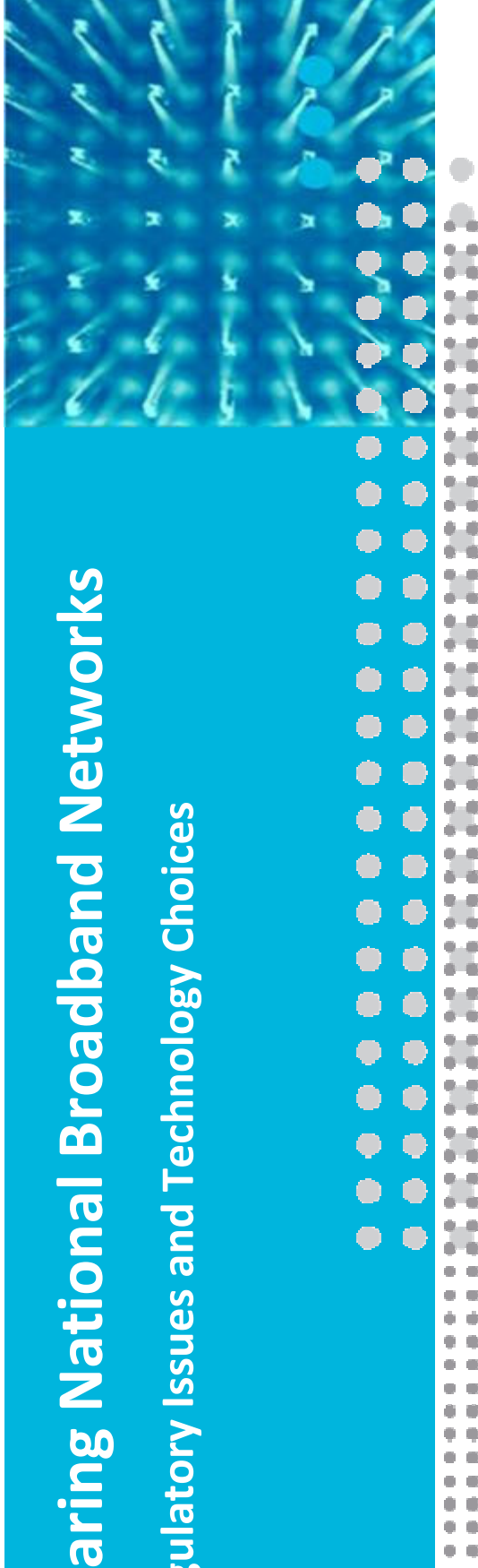


Sharing National Broadband Networks

Regulatory Issues and Technology Choices



Dirk Wolter

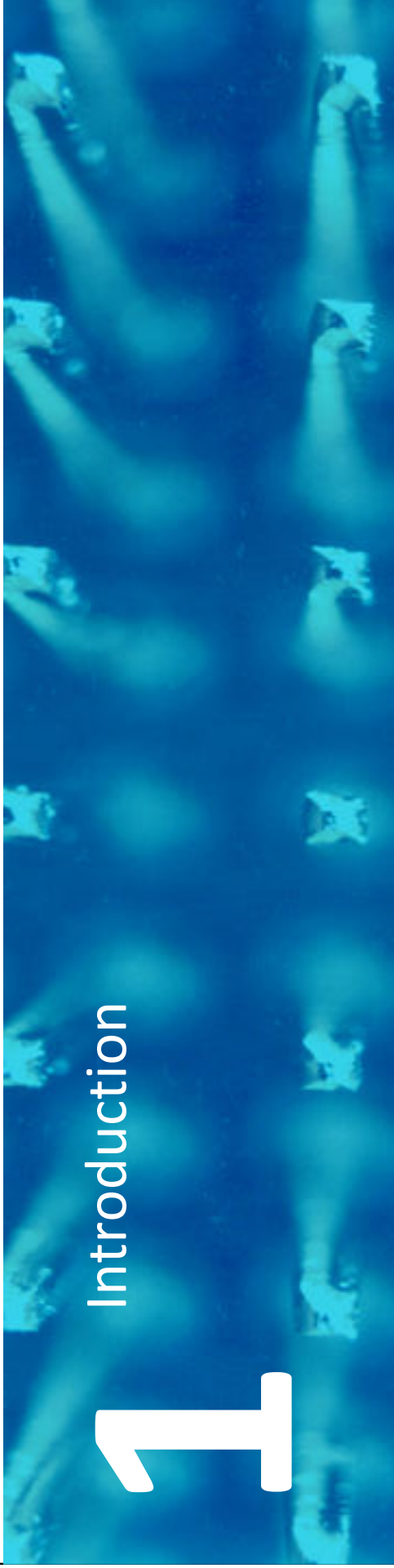
CTO NSEA Region

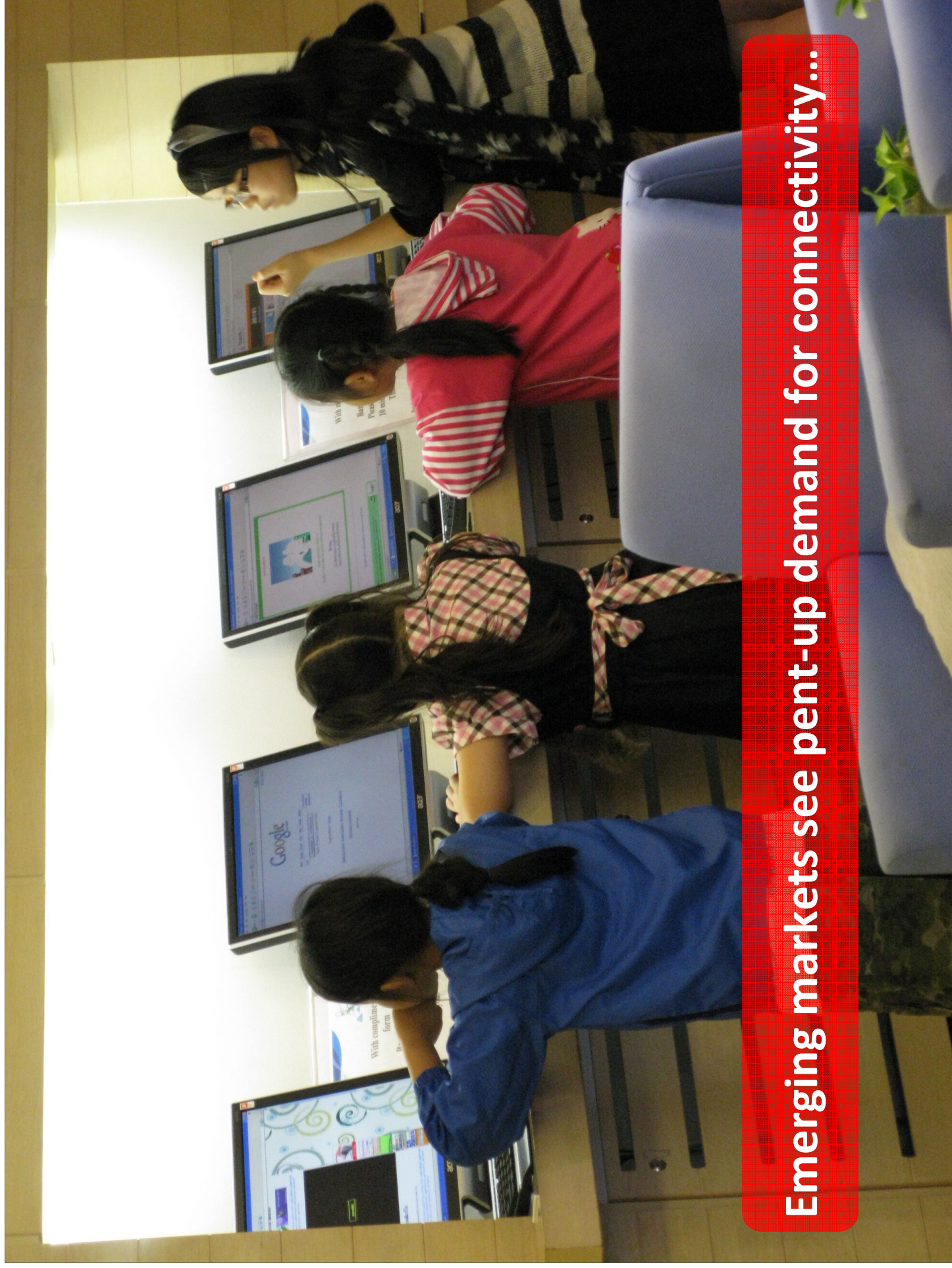
September 2010

Agenda

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

1 Introduction





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

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





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



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

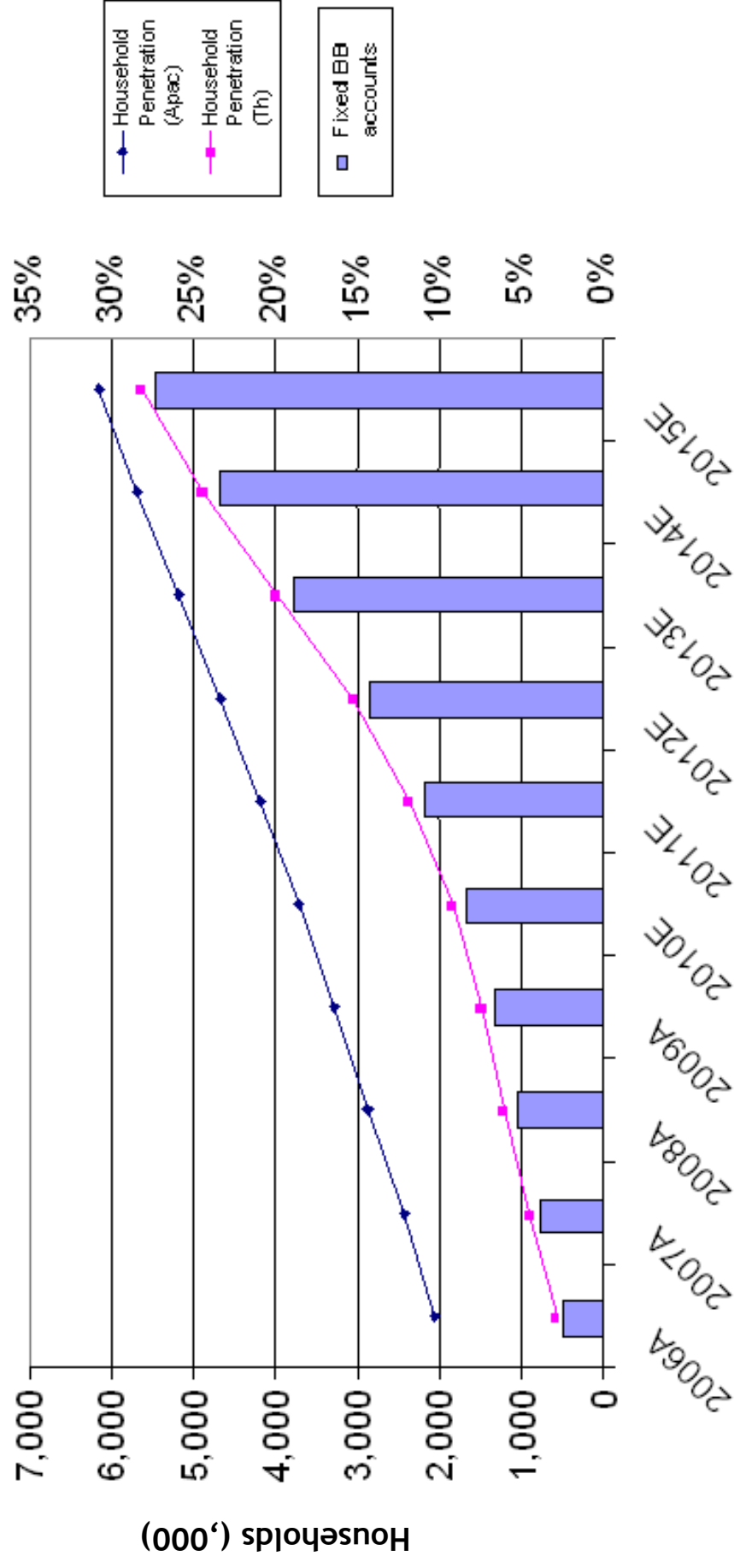
- Convenience
- Availability
- Affordable



...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?

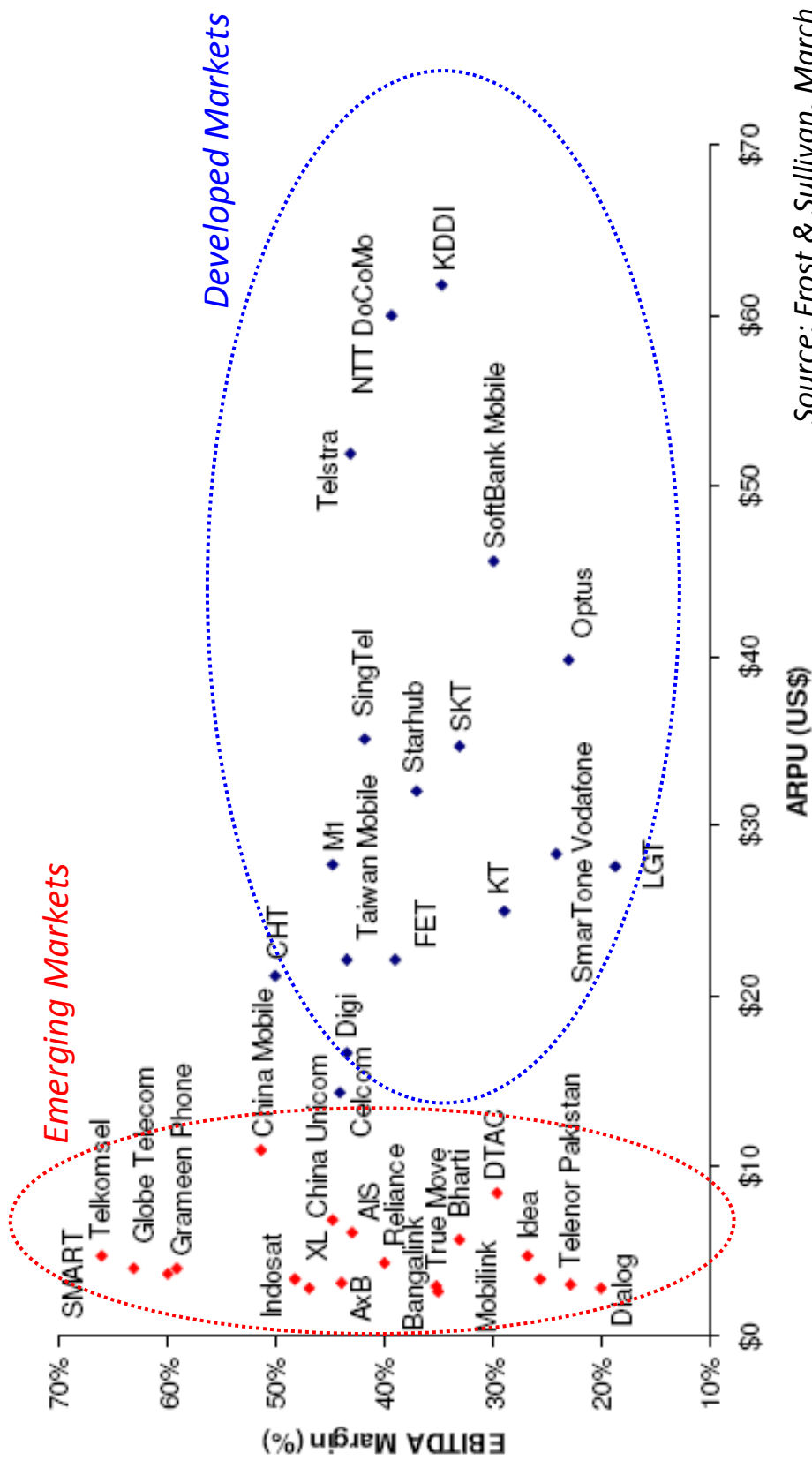
- Fixed broadband infrastructure for residential user to offload mobile networks –Mobile networks alone are not sufficient
- New deployments: Fttx technologies (GPON)
- QoS mechanisms for differentiated service offering
- Broadband optimized RAN based on HOM (16QAM, 64QAM), MIMO, IP (eg. HSPA+, LTE,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

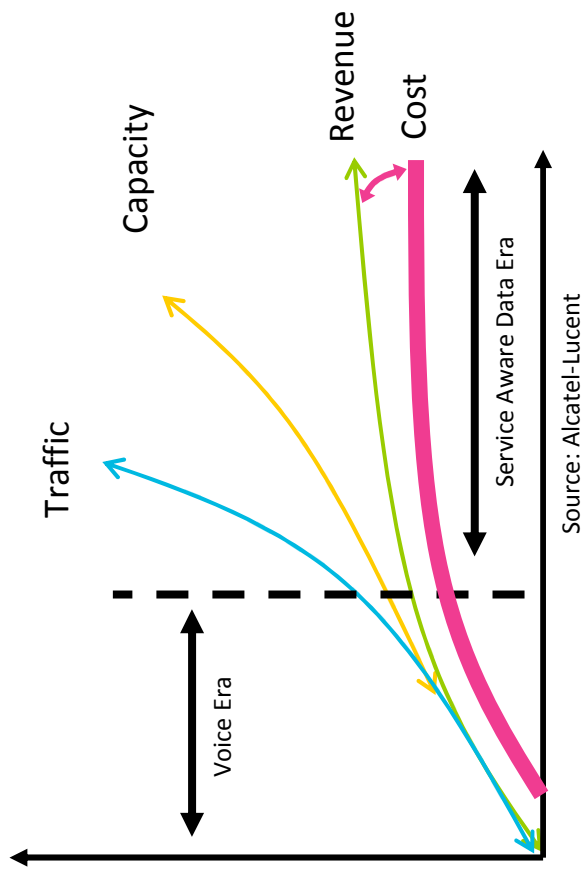
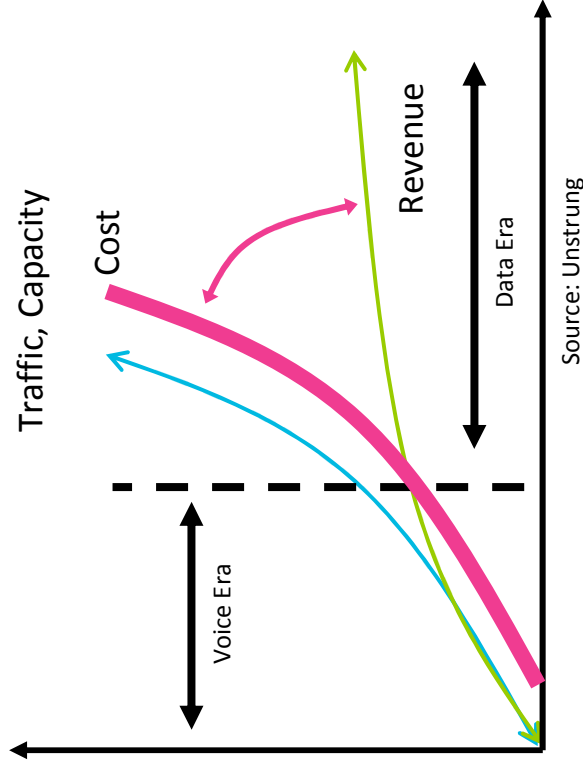


Economics of broadband works against operators

- 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:

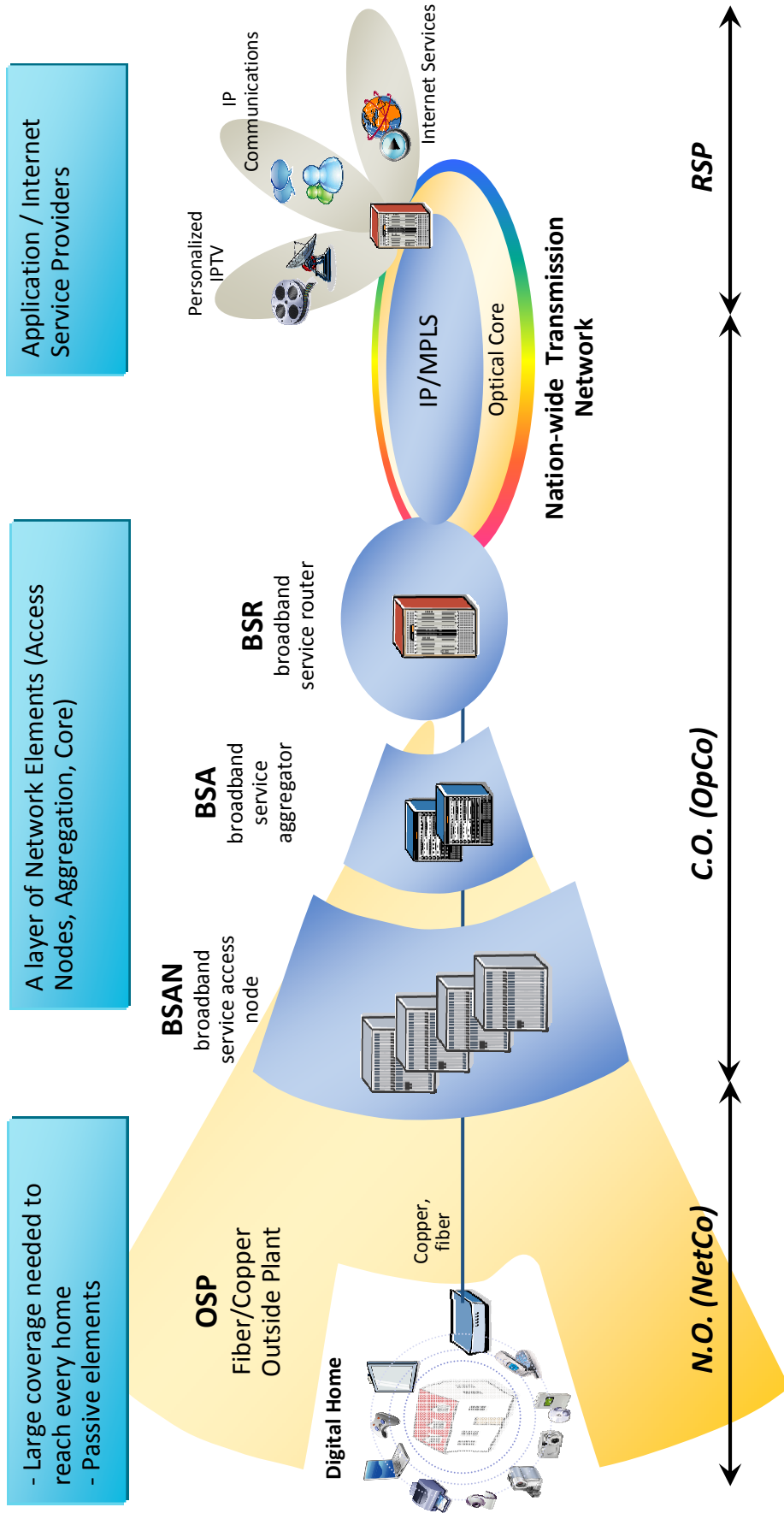
How to enjoy the economical benefits of network sharing while maintaining the service providers “identity” and differentiation?

2

Fixed Networks:

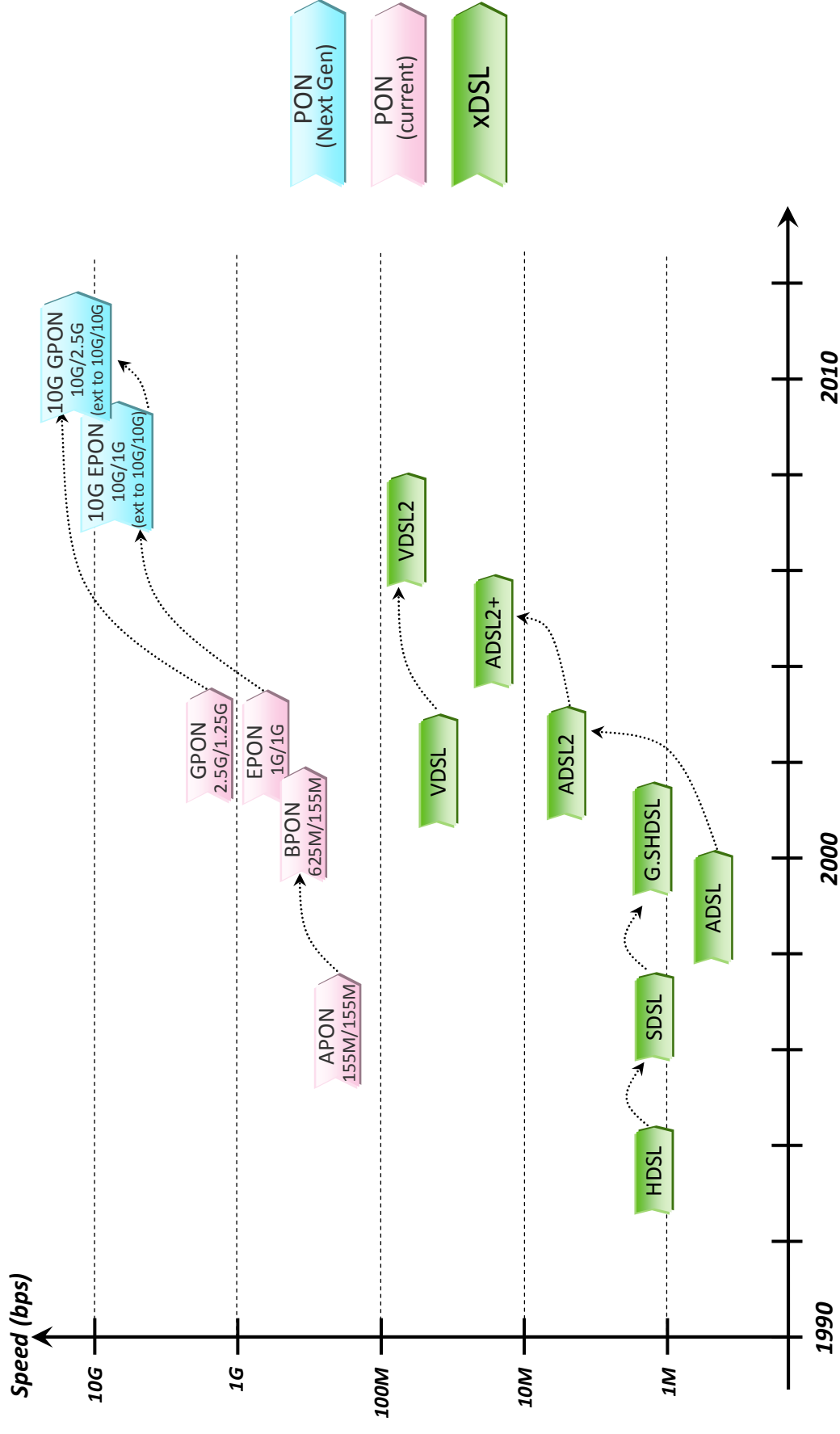
Technology Choices and Infrastructure Sharing Concepts

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

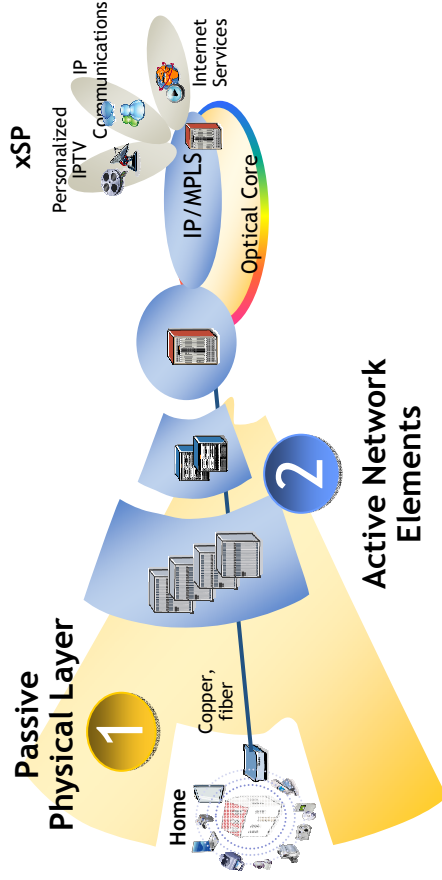


Unbundling Options – Copper based infrastructure

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

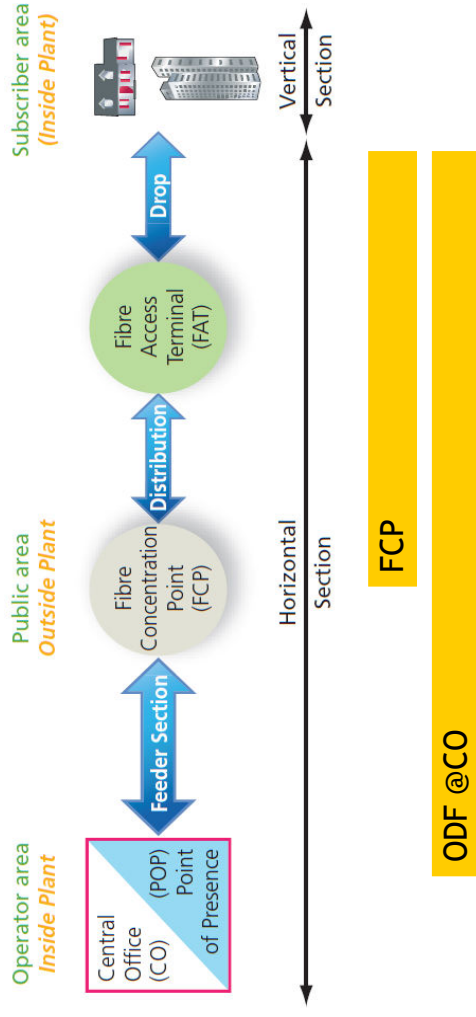
Active Network Elements layer

- 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)

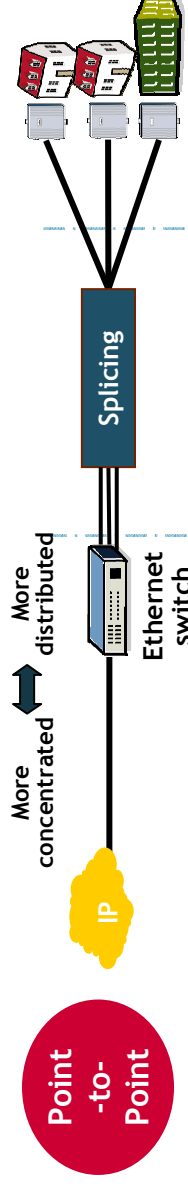
2

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



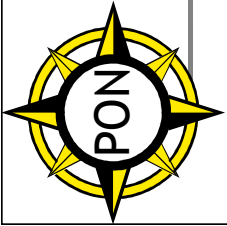
Wavelength per user

Few fibers in feeder section
CO consolidation



Best Scalability

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



Pushing the envelope of PON now

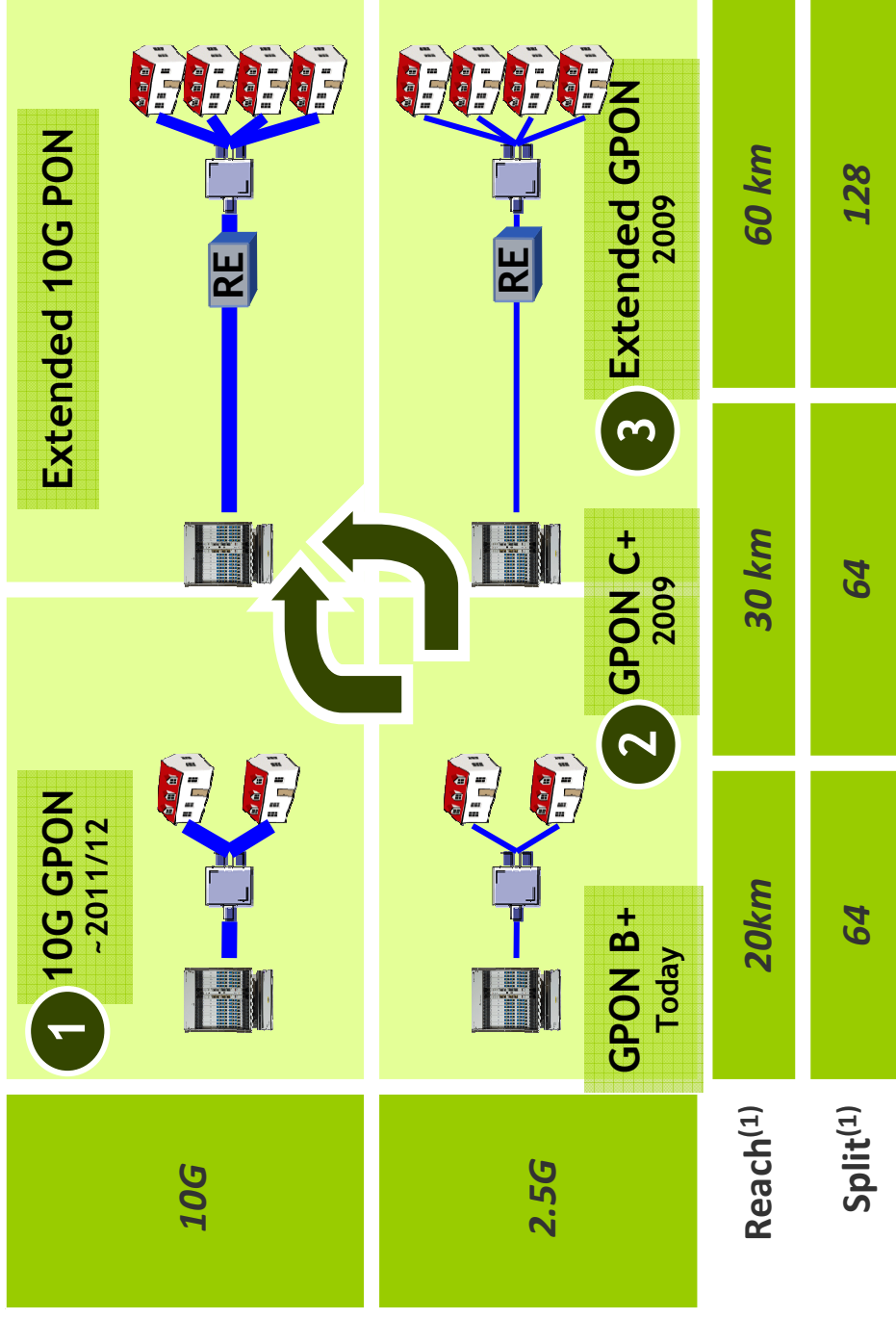
Moving up Capacity, Reach & Split



More BW
for FTTB &
backhaul

Increased
split ratio

More BW &
symmetry
per subs.



Less dense areas addressed & CO consolidation

(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)

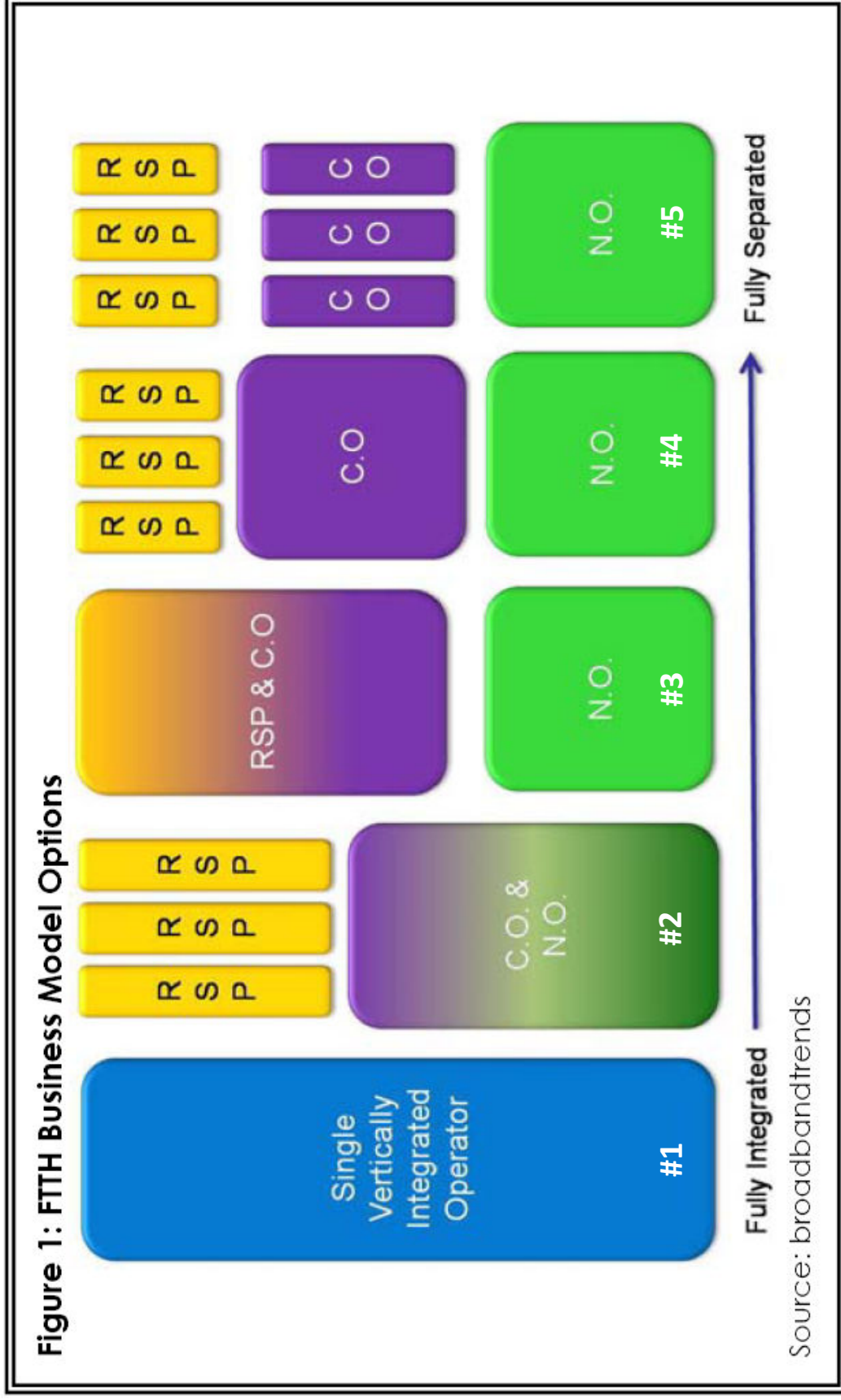
Open Access Model

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

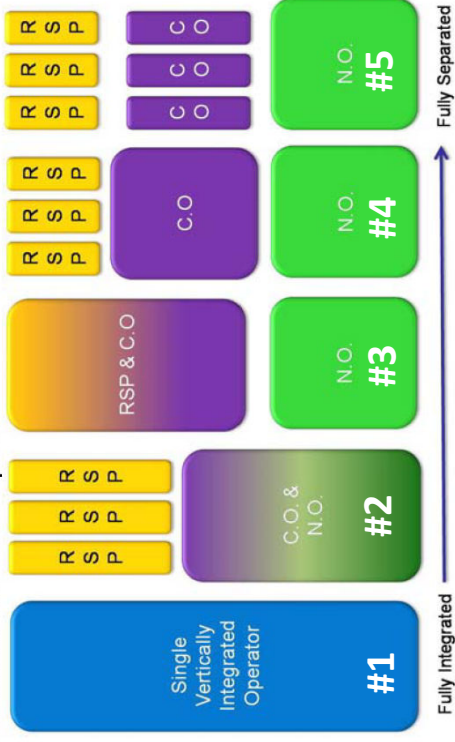
Open Access Business Model Options for implementation



Open Access Business Model

Options for implementation

Figure 1: FTTH Business Model Options



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

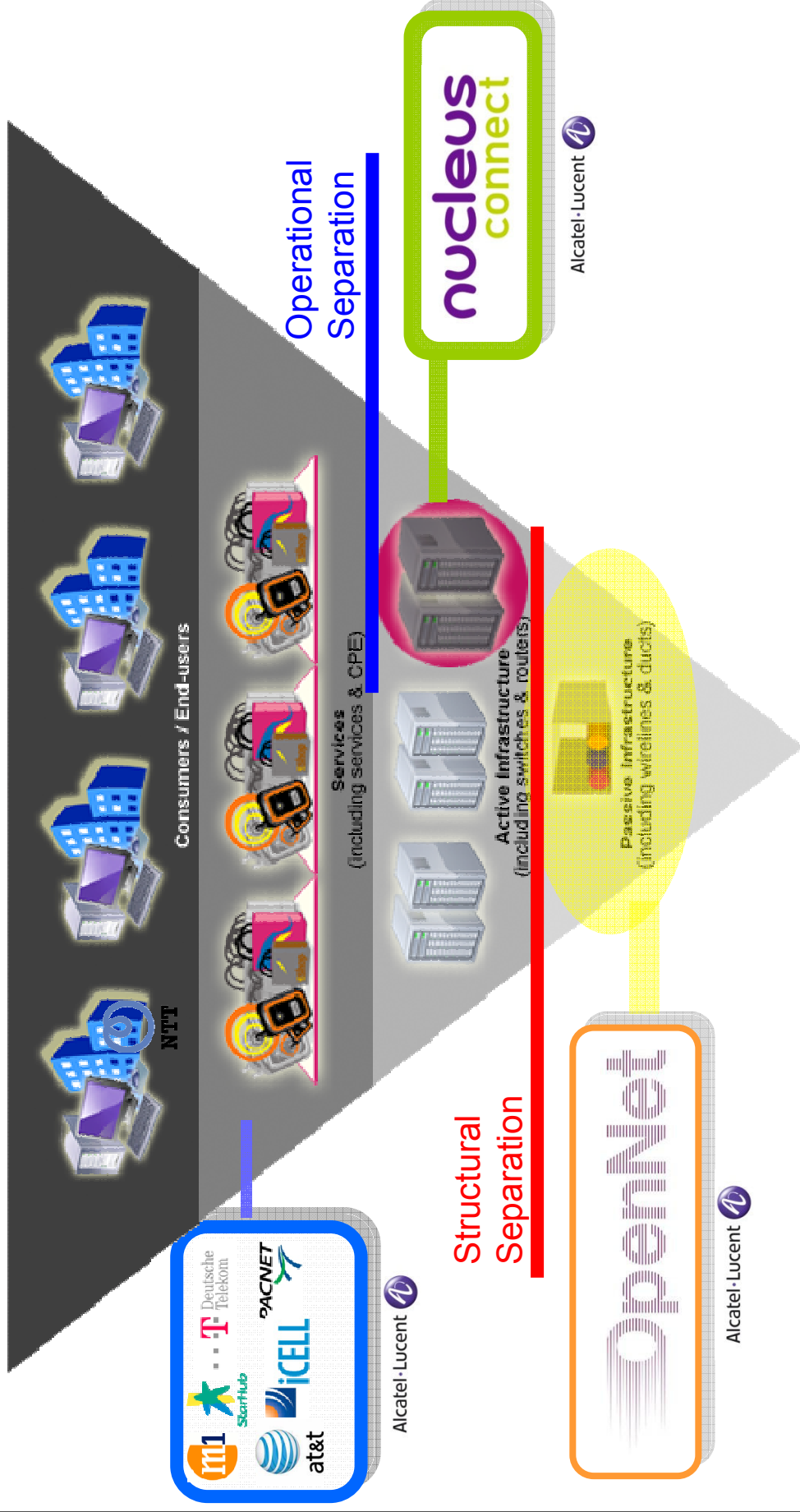
Model #2

- 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)

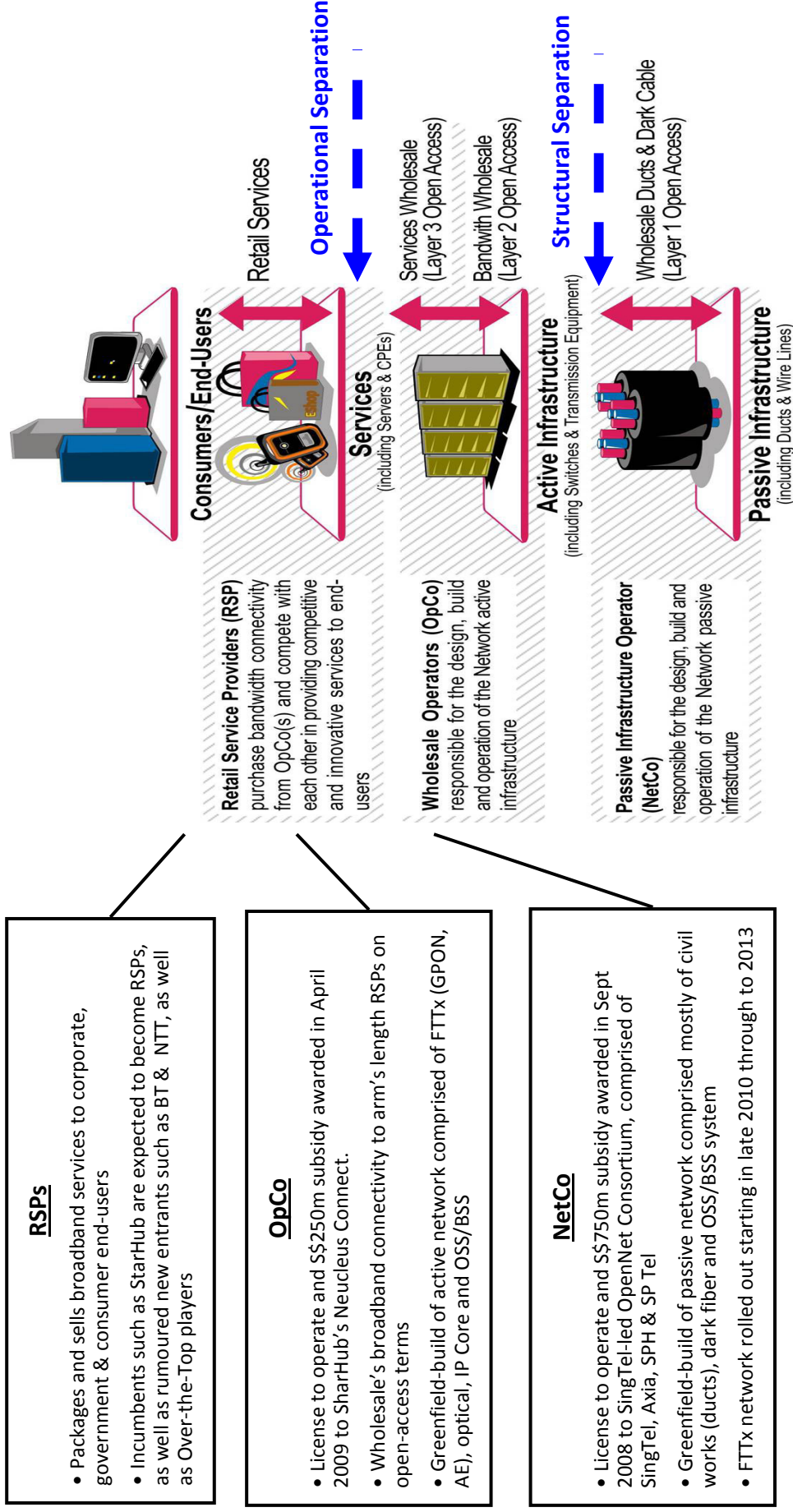
Singapore Next Gen NBN Industry Structure



Singapore's National Broadband Network ("NBN")

The Transformation of the Telecom Landscape in Singapore

Singapore's New Industry Structure



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, Axiata, 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 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 1.0/0.5 Gb/s for SG\$ 121/month <i>(include NetCo Wholesale price)</i>	100/100 Mb/s for SG\$ 75/month 1.0/1.0 Gb/s for SG\$ 860/month <i>(include NetCo Wholesale price)</i>
NetCo	SG\$ 15 / month	SG\$ 50 / month

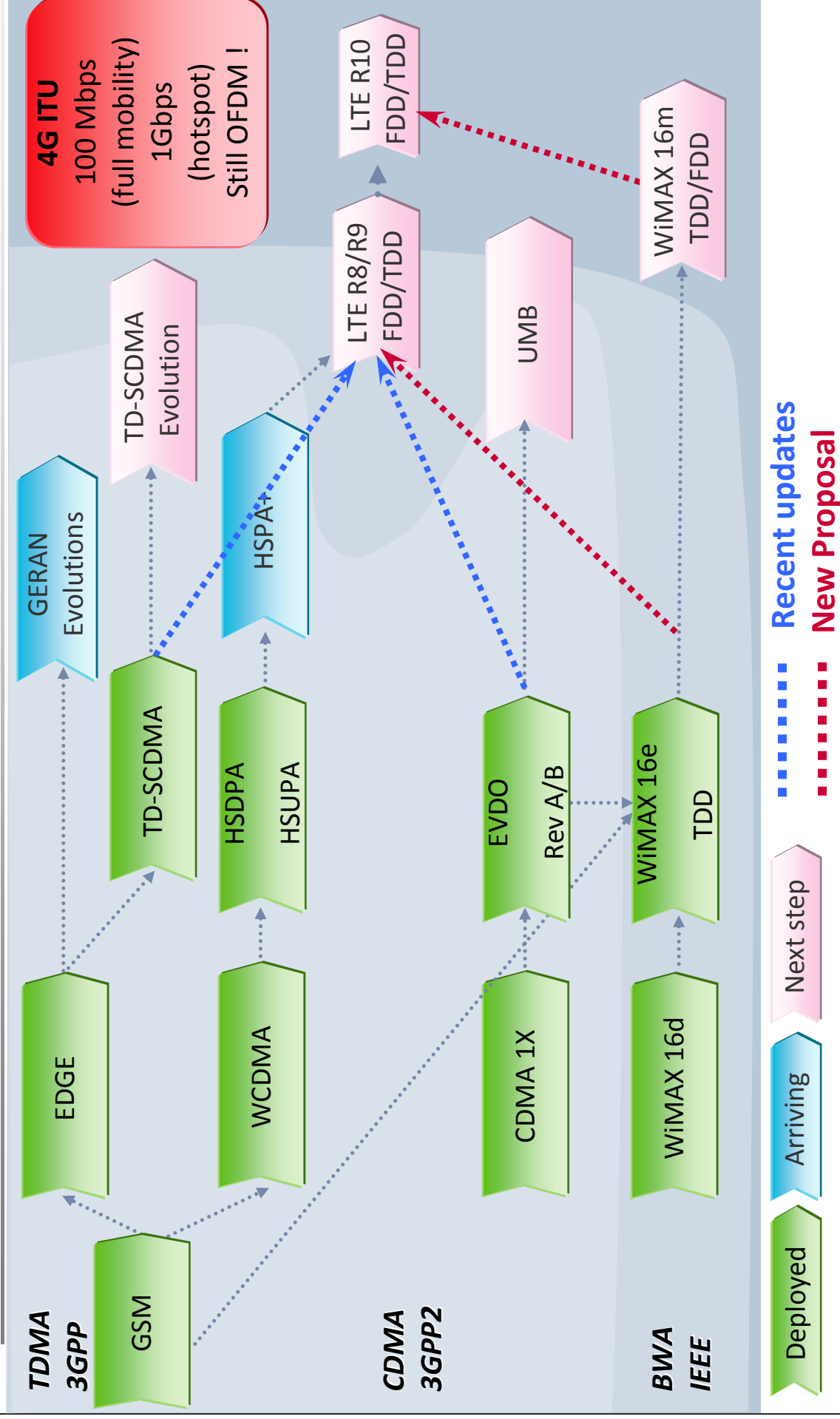
- Asymmetrical offers for residential or business users with GPON
- Symmetrical offers for business users with GPON and P2P/Active Ethernet, up to 1/1 Gb/s
- Wholesale Service Offerings from OpCo to RSPs
 - Class A: real-time (video conferencing, premium VoIP, gaming...)
 - Class B: near real-time (IPTV, 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

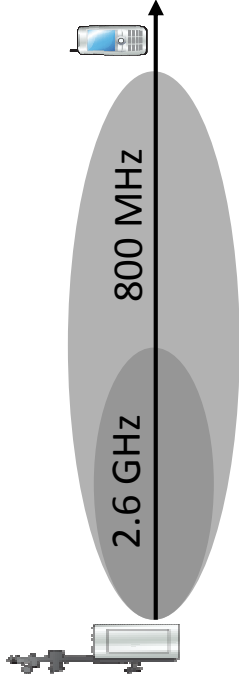
Air Interface / Standards evolutions

All technologies have NOW an upgrade path to LTE

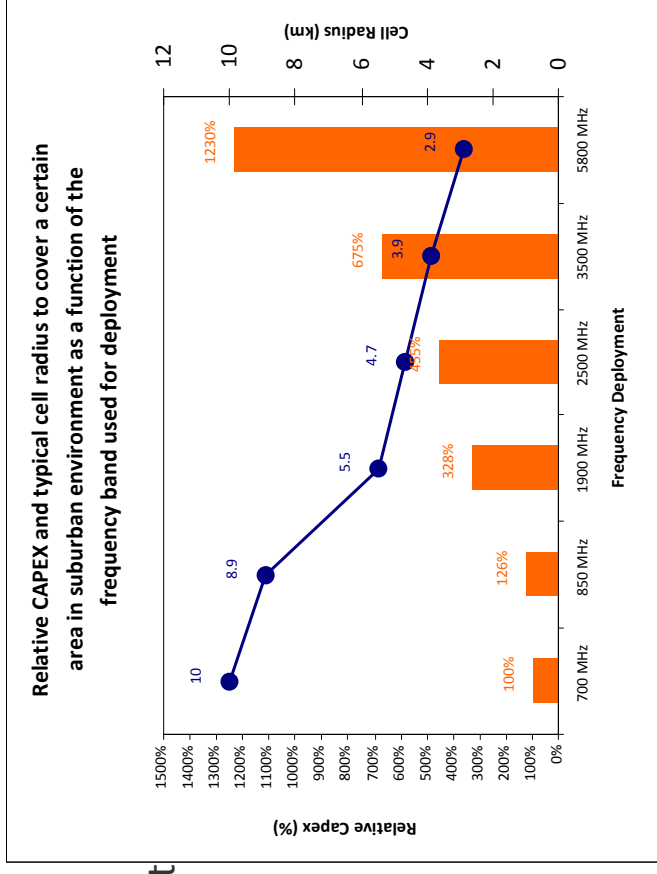


Impact of standards & frequency on network economy

An illustration: 800MHz vs 2.6Ghz in Rural Environment



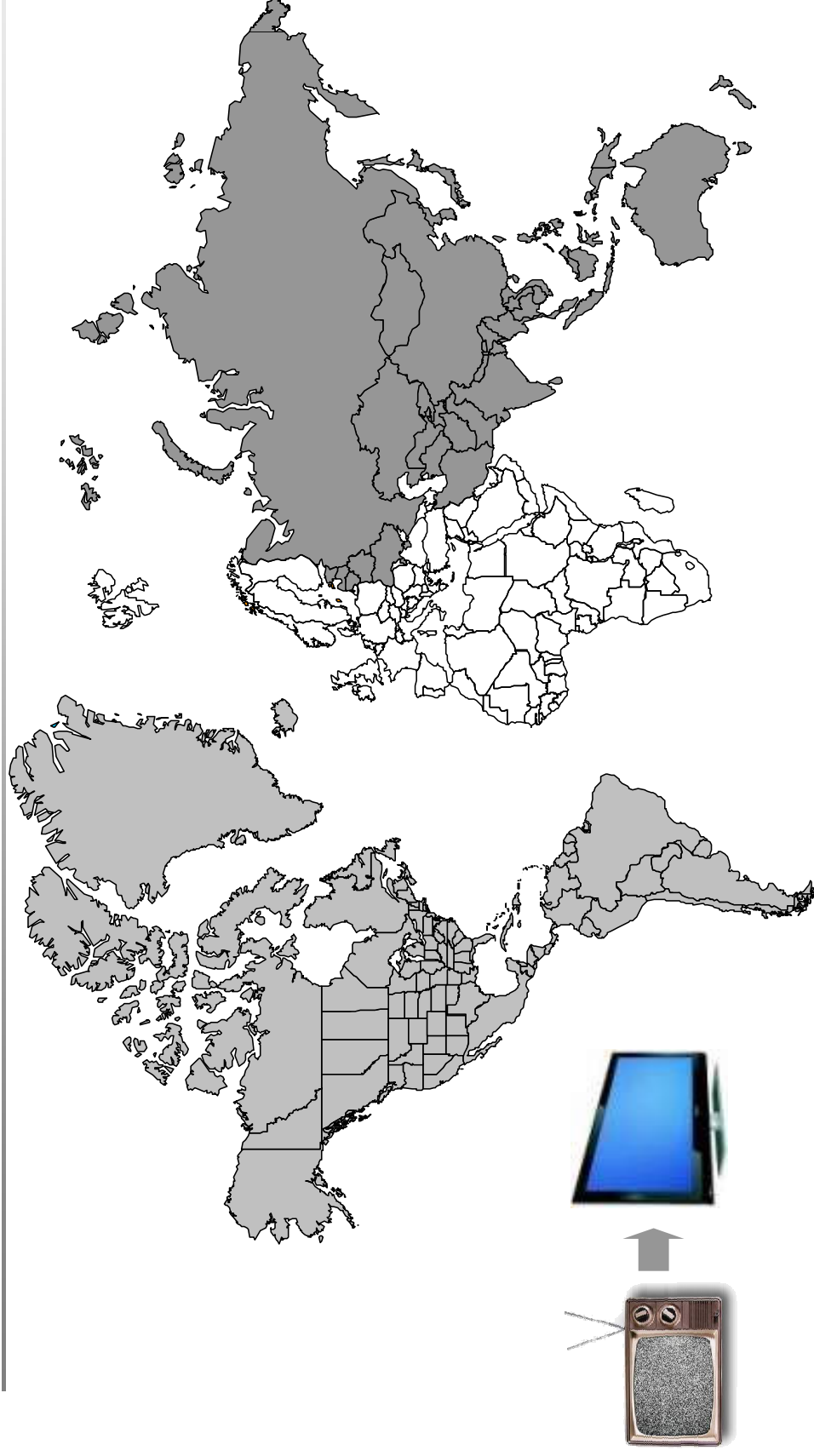
- Typical Cell Ranges for LTE show a significant advantage of using lower frequencies
- Better indoor penetration



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 3: majority follow region 1
9 countries follow region 2

Region 1: 790-862MHz

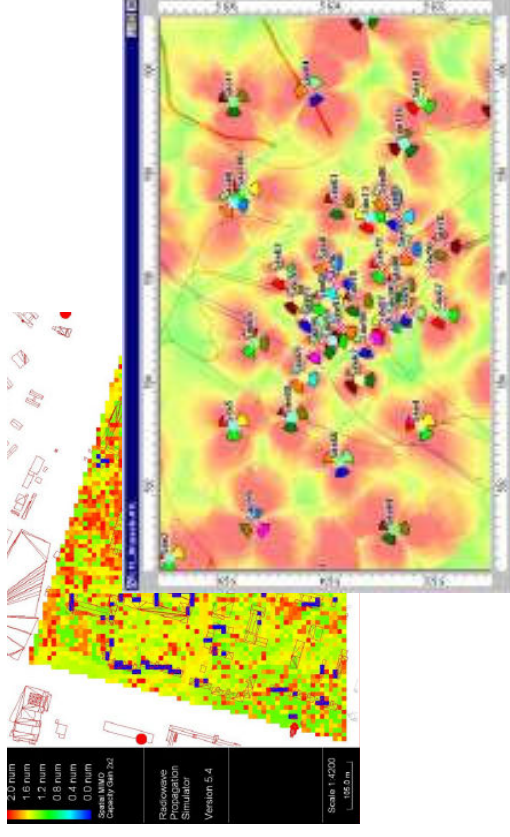
Region 2: 698-806MHz

Motivation and Benefits of network sharing

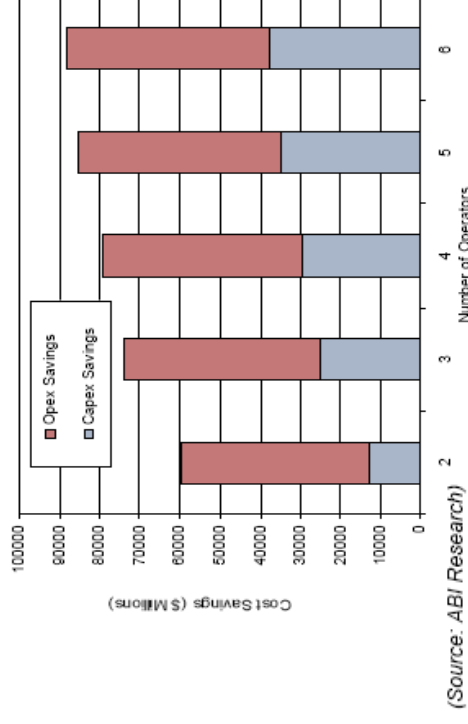
Accelerate rollout enabling faster service to a greater population

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



Reduce investments for rollout, densification, or coverage extension

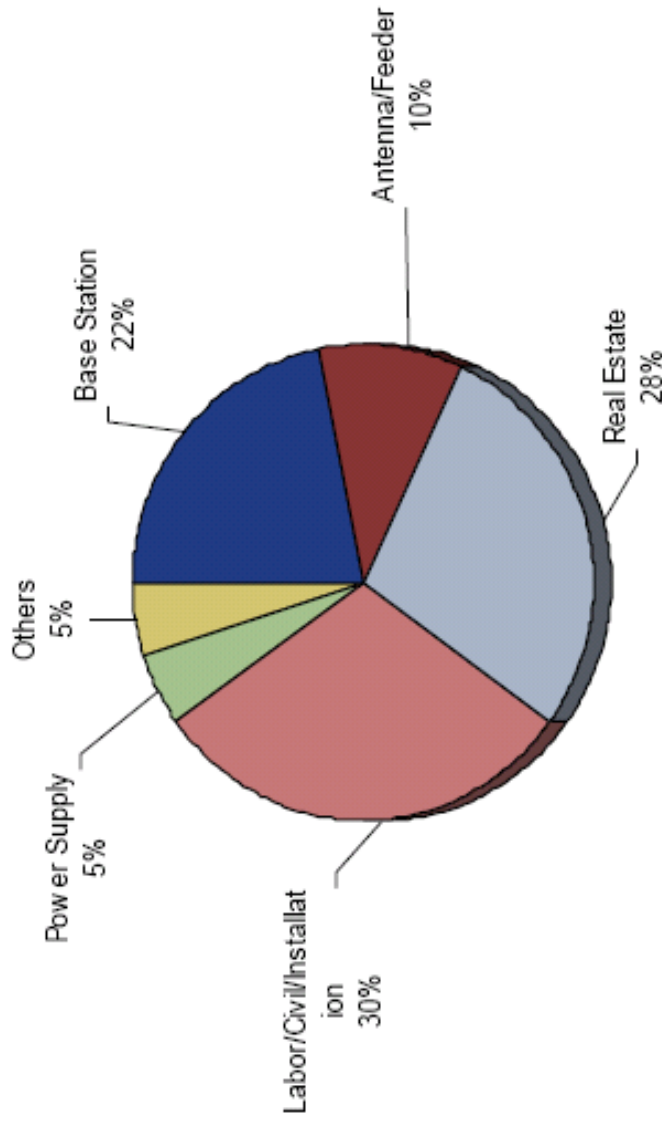
Reduce costs by decreasing OPEX and numbers of “low capacity” sites

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

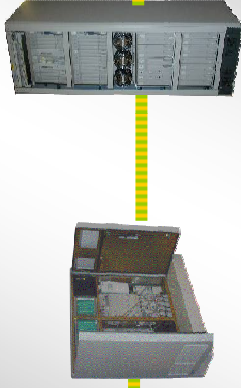
Site Sharing



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

Site

Radio Sharing



BTS & Controller

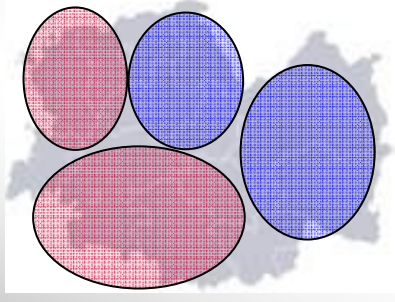
Core Network Sharing



Core Elements

National Roaming

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



Geographical Split

RAN Sharing solutions

Summary

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

RAN Sharing solutions

Summary

	Active			
	Passive	Site Sharing	National Roaming	RAN Sharing
	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	No	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)



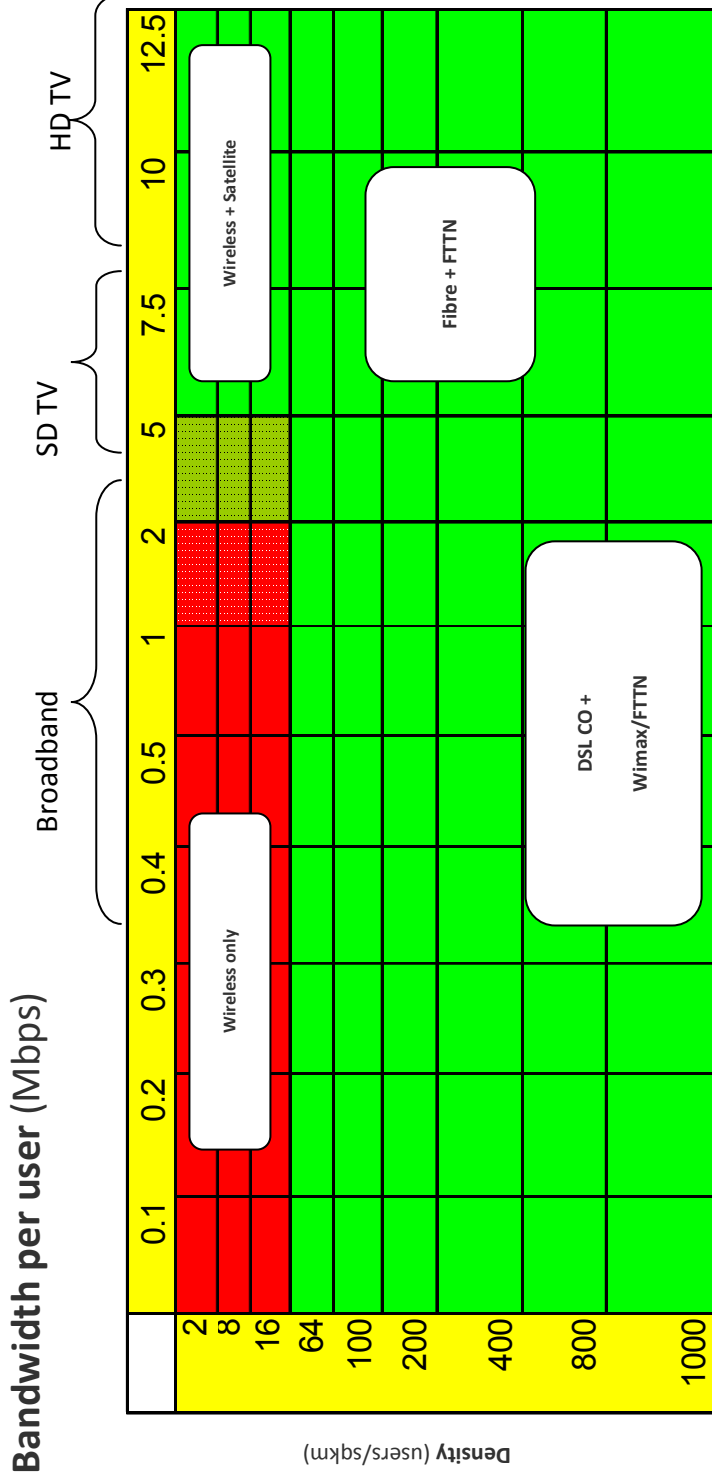
Summary

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)

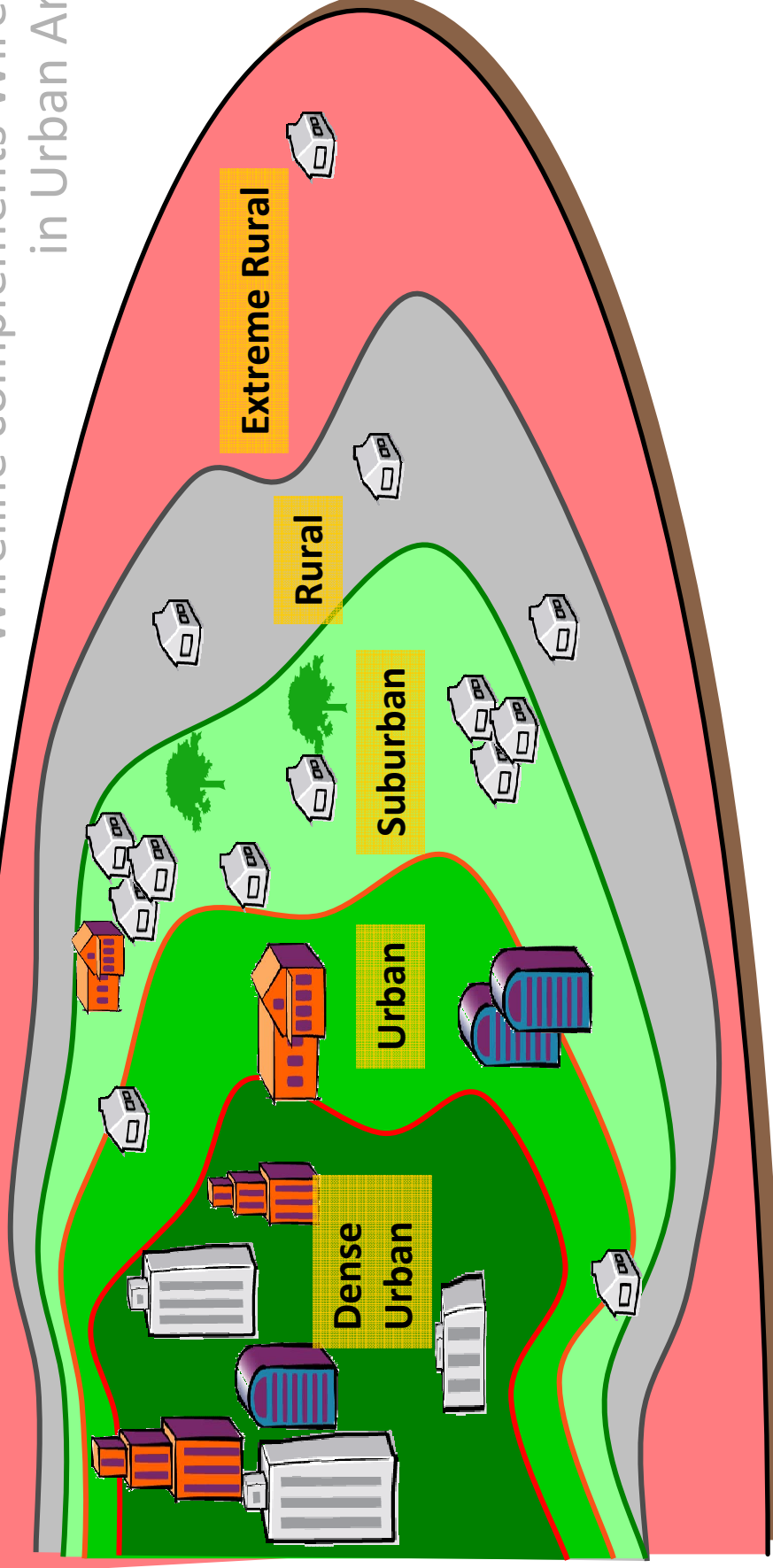
Although mobile is the preferred broadband technology in emerging markets, it will eventually need to be completed with fixed technologies...



- 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

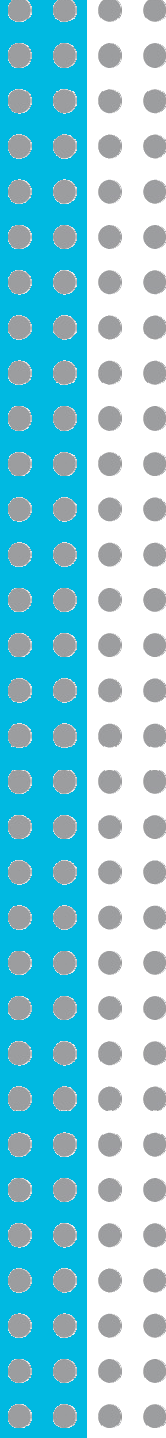
Fixed Networks: Restructuring from vertically to horizontally integrated operators

- 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

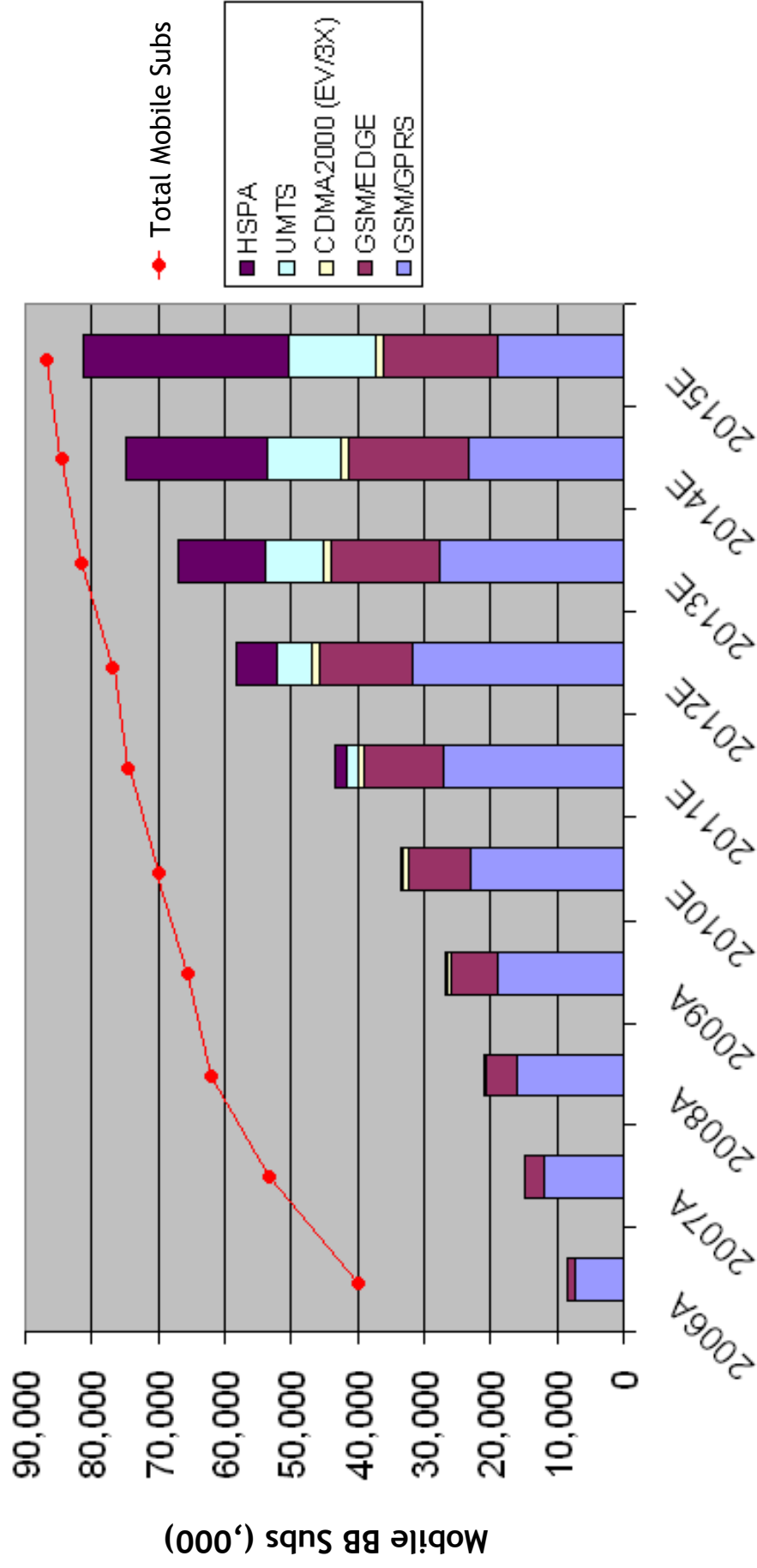
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Annex / Backup slides for dicussion

Thailand Broadband Market - Mobile




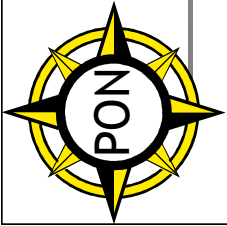
Source: Pyramid Research, Jun 2010

RAN sharing Examples

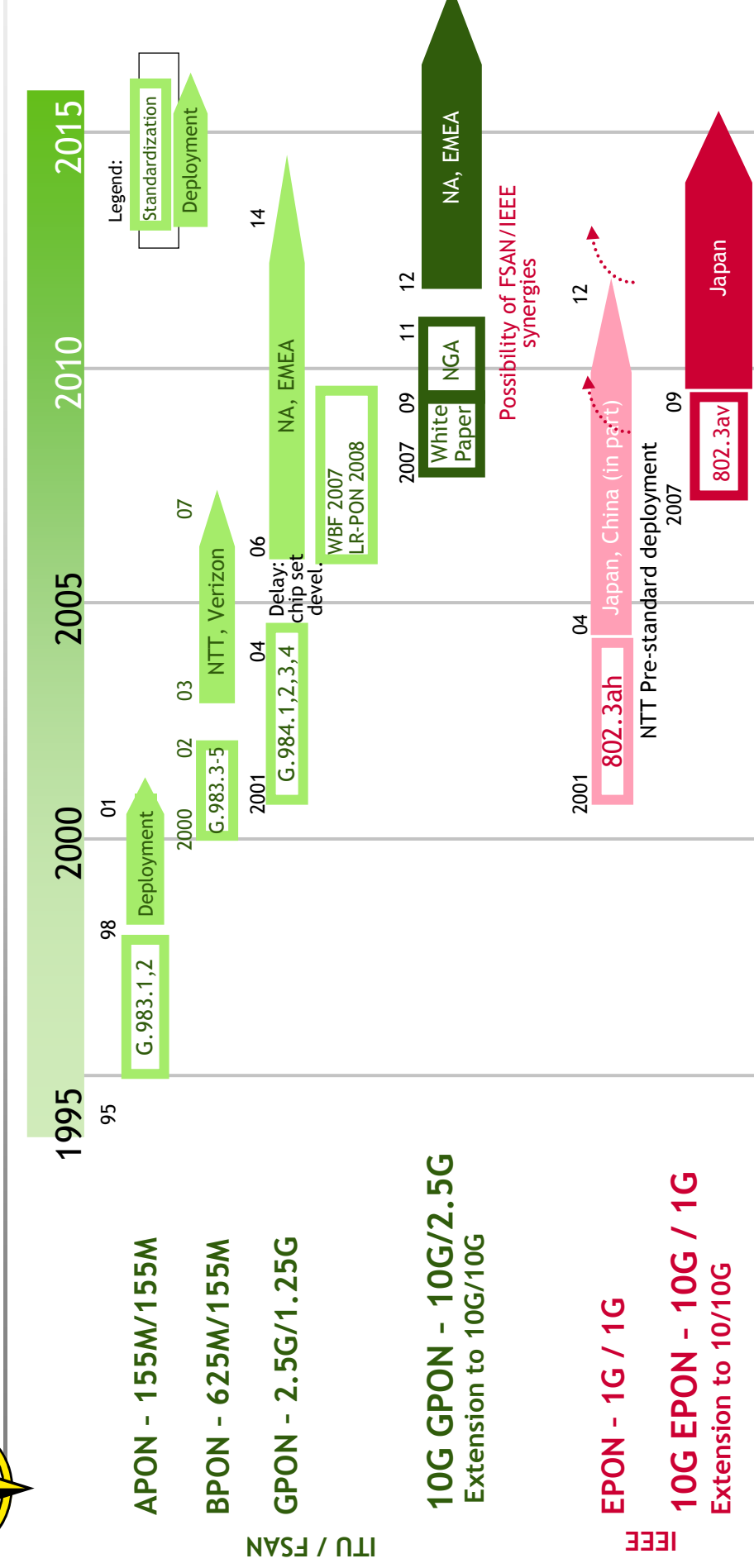
Sweden	2002	Tele2 and Telia formed a JV company known as Swedish UMTS networks to handle complete 3G network sharing (active sharing)
Australia	2004	Telstra & 3 agreed to RAN sharing (active) for their 3G network with joint ownership of 3's 3G network
Australia	2004	Vodafone & Optus share their 3G network including a shared O&M system (active sharing)
Sweden	2005	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)
Spain	2006	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
Iran	2007	MCCI, Irancell and Taliya are sharing their 3G BTS
UK	2007	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.
Czech Republic	2008	Vodafone, 3, and T-Mobile are known to be in advanced discussions about sharing their 3G network infra including BTS and other infra
India	2008	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
UK	2009	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 Efficiency	Downlink:94% Uplink:92%-93%	Downlink:73% 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



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

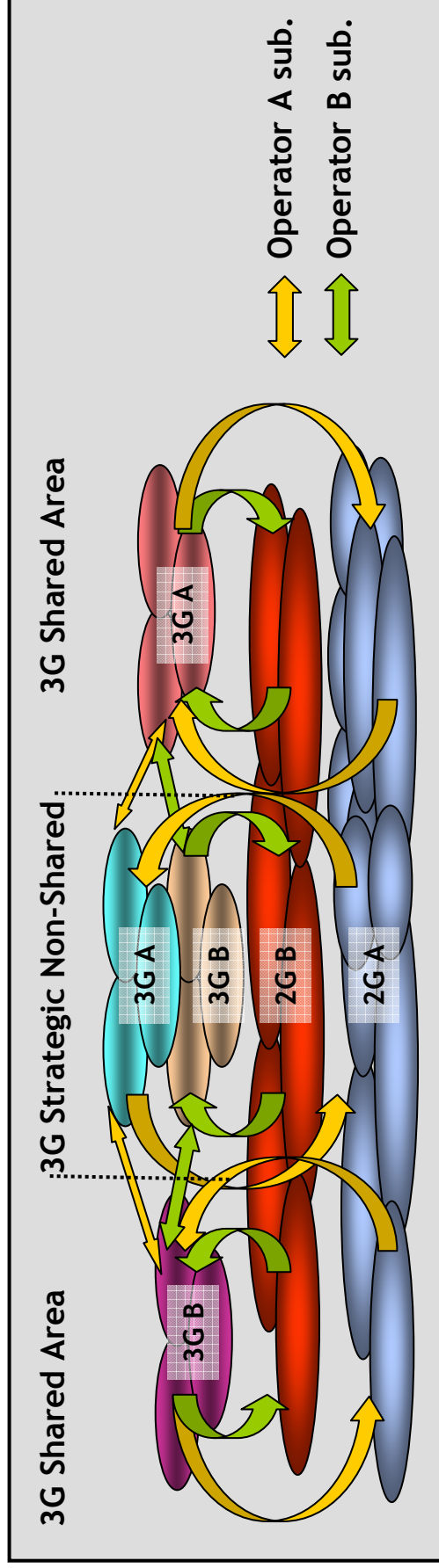
Each operator builds its **own RAN and CN** in its home geographical area, and allows subscribers from the other operator to roam in the visited network

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



UTRAN Sharing overview

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

Each operator uses its **own licensed spectrum**, broadcasts its **own PLMN id**

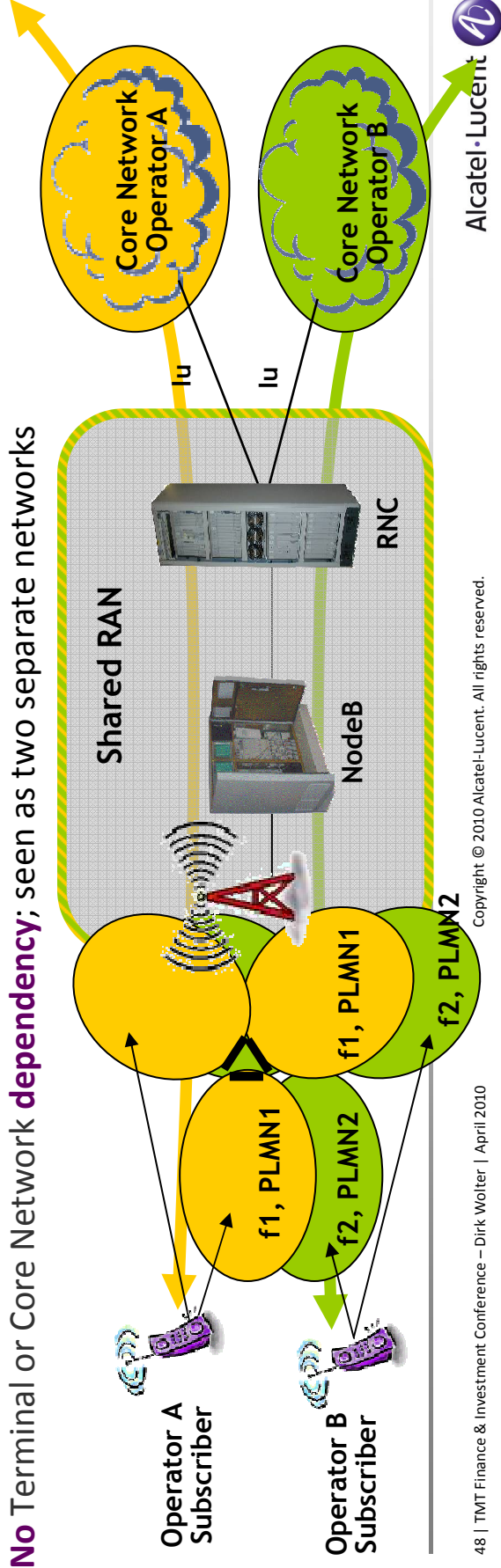
Mobility is handled on separate layers

- Mobile camps on appropriate cell, shows **right operator logo**
 - Handovers are directed to cells of the same operator (both 3G and 2G)
- RNC supports **multiple lus** to independent Core Networks, with or without luFlex

- Routing to CN operator based on the current cell PLMN id

Differentiation at cell level (radio parameters, features activation) and on network services

No Terminal or Core Network **dependency**; seen as two separate networks



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.

