

telenor

Refarming and other challenges for mobile communications
Guest lecture at UNIK4230 – Mobile communications

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Telenor Group mobile operations

Nordic

- Norway  
- Sweden  
- Denmark  

Central and Eastern Europe

- Hungary  
- Serbia  
- Montenegro  

Asia

- Thailand  
- Malaysia  
- Bangladesh  
- Pakistan  
- India  

VimpelCom Ltd.

- Russia
- Ukraine
- Italy
- Kazakhstan
- Georgia
- Uzbekistan
- Tajikistan
- Armenia
- Kyrgyzstan
- Cambodia
- Vietnam
- Laos
- Pakistan
- Bangladesh
- Algeria
- Zimbabwe
- Burundi
- Namibia
- Central African Rep.
- Canada

Telenor Group holds 31,7% of the economic ownership in VimpelCom Ltd.

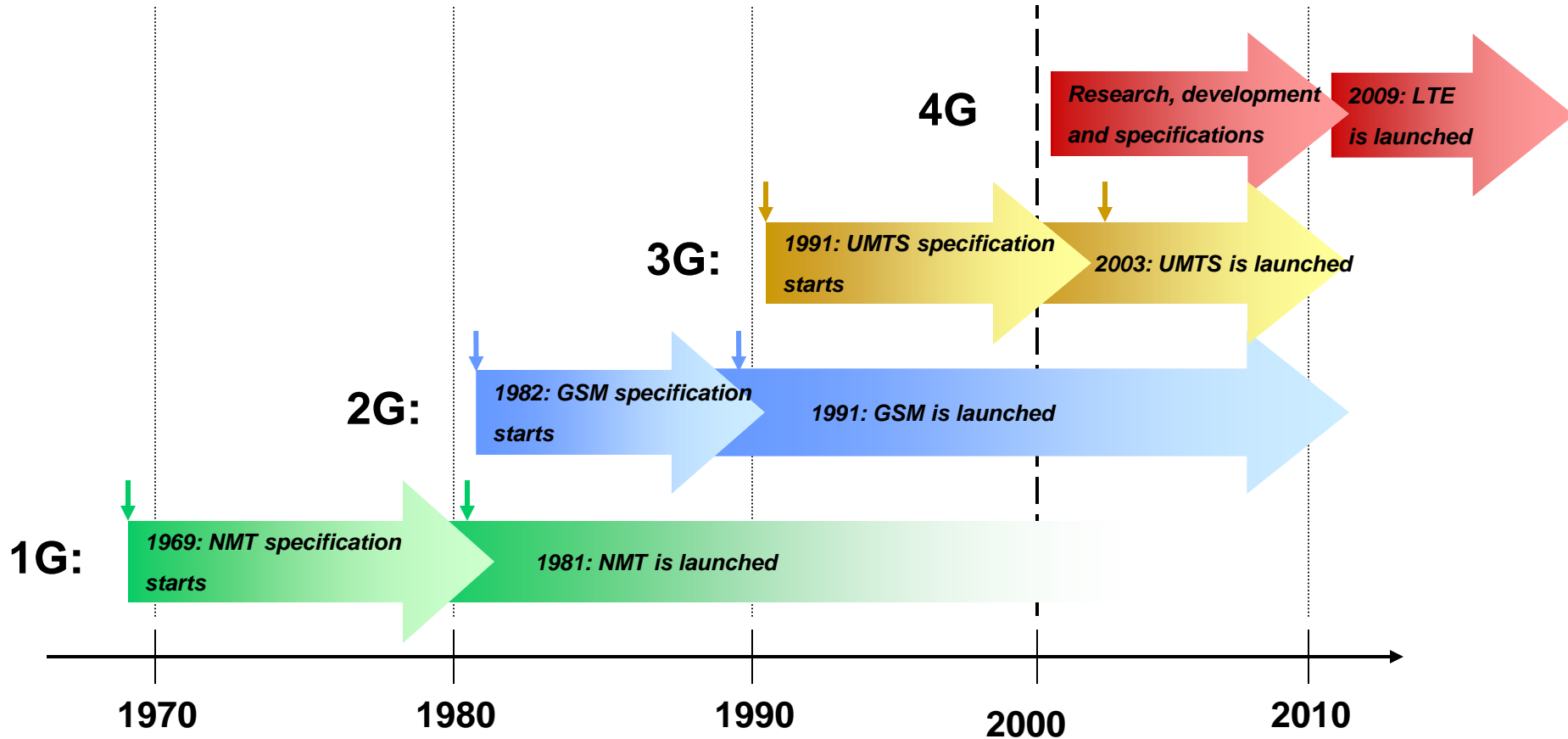


Agenda

1	Background – Technology and frequency bands
2	Challenges for mobile operators
3	Heterogeneous networks
4	The concept of re-farming and its motivation
5	Planning the future – A portfolio of frequency spectrum



Mobile communications: "The generation game"

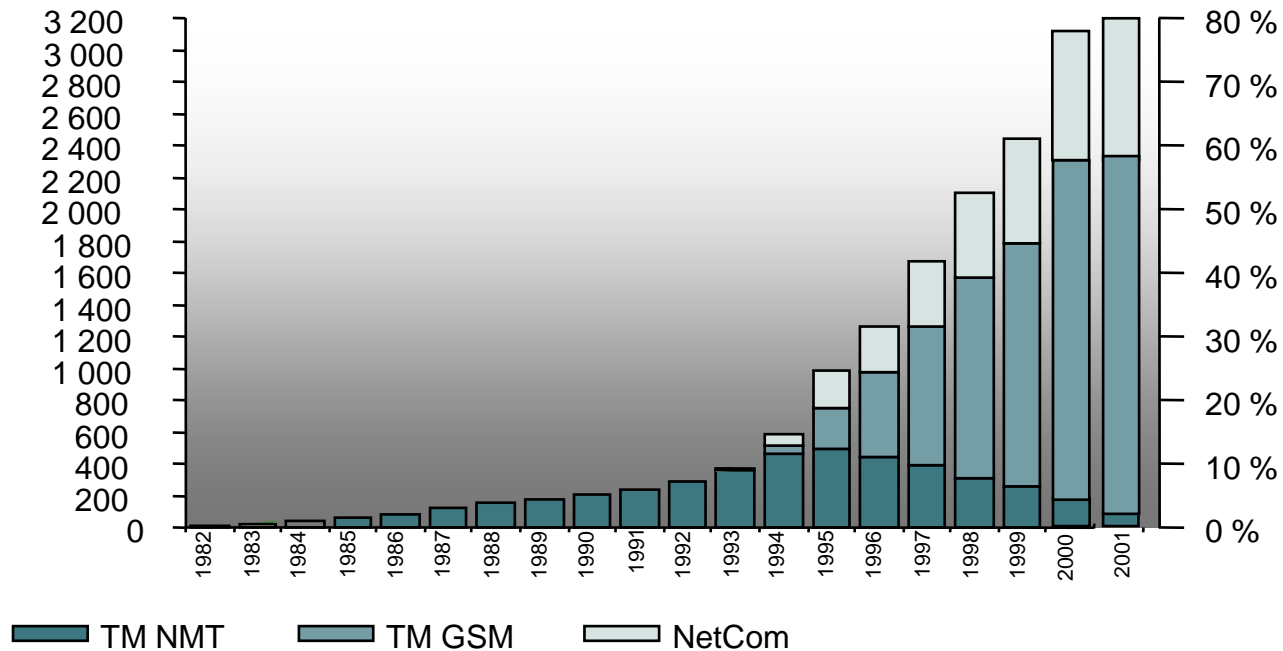


GSM – 2nd generation

1991: First operational GSM network in Finland: Radiolinja

1993: Tele-mobil (later: Telenor Mobil) and NetCom GSM open their networks in Norway

1998: GSM 1800 is deployed to increase capacity in cities and other densely populated areas



UMTS – 3rd generation

The first UMTS networks in Europe started in 2003 (Sweden, Italy, UK, Austria..). Norway: 2004

The most important differences from 2G were:

- Global standard (but with regional variations)
- Higher datarates (up to 2 Mbit/s defined, typically 384 kbps achieved in first phase)
- Improved multimedia support and security

Does not take over from 2G – supplements

Slow start – real breakthrough not until Mobile Broadband in 2006/2007

- High Speed Packet Access (HSPA) – “Turbo 3G”

3G handset penetration in “Telenor countries” 30.08.2010:

Sweden	Norway	Denmark	Malaysia	Serbia	Hungary	Ukraine	Thailand	Bangladesh	Pakistan
73%	53%	42%	21%	16%	16%	10%	9%	4%	3%

LTE – 4th generation

Data (IP) only

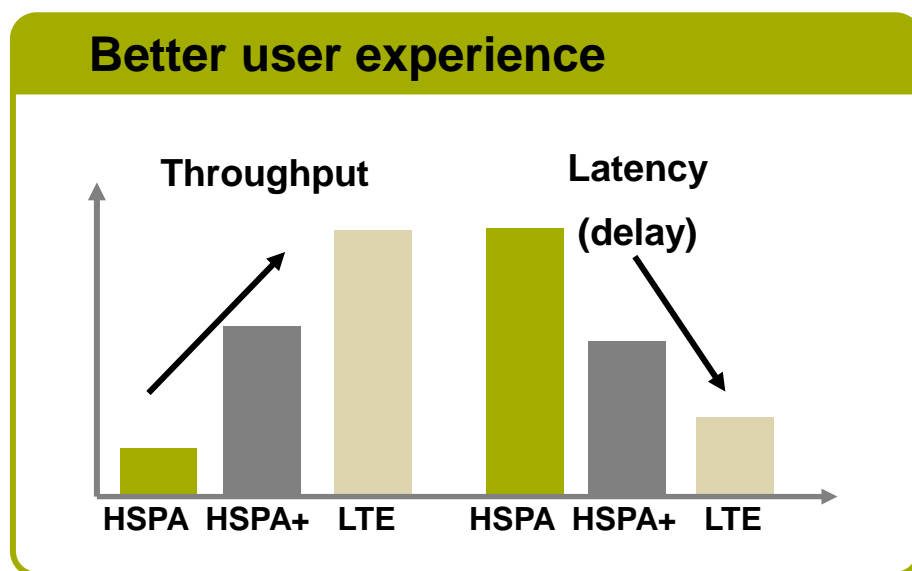
Laptop/PC support only in first phase

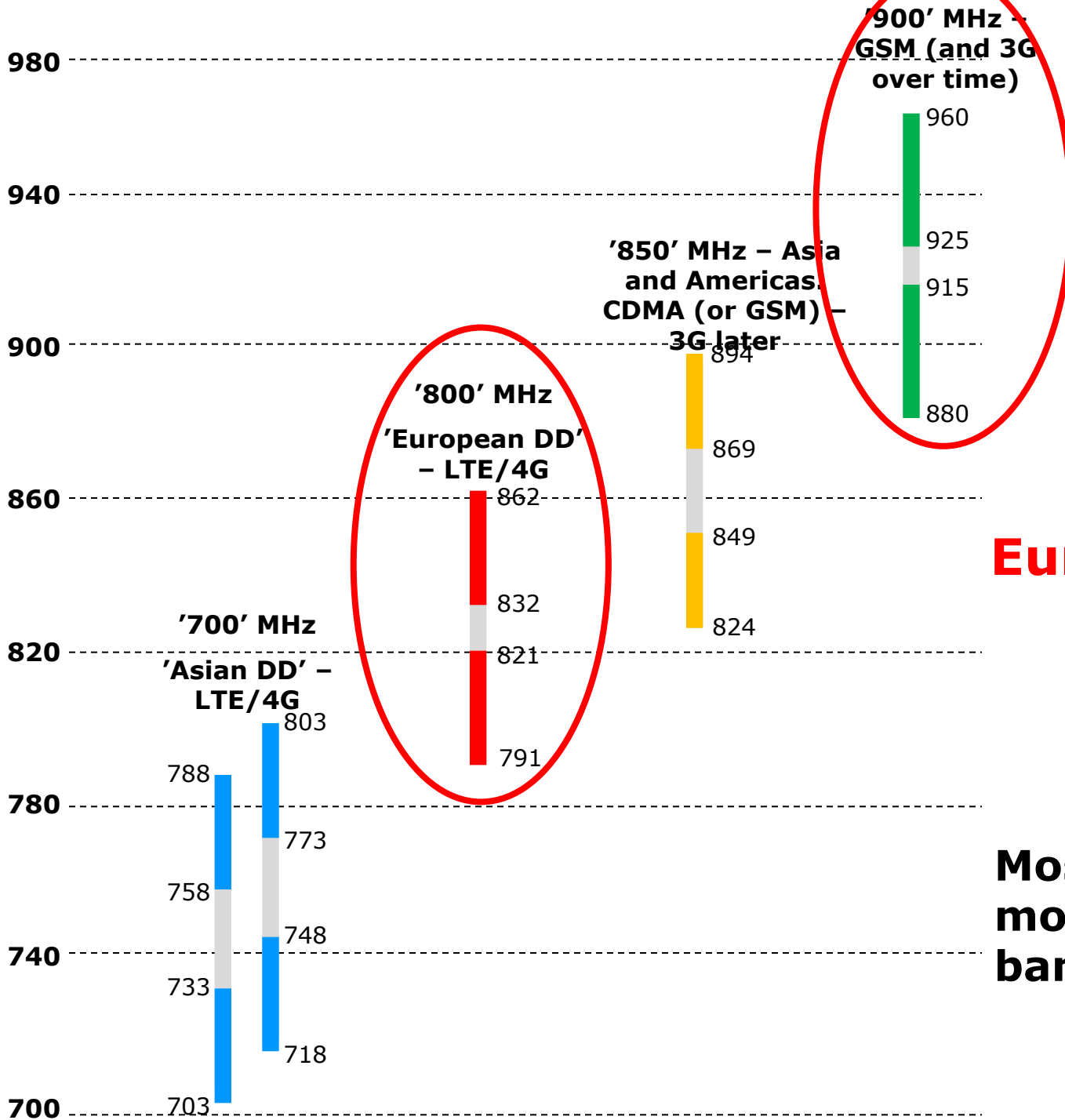
Mobility towards 2G/3G

Benefits from 2G and 3G ecosystem

First commercial launch:

- Sweden and Norway Dec 2009 (TeliaSonera)

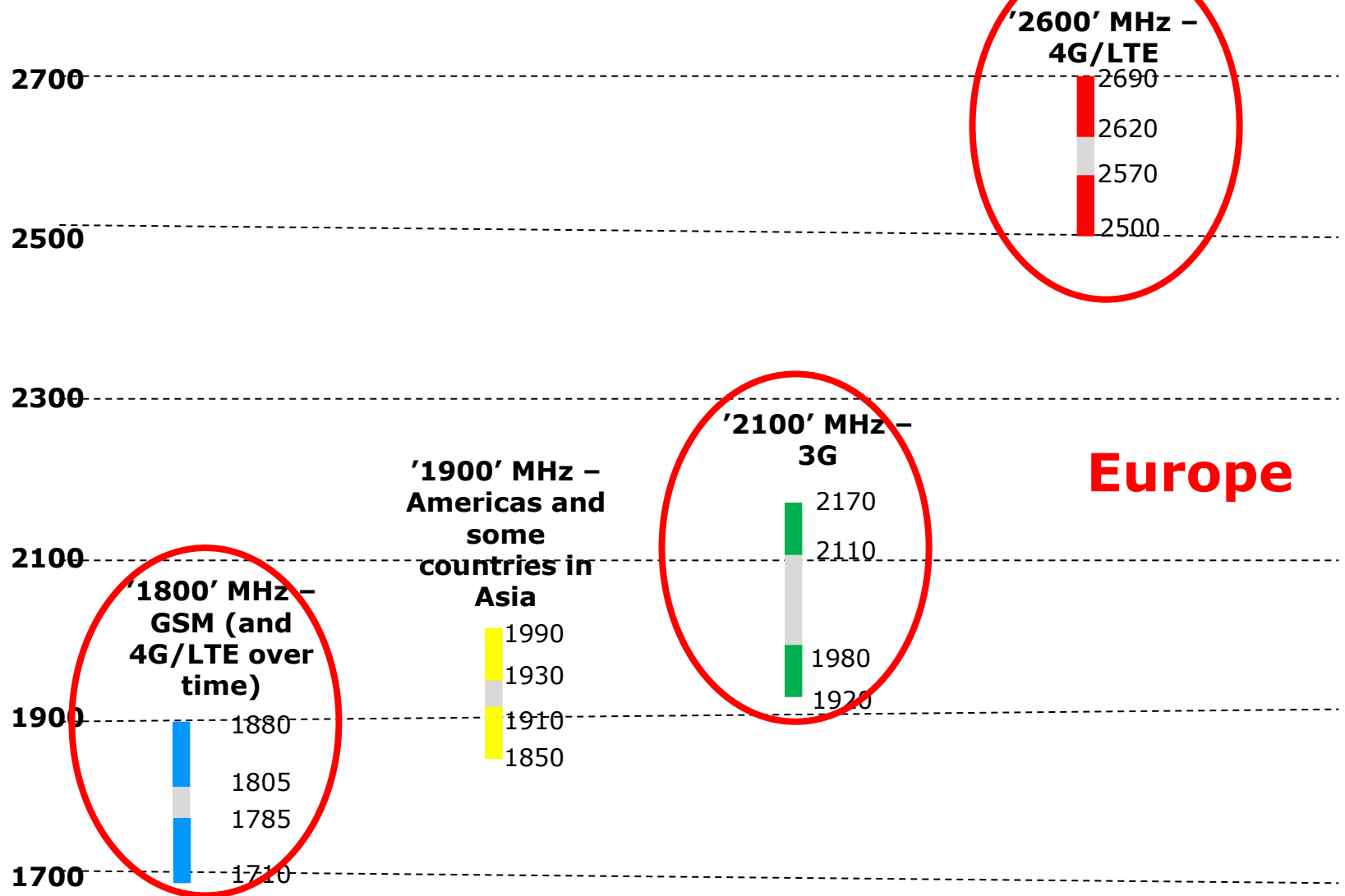




Europe

**Most important
mobile "Coverage
bands"**

Most important mobile "capacity bands"



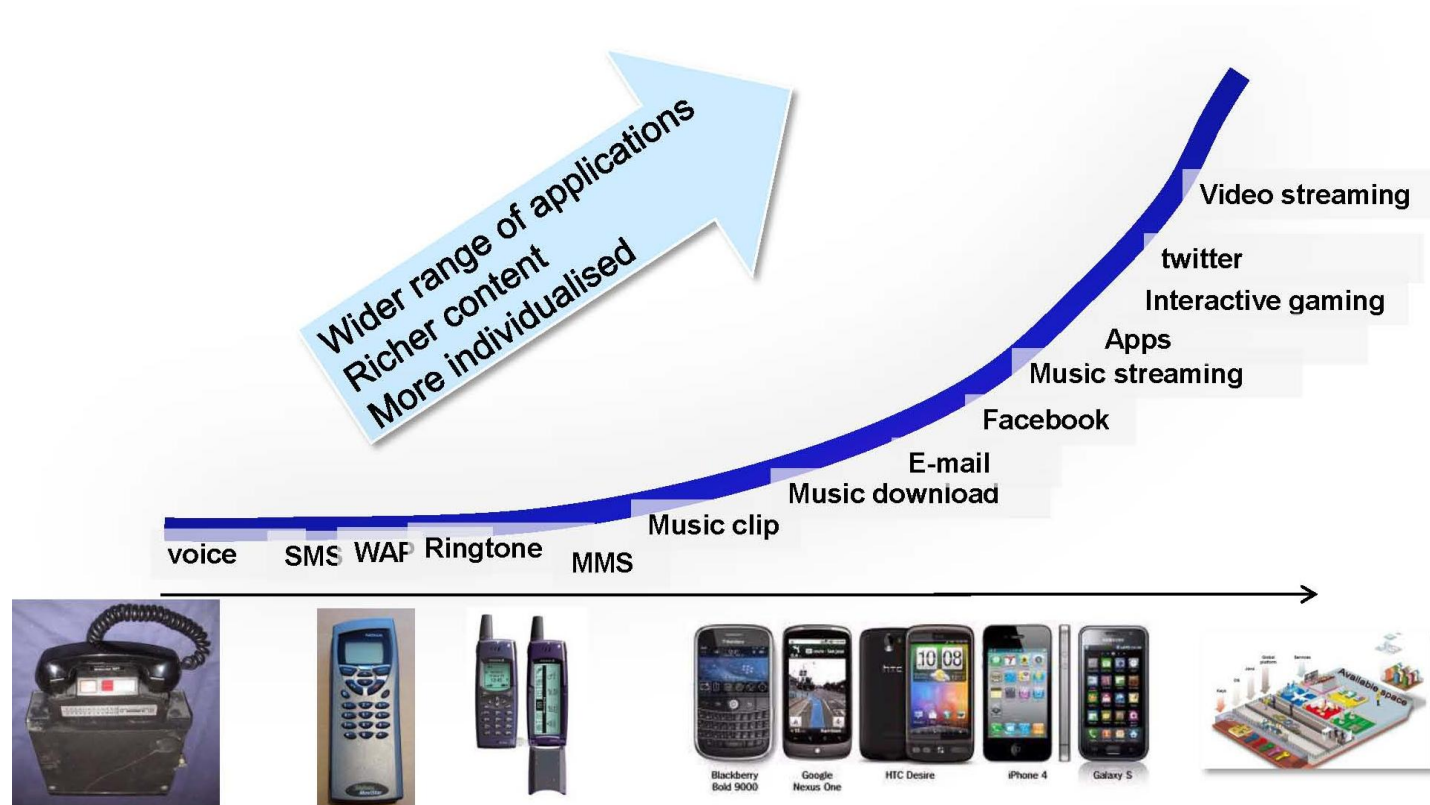
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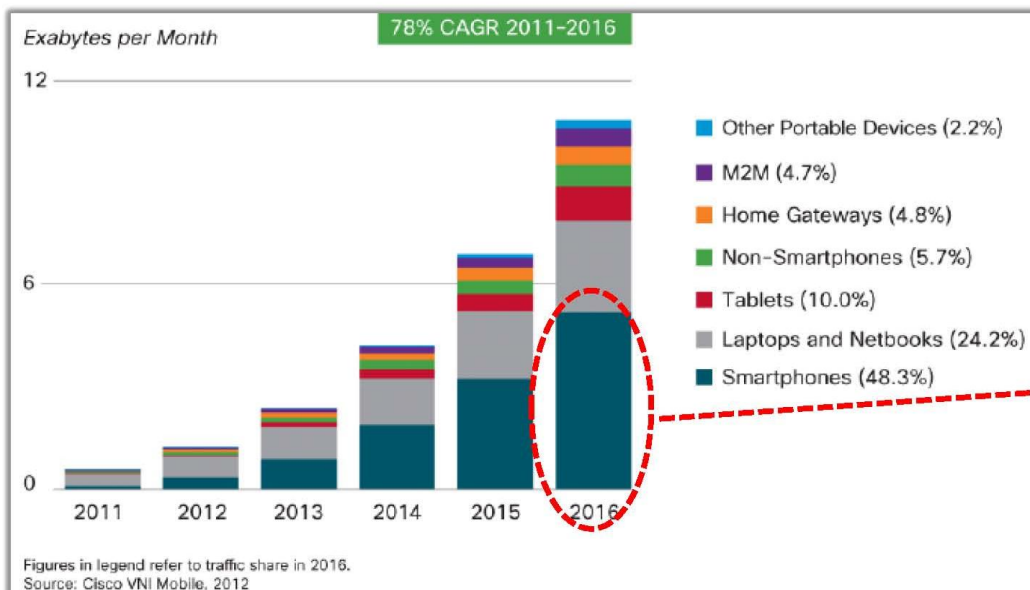
Challenge: Smartphones driving traffic explosion

Data and signalling



Handsets becoming more powerful and versatile

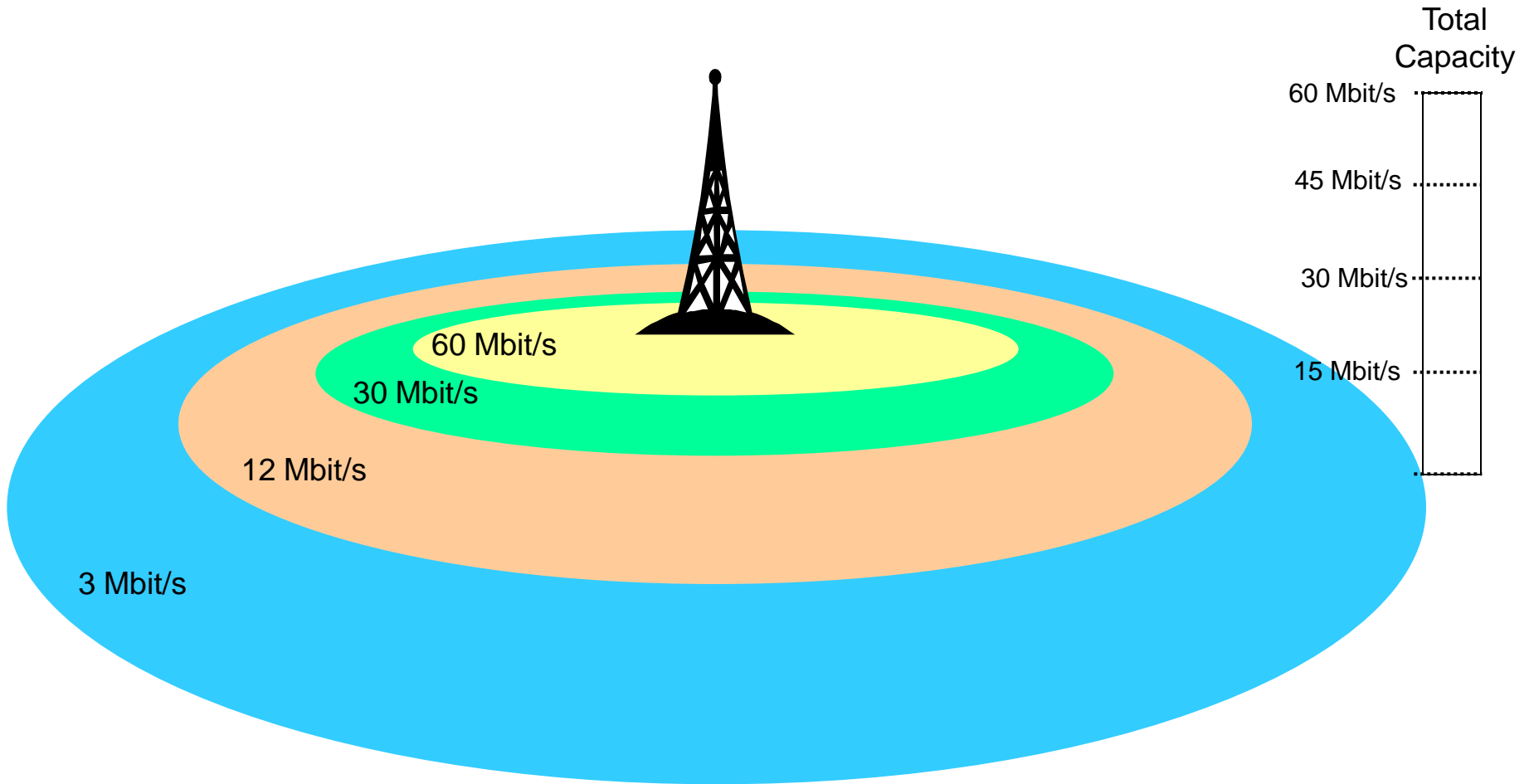
Challenge: Current network is not ready for the expected traffic growth



- Exponential growth in data traffic in mobile broadband
- Customer expectation is rising quickly
- Current mobile network is based on macro (large) sites
- Adding costly macro sites in certain geographical areas is challenging because of unsuccessful site acquisition
- The majority of mobile broadband users are indoors

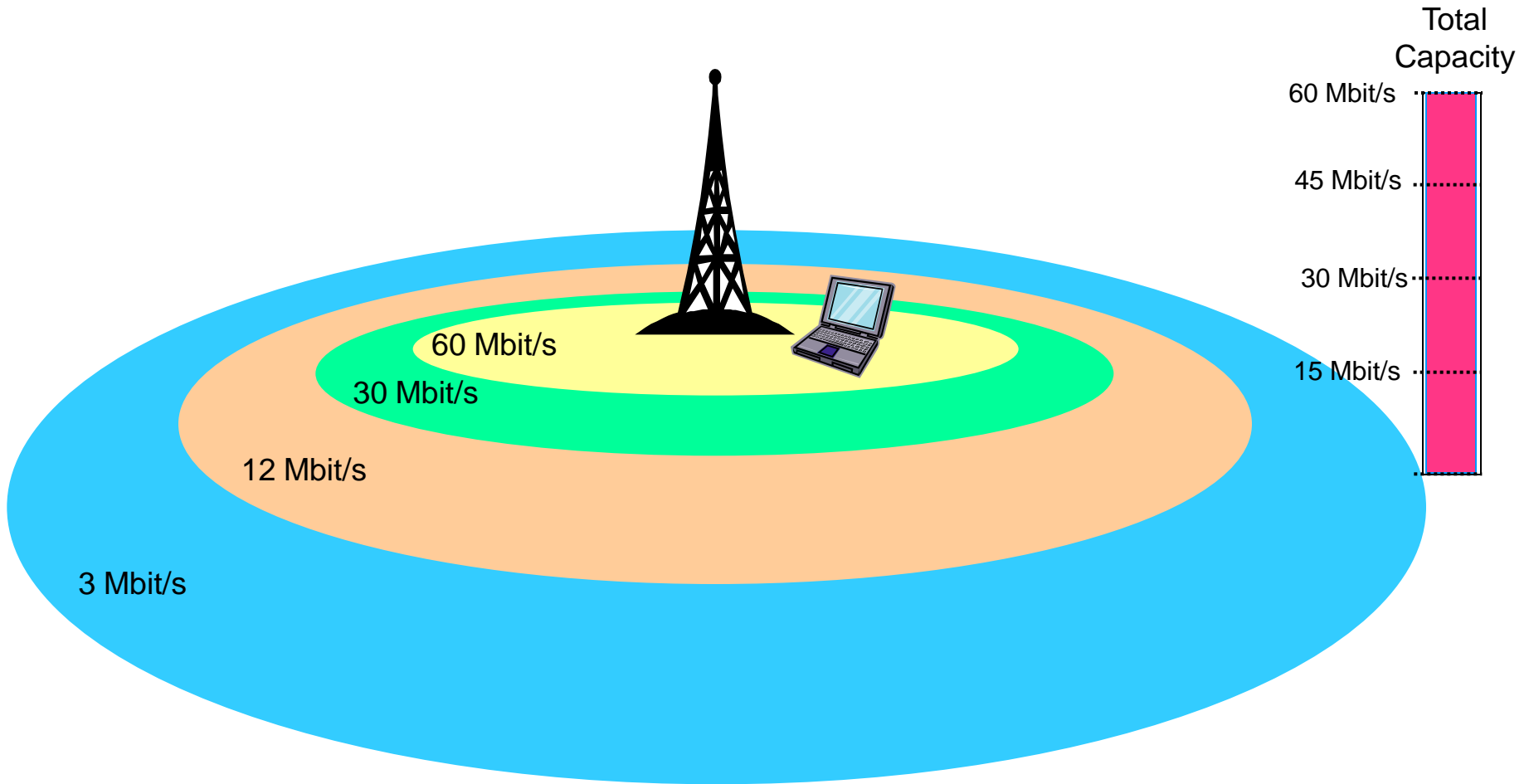
Can LTE handle the capacity needs?

Download data rates depending on distance to base station as well as number of simultaneous users



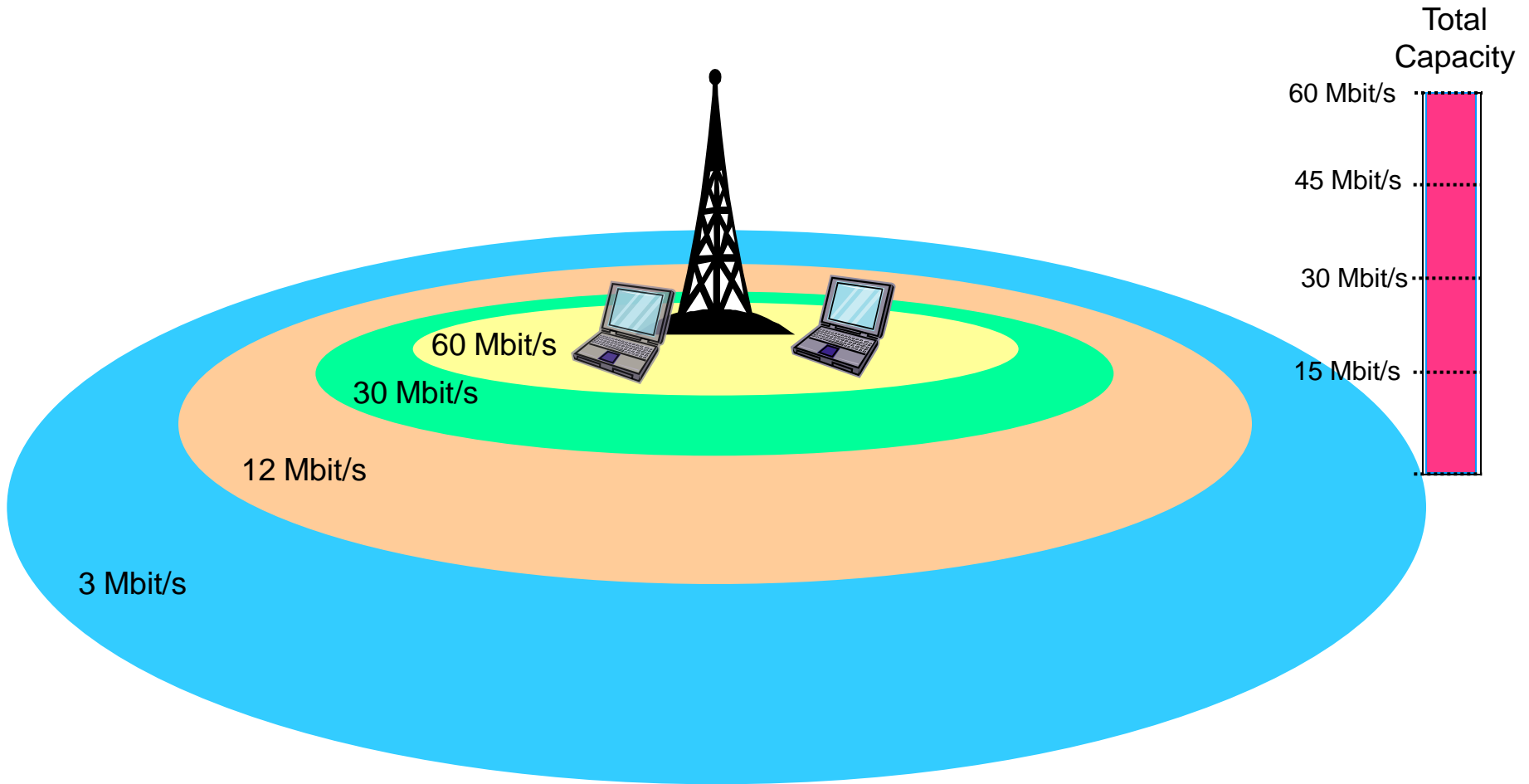
Can LTE handle the capacity needs?

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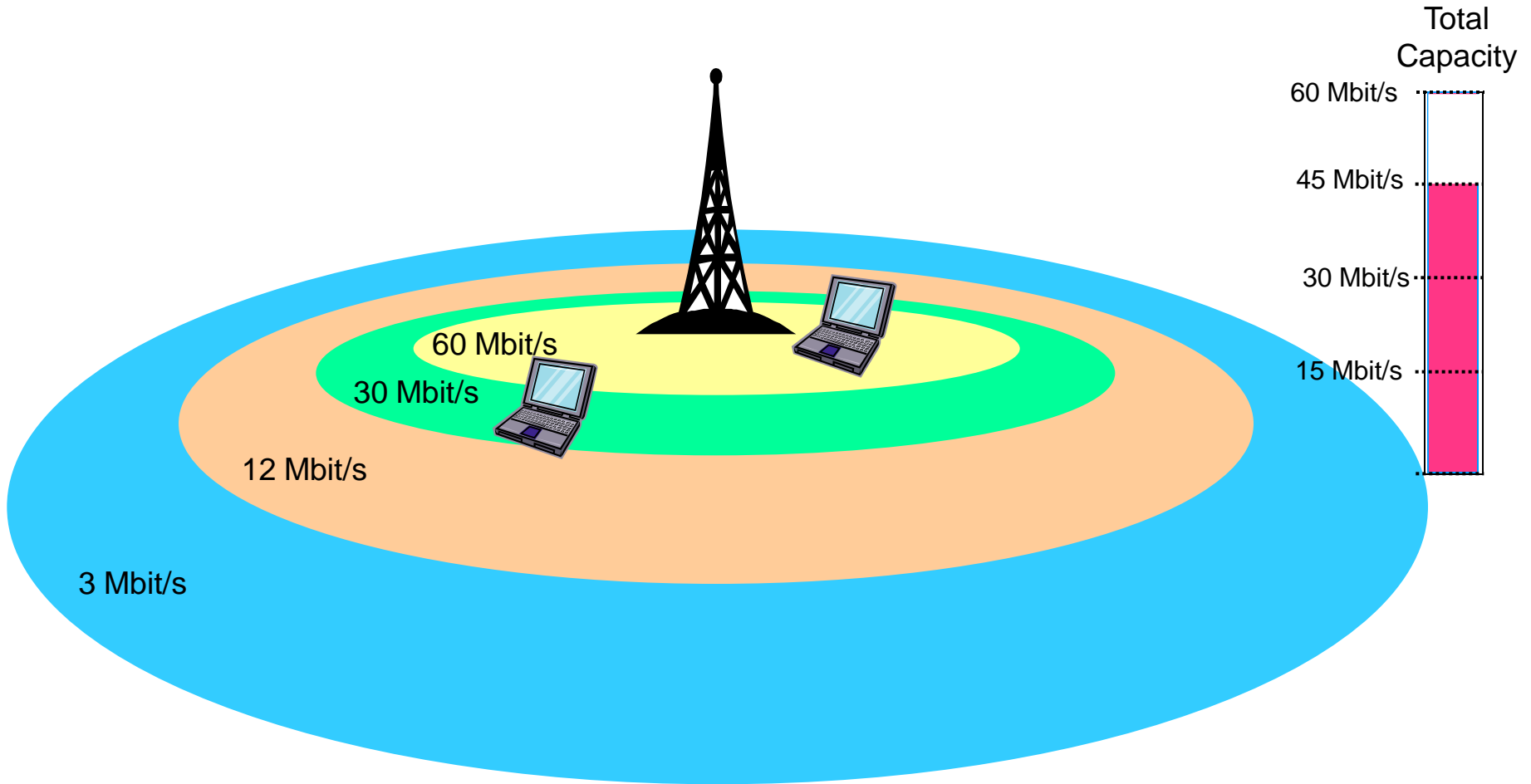
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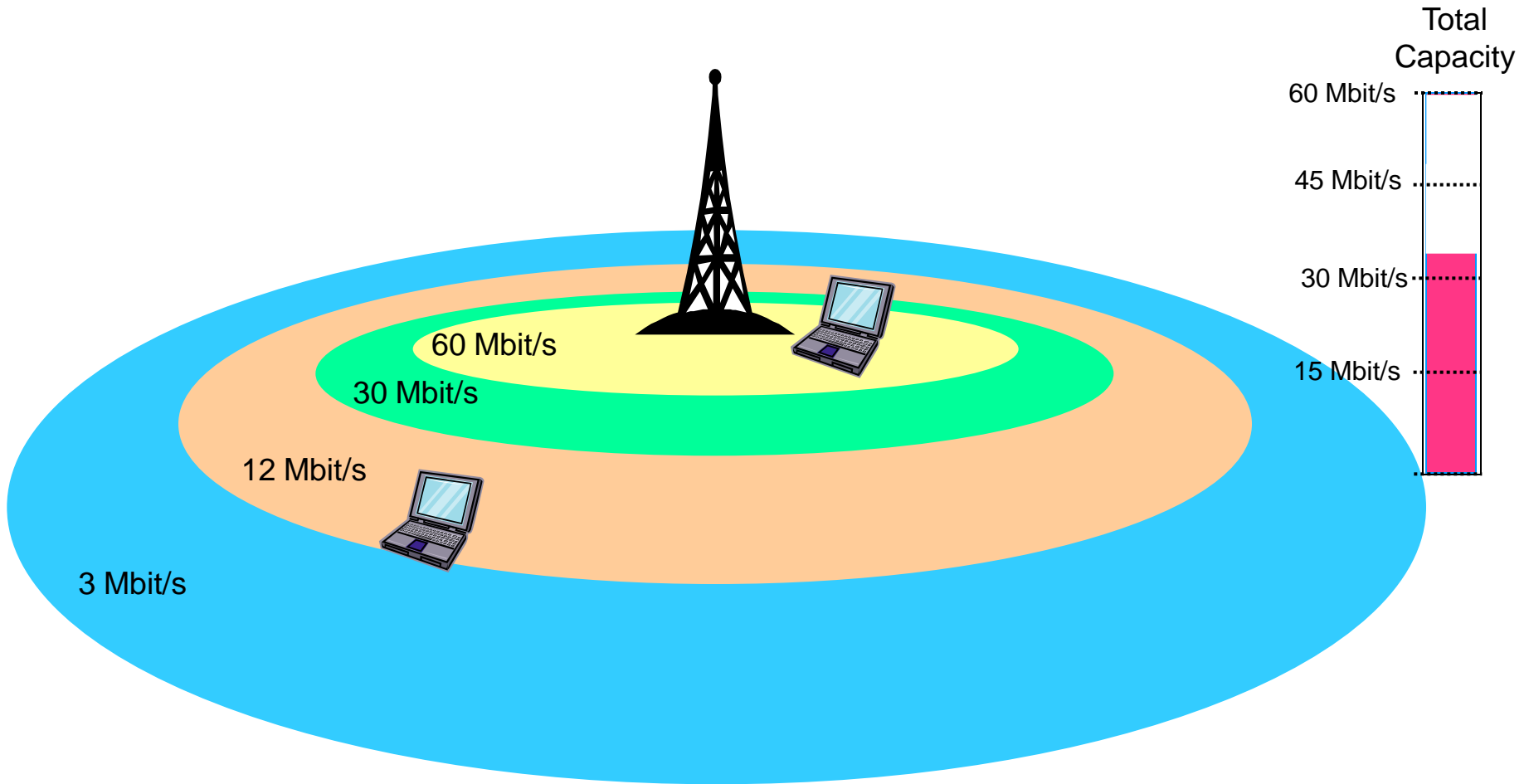
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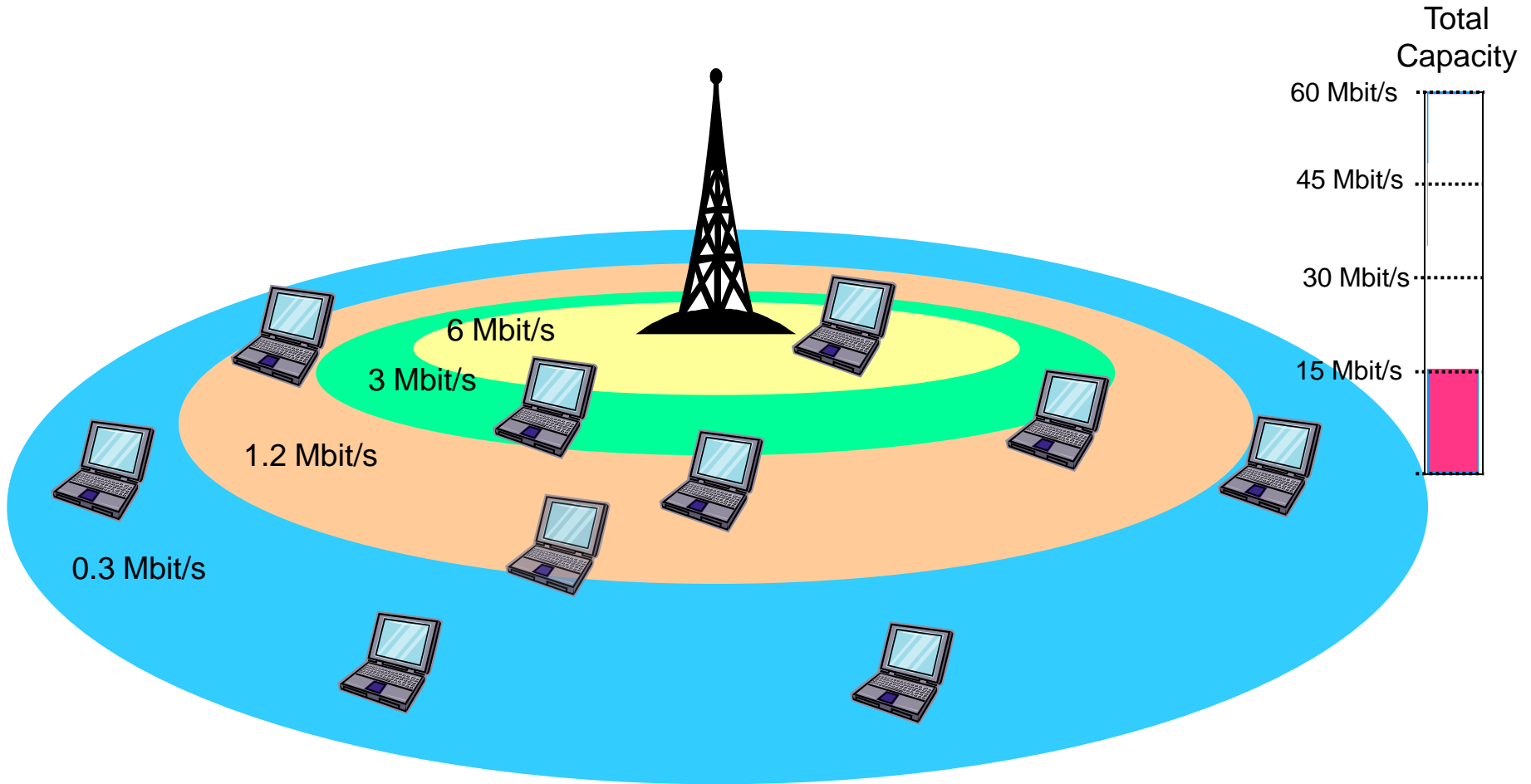
Can LTE handle the capacity needs?

Download data rates depending on distance to base station as well as number of simultaneous users

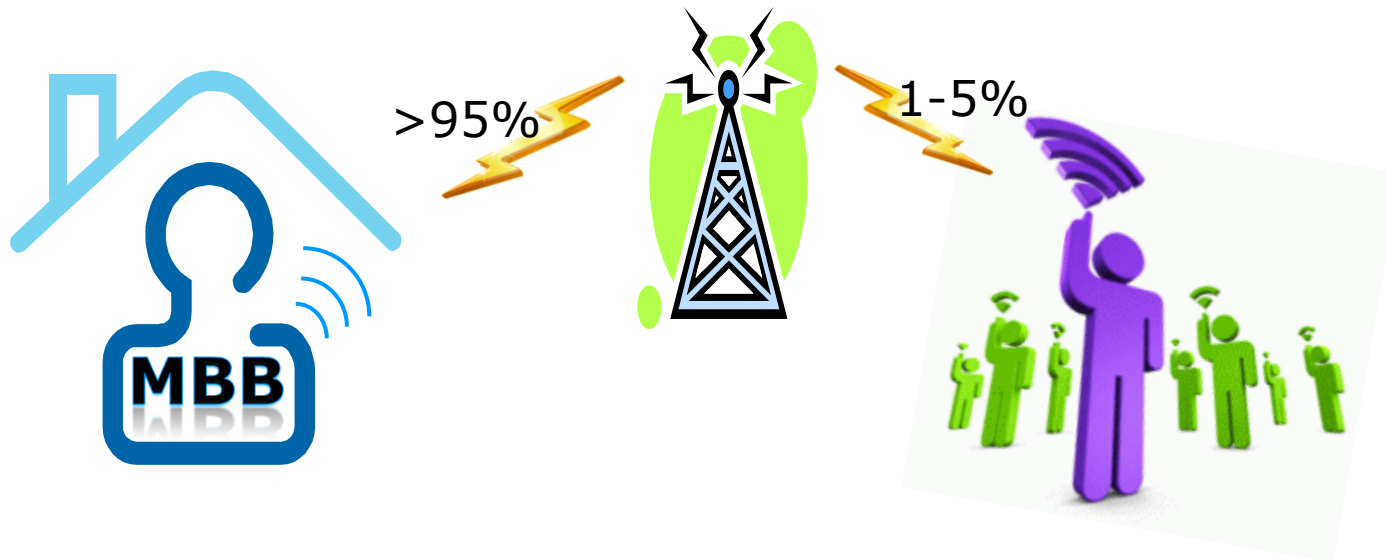


Can LTE handle the capacity needs?

Download data rates depending on distance to base station as well as number of simultaneous users



Challenge: Indoor users place additional strains on macro network resources



1. Analysis Mason: Nearly 90% of MBB users will be indoor
2. An indoor user occupies up to 10 times more macro cell capacity per consumed Byte => up to 10 times the cost

Challenge: Operating multiple technology generations in parallel

	Technology	Typical Usage	Typical terminal	Handset penetration (Norway 2011)
2G	GSM/GPRS	Voice, messaging	Handsets	100%
3G	UMTS/HSPA/HSPA+	Voice, handset data, mobile broadband	Handsets, dongles	60%
4G	LTE	Mobile broadband	Dongles, PC cards	0%

Operate 2G because:

- *Legacy handsets*: Long time till all handsets support 3G
- *Footprint*: Operators do not have the same coverage for 3G as 2G

Operate 3G because:

- *Efficiency*: More efficient than 2G
- *Mobile broadband*: Data rates and capacity
- *Terminals*: 4G not a handset technology (yet), long time till penetration reaches significant levels

Operate 4G because:

- *Efficiency*: More efficient technology
- *Cost*: Lower production cost

Challenge: Coverage, capacity and spectrum (1)

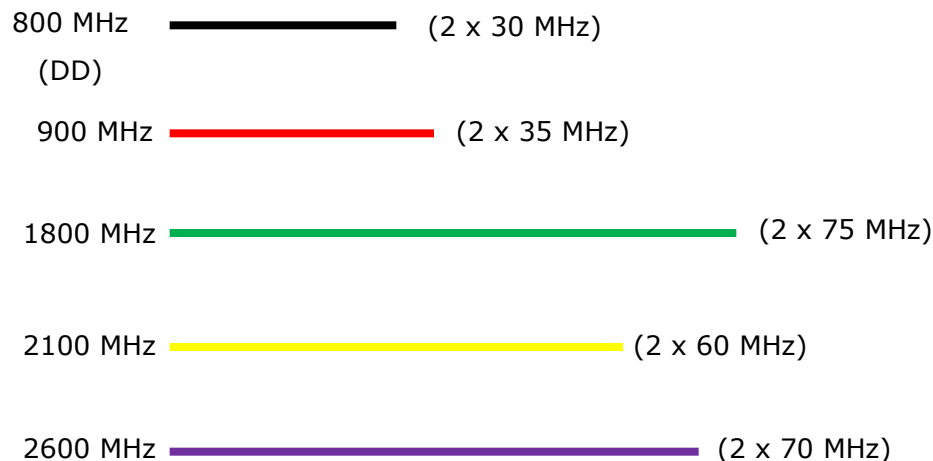
For each country and region there is a finite and predictable amount of frequency spectrum available

'Low frequencies' ($< \approx 1000$ MHz): Larger range – 'Coverage bands'

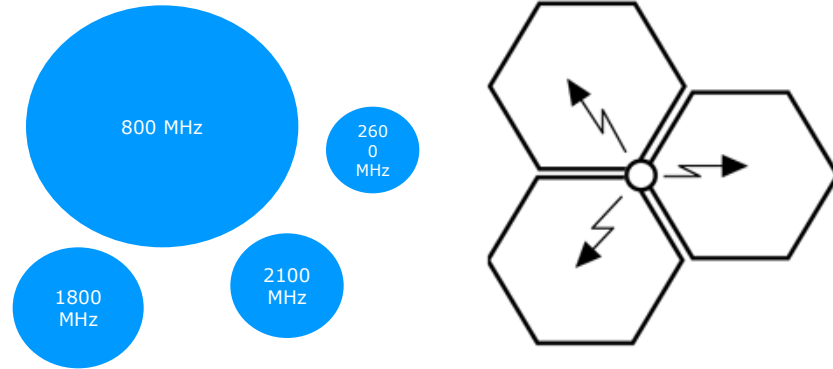
'High frequencies' ($> \approx 1000$ MHz): Larger bandwidth available – 'Capacity bands'

A mix of 'low' and 'high' frequencies will normally be desirable

European frequency bands:



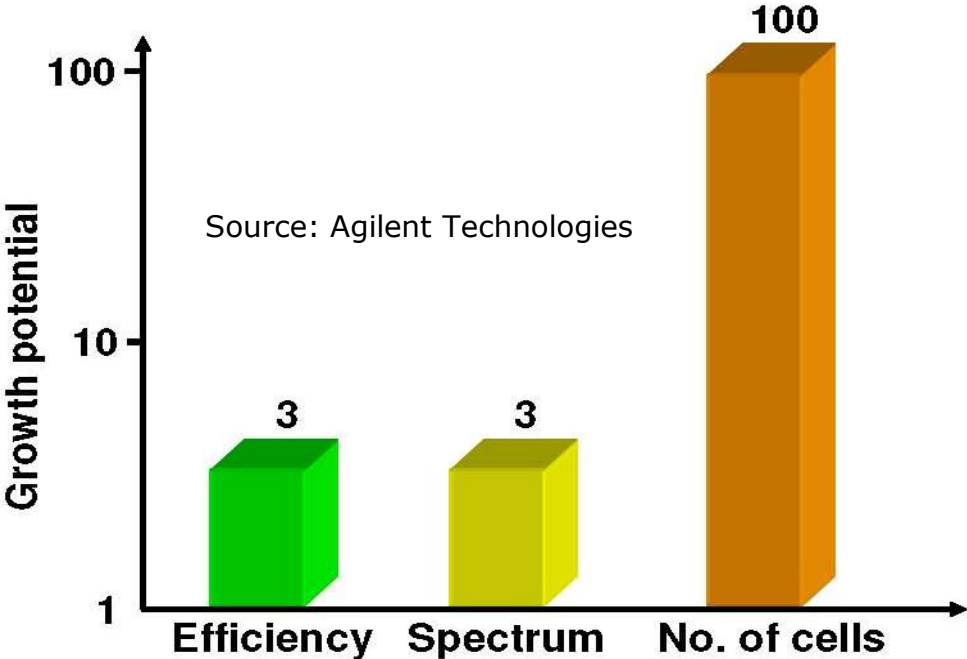
Challenge: Coverage, capacity and spectrum (2)



	DD	900 MHz	1800 MHz	2100 MHz	2600 MHz
DD	1.00	0.80	0.22	0.17	0.11
900 MHz	1.24	1.00	0.28	0.21	0.14
1800 MHz	4.51	3.63	1.00	0.75	0.50
2100 MHz	6.01	4.83	1.33	1.00	0.67
2600 MHz	8.94	7.18	1.98	1,49	1.00

Based on COST-Hata model

Out of the three ways to increase network capacity, adding new, smaller cells has by far the highest growth potential.



Spectrum and efficiency still matter but the future is all about small cells

For doubled spectrum size, required number of new cells can be halved

A Small cell provides similar capacity as a macro cell, but at a fraction of the cost

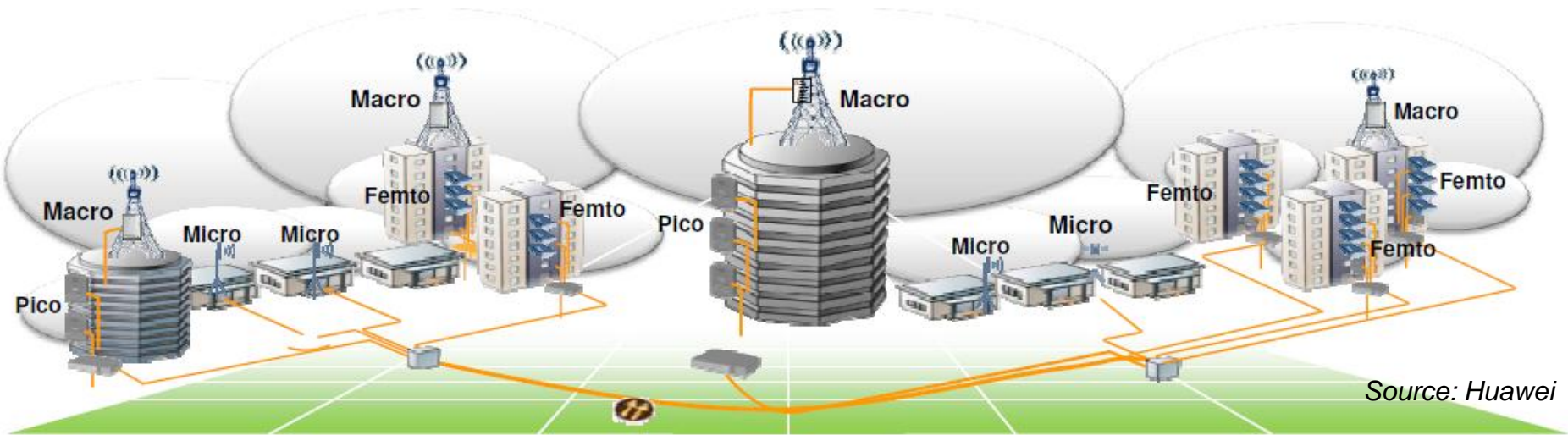
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HetNet: Heterogeneous Network

- A new term for mixed network architecture



- HetNet: Using a mix of large and small (outdoor and indoor) cells to secure customer experience the most cost-efficient way
- Possibly combining different access technologies
- Intelligent steering of traffic across different cell types to optimize user experience and traffic capacity

GSM macro cells and microcells can be considered as the first HetNet deployment, but without advanced traffic steering options

Heterogeneous Networks

HetNet

WiFi
Mobility &
Integration

Femtocells

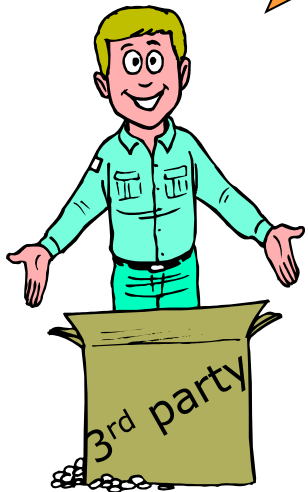
Backhaul
solutions
for Small
Cells

Traffic
steering in
HetNet

Self
organising
networks

WiFi as part of HetNet

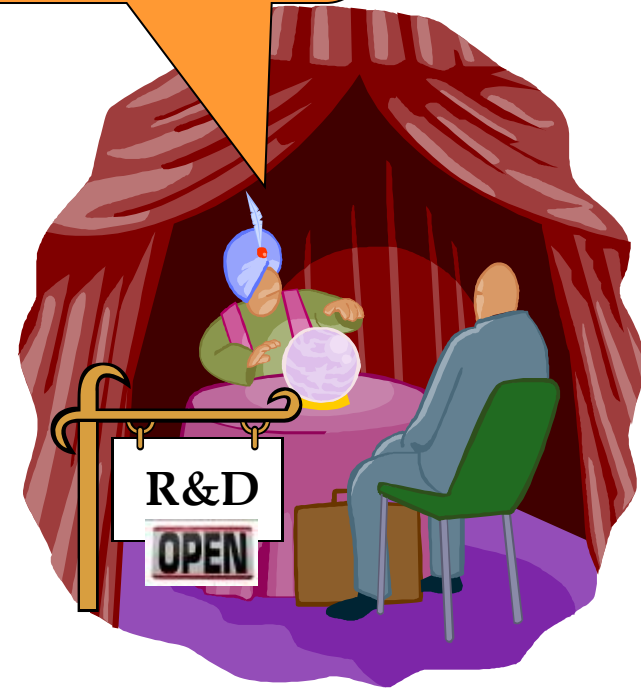
We can offer any kind of solution for WiFi integration



WiFi no more a tool just for data nerds



Security
Mobility
Discovery/Selection



Femtocell

3G/HSPA/LTE micro base station

Works with standard handsets

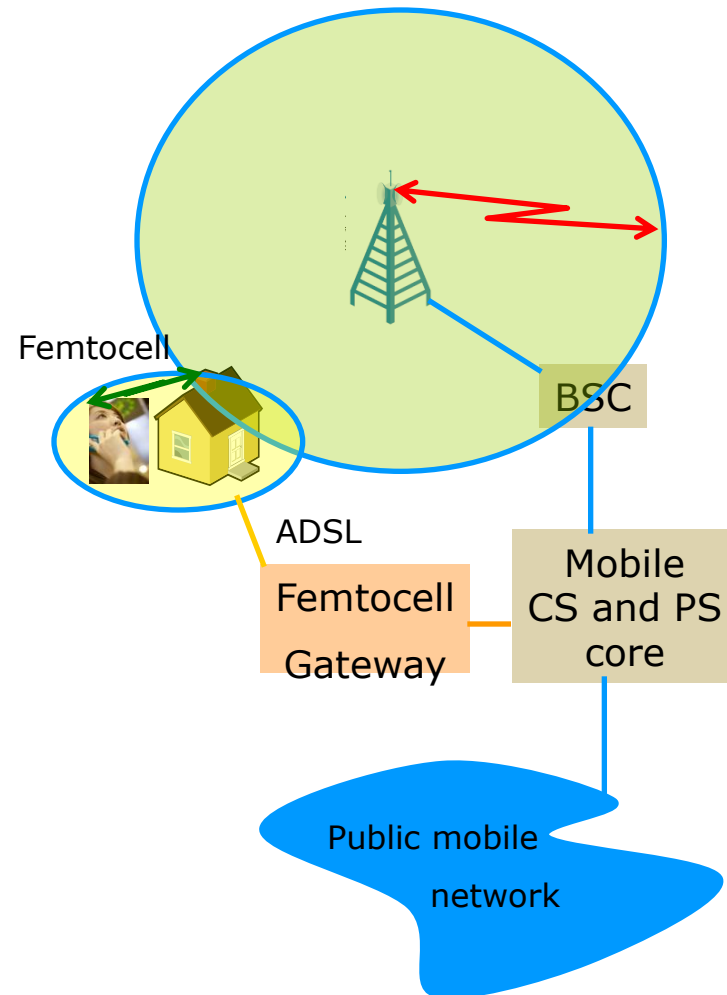
Zero touch, plug and forget

Improved indoor coverage and capacity.

Saves CAPEX in macro network

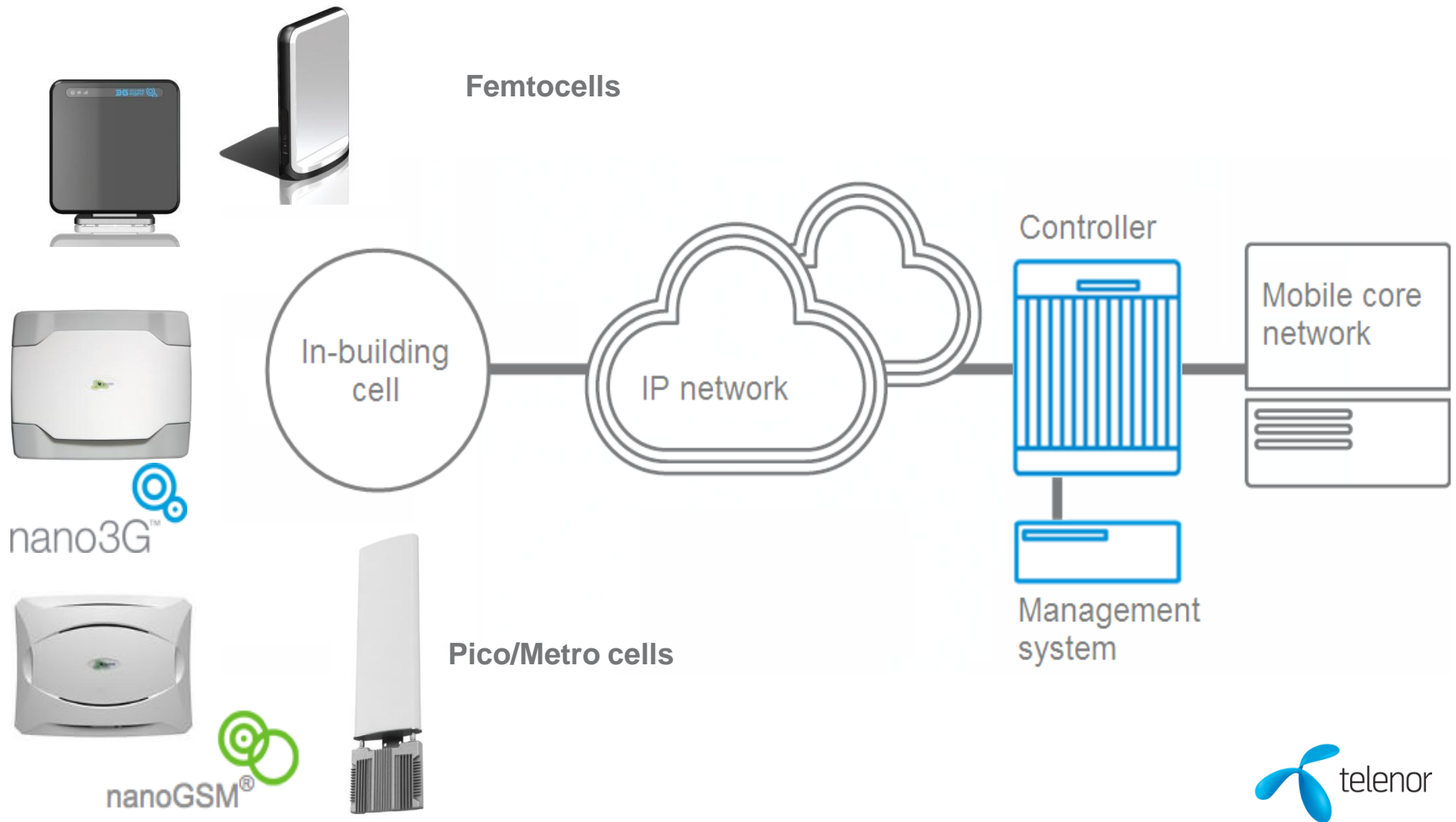
Target price < 100 US\$.

Requires additional management system and femto gateway



Example: Ip.access small cells

CONFIDENTIAL



Example: Alcatel Lucent femtocells

3G Small Cells family



9361 HOME CELL

- W-CDMA
- Integrated omni directional antenna
- 4 users



9362 ENTERPRISE CELL

- W-CDMA
- Integrated or external omni directional antennas
- 100mw/250mw
- Small cell net
- 8 to 32 users



9363 METRO CELL INDOOR

- W-CDMA
- Tamper resistant
- Integrated or external omni directional antennas
- Rx div /MIMO
- HSDPA 64 QAM
- Small cell net
- 16 to 32 users



9364 METRO CELL OUTDOOR

- W-CDMA
- Ruggedized design
- External omni directional antennas
- Rx div/MIMO
- HSDPA 64 QAM
- Range 2 km at 120km/h
- 16 to 32 users

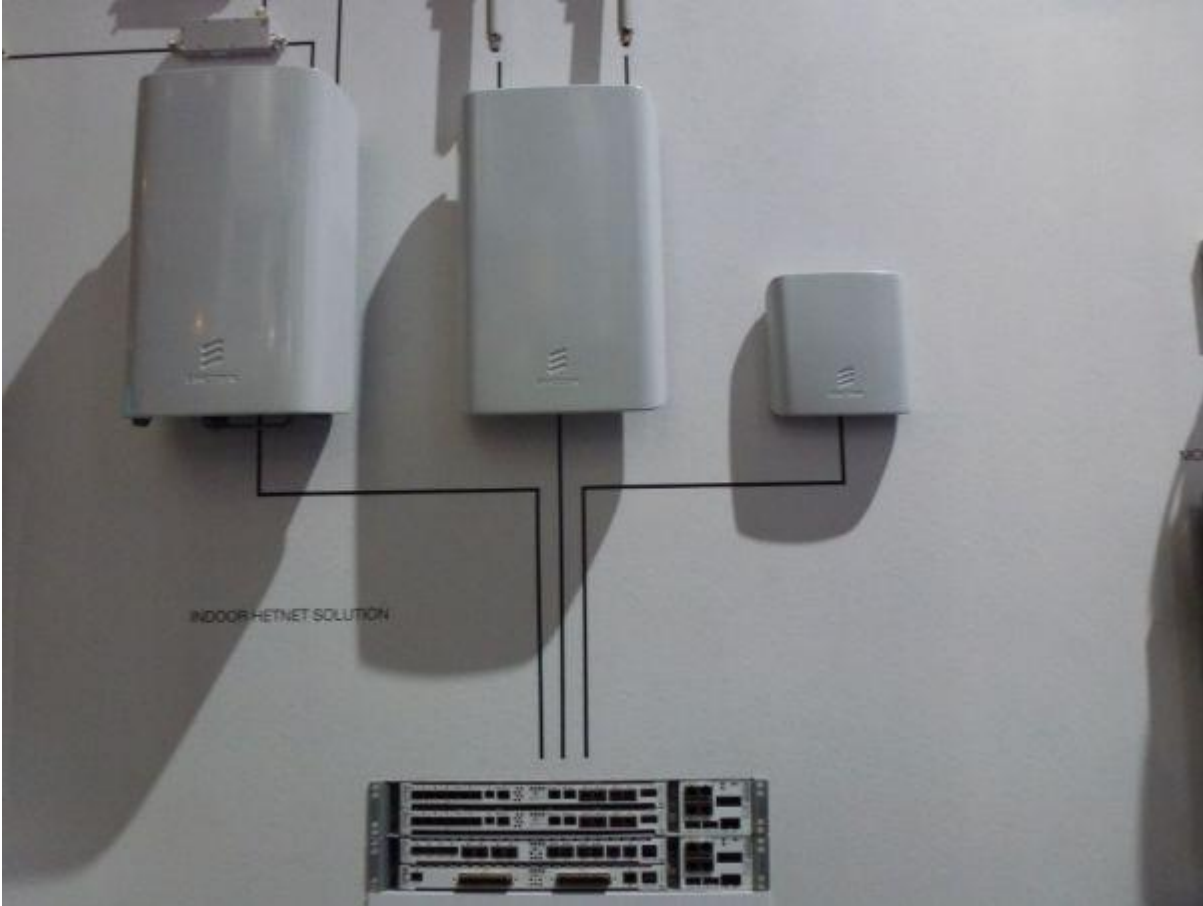
First lightRadio™ product



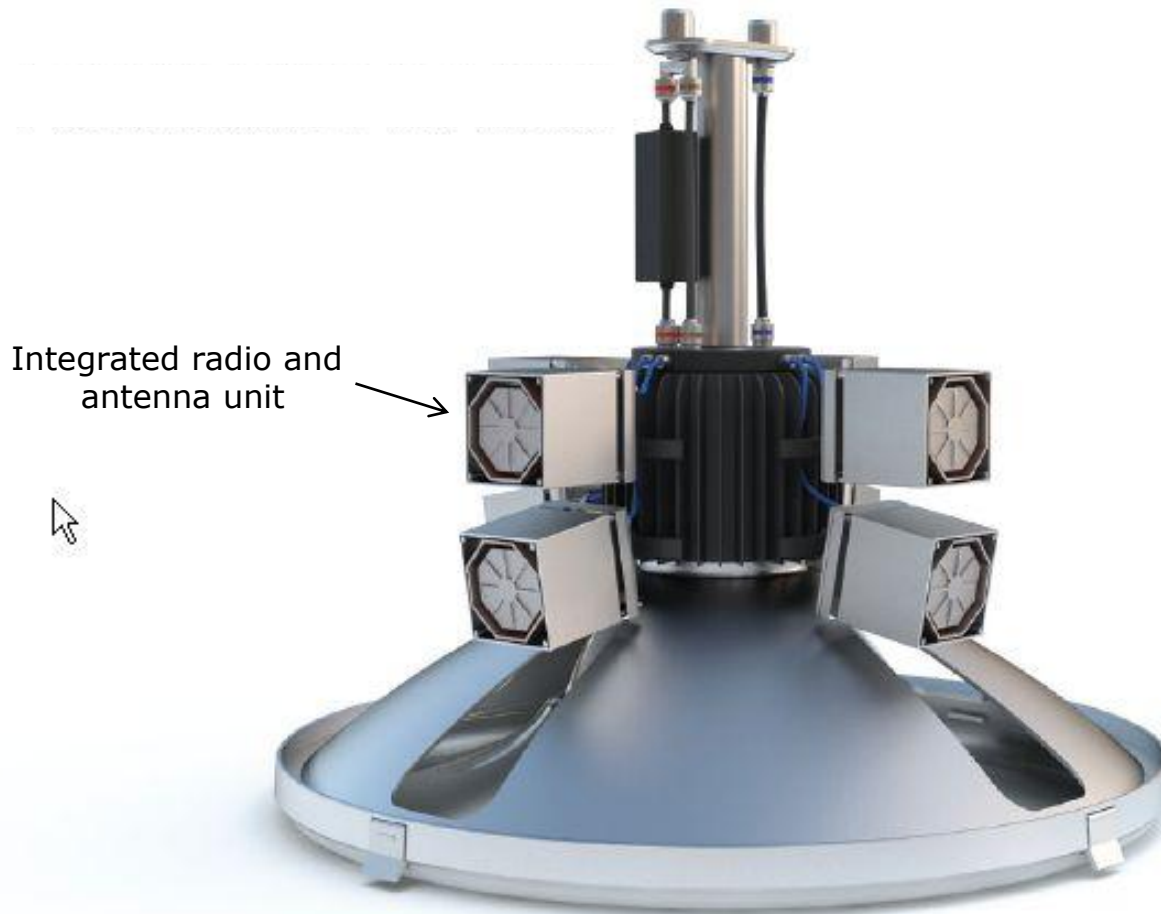
W-CDMA 1x2 1W All-in-One

- W-CDMA
- Ruggedized design
- 1Tx & 2Rx
- AC input with 30W power dissipation
- GbE over SFP (electrical or optical)
- 16 active users
- 1 carrier full HSPA

Ericsson's Small Cell solution



Is this the new small cell? Mobile cells integrated in lamp posts



In 2015, all mercury light sources in outdoor lighting will be phased out in favour of more energy efficient alternatives, following the EU directive 245/2009

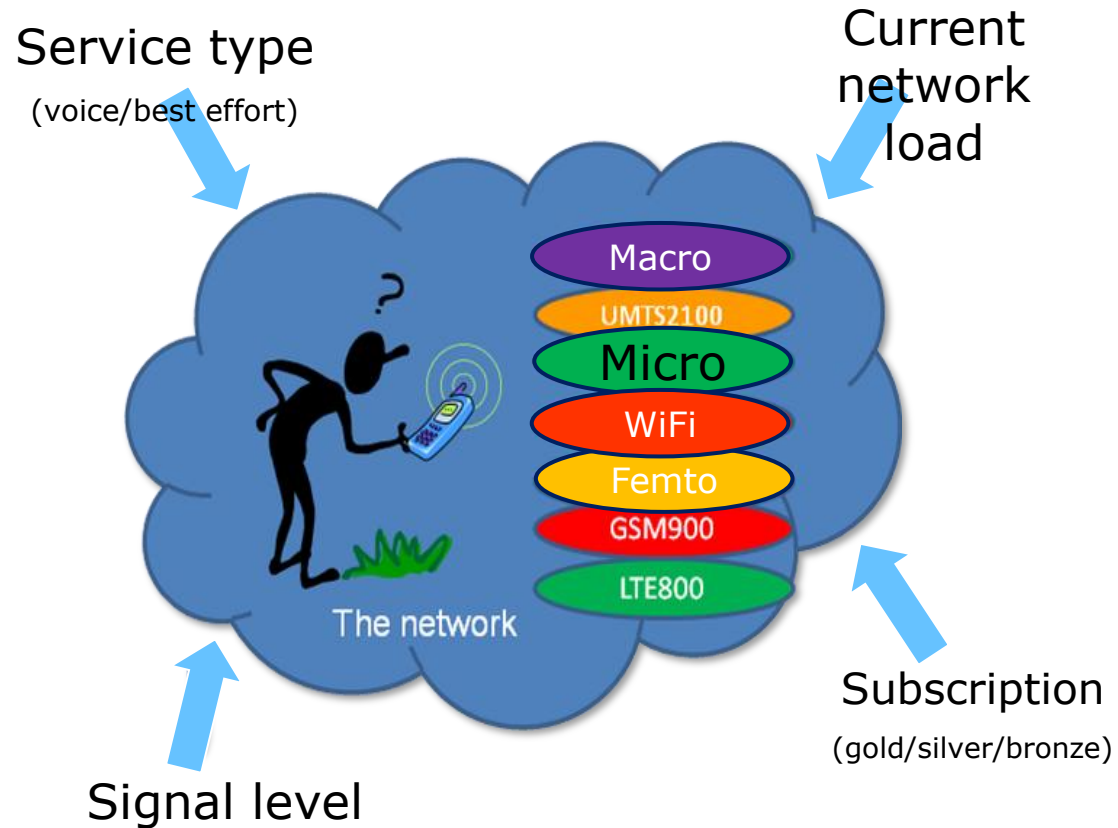
HetNet backhaul options

- xDSL
- Cable
- Fibre
- Microwave →



Traffic steering in HetNet to improve user satisfaction and network efficiency

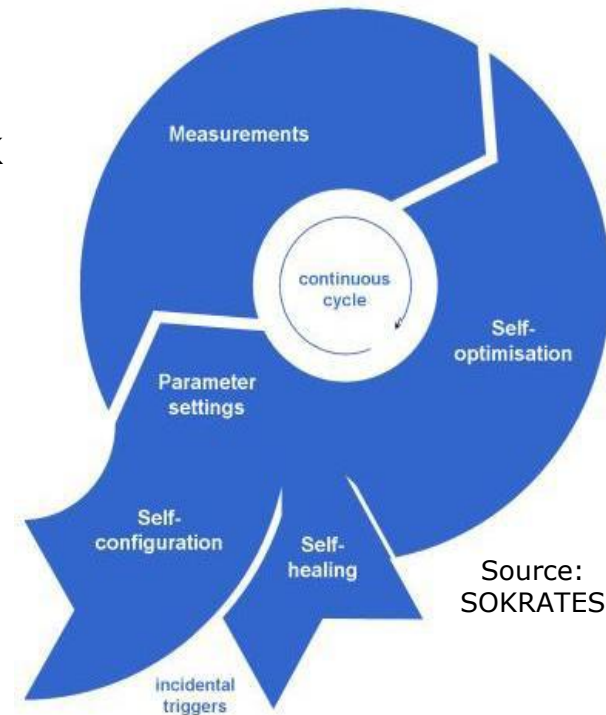
- Several parameters can be used to influence traffic steering
- Steering between macro – micro cells or between access technologies (even WiFi)
- Implementing traffic steering could reduce Capex for capacity and coverage



Self Organising Networks (SON) improves customer experience and network efficiency

SON is a growing family of functions for automating network configuration & operation. SON enables a much more dynamic network optimization than what would be possible by manual control.

- **Self-configuration**
Functions that allows newly deployed network elements to be automatically configured.
- **Self-optimization**
Functions for auto-tuning of the network to optimize given performance criteria.
- **Self-healing**
Functions for failure detection, diagnosing and healing.
- **Self-planning**



For every new access network generation, number of network parameters increases 10-fold. HetNet deployment complicates this even further. Optimum processing and tuning of all these parameters can only happen with SON.

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What is "refarming"



In agriculture: Switch from growing one type of product to another: E.g. from potato to carrot.

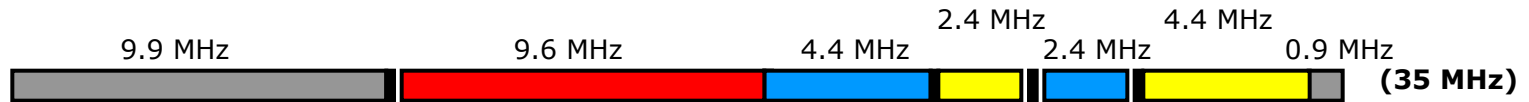
In mobile communications: Switch from one technology to another (in the same frequency band) – e.g. from GSM to GSM + UMTS

Requirements:

- Licenses are *technology neutral*
- (Often) Spectrum holding is *contiguous*
- Operators have a *minimum amount of spectrum each*

Refarming example 900 MHz

Before:



9.9 MHz + 0.9 MHz not allocated

Only red operator are able to reform from GSM to GSM + UMTS (requires ~10 MHz and contiguous spectrum)

After



Government has:

- Allocated the unassigned spectrum to the three operators
- Reshuffled the spectrum so that all operators have contiguous spectrum
- All operators can reform from GSM to GSM + UMTS

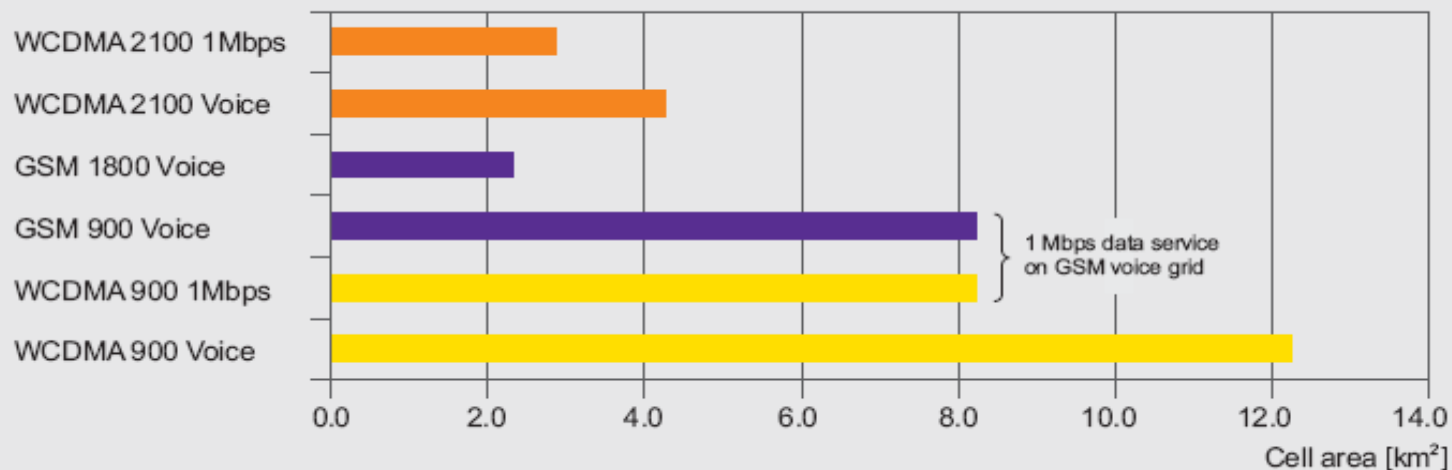
Legends: Red operator Blue operator Yellow operator Unassigned

Why refarm from GSM to UMTS in 900 MHz?

(WCDMA = UMTS = 3G)

Larger UMTS cells: Less expensive deployment in areas with low population density

Better UMTS indoor coverage: Better quality in cities/urban areas



(Source: Nokia Siemens Networks & Elisa)

Other refarming options

From GSM to GSM + LTE in 1800 MHz band

Recently large interest in LTE1800 among operators:

- Chipset and terminal support
- Infrastructure (base station) support

LTE1800 advantages (compared to LTE2600):

- (Approximately) twice the coverage
- Reuse of antennas and cell grid for operators which use GSM1800

Agenda

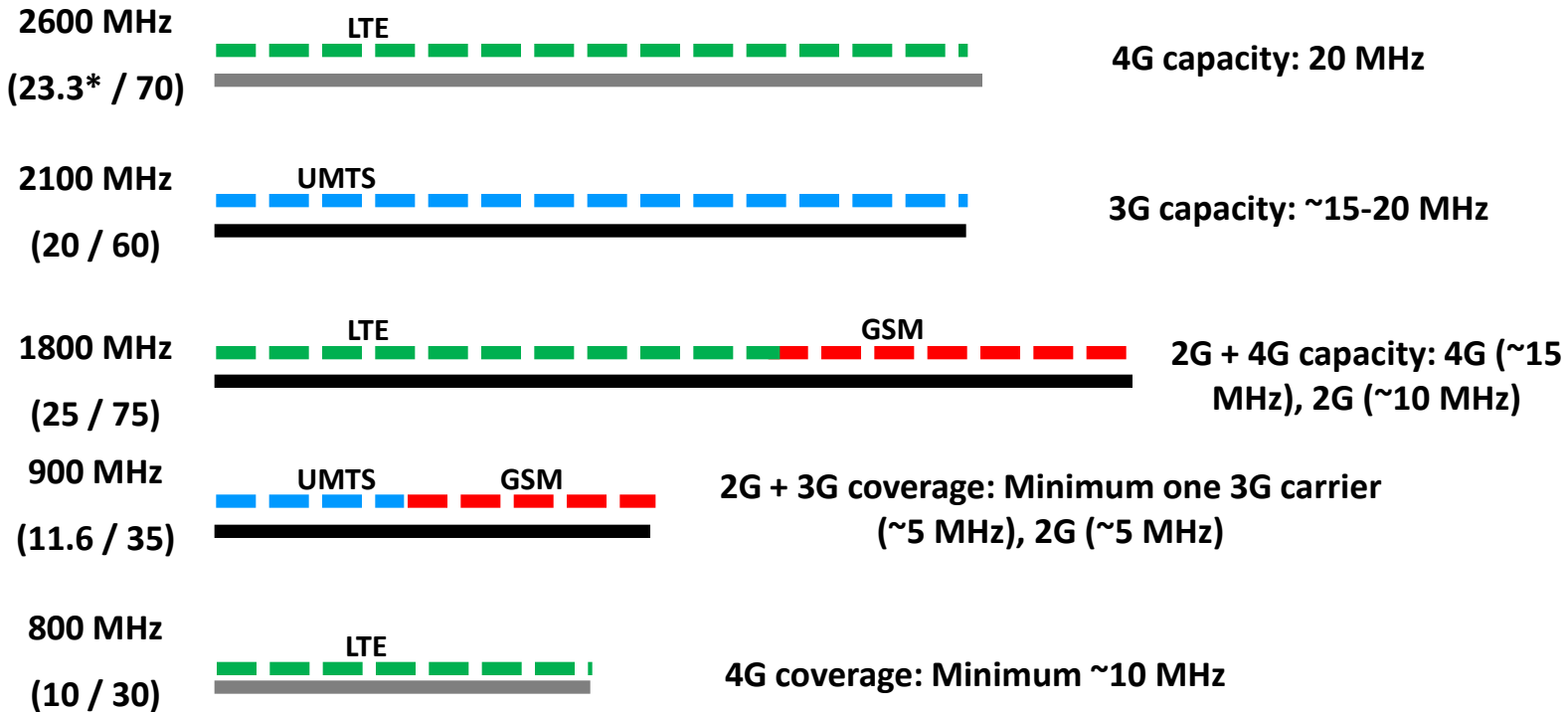
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Planning a portfolio – The magical number three? (1/2)

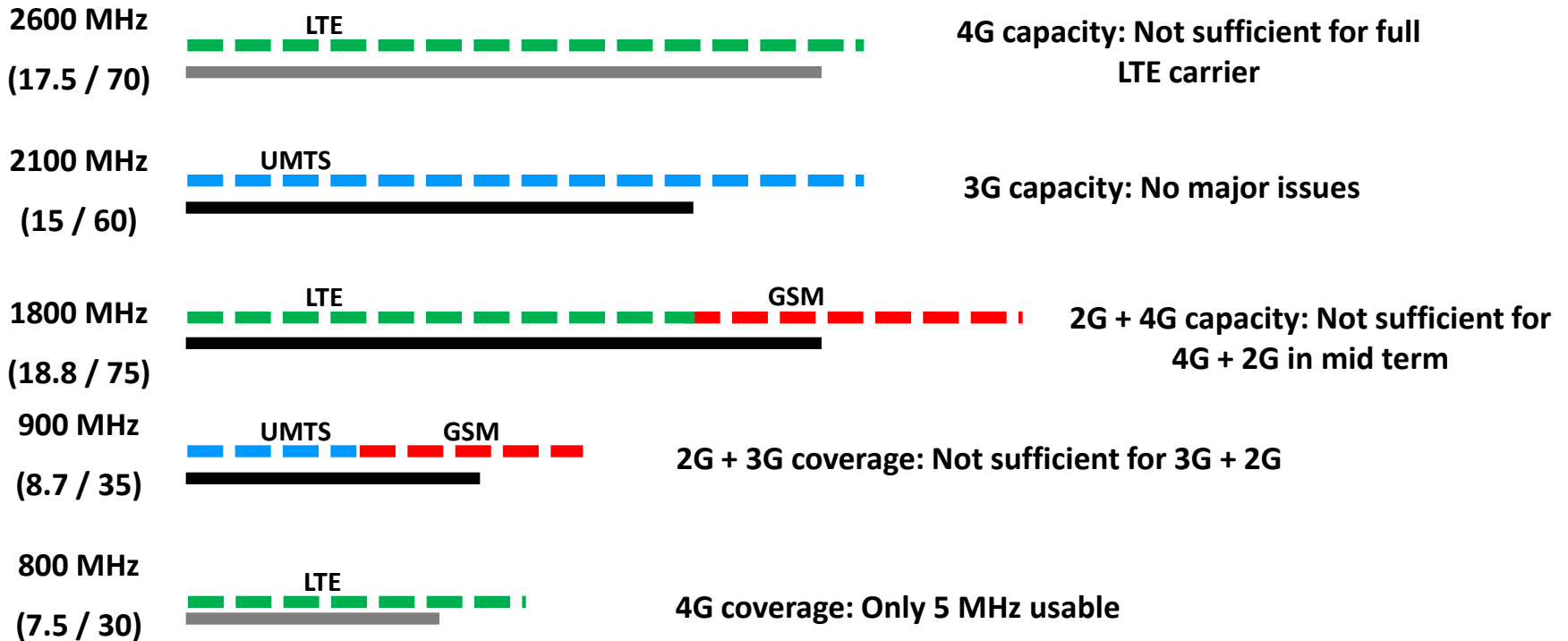
Imagine a situation where an operator has **one third of the maximum available spectrum** in the most important spectrum bands.

What would typically be the spectrum usage in mid term (2-5 years):



Planning a portfolio – The magical number three? (2/2)

Imagine a situation where an operator instead has **one fourth of the maximum available spectrum** in the most important spectrum bands:








Technology constraints one major reason for **consolidation** among mobile network operators in recent years, as well as the focus on **network sharing**



Data support: Making the right choices

• For each category, which frequency / technology combination will be supported by more than e.g. 10 % of devices?

• Any investment decision is based on a forecast of device penetration and density and an assessment of how we can invest to influence penetration

	UMTS 900	UMTS 2100	LTE 800	LTE 1800	LTE 2600	
	✓	✓	?	✓	✓	
	✓	✓	?	?	?	
	✓	✓	?	✓	✓	
	✓	✓	?	✓	✓	
	✓	✓	✗	✗	✗	

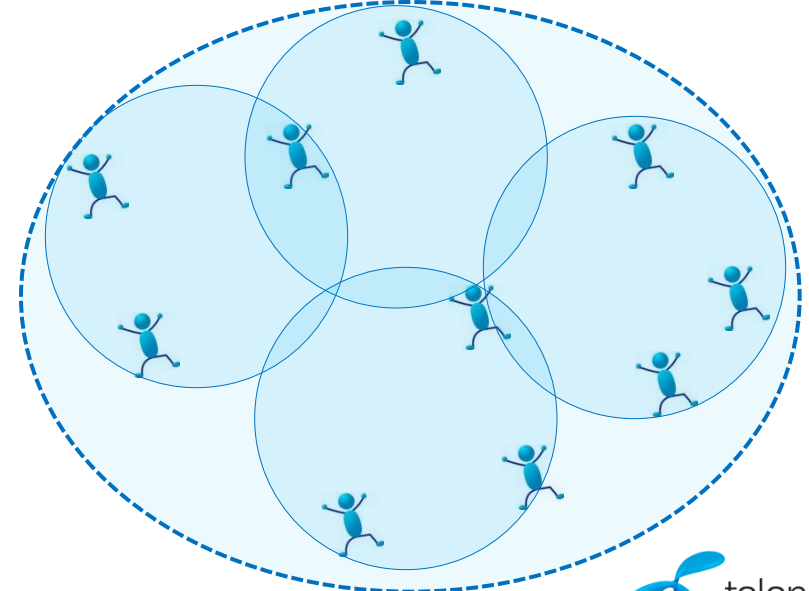
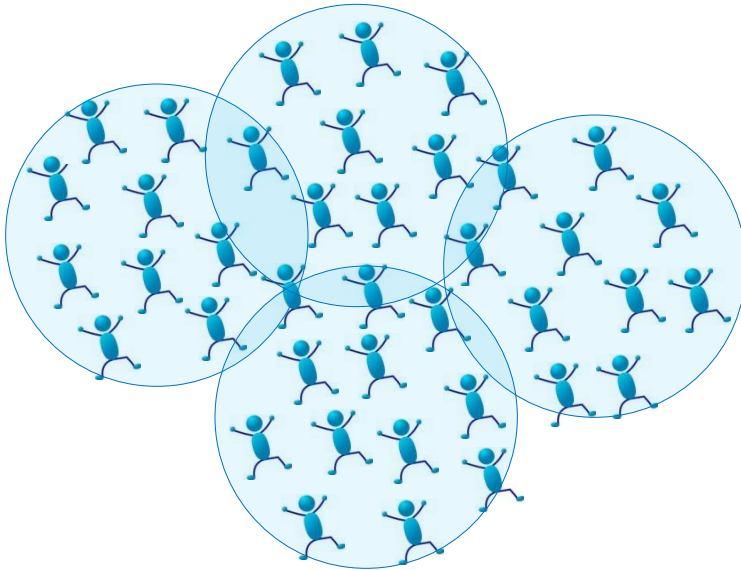
Building profitably across different area types

Urban area

- In this example, one must cover at least five customers in order for it to be commercially viable to set up a site
- In urban areas, the population density supports profitable rollout

Rural area

- Population density too low to support commercial rollout
- Larger coverage areas might ensure profitability
- Low market share 'looks like' low population density
- Low device penetration also 'looks like' low population density



The value of an amount of spectrum

Case Example – Mobile Broadband in Oslo:

Urban part of Oslo:

Area: 135 km²

Population: 560.000 people

Expected penetration: 40%

Average usage in peak hour: 100 kbit/s (downlink, mobile receive)

Case 1 – 2*10 MHz spectrum:

Traffic / site: 24 Mbit/s

Number of sites needed: 930

Case 2 – 2*20 MHz spectrum:

Traffic / site: 48 Mbit/s

Number of sites needed: 465

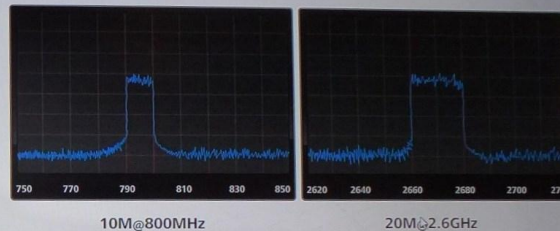
Conclusion:

(Provided Case 1 is profitable) The value of the additional 2*10 MHz spectrum in this example is equal to the cost of 465 sites (930 – 465).

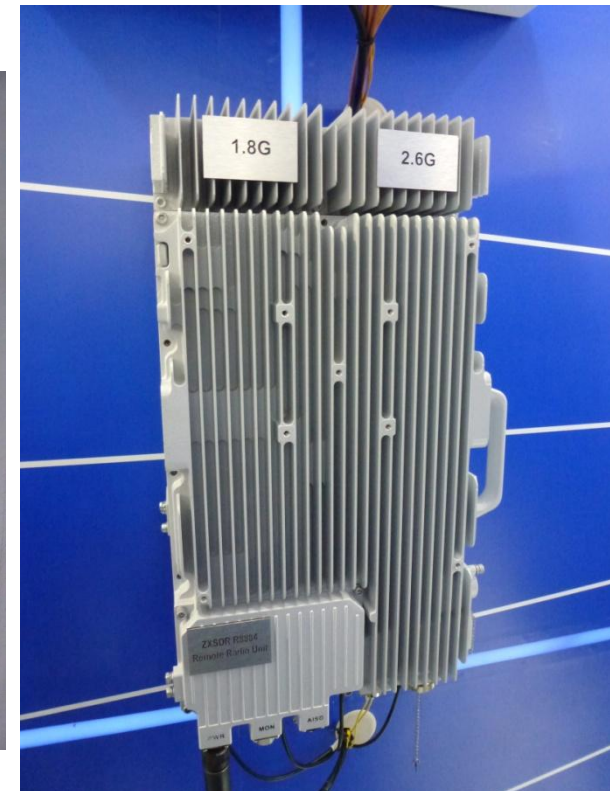
Next step: Spectrum aggregation From MWC 2012

LTE-Advanced: World's 1st Field Inter-Band Carrier Aggregation

- Ultra wide-band RF module and antenna
- Leading baseband processing capability
- Flexible channel selection & resource scheduling
- Maximize spectrum utilization

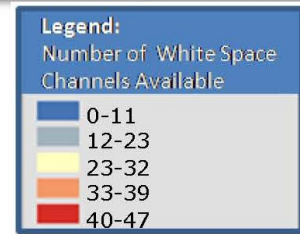
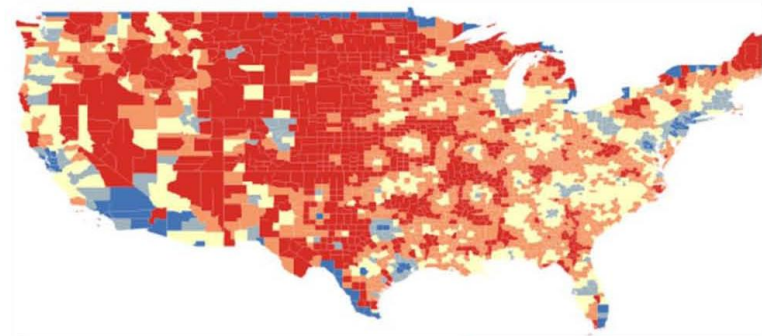
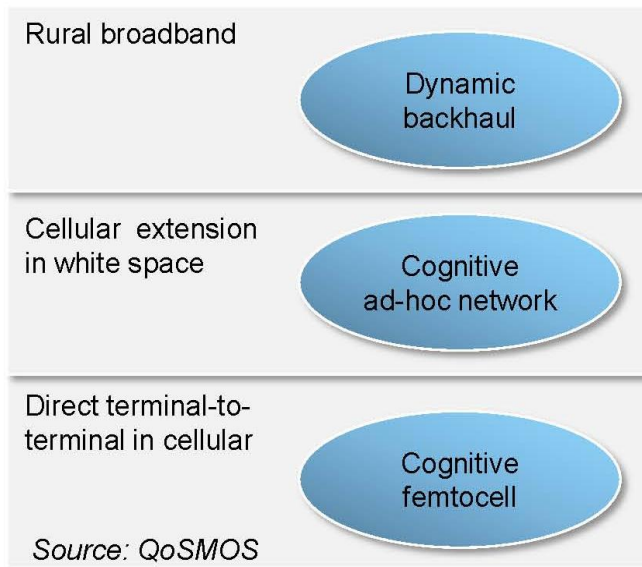


Please visit **Vodafone** booth for live demo



Future: Cognitive radio and dynamic spectrum management

- Generally lower utilization of several frequency bands (and different allocation principles)
- Standardization and improving technical capabilities
- Threat or opportunity – depending on use case



Driving more dynamics in utilization of frequency spectrum

Thank you for listening!



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