

Mobile Broadband driven by Convergence of IP and LTE technologies



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Ericsson North America

Today's Topics

- Mobile Broadband and IP Convergence
- Technology Details

Key Takeaways

1

Mobile Broadband is next big global phenomena

2

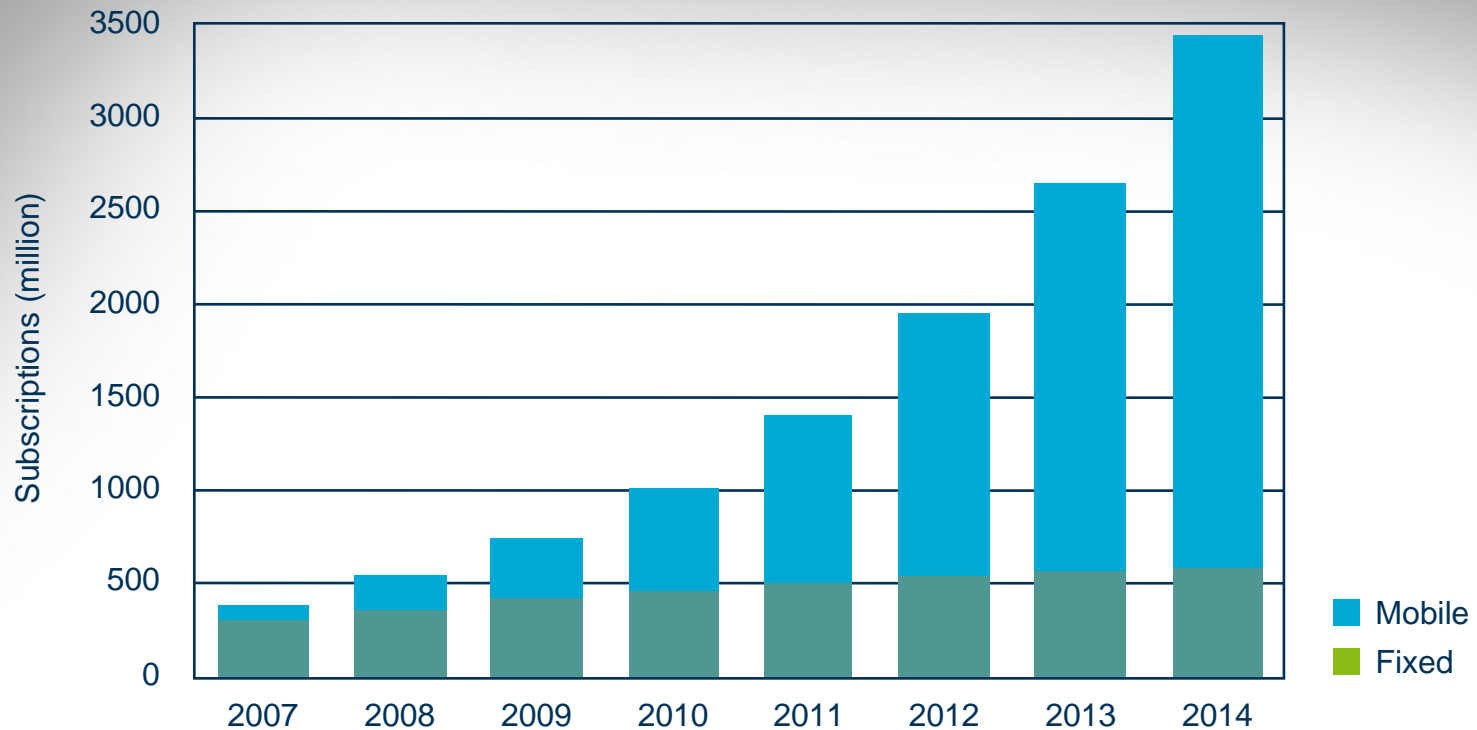
IP & LTE Technologies enable convergence

3

Ericsson is committed to drive ecosystem globally towards 50B Connections in 2020

Broadband goes mobile

From household to individuals and devices



Mobile dominates broadband access in 2014

Source: Q2 2009 Ericsson

Ericsson North America

Increased Momentum in 2009



Network Transformation

AT&T, T-Mobile Partner
AT&T Wireline Domain Partner
Verizon & Metro PCS LTE/EPC

Services Transformation

Sprint Wireline and Wireless

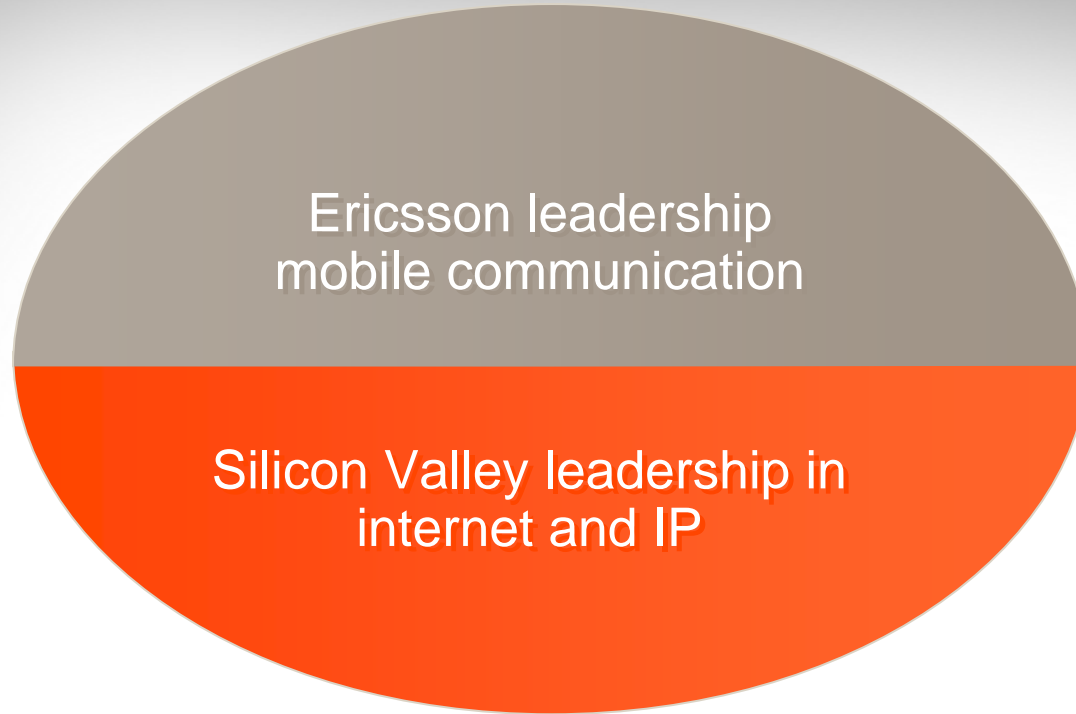
Increased R&D

Nortel CDMA and LTE Assets
Ericsson Silicon Valley: Mobility + IP + Broadband Convergence

Ericsson Operator Momentum with increased R&D

Ericsson Silicon Valley

Position



Ericsson complements Silicon Valley companies

Ericsson Silicon Valley



Ericsson Global IP Business

Ericsson Global Broadband Access

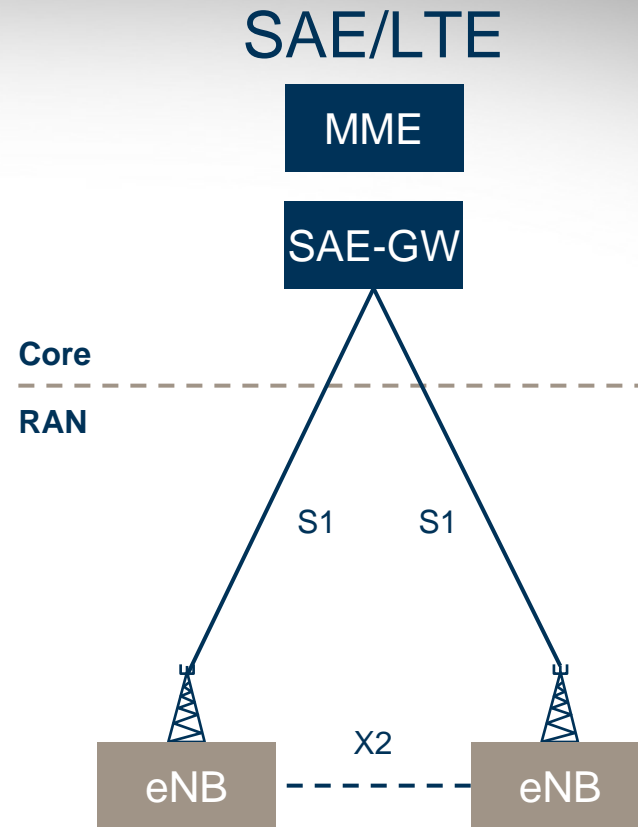
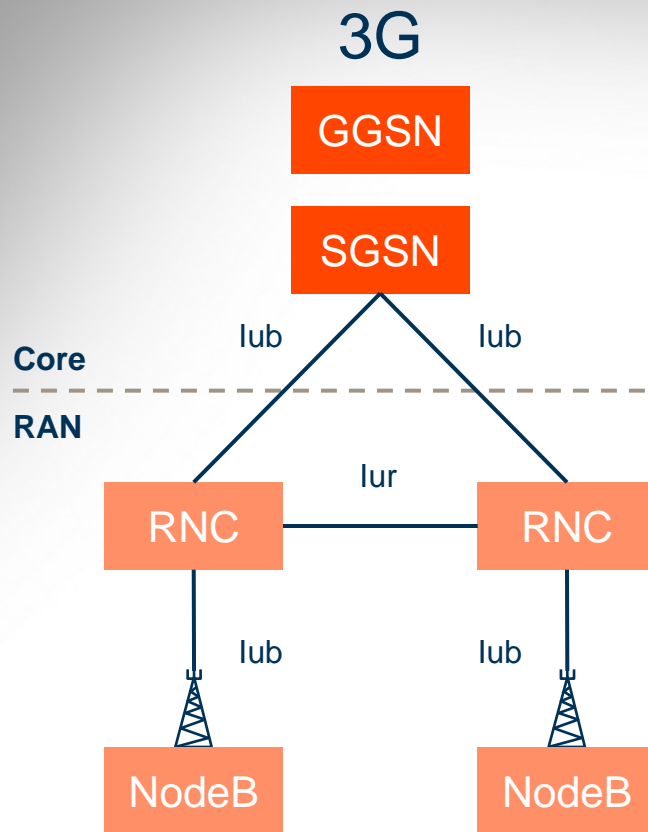
Ericsson Global Transport & Optical

Mobile Broadband & Applications
Ecosystem – External Collaboration

Ericsson Group Functions Technology,
Research, Strategy, Marketing....

Headquarter Group Functions beyond Business Functions

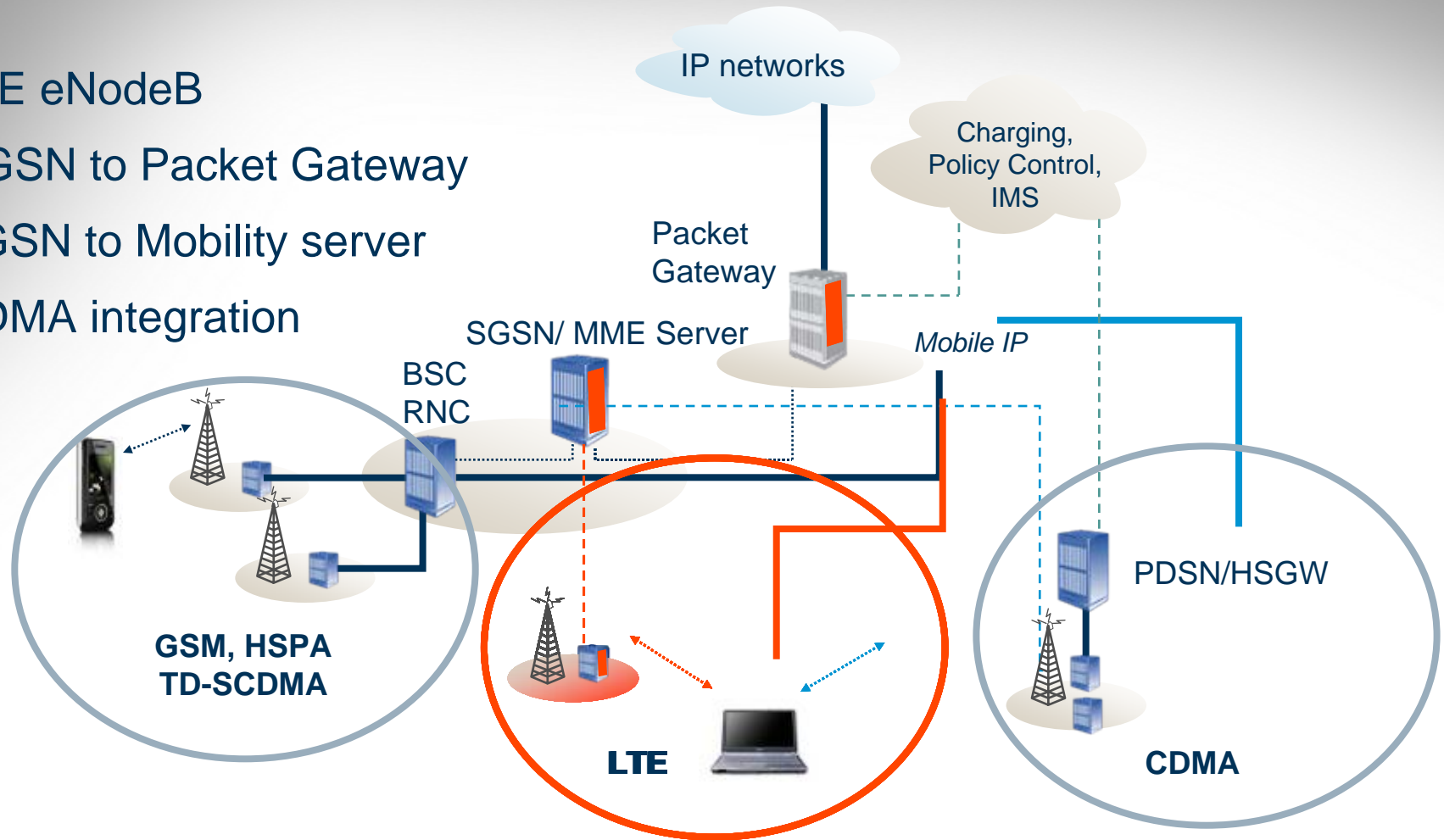
Mobile Packet Networks – Flat IP



LTE integrated with 2G/3G Mobile Networks

Smooth multi-access evolution

- LTE eNodeB
- GGSN to Packet Gateway
- SGSN to Mobility server
- CDMA integration



Converged Packet Gateway

Part of Evolved Packet Core

World's Most Sophisticated Core

Converged Edge
Fixed & Mobile



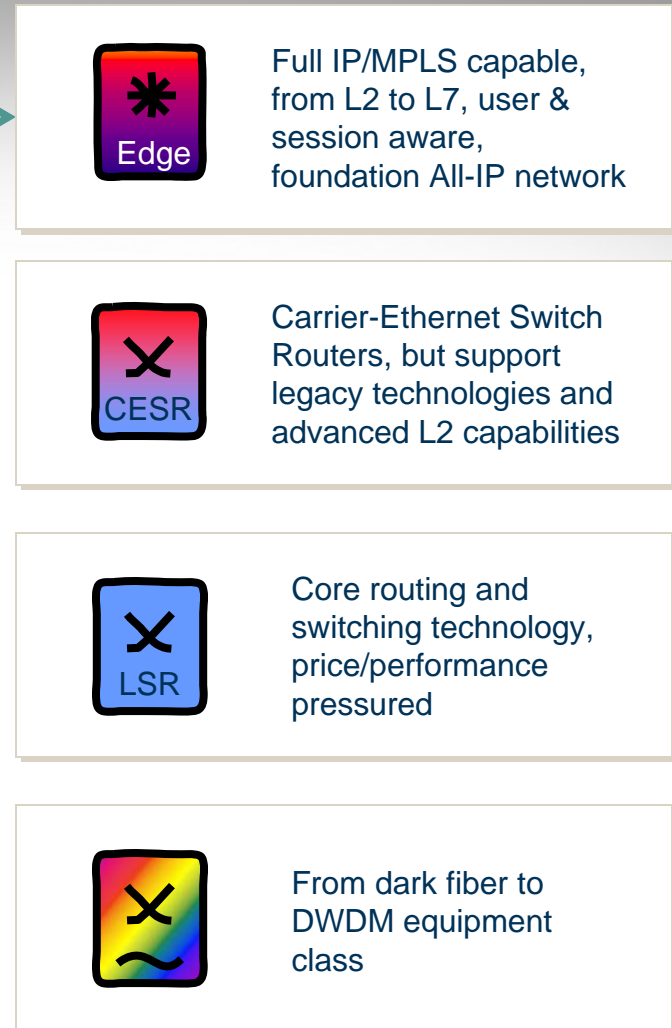
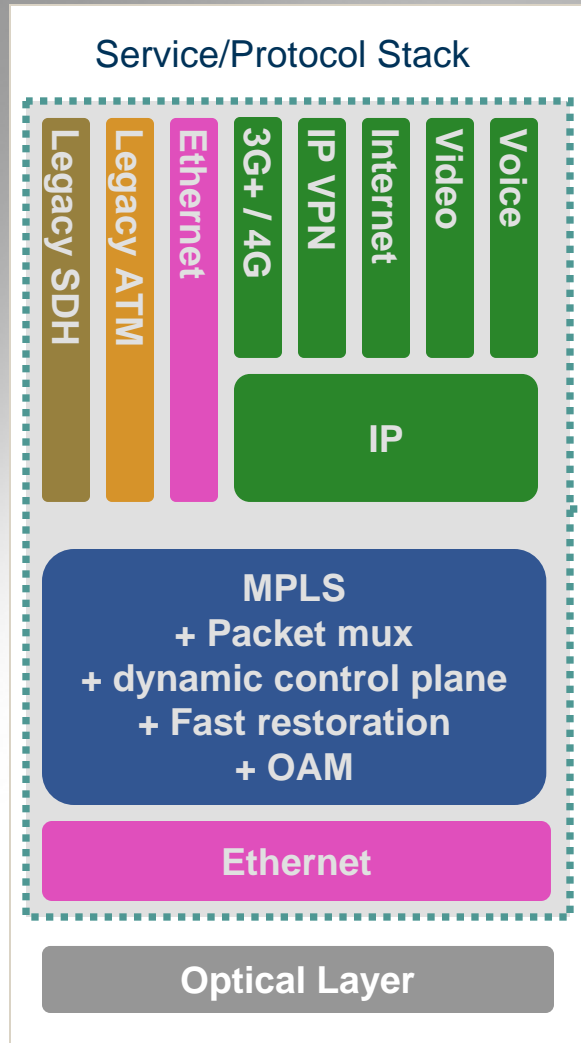
Best of Both worlds

- LTE, GSM/WCDMA, CDMA
- Fixed MSER networks

Mobility + Fixed throughput

Software upgrades to SGSN/GGSN

IP in Relation to Protocol Stack



Towards 50 Billion Connections

Today

Mobile

Fixed



>4 billion subscribers

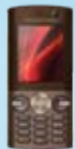
**Personal services, Mobility, Interoperable
Subscriber scale optimized**

>400 million subscribers

**Per household
Cost/bit optimized**

Tomorrow

Full Service Broadband



50 billion connections

**Personal, Mobility, Interoperable
Subscriber, device & cost/bit optimized**

Mobile excellence proven for personalized services, interoperability and scale

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IP & LTE Technologies enable convergence

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Ericsson is committed to drive ecosystem globally towards 50B Connections in 2020

Today's Topics

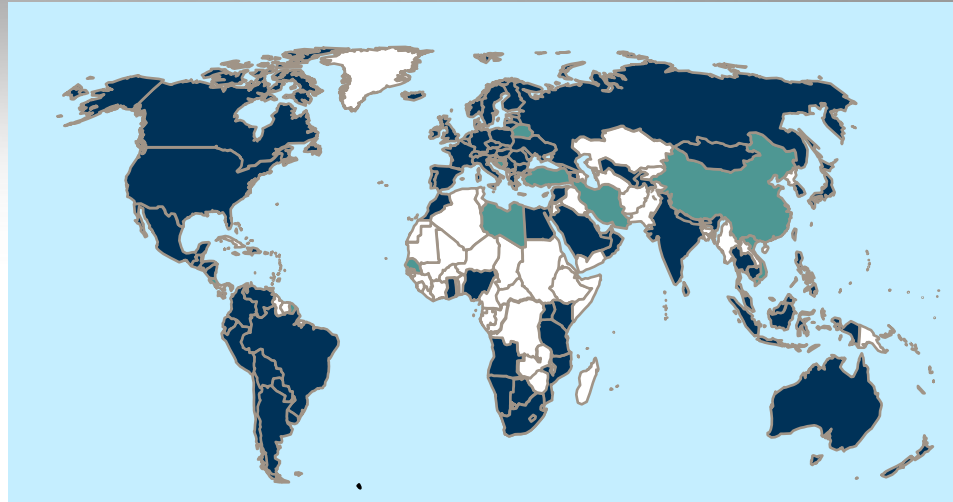
- Mobile Broadband and IP Convergence
- **Technology Details**

Mobile Broadband

A global success story

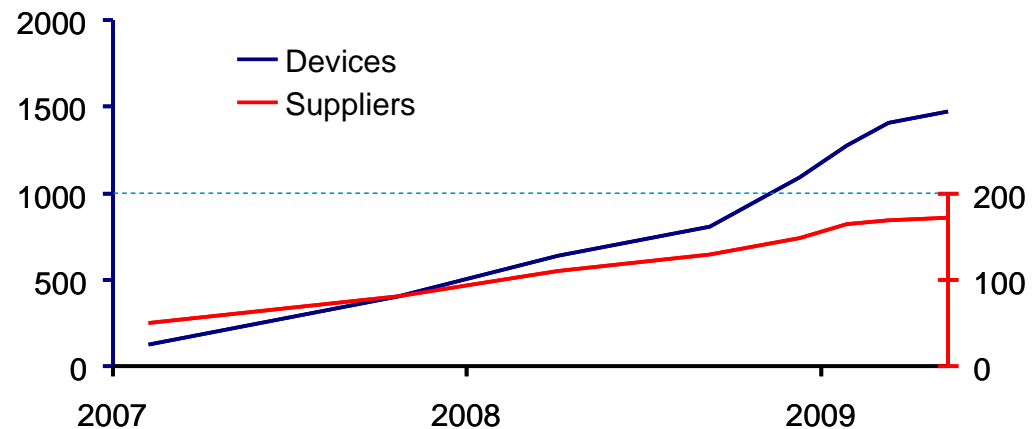


- 267 commercial HSPA networks
 - Ericsson: 127 (48%)
- >350 million WCDMA/HSPA subscribers



■ Commercial HSPA networks
■ HSPA network launch commitments

- 1470 HSPA devices
- 171 suppliers



Source: GSA – Global mobile Suppliers Association and Informa: May/June 2009

Cellular System Design

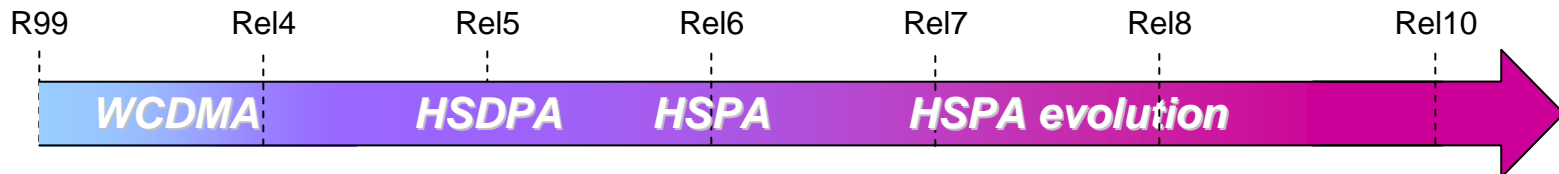
- Bandwidth
- Carrier frequency
- Power
- Cell sites
- Air interface
- Antennas
- Receivers
- Standards / proprietary

Air Interface

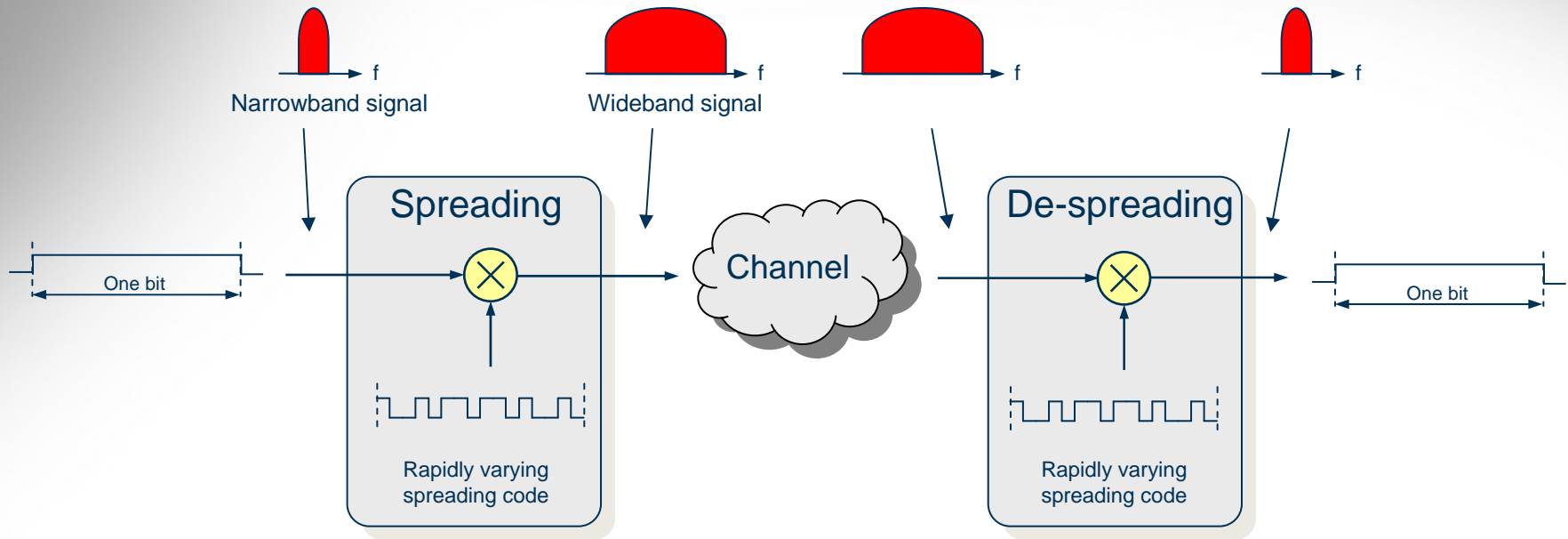
- Abstract
 - *TDMA, CDMA, OFDM etc*
 - *Divy up resources of time, frequency, energy, space*
 - *Largely equivalent*
- Reality
 - *Finite complexity and real technology*
 - *Standards deviate from basic concept*
 - *Introduce specific limitations*
 - *Results in eco-system of specific techniques*
 - *Advantages in particular scenarios*
- Different generations
 - *Different technology ambitions*
 - *New techniques go with new systems*
 - *Unfair comparisons*

WCDMA Background

- WCDMA ("3G")
 - *Basics developed mid-90's, standard ready -99*
 - *Circuit-switched voice*
 - *"ISDN-like" packet data (typically up to 384 kbit/s)*
- HSPA ("Turbo-3G")
 - *Packet-data improvement add-on to WCDMA*
 - *First version ~2002*
 - *Data rates up to 42 Mbit/s (downlink), 11 Mbit/s (uplink)*
- HSPA is an evolution of WCDMA
 - *Incorporating the basic principles from last session*



WCDMA Basics – Spreading

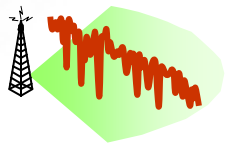


HSPA Basics – Downlink and Uplink

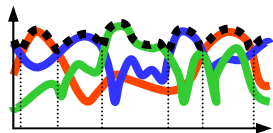
- Similar principles for uplink and downlink
- But there are some fundamental differences



Shared resource



Link adaptation



Scheduling

Downlink



Power, codes
– Tx power ‘centralized’

Rate adaptation
(orthogonal \Rightarrow
no near-far problem)

favorable conditions \Rightarrow
high user data rate

Uplink



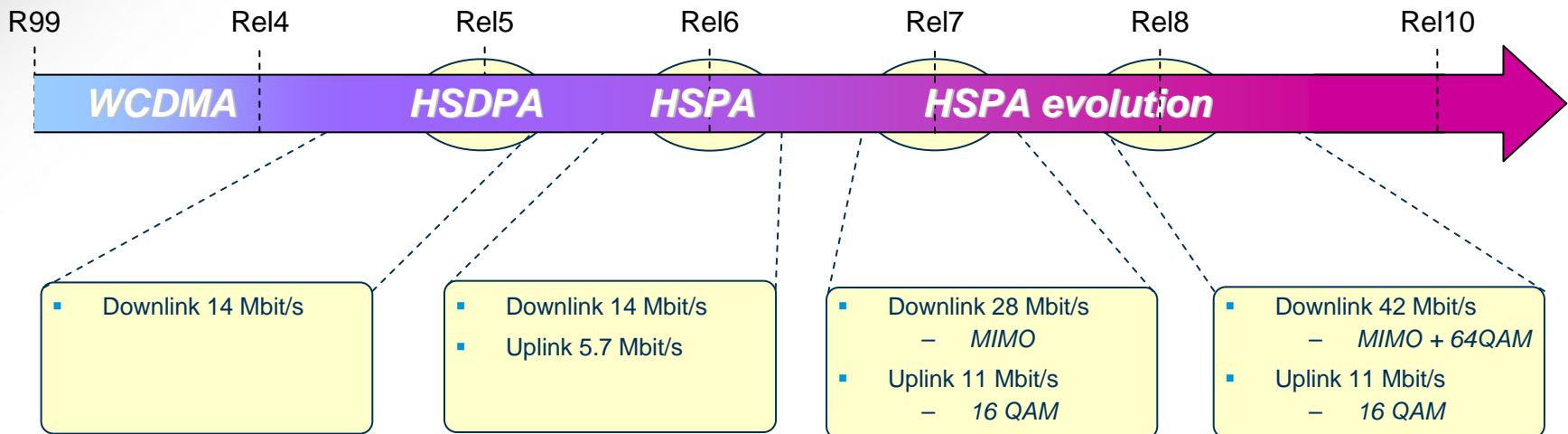
Interference headroom
– Tx power ‘distributed’

Power control
(non-orthogonal \Rightarrow
near-far problem)

favorable conditions \Rightarrow
less interference

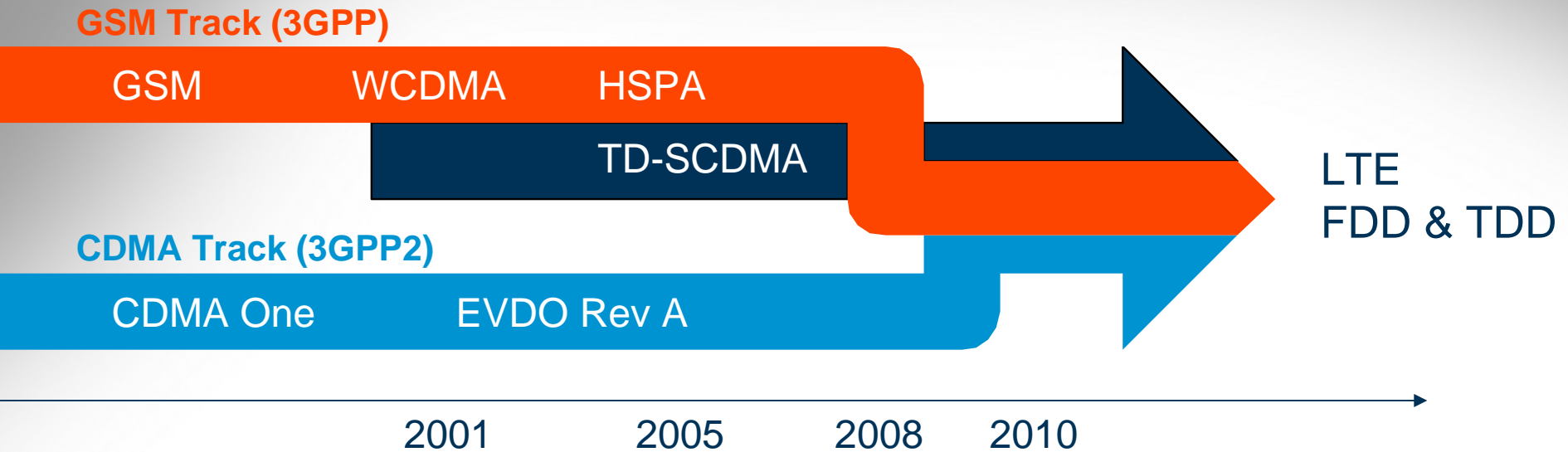
HSPA Evolution

- HSPA – High-Speed Packet Access
 - Evolution of 3G/WCDMA
 - Gradually improved performance in existing networks at a low additional cost
 - Data rates up to 42 Mbit/s in 5 MHz
- Evolution continues
 - Wider bandwidth, receiver improvements, protocol enhancements, ...



Mobile System Evolution

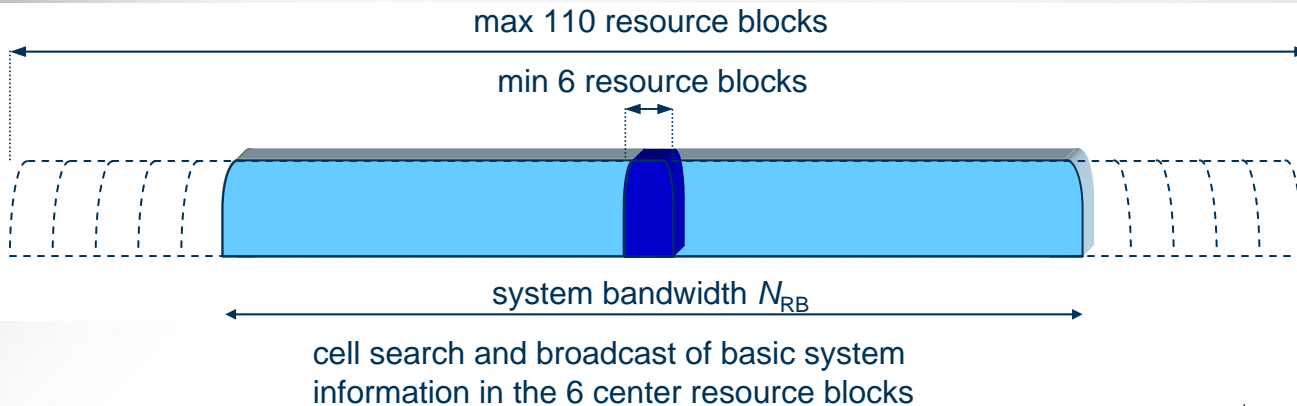
Global Support



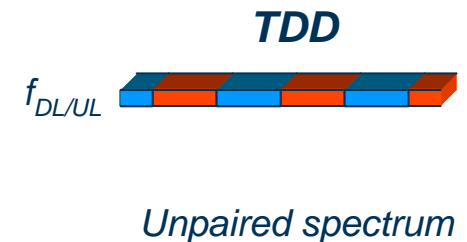
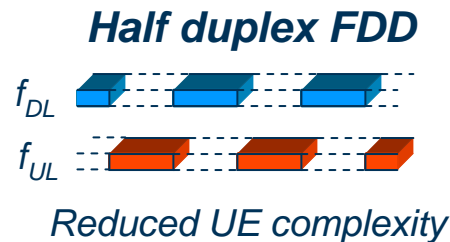
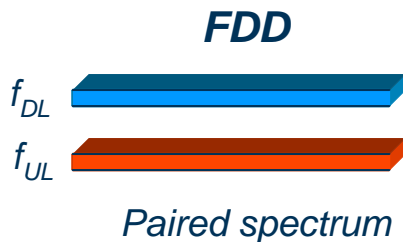
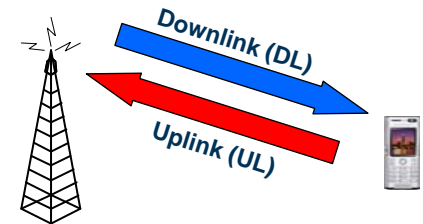
LTE is the Global standard for Next Generation – FDD and TDD

Spectrum Flexibility

- Spectrum flexibility → operation in differently-sized spectrum allocations



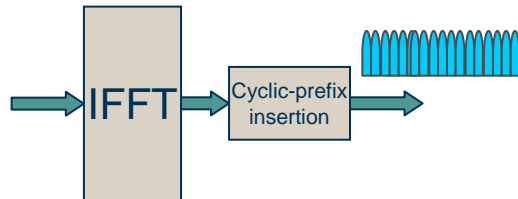
- Support for paired *and* unpaired spectrum allocations



LTE radio access

Downlink: OFDM

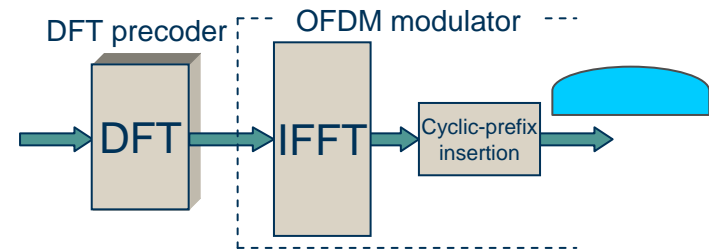
- Parallel transmission on large number of narrowband subcarriers



- Benefits:
 - Avoid own-cell interference
 - Robust to time dispersion
- Main drawback
 - Power-amplifier efficiency

Uplink: DFTS-OFDM

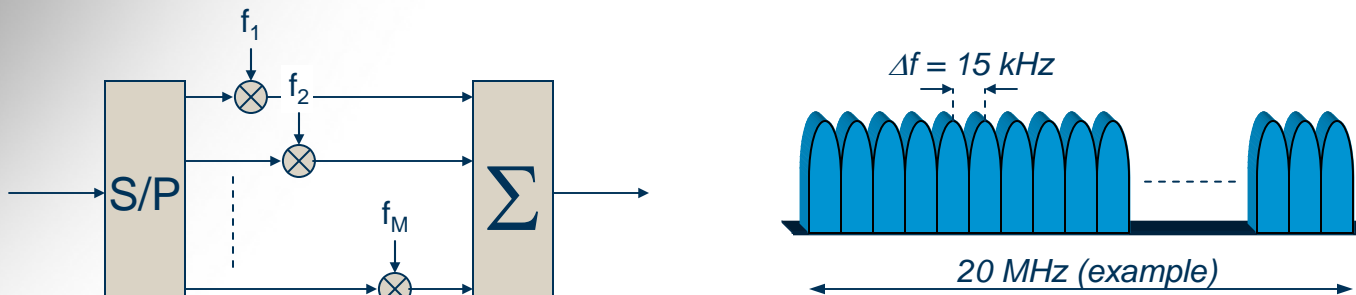
- DFT-precoded OFDM



- TX signal has single-carrier properties
 - ⇒ Improved power-amplifier efficiency
 - Improved battery life
 - Reduced PA cost
 - Critical for uplink**
- Equalizer needed ⇒ Rx Complexity
 - Not critical for uplink**

Downlink – OFDM with Cyclic Prefix

- Parallel transmission using a large number of narrowband “sub-carriers”
- “Multi-carrier” transmission
 - Typically implemented with FFT

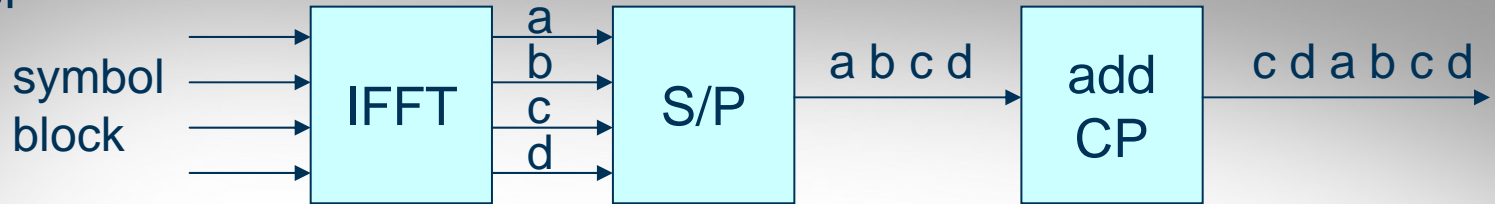


- Insertion of cyclic prefix prior to transmission
 - Improved robustness in time-dispersive channels – requires $CP > \text{delay spread}$
 - Spectral efficiency loss

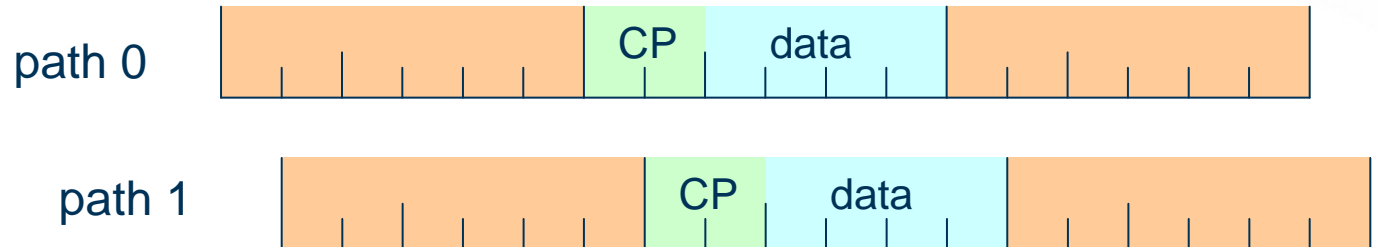


Cyclic Prefix – Simpler Receiver

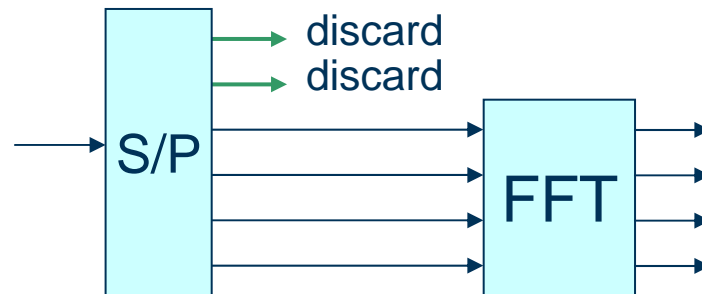
- Transmitter



- Time dispersion

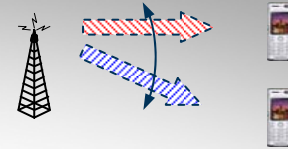


- Receiver

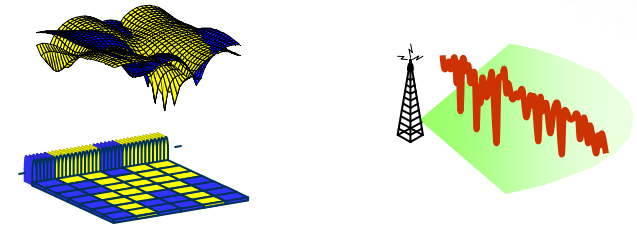


Basic Principles

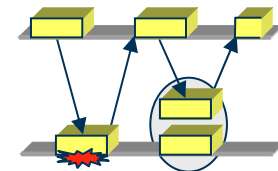
- Shared-channel transmission
 - *Packet-data only*
 - *No CS support*



- Channel-dependent scheduling
 - *In time and frequency*

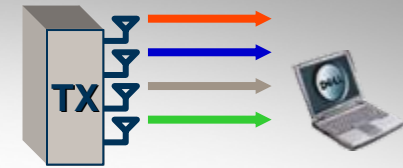


- Hybrid-ARQ with soft combining

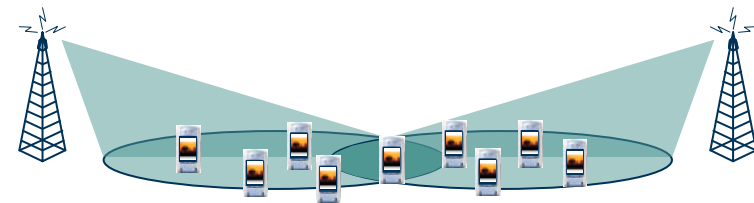
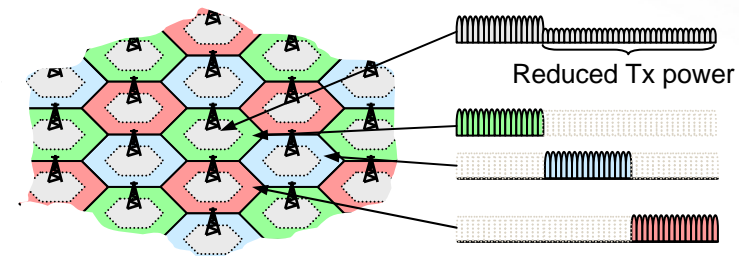


MIMO, ICIC, and MBSFN

- Multi-antenna support
 - *Integral part of LTE*
 - *All terminals support at least 2 Rx antennas*
- ICIC
 - *Inter-Cell Interference Coordination*
 - *To improve cell-edge performance*
- MBSFN
 - *Multicast-Broadcast Single-Frequency Network*



Multi-layer transmission
("MIMO")



Downlink Physical Layer

CRC insertion (24 bits)

Rel 6 Turbo coding (with QPP interleaver)

Rate matching, redundancy version generation

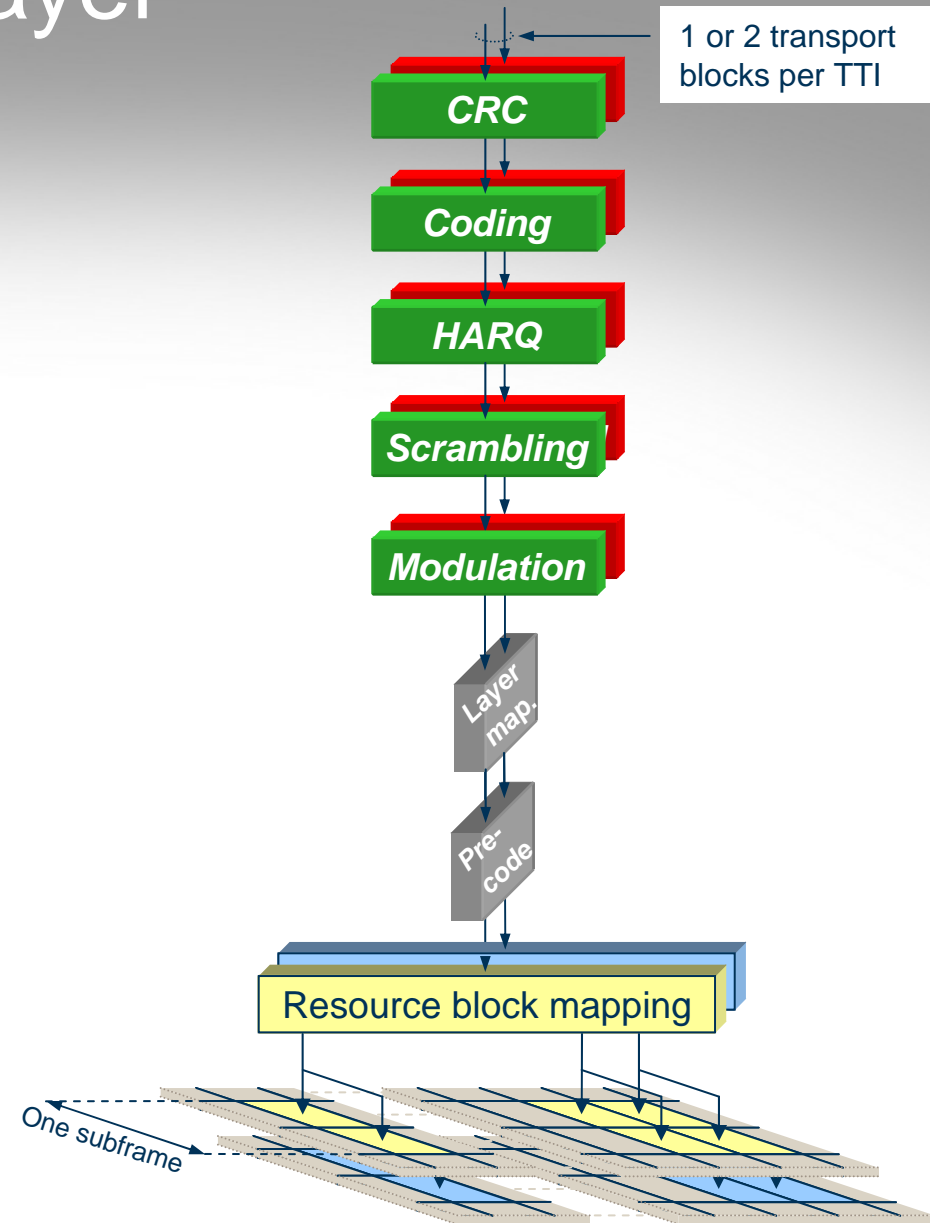
Scrambling for inter-cell interference randomization

Modulation (QPSK, 16QAM, 64QAM)

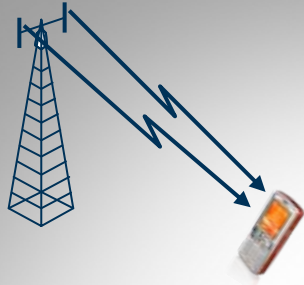
Mapping to transmission layers (for multi-layer transmission)

Precoding (for multi-rank transmission)

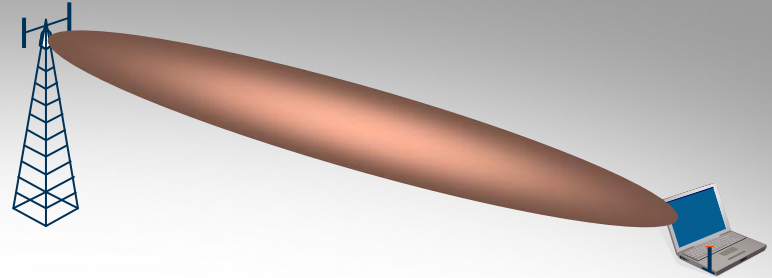
Resource block mapping



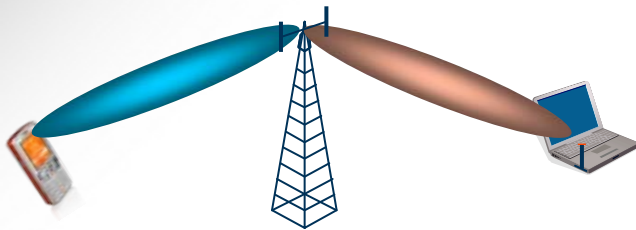
Multi-antenna transmission techniques



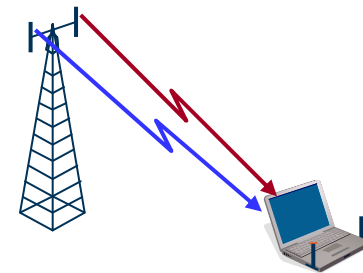
Diversity for improved system performance



Beam-forming for improved coverage (less cells to cover a given area)



SDMA for improved capacity (more users per cell)



Multi-layer transmission ("MIMO") for higher data rates in a given bandwidth

The multi-antenna technique to use depends on what to achieve

VoIP capacity

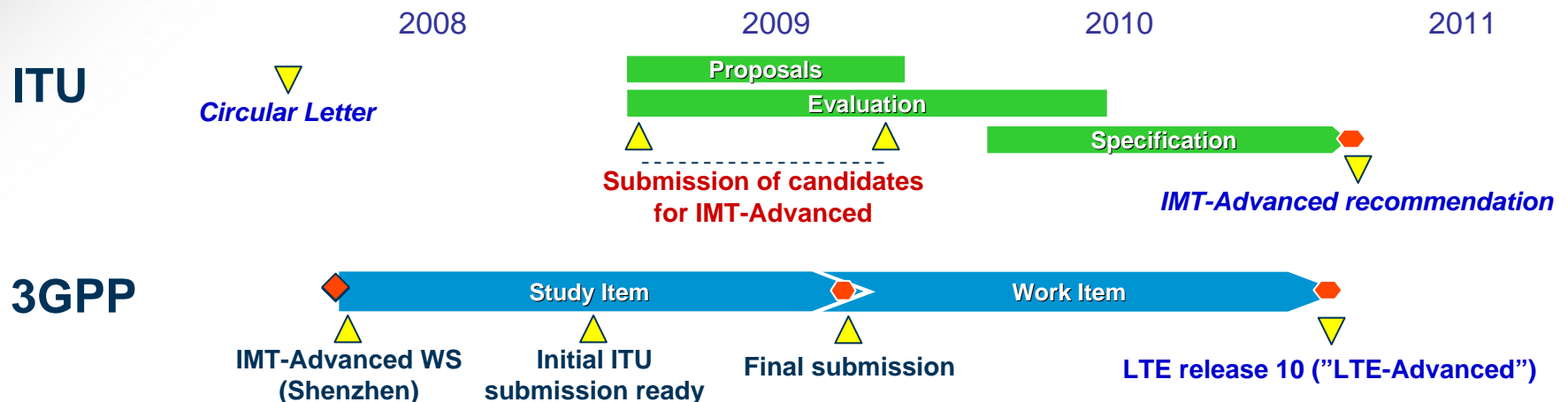
Environment	LTE*	IMT-Advanced requirement
Indoor Hot Spot	≈140	50
Urban Micro	≈80	40
Urban Macro	≈70	40
High Speed	≈90	30

* According to 3GPP ITU submission / TR 36912 v9.0.0

Very high VoIP capacity, substantially exceeding targets for IMT-Advanced

LTE evolution towards LTE-Advanced

- LTE-Advanced is the next major step for LTE
 - Corresponding to LTE release 10
 - Direct evolution of the first release of LTE
- The 3GPP candidate for IMT-Advanced radio access





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