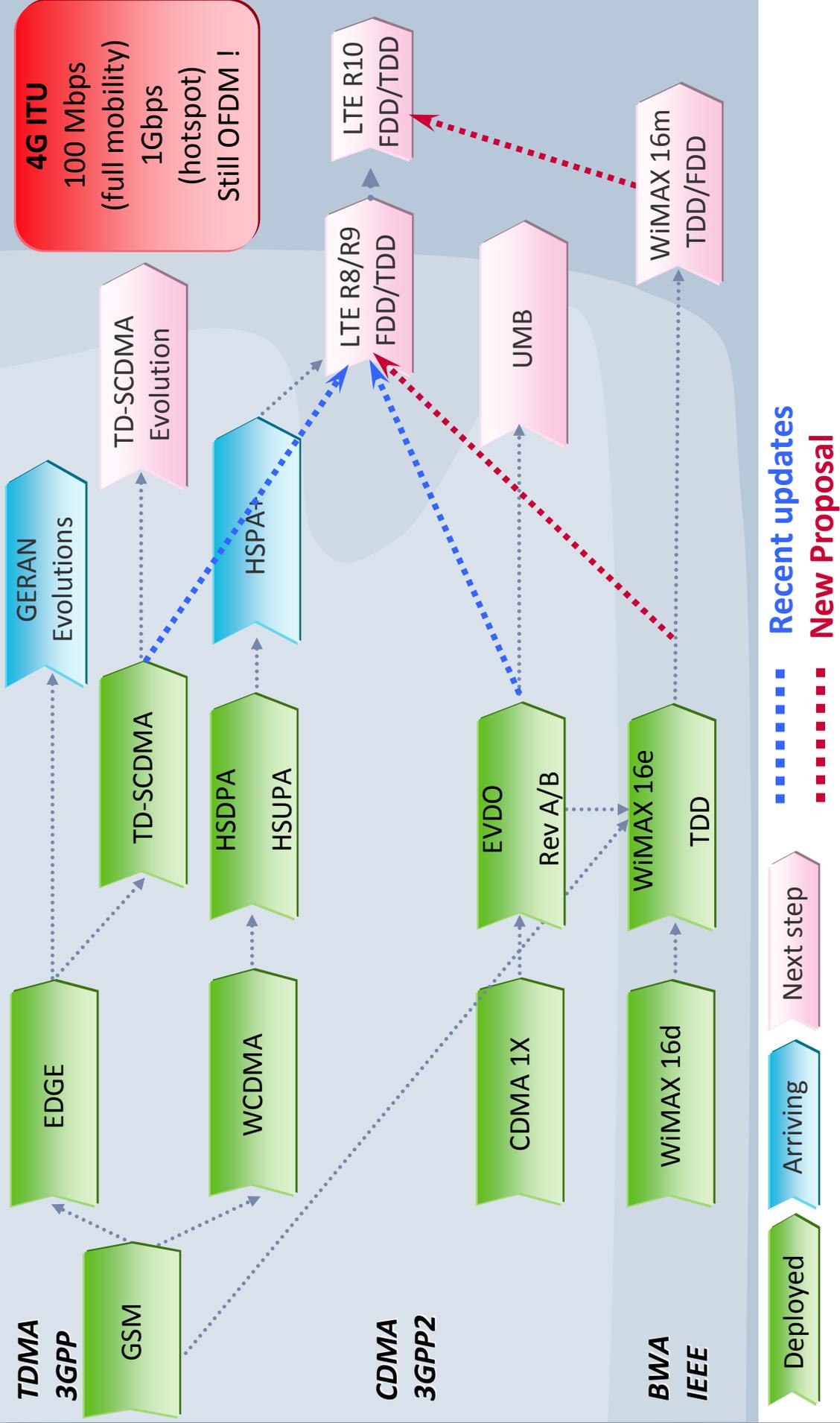
# 3

## Mobile Networks: Technology Choices and Infrastructure Sharing Concepts



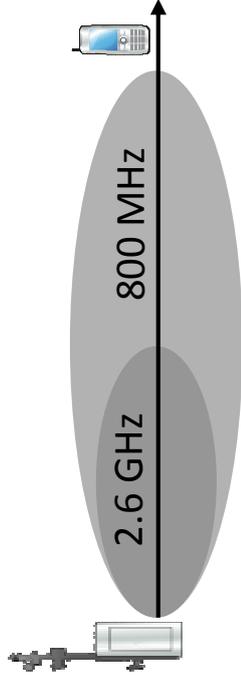
# Air Interface / Standards evolutions

All technologies have NOW an upgrade path to LTE

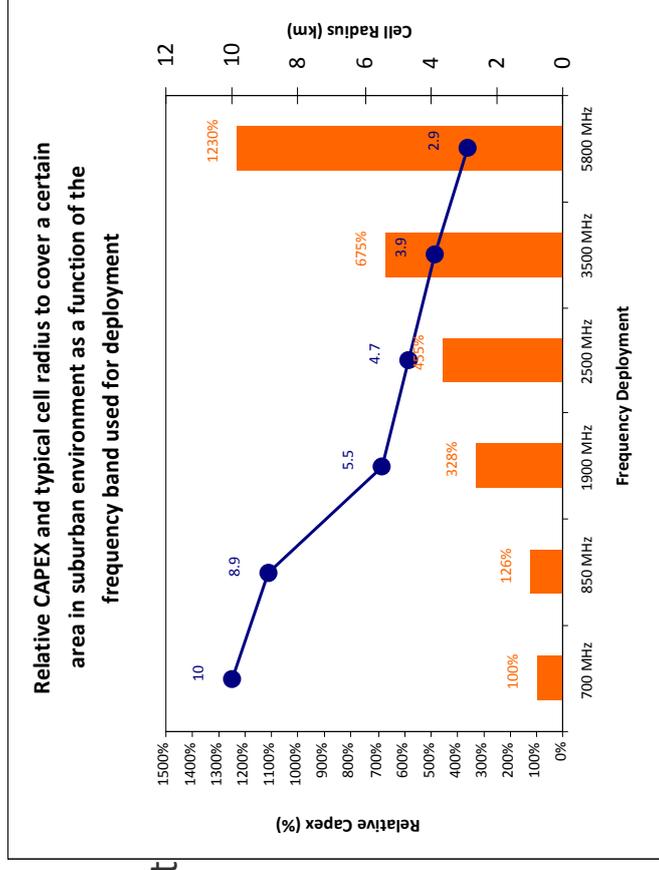


# Impact of standards & frequency on network economy

An illustration: 800MHz vs 2.6Ghz in Rural Environment



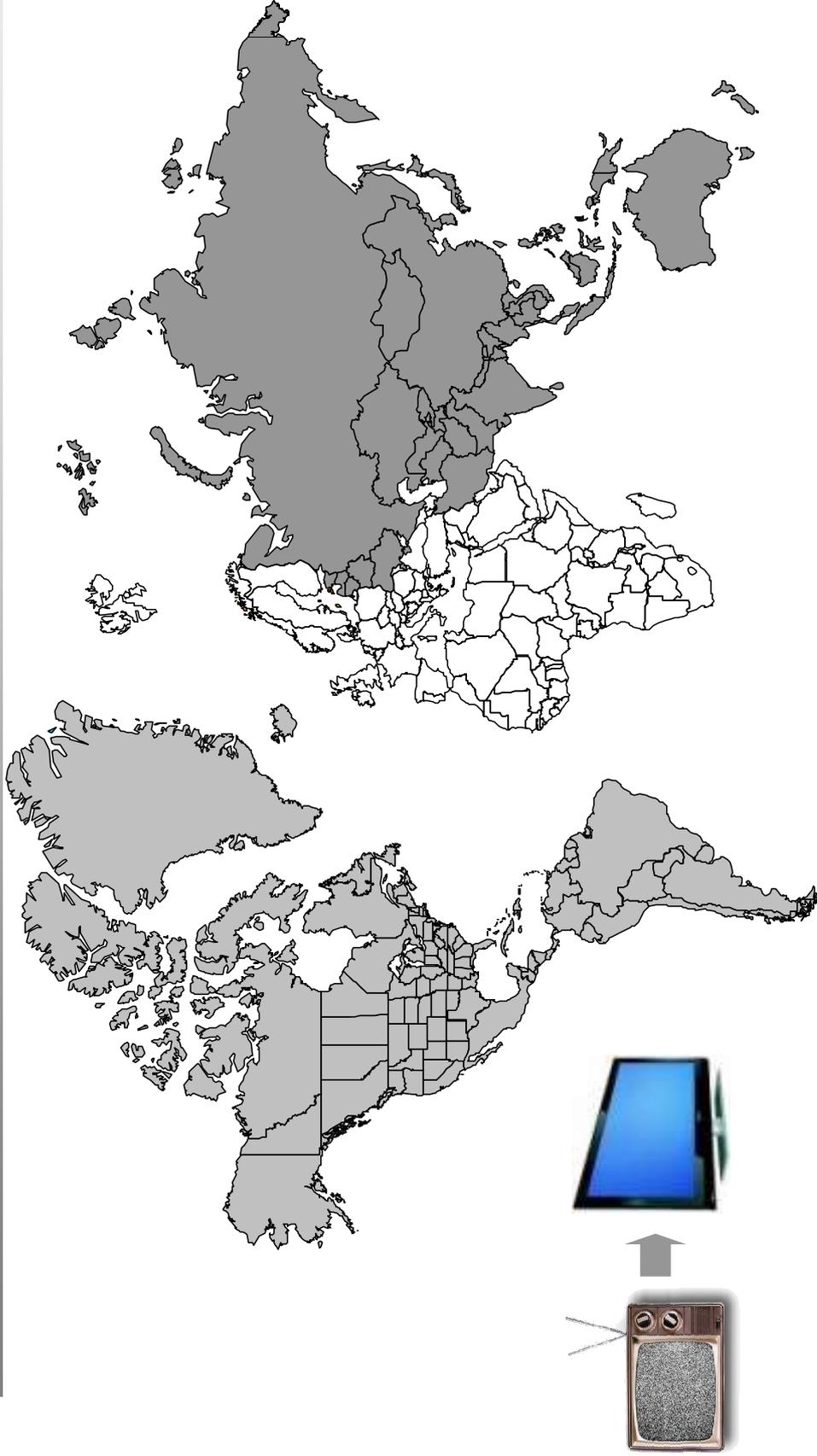
- Typical Cell Ranges for LTE show a significant advantage of using lower frequencies
- Better indoor penetration



Source: Business case summary for NGMN - Milan Salaba

*The type & amount of spectrum available to an operator determines its ability to compete in the future.*

# IMT Digital Dividend spectrum blocks according to WRC 2007



Region 2: 698-806MHz

Region 1: 790-862MHz

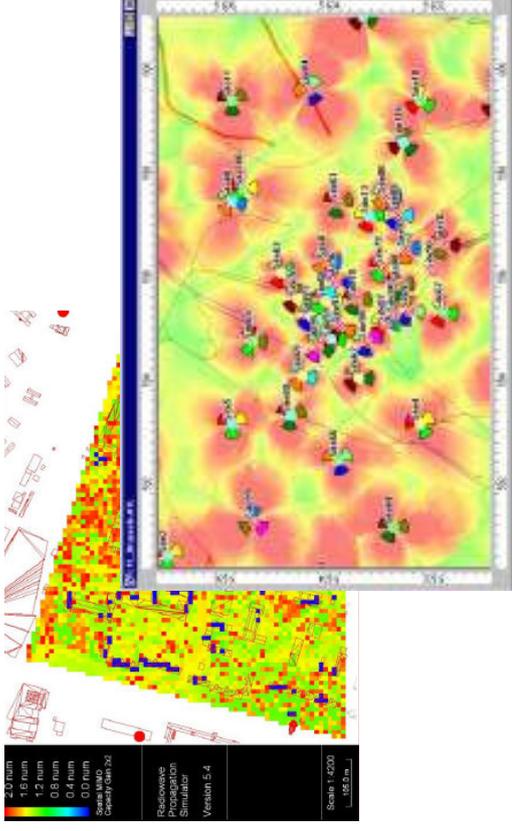
Region 3: majority follow region 1  
9 countries follow region 2

## Motivation and Benefits of network sharing

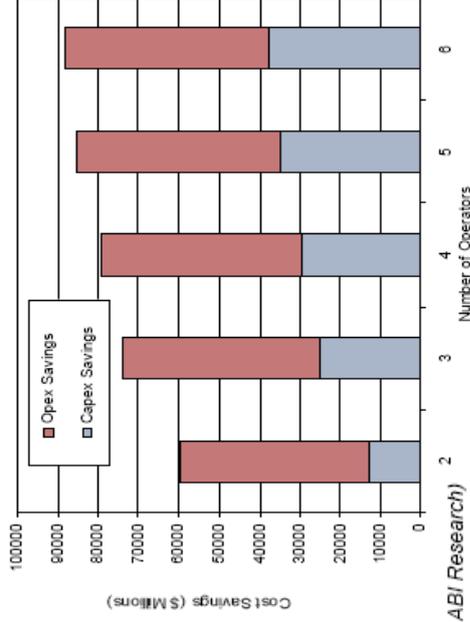
**Accelerate rollout** enabling faster service to a greater population

**Provide environmental benefits** with fewer towers and antennas

**Regulatory benefits** by faster time to universal service



Total RAN Sharing Savings Potential from 2010 to 2014



(Source: ABI Research)

**Reduce investments** for rollout, densification, or coverage extension

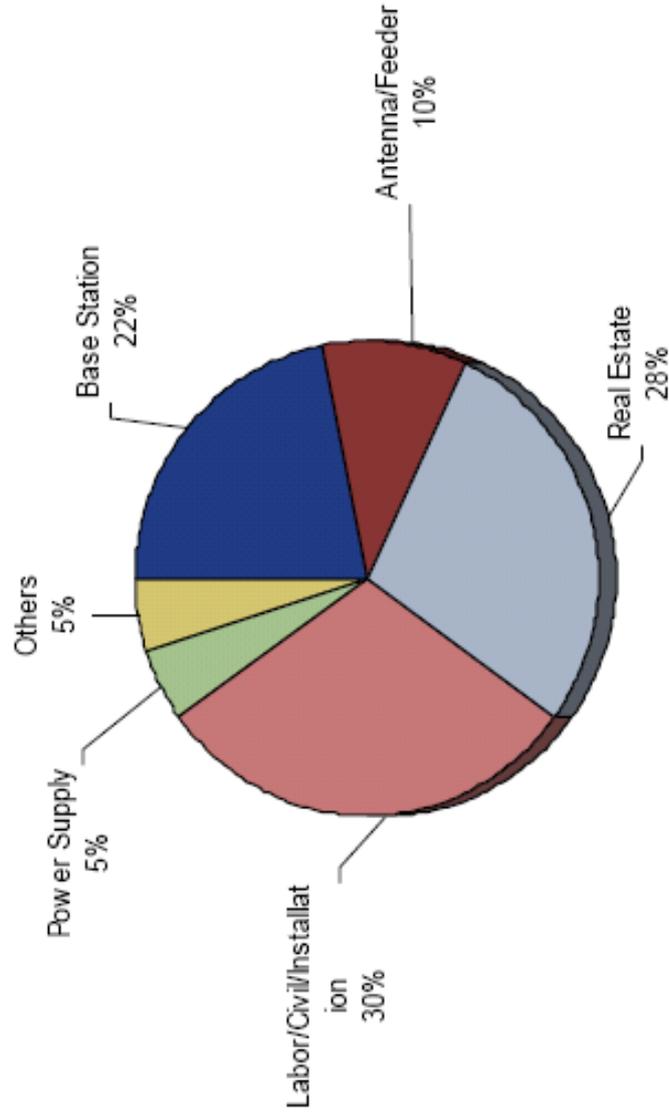
**Reduce costs** by decreasing OPEX and numbers of “low capacity” sites

**Key Challenge for Infrastructure Sharing: How to enjoy the economical benefits of network sharing while maintaining the service providers “identity”?**



## RAN Investments: CAPEX breakdown

### Breakdown of CAPEX for RAN deployment



(Source: ABI Research)

**Passive infrastructure sharing provides the most significant saving potential**

# RAN Sharing Solutions

Passive

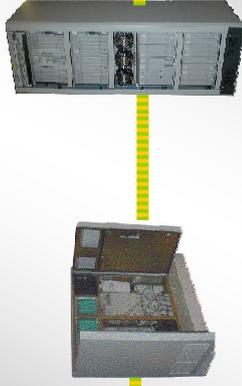
## Site Sharing



- Tower
- Site
- Antenna
- Shelter
- Transmission (option)
- Site Support

Active

## Radio Sharing



## BTS & Controller

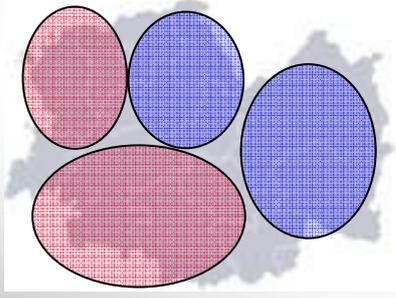
## Core Network Sharing



## Core Elements

## National Roaming

- Area covered by Operator A
- Area covered by Operator B



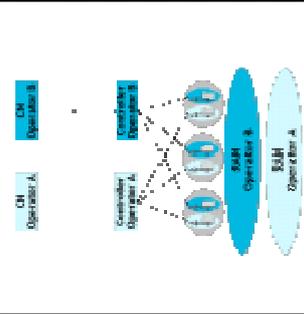
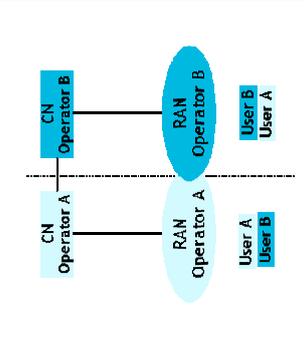
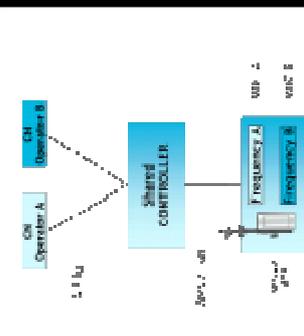
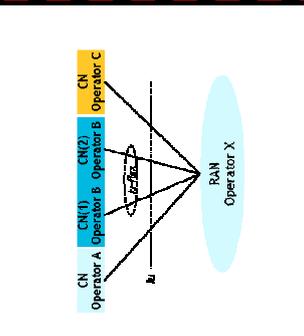
## Geographical Split

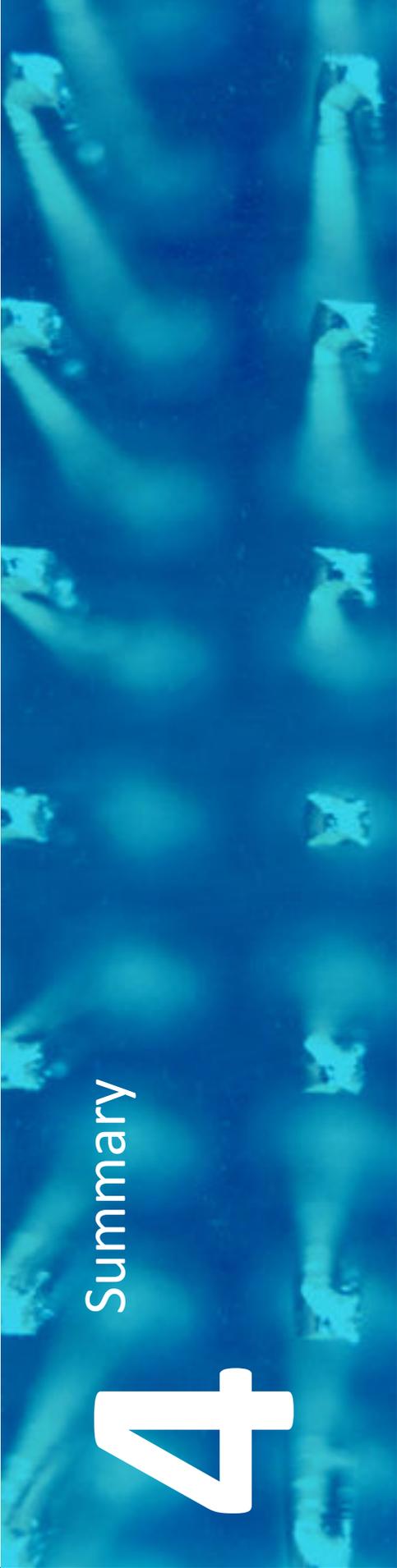
# RAN Sharing solutions

## Summary

|   |                     | Passive                | Active |
|---|---------------------|------------------------|--------|
|   | <b>Site Sharing</b> |                        |        |
| Shared Spectrum                                       |                     | No                     | No     |
| Terminal & Core Network dependency                    |                     | No                     | No     |
| Fixed allocation of radio resources between operators |                     | Yes                    | Yes    |
| Guaranteed resources and QoS per operator             |                     | Yes                    | Yes    |
| Examples  |                     | India, Bangladesh, etc |        |

# RAN Sharing solutions Summary

|   |  | Passive   |  | Active  |   |
|---|--|---|--|---|---|
|   |  | Site Sharing  | National Roaming   | RAN Sharing   | MOCN (Spectrum Sharing)   |
|   |  |  |  |  |  |
| Shared Spectrum                                       |  | No  | Yes  | No  | Yes   |
| Terminal & Core Network dependency                    |  | No  | No   | No  | Yes   |
| Fixed allocation of radio resources between operators |  | Yes   | No   | Yes   | No  |
| Guaranteed resources and QoS per operator             |  | Yes   | No   | Yes   | No  |
| Examples  |  | India, Bangladesh, etc  | TOT (Thailand), T-Mobile (USA)   | 3GIS (Sweden), Everything Everywhere (UK)   | Telus/Bell (Canada)   |



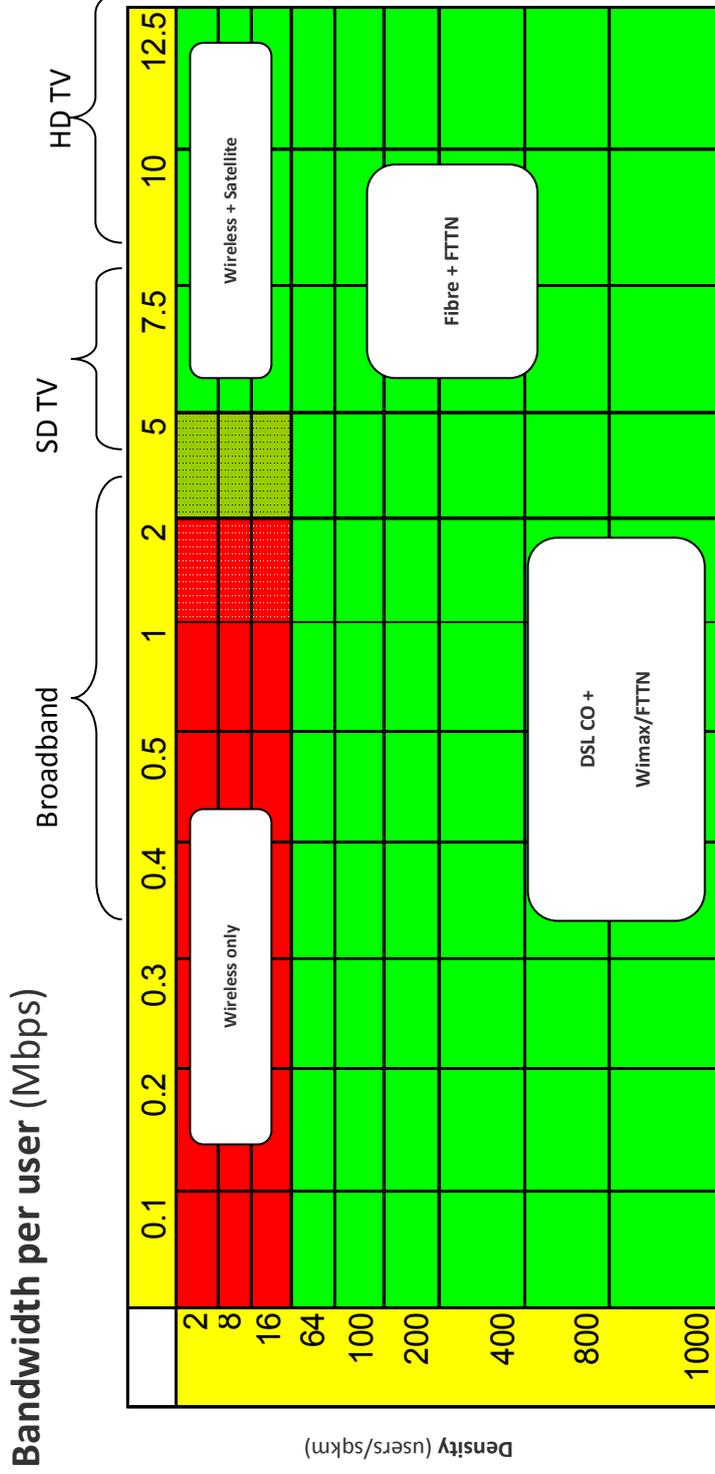
Summary

# 4

## Key technology considerations

- **No single technology is the best choice but the right technology mix**
- **Although mobile is the preferred broadband technology in emerging markets, it need to be complemented with fixed technologies in urban areas.**
  - Copper based infrastructure has reached its bandwidth and coverage limits (DSL)
  - Replacement / supplemented by fiber to the most economical point (FTTx).
  - PON technologies most economical for residential use
- **All major legacy radio technologies (GSM, CDMA, WiMax, UMTS) will evolve to LTE**
  - Rural areas need low frequency bands (for better coverage, DD Band 700 MHz)
  - urban areas need a quantity of frequency (for sufficient capacity, including Band 7 / S-Band 2,6 GHz)

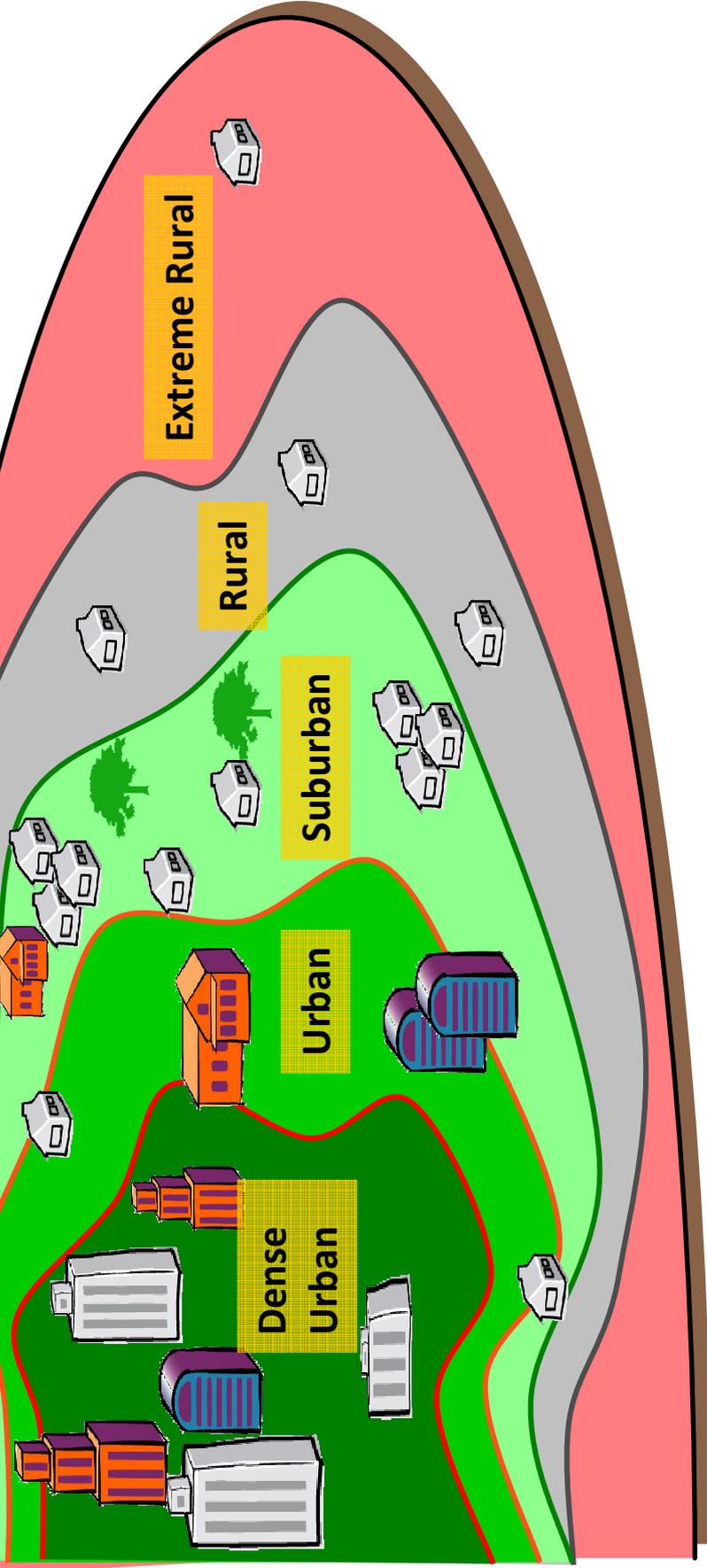
## Although mobile is the preferred broadband technology in emerging markets, it will eventually need to be completed with fixed technologies...



- Mobile Broadband is a quick and easy approach to address broadband demand – but flat rate data offers not sustainable
- Fixed technologies scale better for high density areas and greater bandwidth demand
- Optimum solution is a combination of multiple technologies

... with the right technology mix being a combination of fixed & wireless

## Wireline complements Wireless in Urban Areas



Fixed (eg FTTx, DSL, GPON) and Cellular (HSPA, LTE, EVDO, WIMAX)

Cellular technologies at low frequency bands (eg HSPA, LTE, EVDO)

Satellite? (USO funds?)

## **Regulatory initiatives to improve Telco economics:**

- **Wide availability of broadband services have a positive impact on the countries' economy.**
  - Where the business case for telecom services is challenging – stimulation through government subsidies (USO/USF funds, NBN projects) needed.
  - Infrastructure sharing provides the largest saving potential for operators

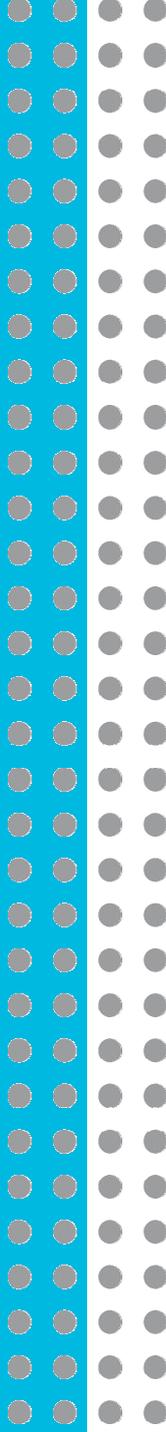
## **• Fixed Networks: Restructuring from vertically to horizontally integrated operators**

- Allowing / promoting infrastructure sharing
- Structural Separation
- Subsidized, regulated Open Access Model

## **• Mobile Networks: Overcome Market and Spectrum fragmentation**

- Infrastructure Sharing,
- early consideration for LTE (FDD and TDD), spectrum allocation in larger, contiguous blocks
- Rebalance spectrum assignments for broadcasting and telecommunication services needed
- Availability of DD Spectrum (700 MHz, LTE) for urban areas

www.alcatel-lucent.com

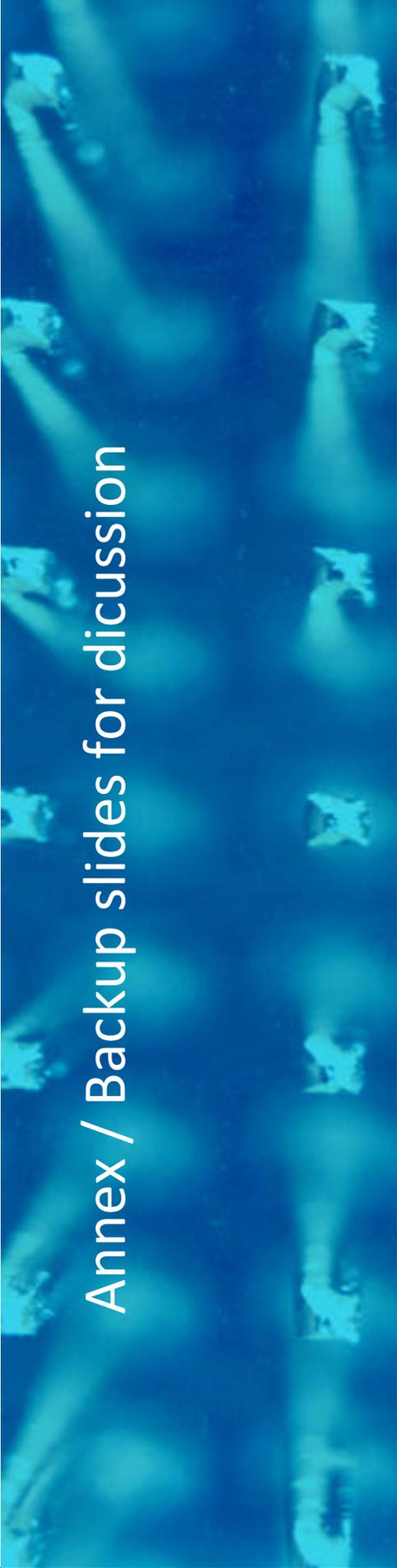


Dirk Wolter

CTO NSEA Region

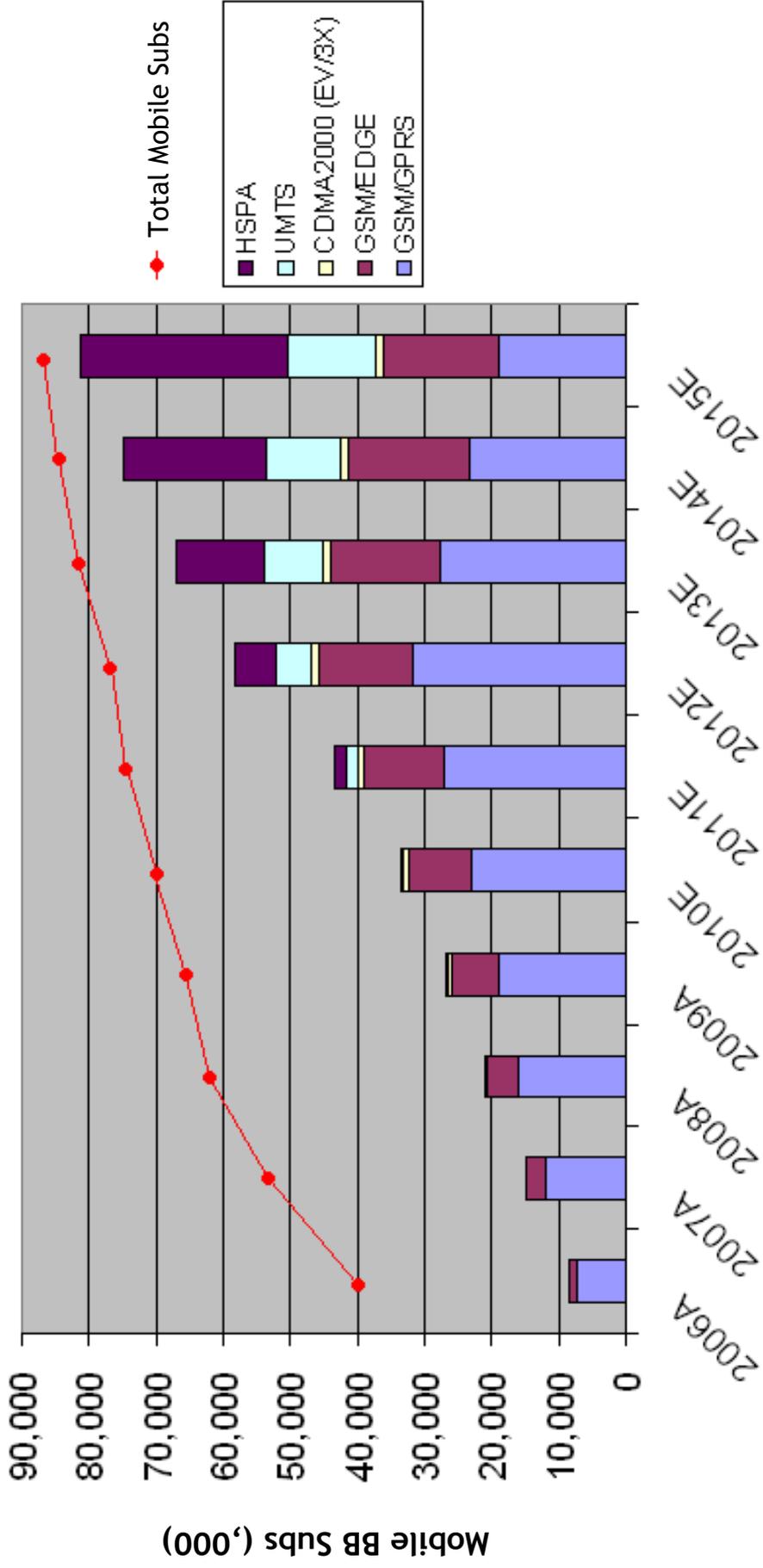
[dirk.wolter@alcatel-lucent.com](mailto:dirk.wolter@alcatel-lucent.com)

+65 9650 6928



## Annex / Backup slides for dicussion

## Thailand Broadband Market - Mobile



Source: Pyramid Research, Jun 2010

## RAN sharing Examples

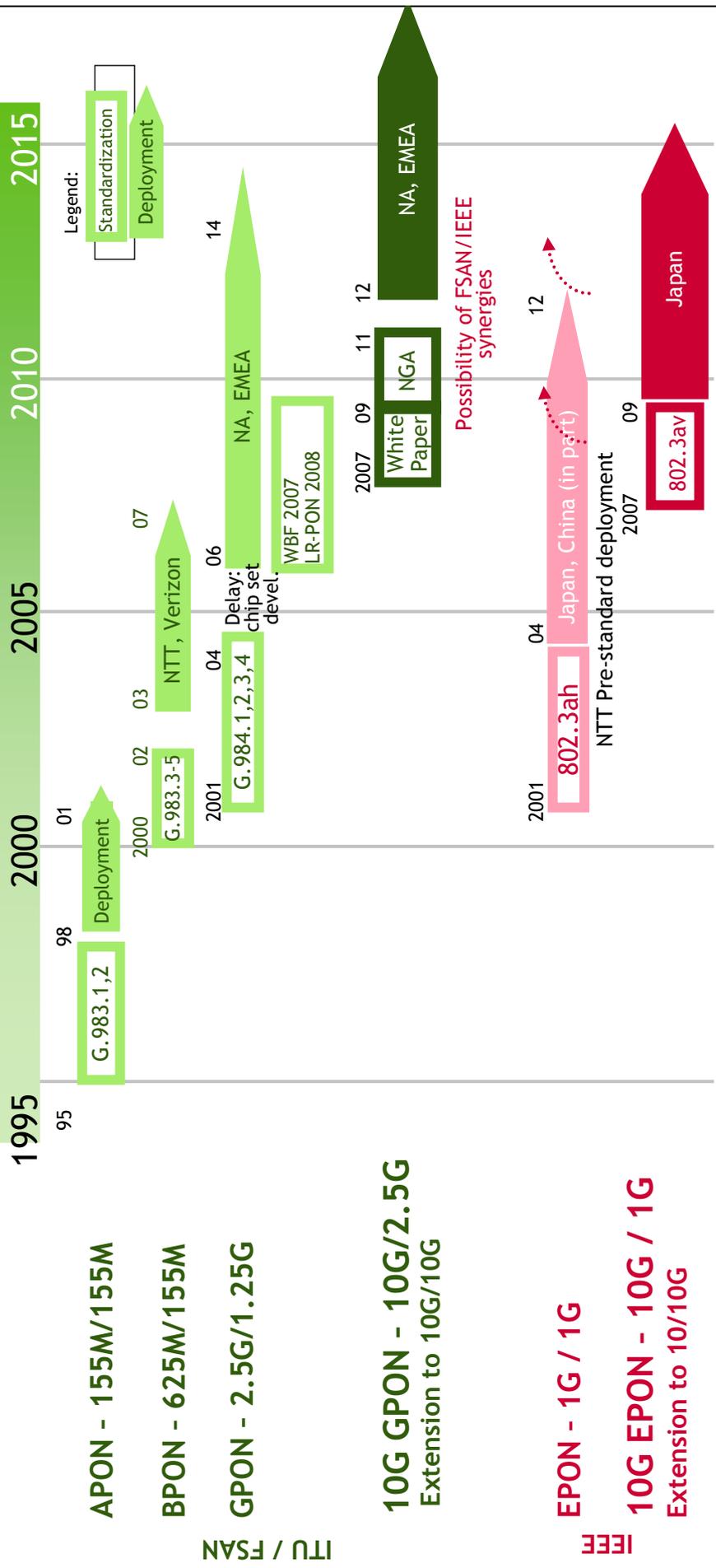
|                       |             |   |
|-----------------------|-------------|---|
| <b>Sweden</b>         | <b>2002</b> | Tele2 and Telia formed a JV company known as Swedish UMTS networks to handle complete 3G network sharing (active sharing)   |
| <b>Australia</b>      | <b>2004</b> | Telstra & 3 agreed to RAN sharing (active) for their 3G network with joint ownership of 3's 3G network  |
| <b>Australia</b>      | <b>2004</b> | Vodafone & Optus share their 3G network including a shared O&M system (active sharing)  |
| <b>Sweden</b>         | <b>2005</b> | Tre (3) & Telenor are known to share their 3G network in rural areas while maintaining separate networks in urban areas. The network is managed by a joint-venture company as 3-GIS (active sharing)  |
| <b>Spain</b>          | <b>2006</b> | Vodafone & Orange with a venture: for 3G sites and restricted to towns with fewer than 25,000 inhabitants. Combined CAPEX/OPEX savings anticipated at around 200 million  |
| <b>Iran</b>           | <b>2007</b> | MCCI, Irancell and Taliya are sharing their 3G BTS  |
| <b>UK</b>             | <b>2007</b> | T-Mobile & 3 are sharing their 3G network equipment across the UK via a MVNO (active sharing). This includes masts and equipment, but connects to separate Core Network. Over 5000 sites were decommissioned and £2 billion is the estimated savings over 10 years. |
| <b>Czech Republic</b> | <b>2008</b> | Vodafone, 3, and T-Mobile are known to be in advanced discussions about sharing their 3G network infra including BTS and other infra  |
| <b>India</b>          | <b>2008</b> | TRAI has given the nod for active infra sharing. Currently operators are known to be trialing RAN Sharing solutions. RAN sharing is also expected to play a major role in the 3G auctions with subsequent build-outs  |
| <b>UK</b>             | <b>2009</b> | Vodafone & O2 network sharing agreement for UK, Ireland, Spain and Germany. T-Mobile and Orange UK form JV to merge networks.   |

## Comparing GPON and EPON - Service Support view

| Objective   | Supporting Functionality       | GPON              | EPON                                     |
|---|--------------------------------|-------------------|--|
| High Speed Internet & TV   | Capacity                       | >70 Mbps/user     | <30 Mbps/user                            |
|   | Bandwidth                      | Downlink:94%      | Downlink:73%                             |
|   | Efficiency                     | Uplink:92%-93%    | Uplink:61%-69%                           |
|   | RF overlay                     | Standardized      | No or Proprietary                        |
|   | Fragmentation                  | Standardized      | No                                       |
| Telephony, TDM, real-time  | Dynamic Bandwidth Allocation   | Standardized      | Proprietary                              |
|   | Fixed framing                  | Yes, 125µs        | No                                       |
| Secure Services          | Encryption                     | Standardized AES  | No or Proprietary                        |
| ONT management  | Management & Control Interface | Standardized OMCI | Partly standardized. Proprietary needed. |
| Multi vendor  | Interoperability testing       | Yes               | No or Proprietary                        |



# NG PON is a Natural Continuation in the Evolution of PON Technologies



**APON - 155M/155M**

**BPON - 625M/155M**

**GPON - 2.5G/1.25G**

ITU / FSAN

**10G GPON - 10G/2.5G**  
 Extension to 10G/10G

**EPON - 1G / 1G**

**10G EPON - 10G / 1G**  
 Extension to 10/10G

IEEE

GPON widely perceived to possess sufficient BW (80 Mbps CIR, 2.5 Gbps PIR for next 5+ years)  
 ⇒ FSAN beginning 10G GPON specification  
 EPON perceived to be running out of BW (30 Mbps CIR, 1 Gbps PIR)  
 ⇒ IEEE actively standardizing NG EPON

## National Roaming (Geo Split) overview

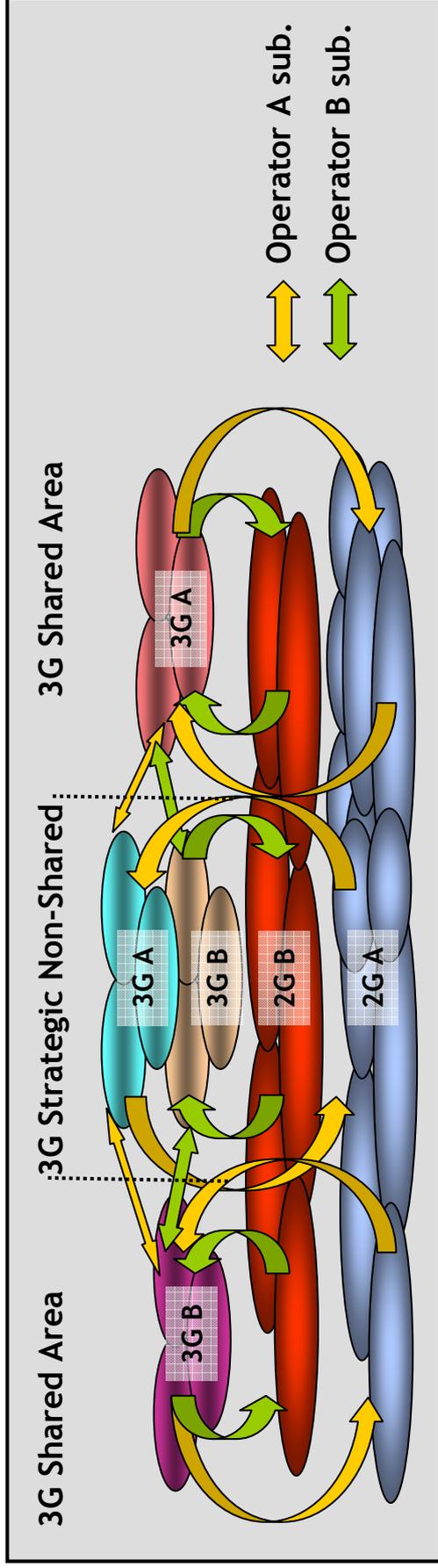
Each operator builds its **own RAN and CN** in its home geographical area, and allows subscribers from the other operator to roam in the visited network

Traffic from roamers is **rerouted** in the core network

Operators may also deploy non-shared, overlapping coverage in strategic areas

In order to provide Seamless roaming across the network, ALU provides in particular following mobility features :

- Inter-RNC Inter-frequency Inter-PLMN Handover without lur
- **IMSI Based Handover**, to direct subscribers to the correct non-shared 3G or 2G areas





## MOCN (Multiple Operator Core Network) overview

Operators share physically the Radio Access Network (NodeB and RNC) from a common supplier, but do not share any Core Network node

On a **shared cell**, a common PLMNid is broadcast for non-MOCN capable UEs, plus additional PLMNids for MOCN-capable UEs

RNC supports **multiple IUs** to independent Core Networks

Supporting UEs indicate the selected PLMN to the RNC, which routes accordingly

Non-supporting UEs only see the common PLMN, hence are unable to select one; the RNC selects one CN and reroutes to another CN if rejected

**No differentiation** at RAN level, but possible on network services

**Support from CN (CS/PS)** is required. Terminal support is recommended.

Limited commercial deployments.

