LTE

LTE DRIVERS & TRENDS

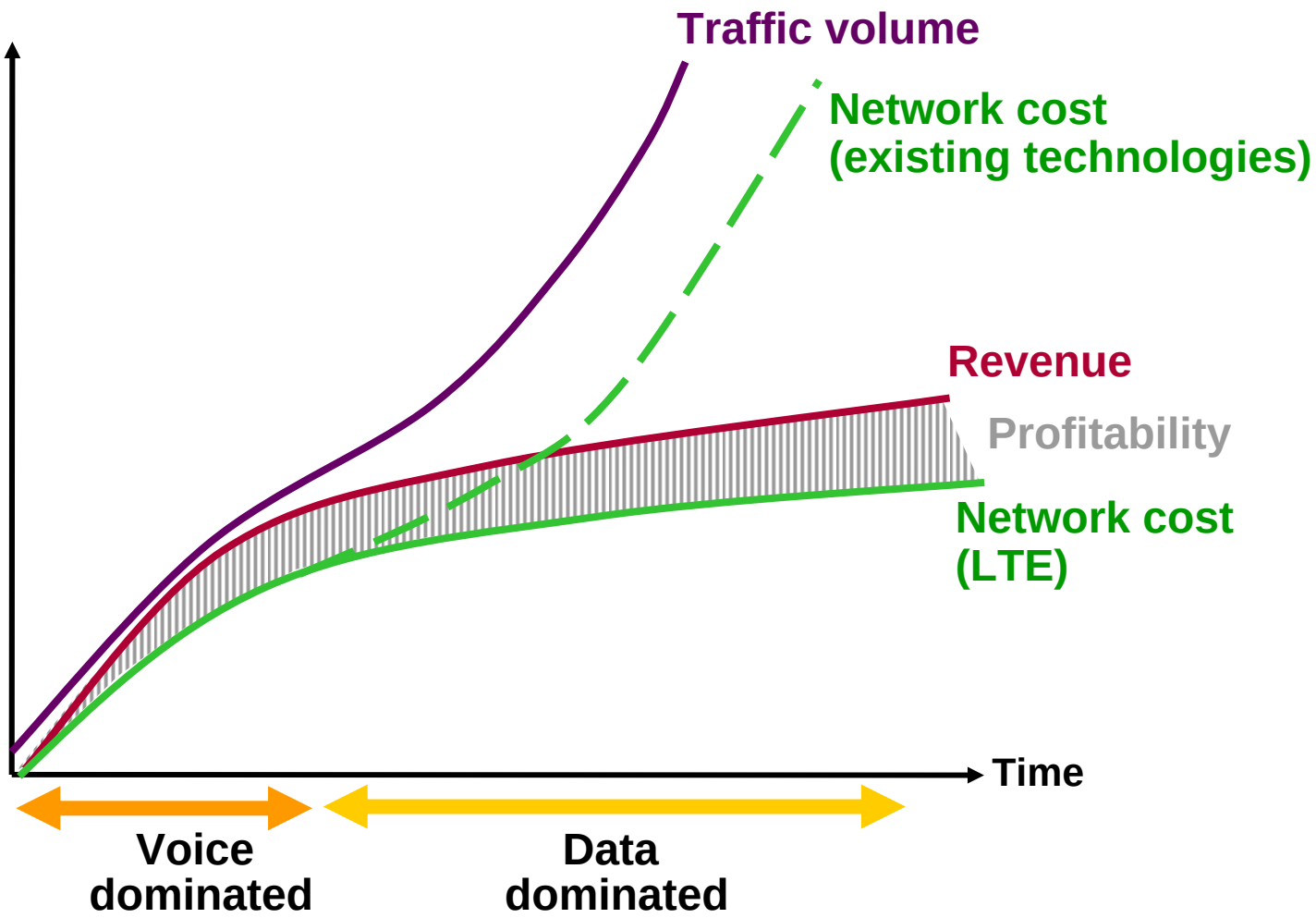
Terminal, network and application development drive traffic growth

European operator:

350% growth in HSPA data volume in 6 months

Advanced terminals **HSPA radio networks** **Internet applications**

Traffic increase requires low cost/bit technologies

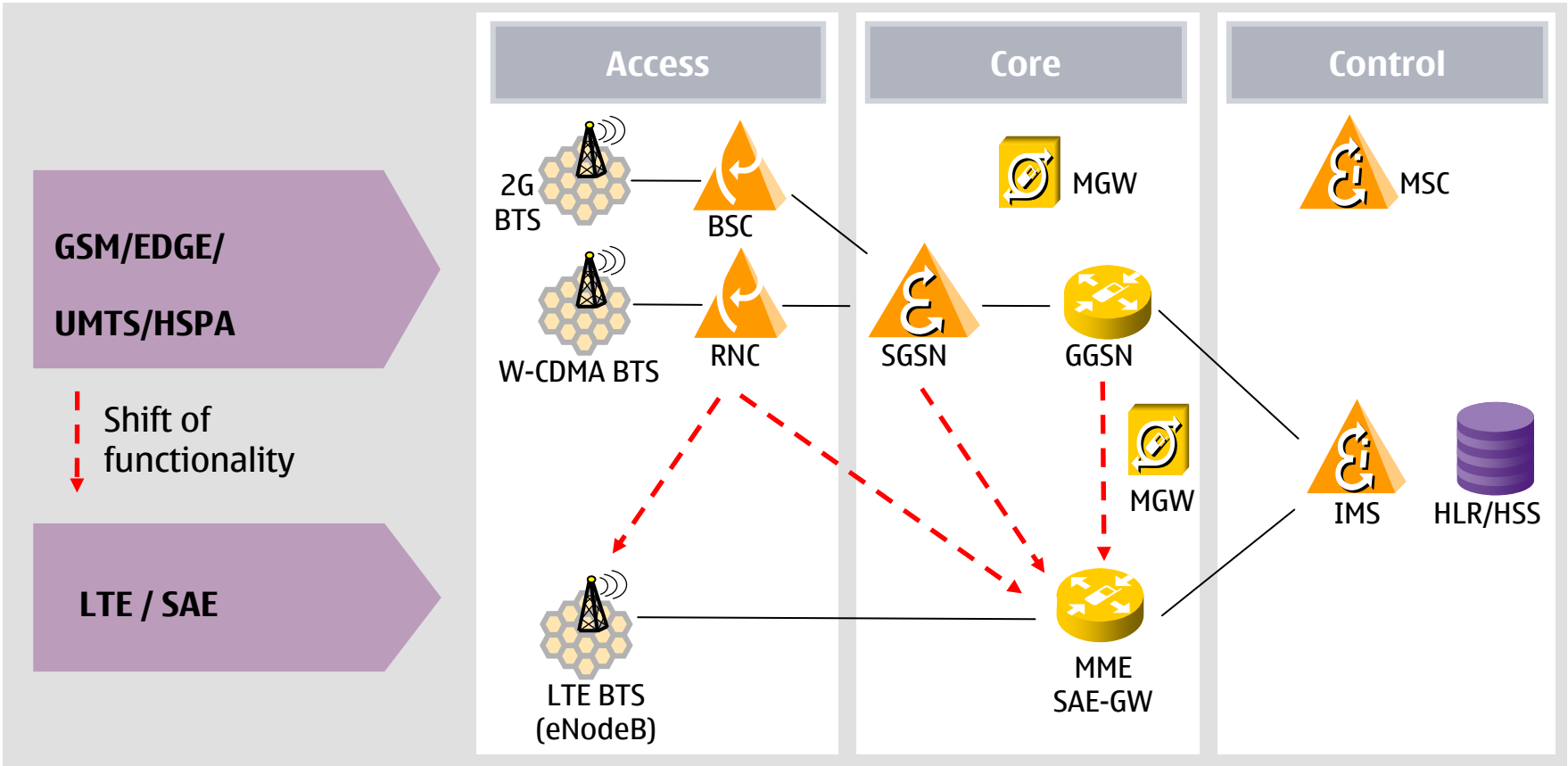


Price per MByte has to be reduced to remain profitable

Source: Light Reading (adapted)

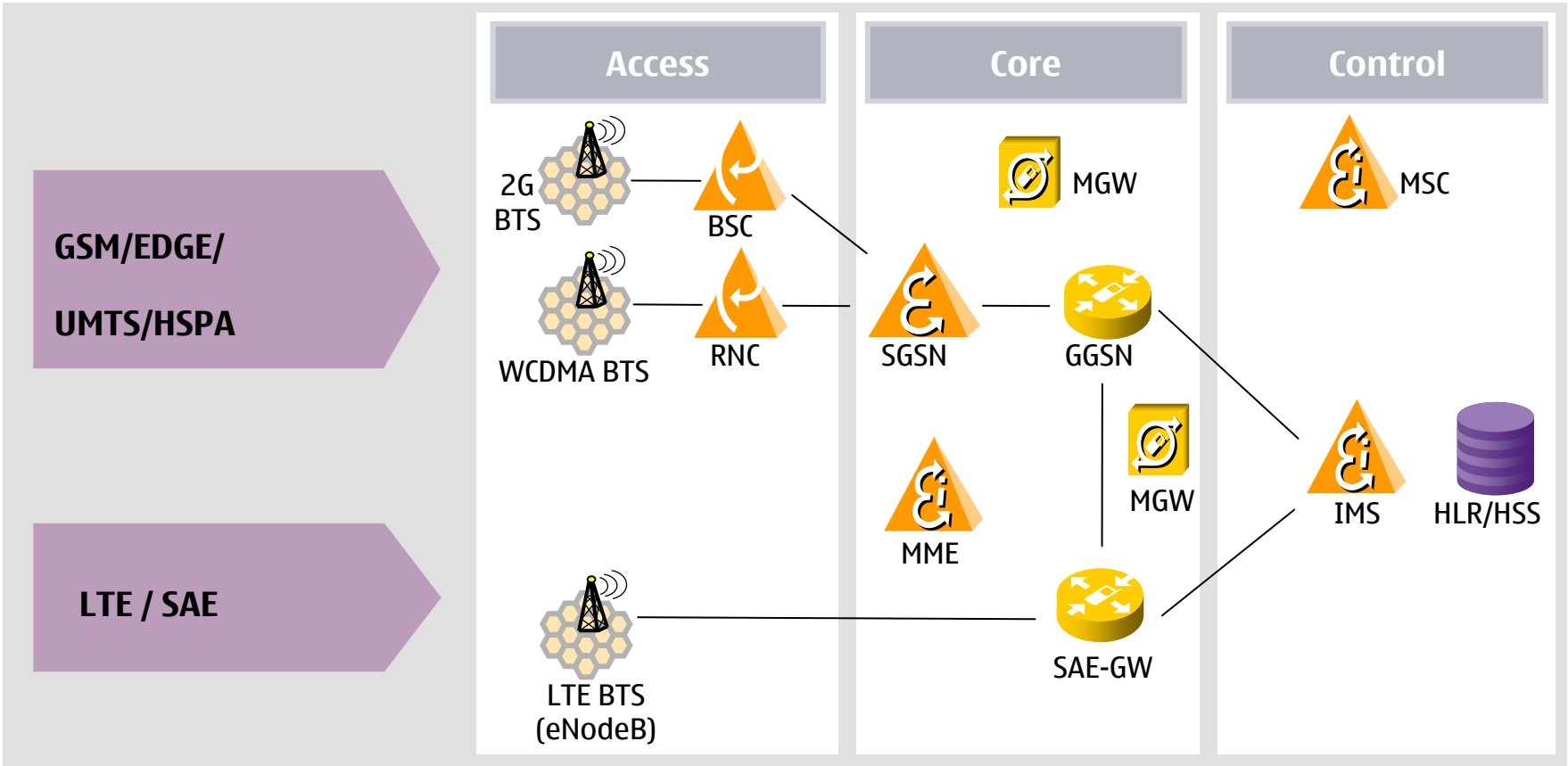
INTRODUCTION TO LTE/SAE

Key Architectural Concept
Flat and Cost effective Mobile Network



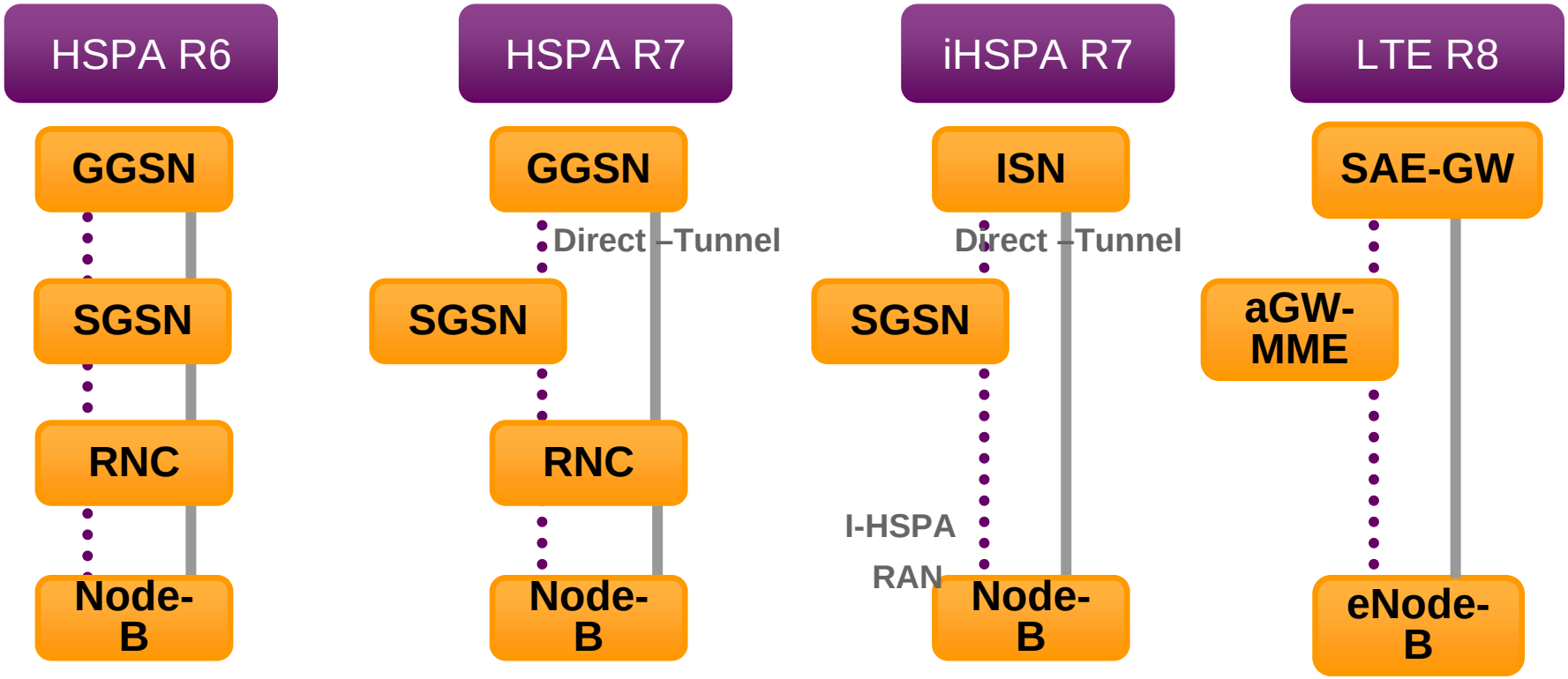
- From CS to PS domain (VoIP), split of functions between eNodeB & aGW
- Interworking, smooth migration, service continuity and investment protection

GSM/GPRS/EDGE, WCDMA/HSPA and LTE architectures



Evolution Path towards LTE-architecture

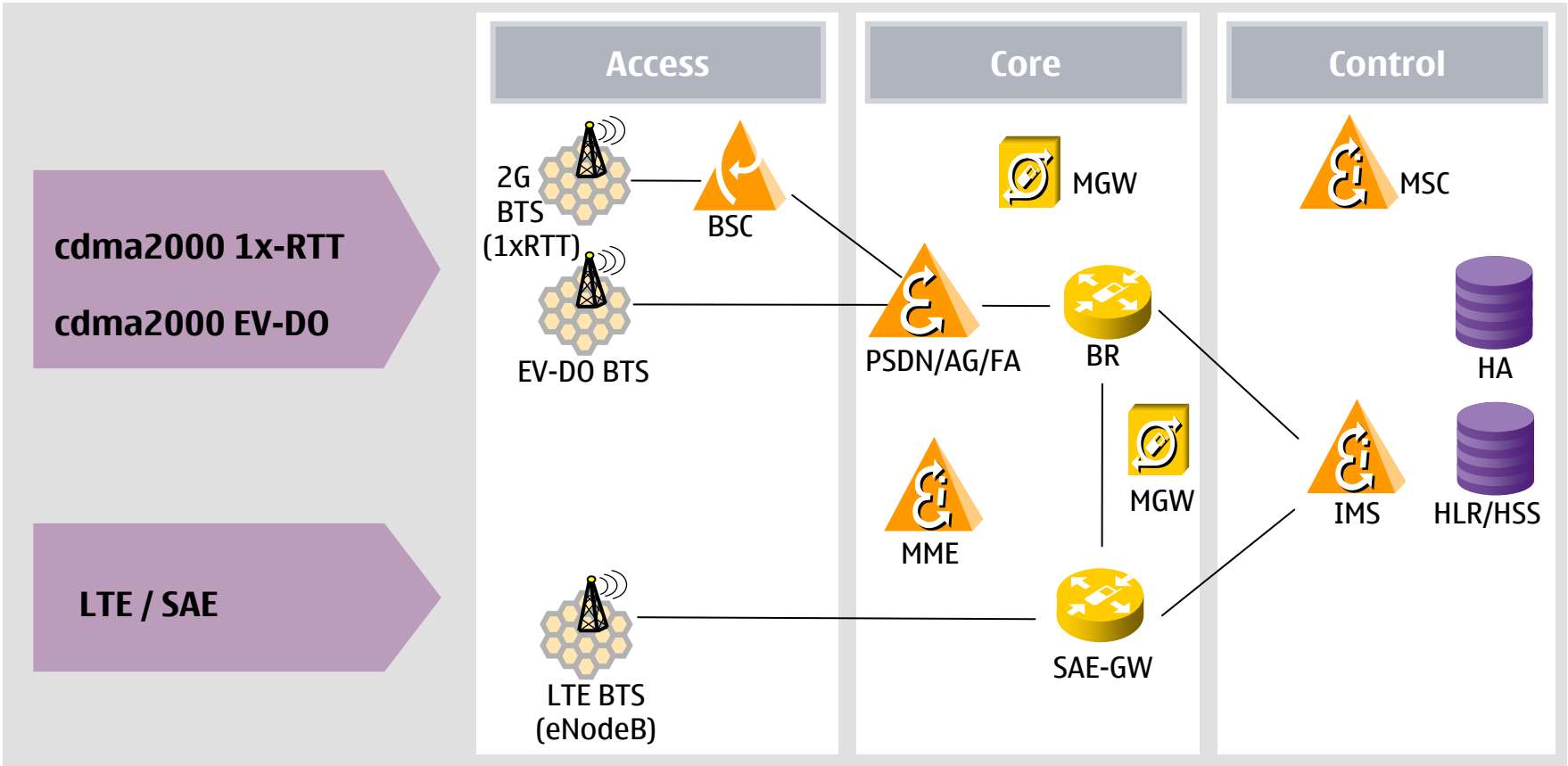
3GPP - Architecture Evolution towards a flat architecture



3GPP Rel.5 or later

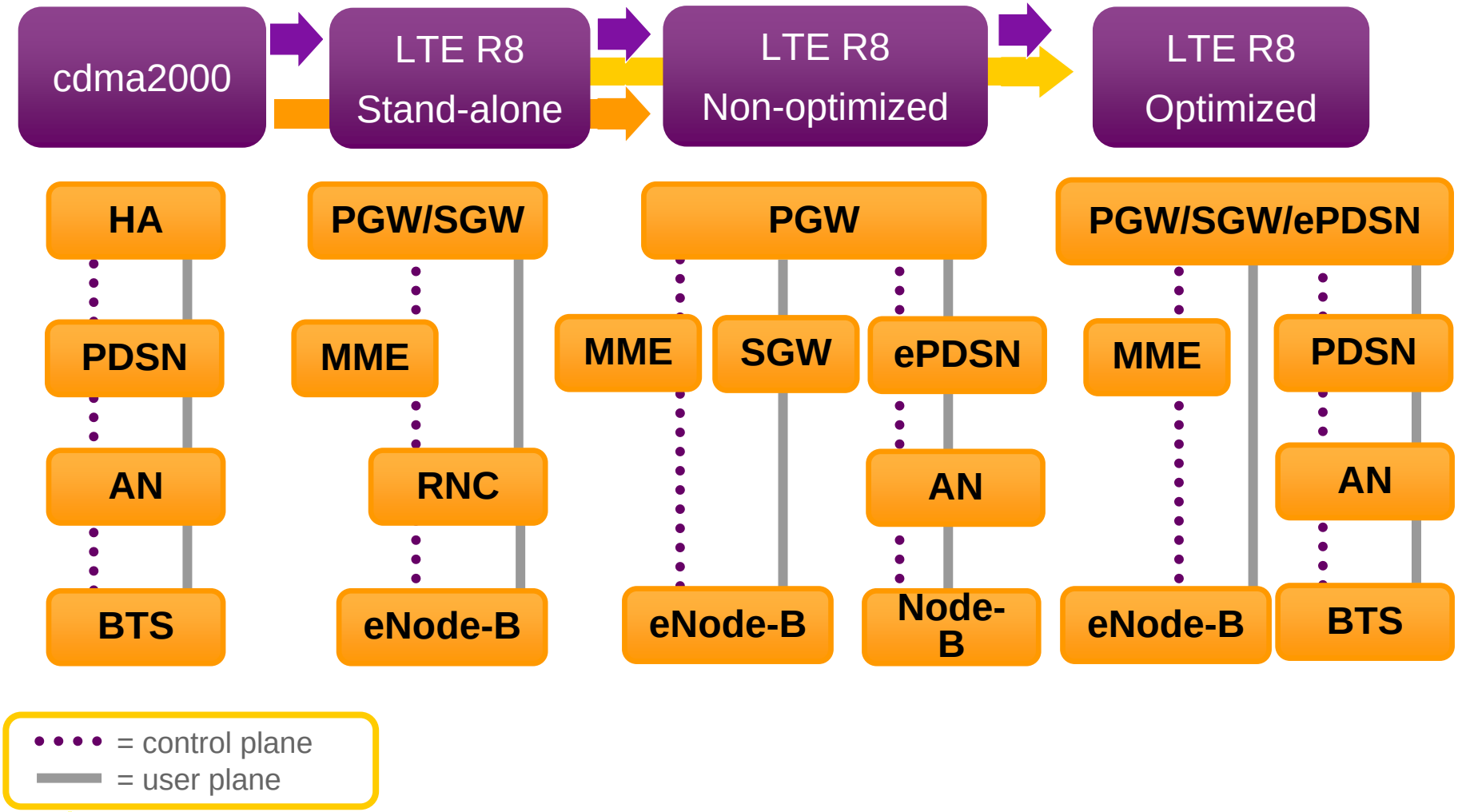
HSPA terminals

Cdma2000-1xRTT, EV-DO and LTE architectures



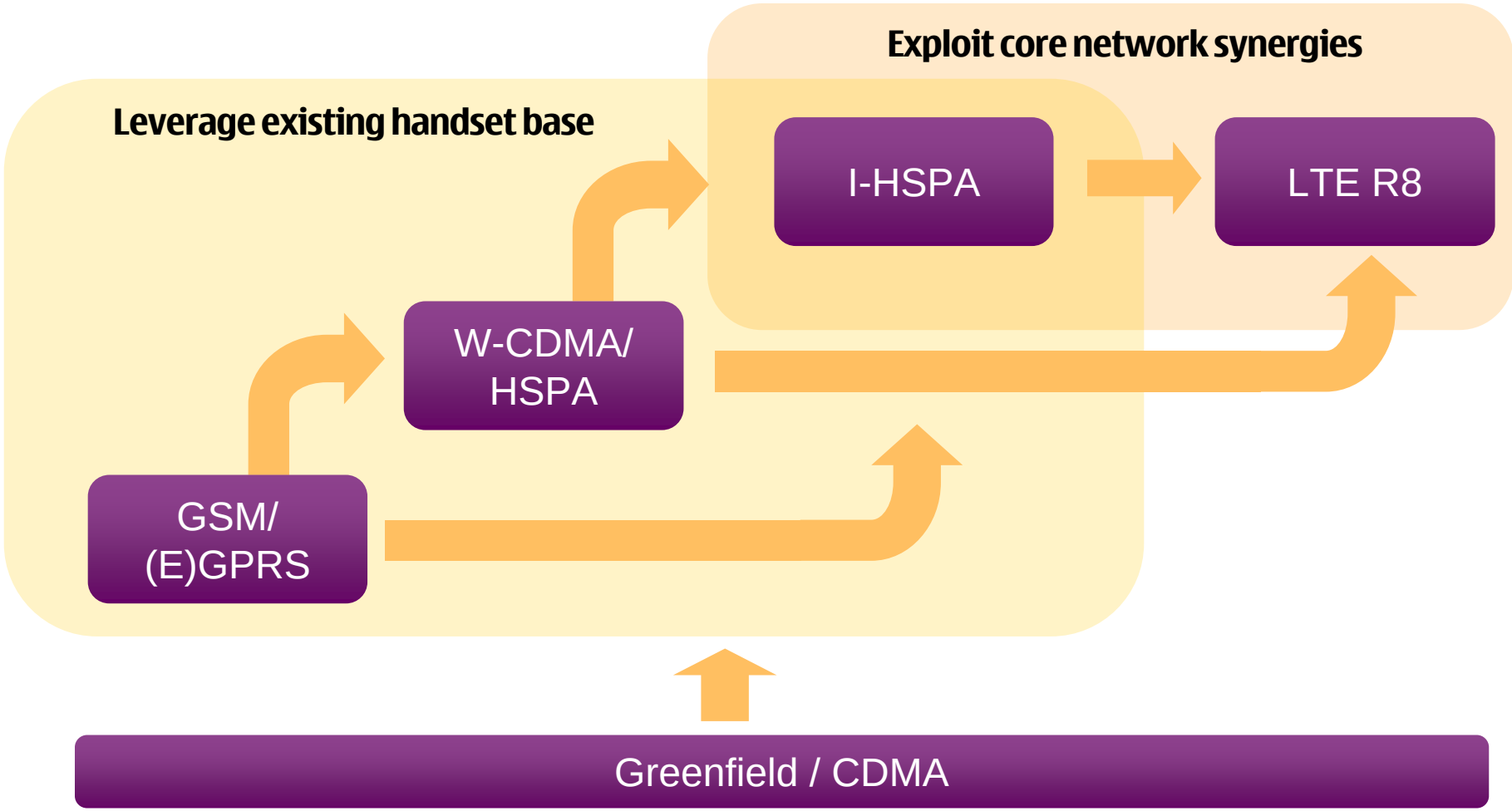
Packet Core Evolution Path for CDMA Networks

3GPP2 - Architecture Evolution towards a flat architecture



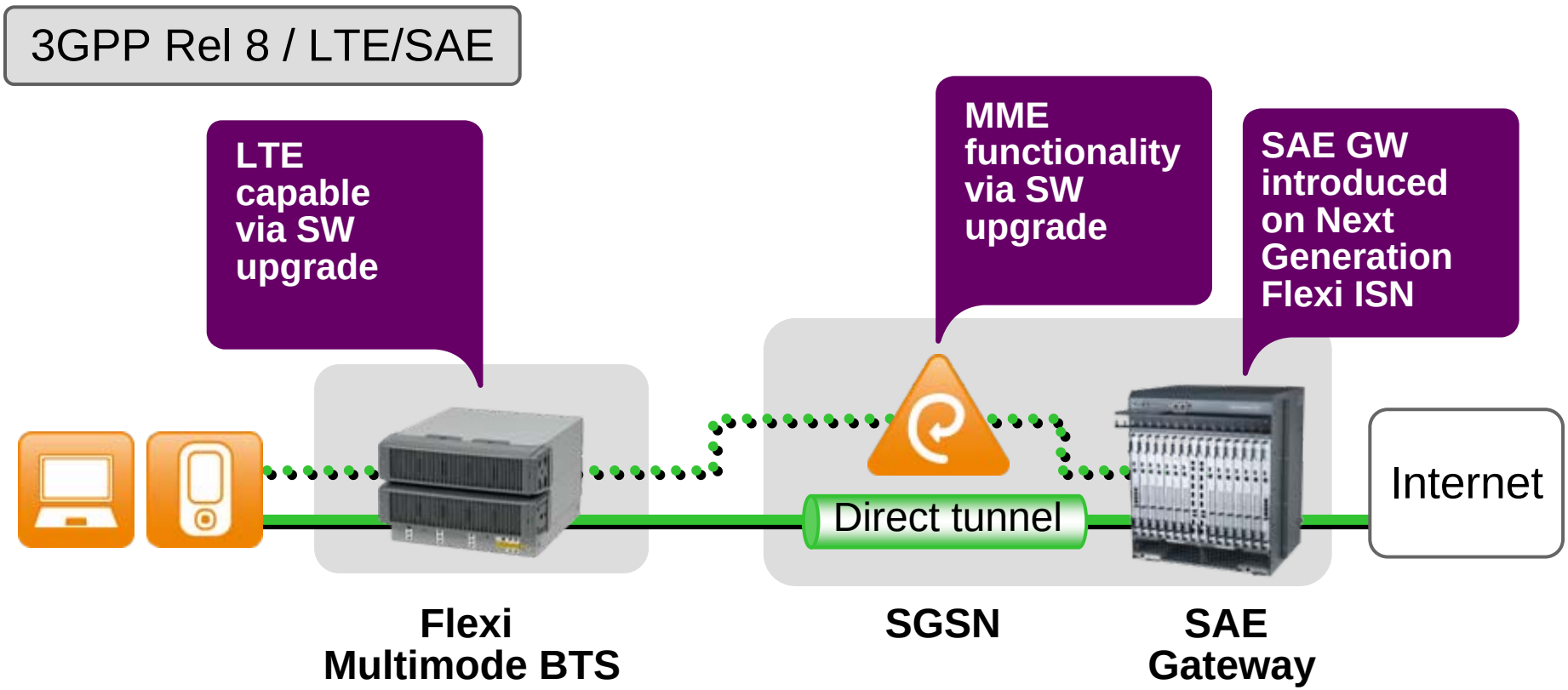
Evolution Paths towards LTE-architecture

LTE provides diverse evolution paths towards a flat architecture



LTE/SAE UPGRADE SOLUTION OVERVIEW

LTE introduction – via SW upgrade
Investment protection built-in



Simple LTE Upgrade with Nokia Siemens Networks

End to end LTE/SAE solution :

Flexi Multimode BTS, MME, SAE-GW

LTE deployment on commercial hardware

3x60 W Flexi Multimode RF Module and System Module:

HSPA now

LTE with software upload

LTE SITE SOLUTION

Flexi Multimode BTS Site

Complete three sector site solution

- System Module
- 3-sector RF Module 3 x 60 W
- WCDMA / LTE operation

System Module

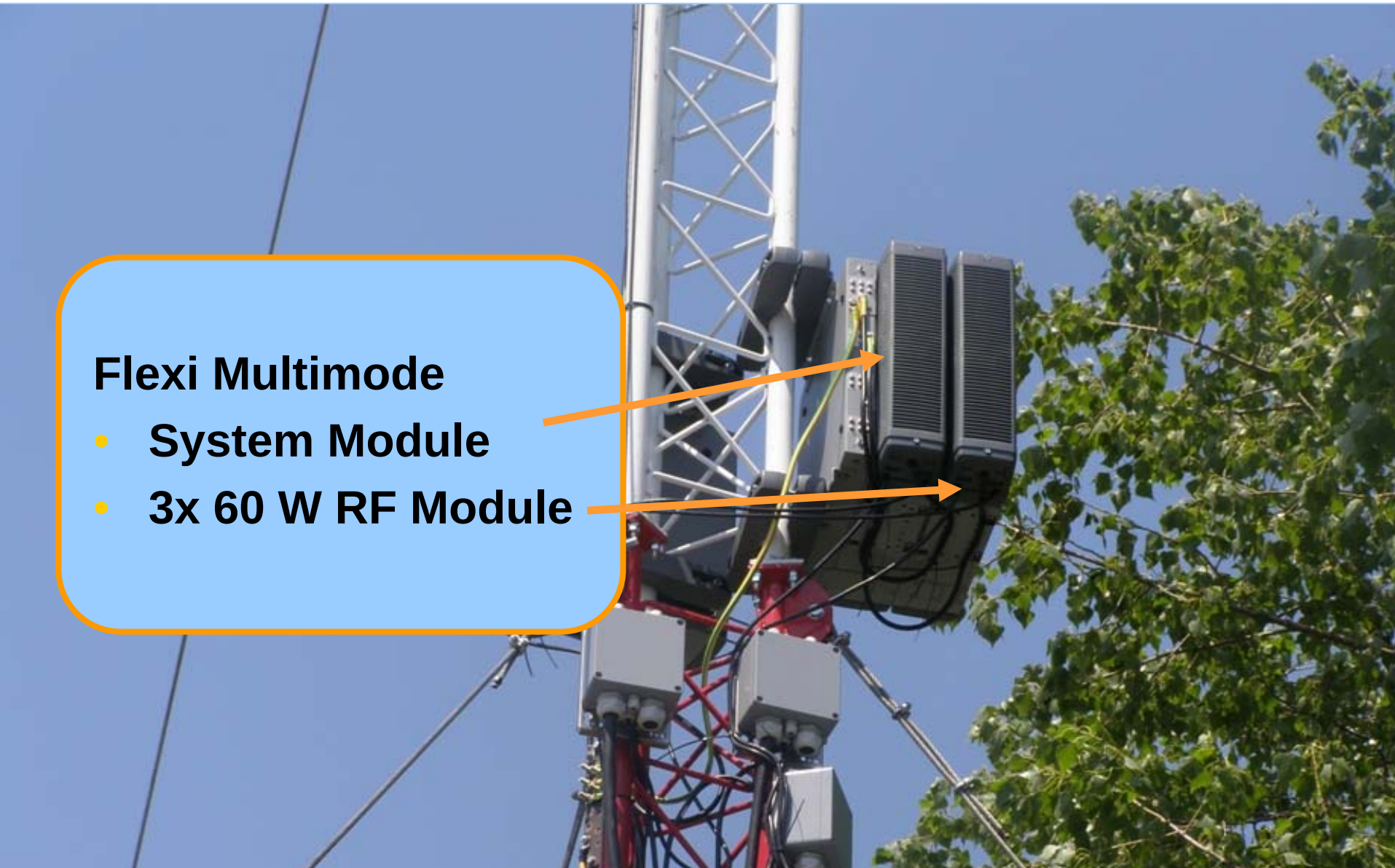
3-sector RF Module

The most cost and size optimized 3-sector site

Complete BTS (DC powered):

- 50 liters
- 50 kg

Complete 3-sector Outdoor site with Flexi BTS



Flexi Base Station fits any location

Wall installation

Floor installation

19” cabinet installation

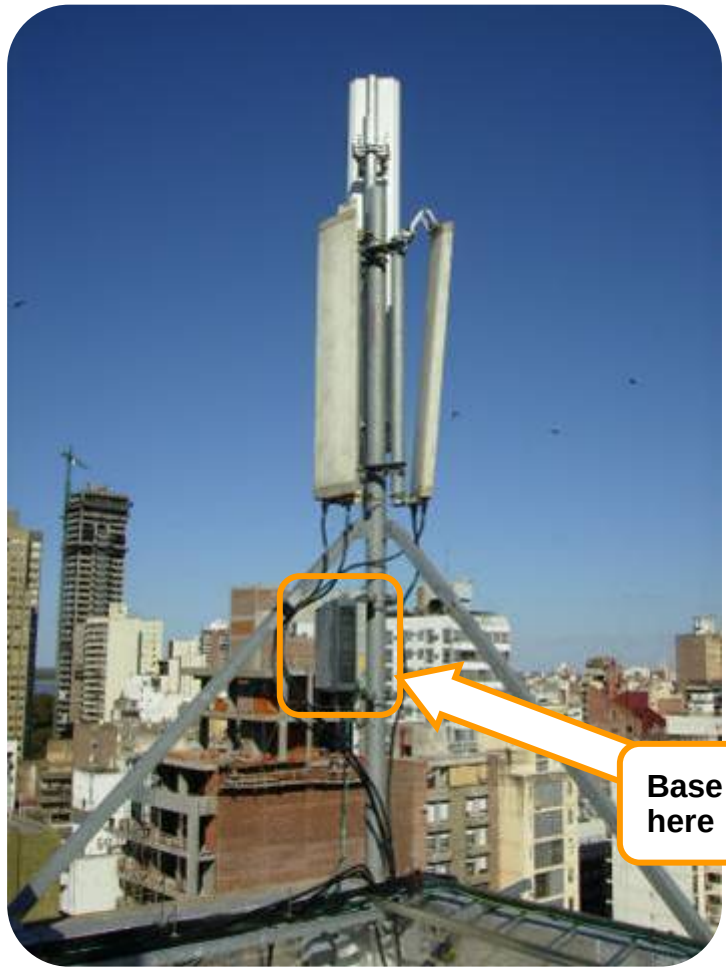
Pole installation

Inside constructions

Flexi Base Station fits any location

Finland

Saudi Arabia



Brazil

Japan

All-Purpose Flexi BTS Reduces Complexity

Flexi Multimode BTS

All-purpose BTS in Micro BTS size

Competitors' BTS Family

Macro BTS models

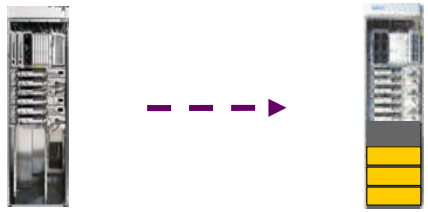
Micro BTS models

Distributed BTS models

Flexi Multimode BTS deployment in existing sites

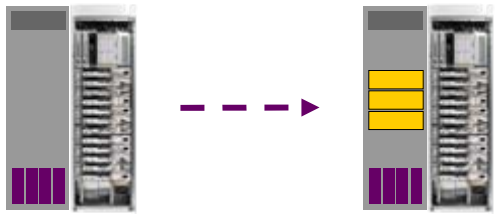
Inside 2G/3G BTS cabinet

(2G/3G BTS with available space)



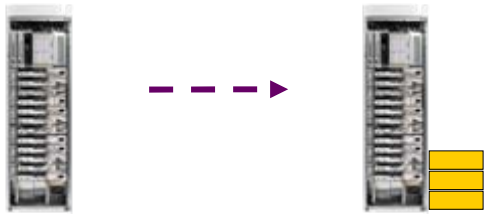
Inside Battery BackUp cabinet

(2G/3G BTS with co-sited BBU)



Next to 2G/3G BTS cabinet

(2G/3G BTS which is completely filled)

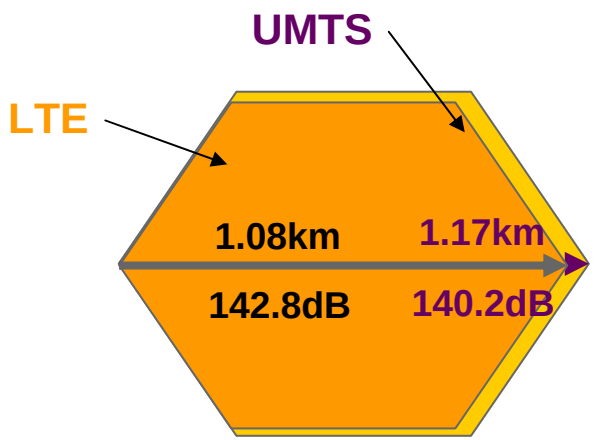


LEGEND

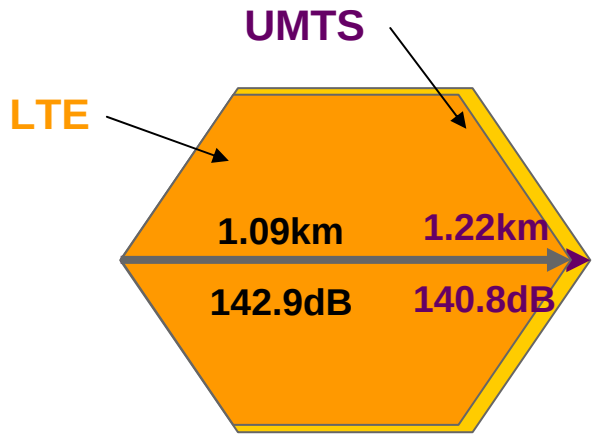
- Flexi Multimode BTS
- Batteries
- Rectifiers

LTE 2600 can be deployed on UMTS 2100MHz grid
(figures applicable to Urban Deployment)

Uplink



Downlink



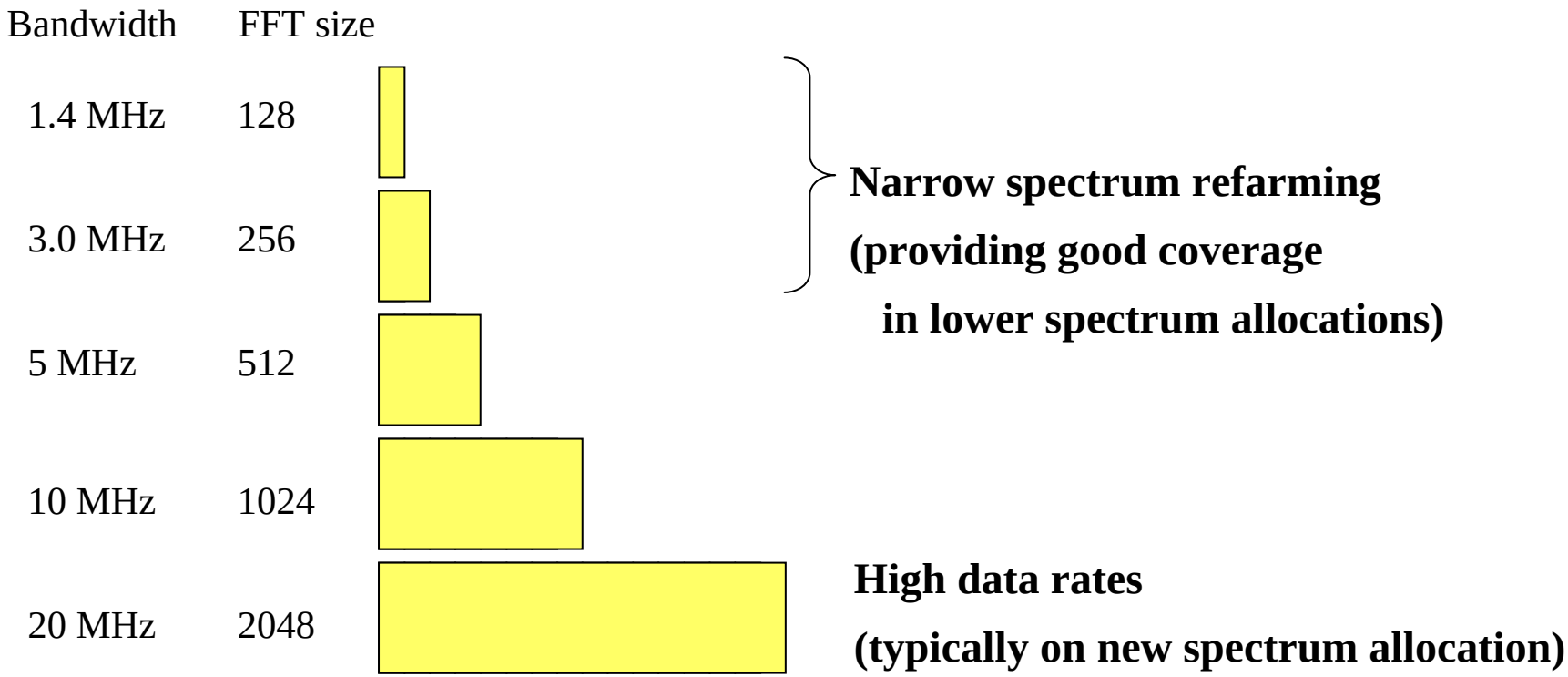
Conclusion

- Delta between max. allowable pathloss values:
  - → 2.1 dB in downlink benefit of **LTE**
  - → 2.6 dB in uplink benefit of **LTE**
- Delta between outdoor cell range values:
  - → **LTE** cell range nearly identical to **UMTS**
  - → **LTE** cell range nearly identical to **UMTS**

LTE DEPLOYMENT
IN EXISTING OR NEW SPECTRUM

LTE Bandwidth Scalability

- LTE provides scalable bandwidth 1.4 – 20 MHz
  using different number of subcarriers and different FFT size
- Large bandwidth provides high data rates
- Small bandwidth allows simpler spectrum refarming,
  e.g. 850 MHz and 900 MHz



LTE Downlink and Uplink Peak Bit Rates

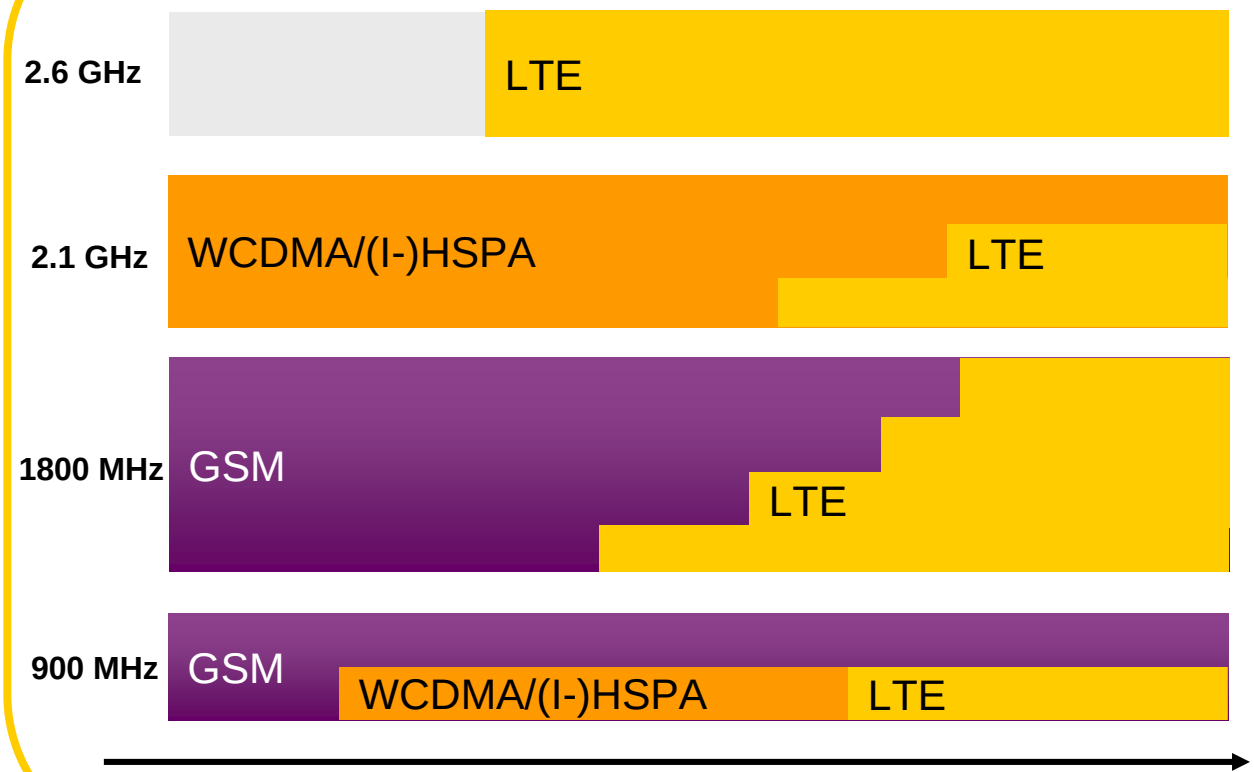
- DL: 2x2 – MIMO: 64QAM => 172 Mbps in 20 MHz and 86 Mbps in 10 MHz
- UL: Single stream Tx:16QAM => 57 Mbps in 20 MHz and 28 Mbps in 10 MHz

	Resource bloc	6	15	25	50	100
	Subcarriers	72	180	300	600	1200
Modulation coding		**1.4 MHz**	**3.0 MHz**	**5.0 MHz**	**10 MHz**	**20 MHz**
QPSK 1/2	Single stream	0.8	2.1	3.6	7.2	14.3
16QAM 1/2	Single stream	1.7	4.3	7.2	14.3	28.7
16QAM 3/4	Single stream	2.6	6.4	10.7	21.5	43.0
64QAM 3/4	Single stream	3.9	9.7	16.1	32.2	64.5
64QAM 4/4	Single stream	5.1	12.9	21.5	43.0	86.0
64QAM 3/4	2x2 MIMO	7.7	19.3	32.2	64.5	129.0
64QAM 4/4	2x2 MIMO	10.3	25.8	43.0	86.0	172.0
64QAM 4/4	4x4 MIMO	20.6	51.6	86.0	172.0	343.9

	Resource bloc	6	15	25	50	100
	Subcarriers	72	180	300	600	1200
Modulation coding		**1.4 MHz**	**3.0 MHz**	**5.0 MHz**	**10 MHz**	**20 MHz**
QPSK 1/2	Single stream	0.8	2.1	3.6	7.2	14.3
16QAM 1/2	Single stream	1.7	4.3	7.2	14.3	28.7
16QAM 3/4	Single stream	2.6	6.4	10.7	21.5	43.0
16QAM 4/4	Single stream	3.4	8.6	14.3	28.7	57.3
64QAM 3/4	Single stream	3.9	9.7	16.1	32.2	64.5
64QAM 4/4	Single stream	5.1	12.9	21.5	43.0	86.0
64QAM 4/4	V-MIMO (cell)	10.3	25.8	43.0	86.0	172.0

Mobile-Broadband Upgrade Example HSPA 900 MHz, LTE 2600&1800 MHz

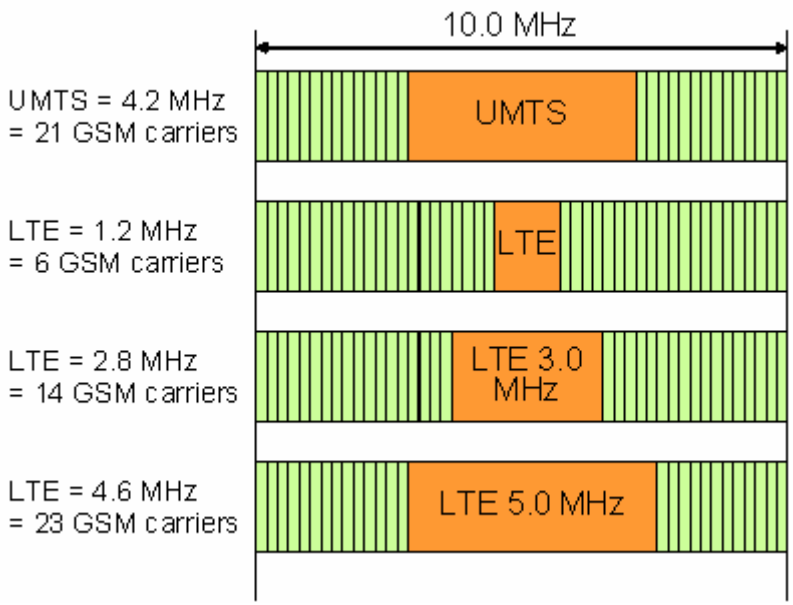
- Early deployment of 4.2 MHz WCDMA with (I-)HSPA at 900 MHz for coverage to indoor and remote areas
- Early rollout of LTE in 2600 MHz
- Flexible phased re-farming of GSM 1800 MHz and UMTS 2100 MHz according to capacity needs, terminal penetration etc.
- Some GSM 900 and UMTS 2100 persists for legacy and incoming roaming



Flexi BTS allows for maximum flexibility in broadband upgrade path since choice of WCDMA/I-HSPA/LTE is defined by software download

LTE co-existence with GSM/GPRS/EDGE networks

- Closest frequencies at both sides of the LTE carrier can be optimally utilized for GSM frequencies
  - Guard bands can be minimized with optimal Flexi BTS filtering and coordinated network deployment

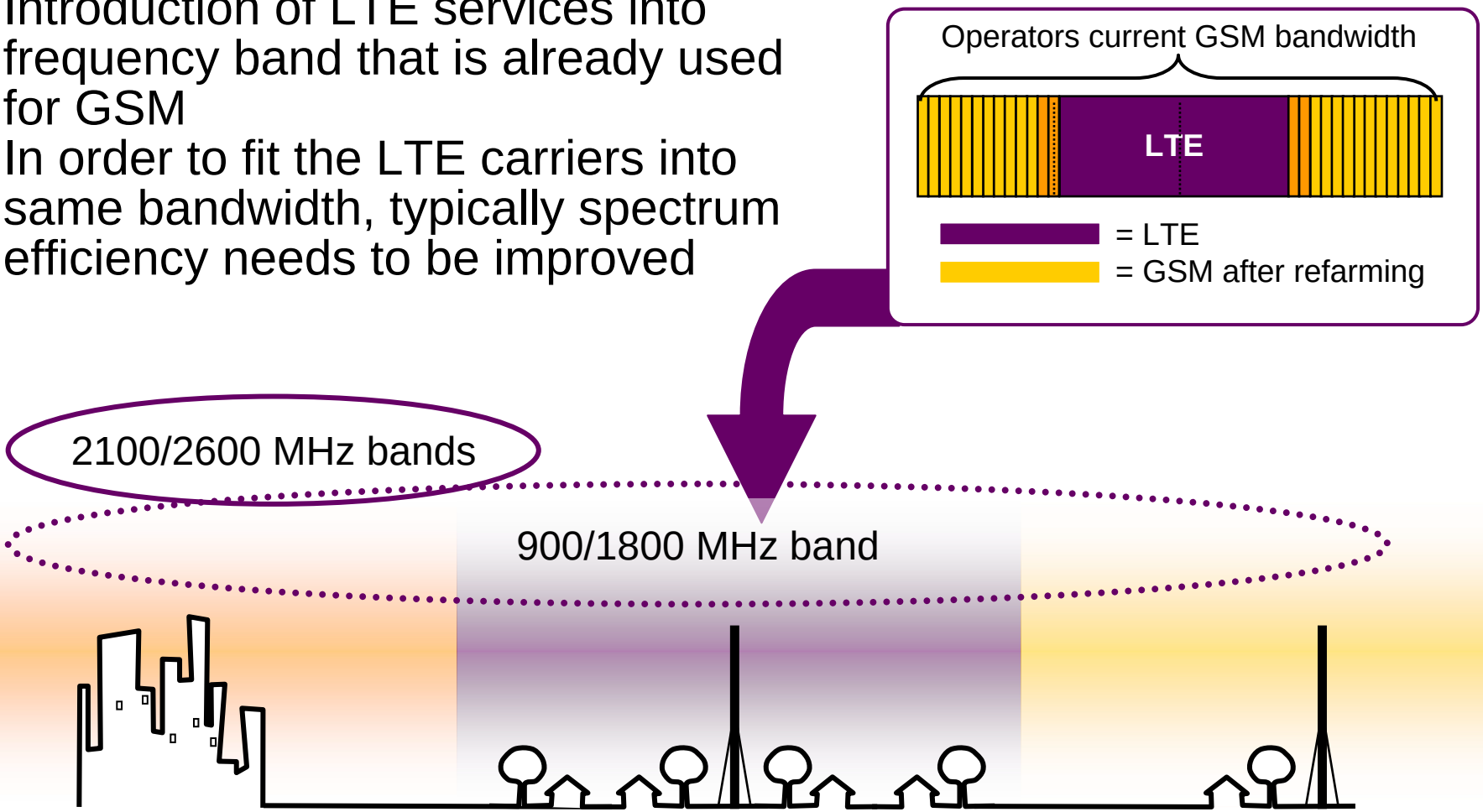


Scalable bandwidth of LTE system design allows to support spectrum migration

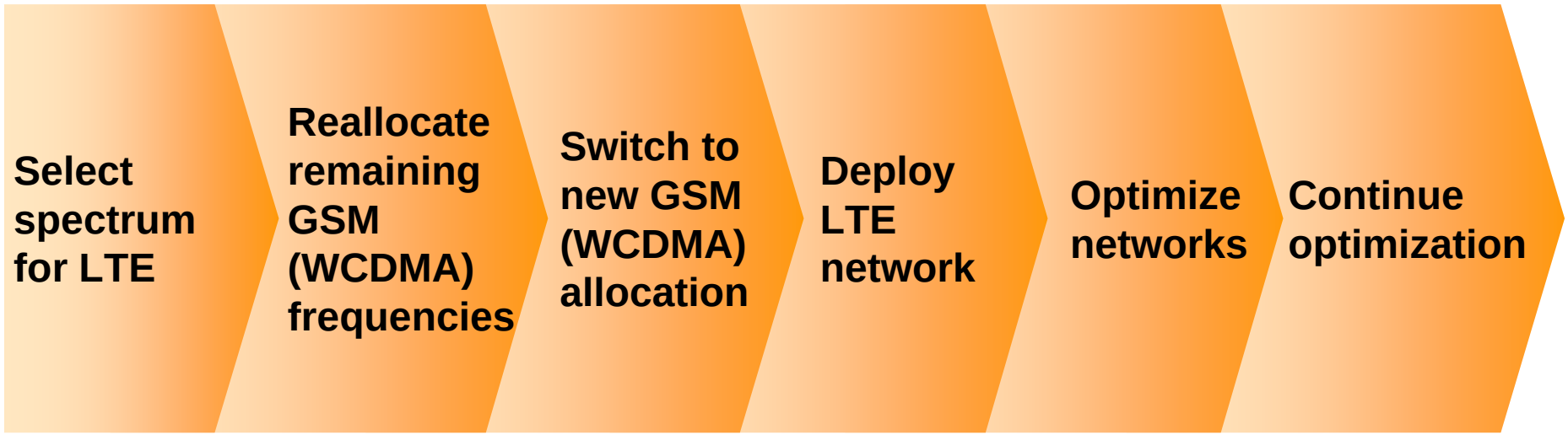
in-line with network operator capacity requirements

LTE refarming to 900/1800 MHz frequency bands

- Introduction of LTE services into frequency band that is already used for GSM
- In order to fit the LTE carriers into same bandwidth, typically spectrum efficiency needs to be improved



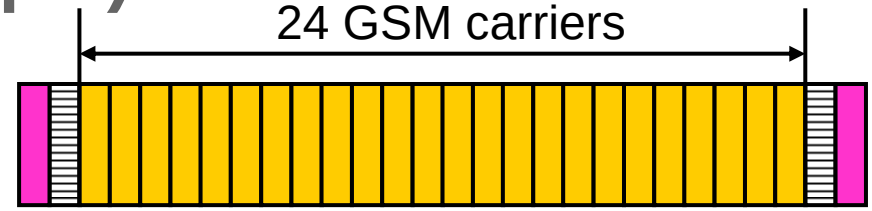
LTE Frequency Refarming deployment phases



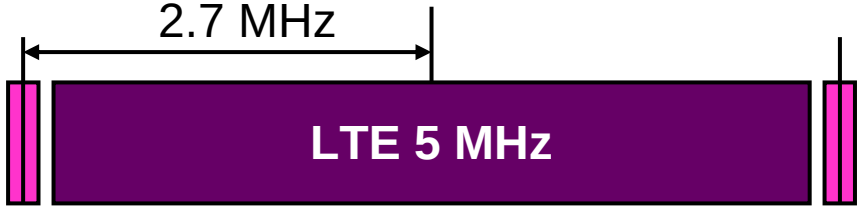
Nokia Siemens Networks provides full set of equipment, functionalities, tools and services for the LTE Frequency Refarming process

LTE Frequency Refarming on 900/1800 MHz (5 MHz Illustration example)

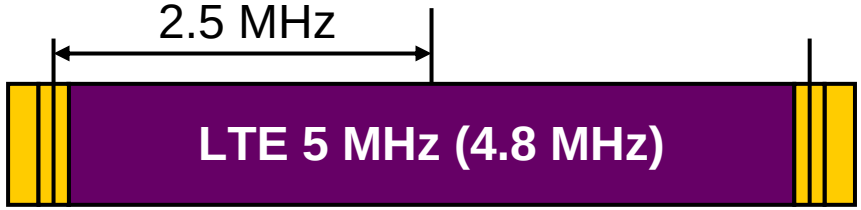
GSM only operation in 5 MHz



LTE 5 MHz in uncoordinated case[1] (different sites than GSM)



LTE 5 MHz in coordinated case (same sites than GSM = same operator)



= GSM carrier by the same operator

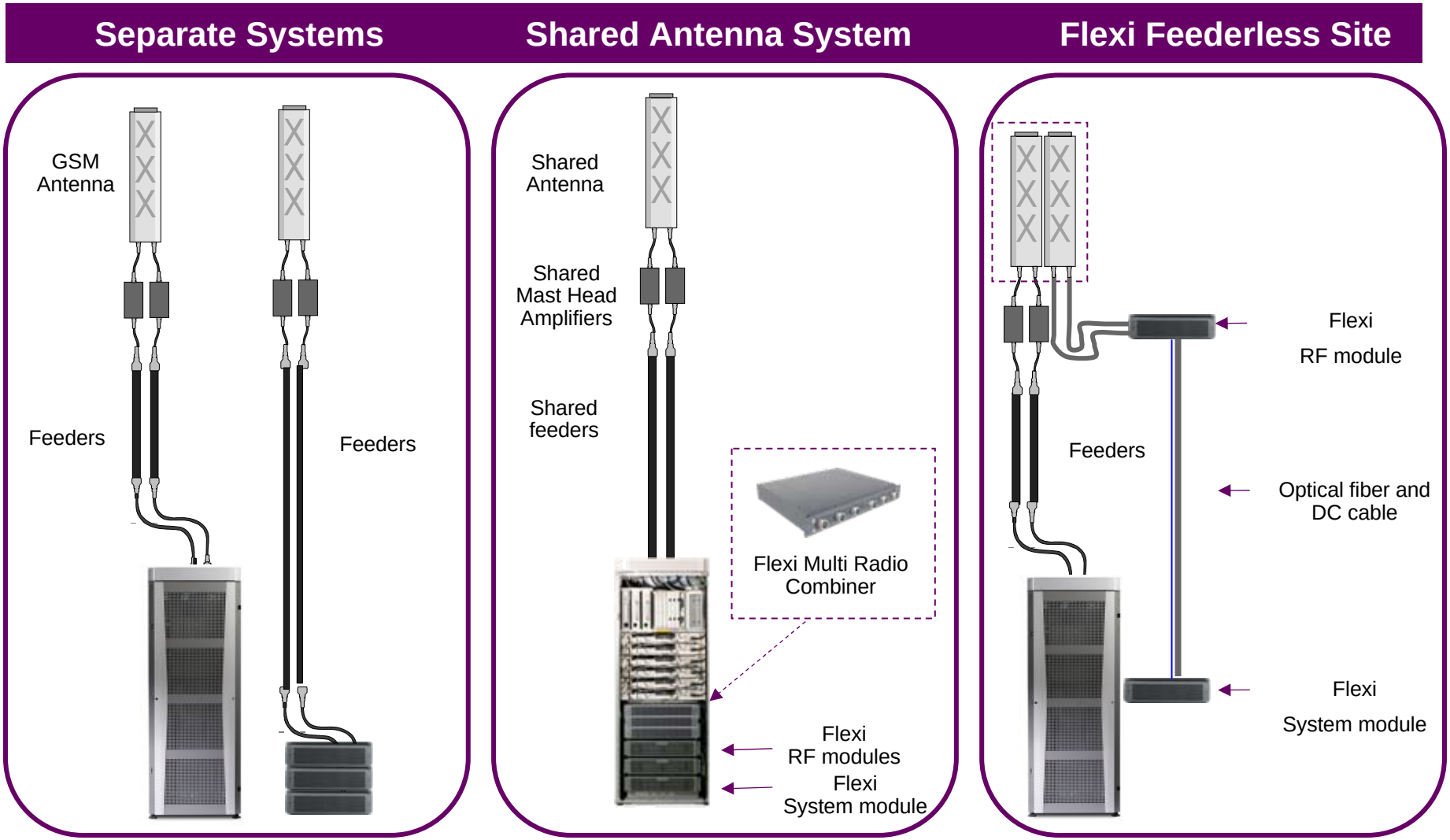
= GSM carrier by a different operator

= guard carrier

= LTE carrier

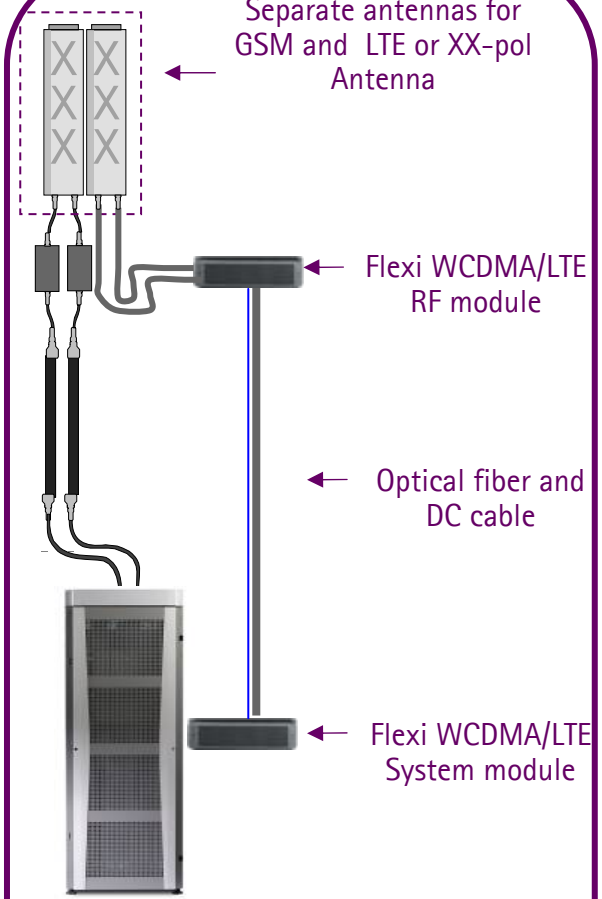
[1]Uncoordinated case based on 36.101 narrowband blocking requirements

Antenna System Options for LTE refarming

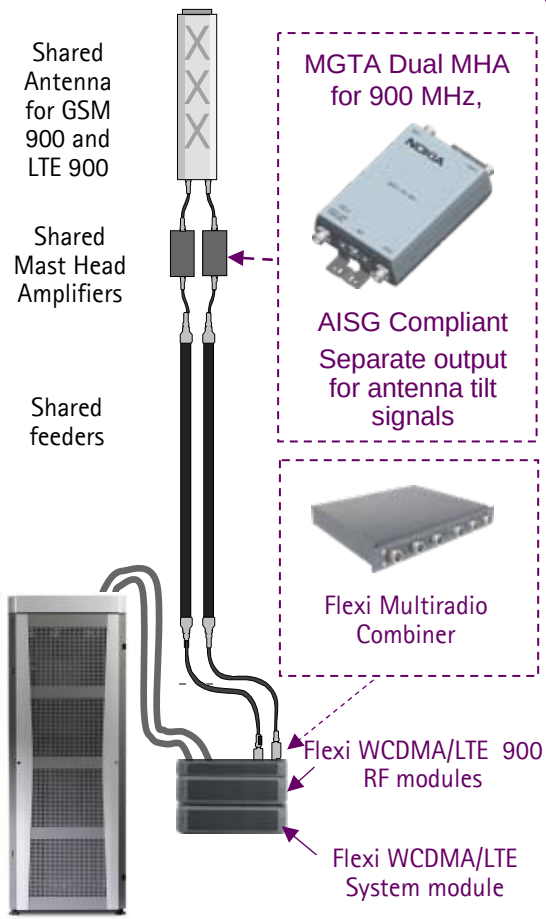


Antenna System sharing for LTE refarming

feederless LTE upgrade



shared feeders with multi-radio combiner



antennas for re-farming

Single antenna with two 880–960 MHz elements inside the same radome with individualy adjustable electrical tilts. Only 44% wider than comparable single Xpol Antenna.

New product: Availability: 2008

High Performance Co-Location for GSM900/1800 co-siting with LTE

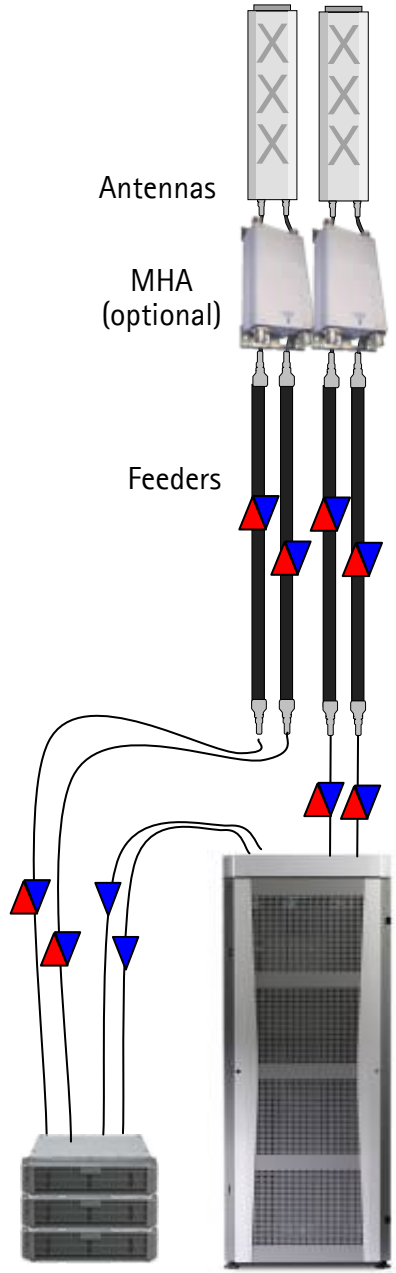
GSM typically requires 2 TX antennas for on-air combining purposes

LTE typically requires 2 TX antennas for MIMO

In re-farming case both system suffer from 3.5 dB hybrid combining loss when sharing TX antennas resp. only 1 feeder per system in DL direction (= no MIMO).

For high-performance sectors, 4 antennas can be used:

- 2 TX chains per Radio Technology
- 2 RX paths for GSM (conventional)
- 4 RX paths for LTE for improved UL sensitivity and capacity. UL gain is ~3..4db over 2 RX diversity and allows for multi user UL MIMO gain.



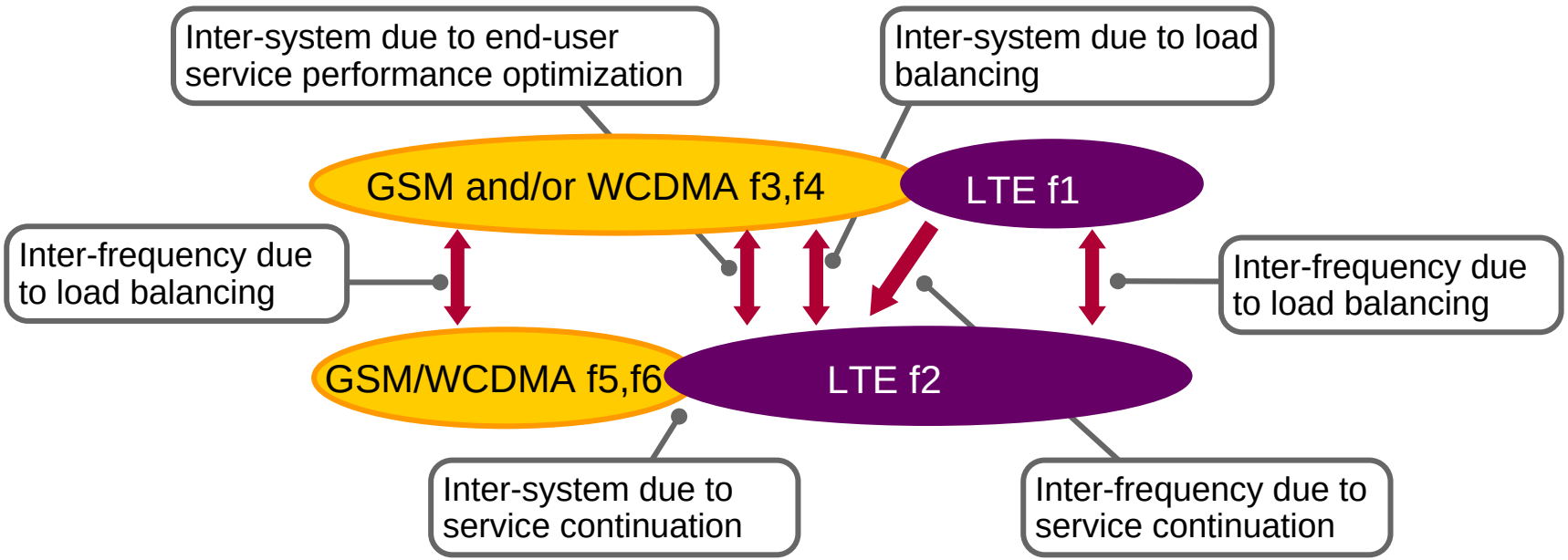
Radio Resource Management for efficient LTE Deployment and Frequency Refarming

Inter-operability capability

- Inter-system traffic management between GSM/WCDMA and LTE network layers
  .
- Inter-frequency traffic management between different frequency layers

Handover combinations supported in commercial phase releases

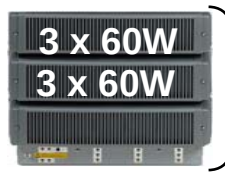
- Coverage based handovers for continuous service provisioning
- Load and service based handovers for traffic balancing and end-user service performance optimization



Evolution to LTE in same band via software

3G BTS

Flexi Multimode BTS
for WCDMA/HSPA
operation



LTE BTS (2x2 MIMO)

LTE upgrade option
via software in existing
spectrum

3G BTS

Existing
WCDMA/HSPA
base station

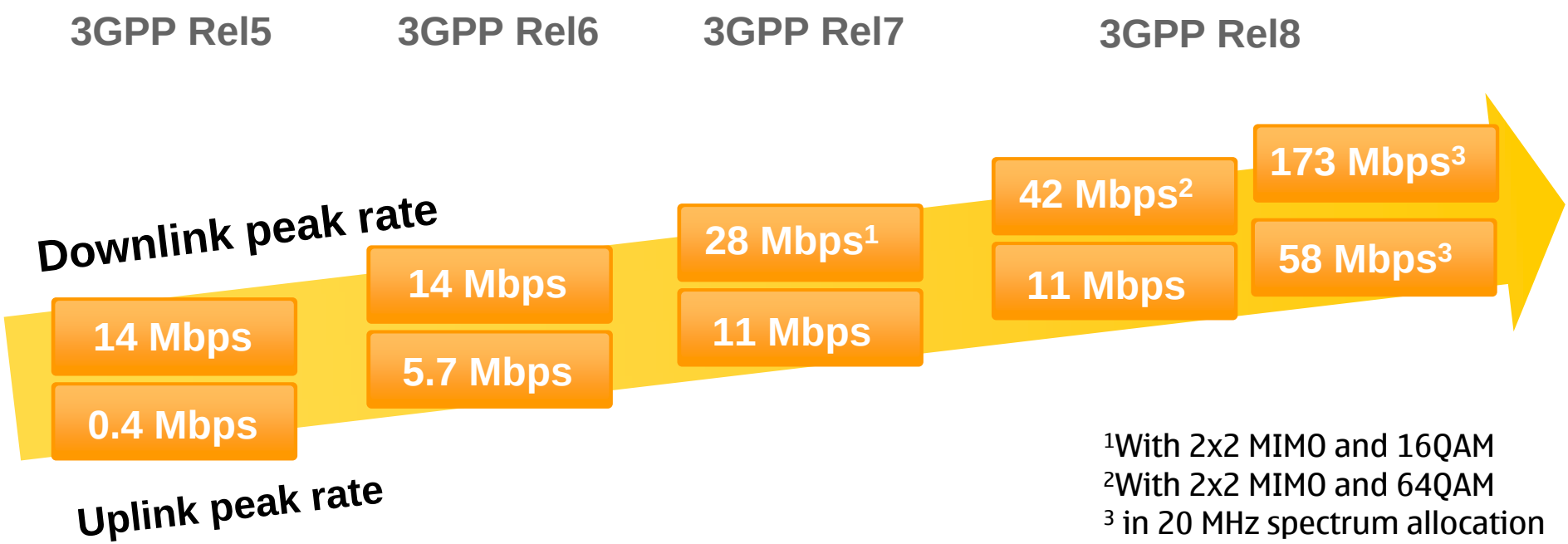
LTE BTS (2x2 MIMO)

3G BTS

Smooth
Multi-Radio site expansion
for new spectrum allocations

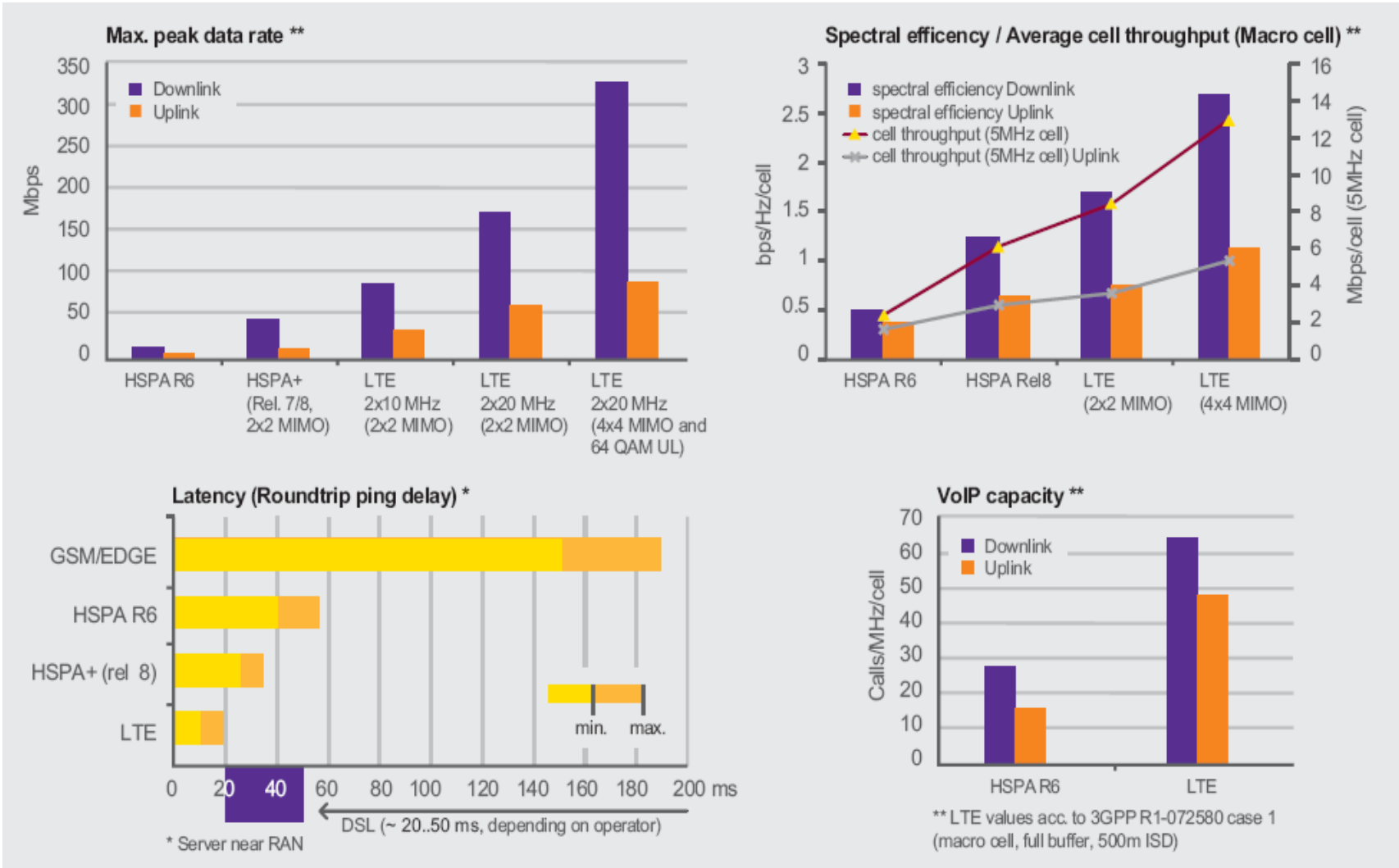
LTE SERVICE STRATEGIES

Peak data rates will continue to grow…



- HSPA downlink data rate increases
  with 2x2 MIMO and 64QAM up to 42 Mbps
  and uplink data rate with 16QAM up to 11 Mbps
- LTE supports data rates of 173 Mbps and 58 Mbps respectively

LTE - Network Evolution with highest performance



LTE UE support Peak data rates above 100 Mbps

- All categories support 20 MHz
- 64QAM mandatory in downlink, but not in uplink (except Class 5)
- 2x2 MIMO in other classes except Class 1

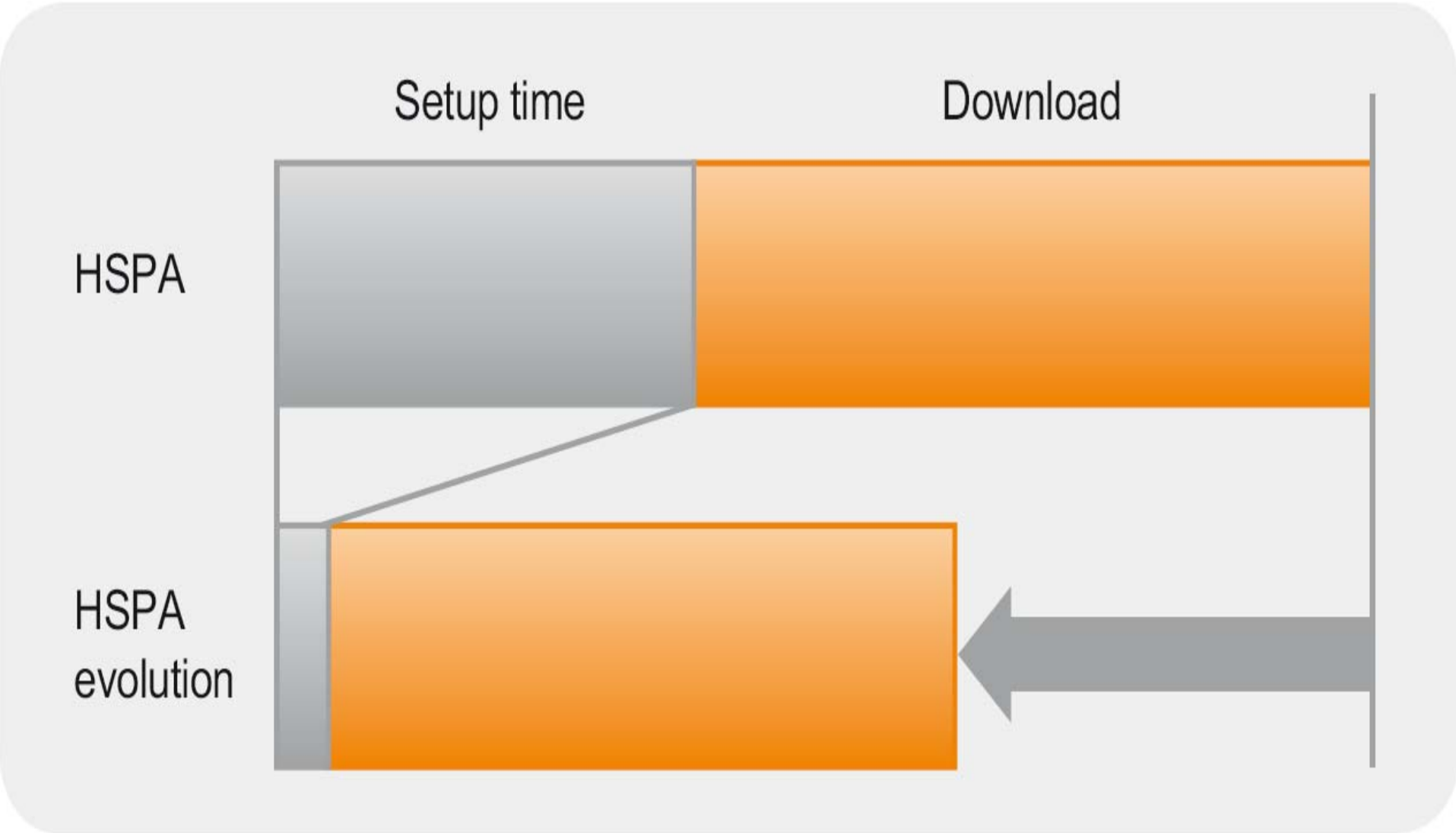
	Class 1	Class 2	Class 3	Class 4	Class 5
Peak rate DL/UL	**10/5 Mbps**	**50/25 Mbps**	**100/50 Mbps**	**150/50 Mbps**	**300/75 Mbps**
RF bandwidth	20 MHz	20 MHz	20 MHz	20 MHz	20 MHz
Modulation DL	64QAM	64QAM	64QAM	64QAM	64QAM
Modulation UL	16QAM[2]	16QAM[2]	16QAM[2]	16QAM[2]	64QAM
Rx diversity	Yes[1]	Yes	Yes	Yes	Yes
BTS tx diversity	1-4 tx	1-4 tx	1-4 tx	1-4 tx	1-4 tx
MIMO DL	Optional	2x2	2x2	2x2	4x4

[1]Performance requirements are based on 2-rx, but 2-rx is not mandated directly

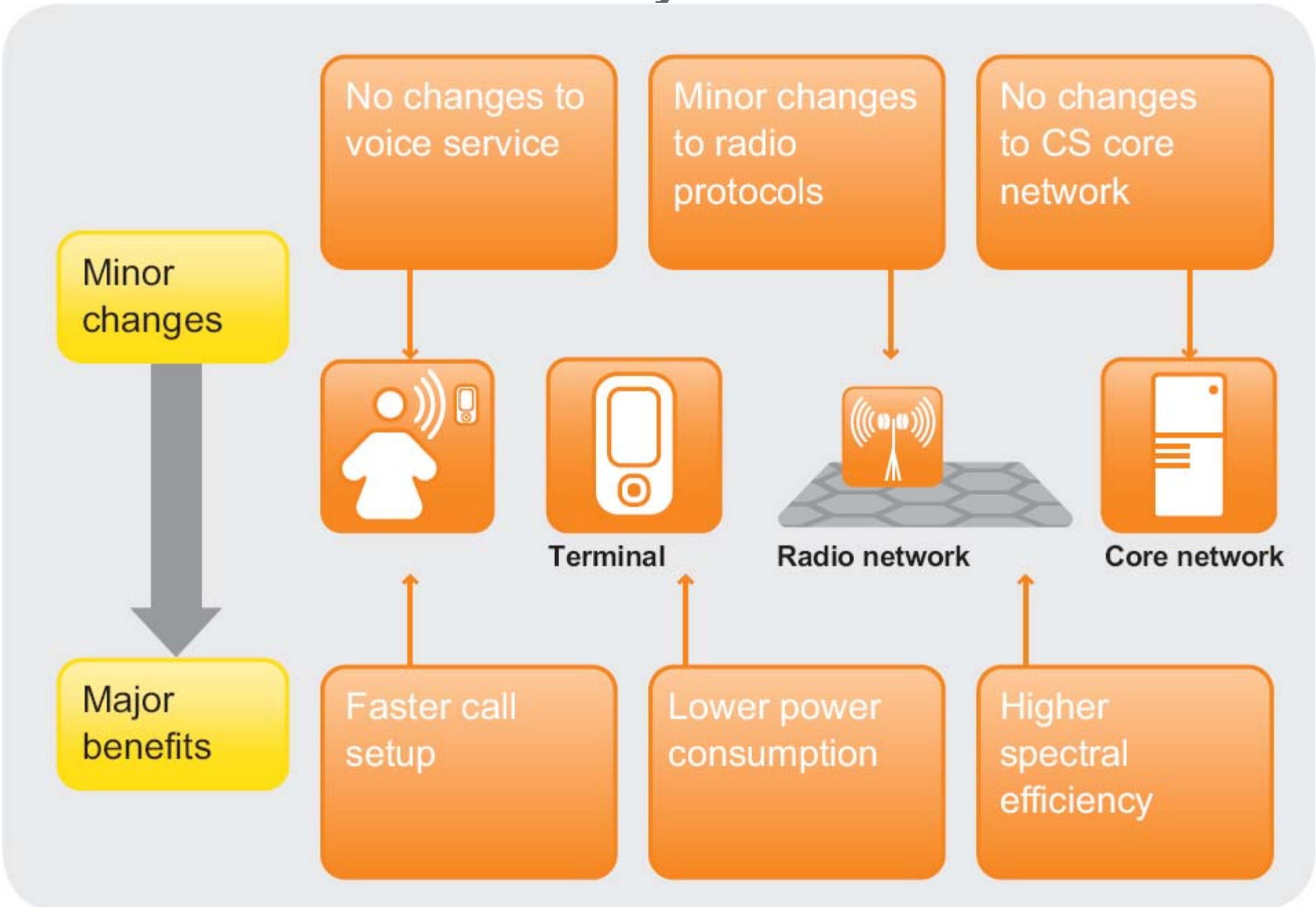
[2]No 64QAM

VOICE EVOLUTION STRATEGIES ON WCDMA/HSPA AND LTE NETWORKS

HSPA evolution – reducing call setup time

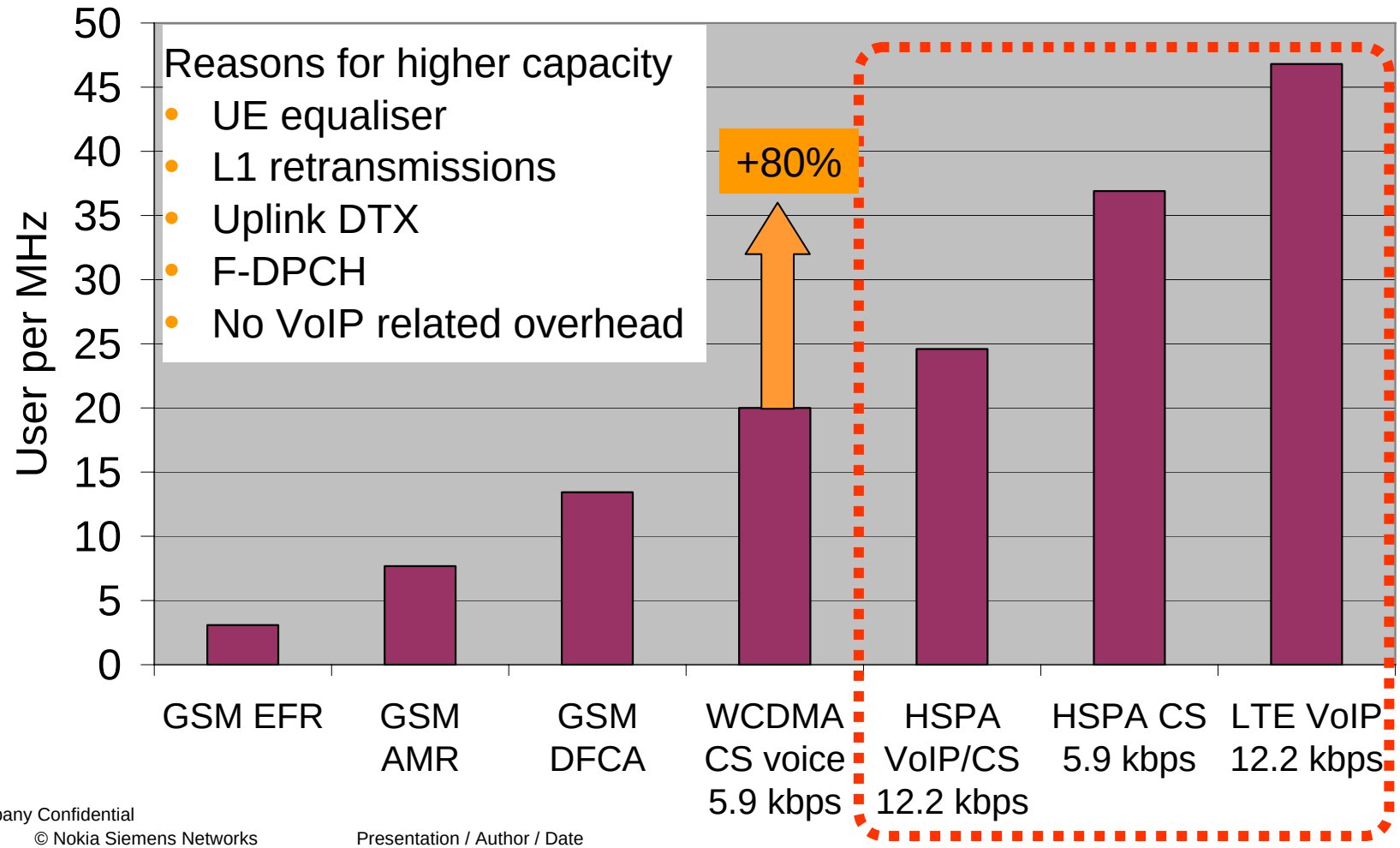


CS Voice over HSPA – key benefits



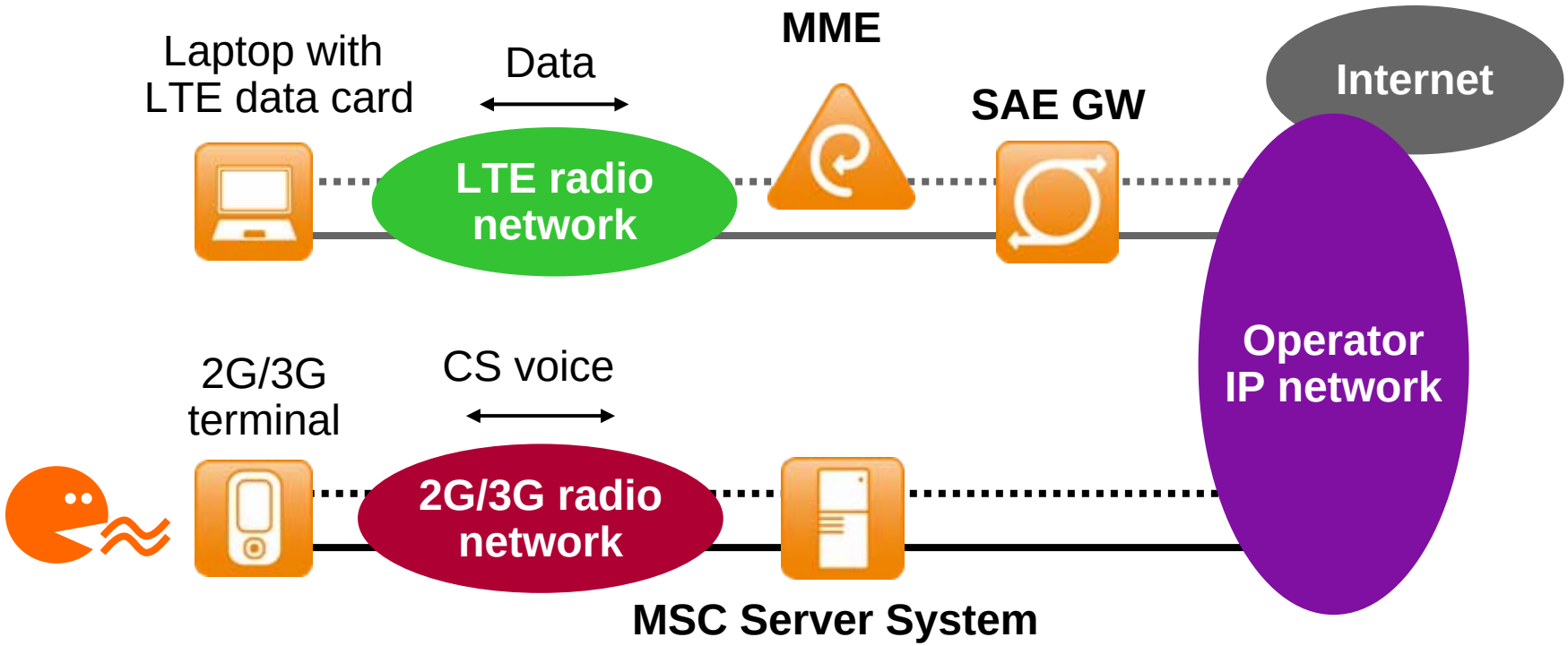
Voice over HSPA and LTE – key benefits

- 50-100% capacity gain over CS over WCDMA Release 99
- Talk time improves considerably
- UE-UE call set-up time improves significantly
  (from today's ~3.5sec to below 1.5sec)



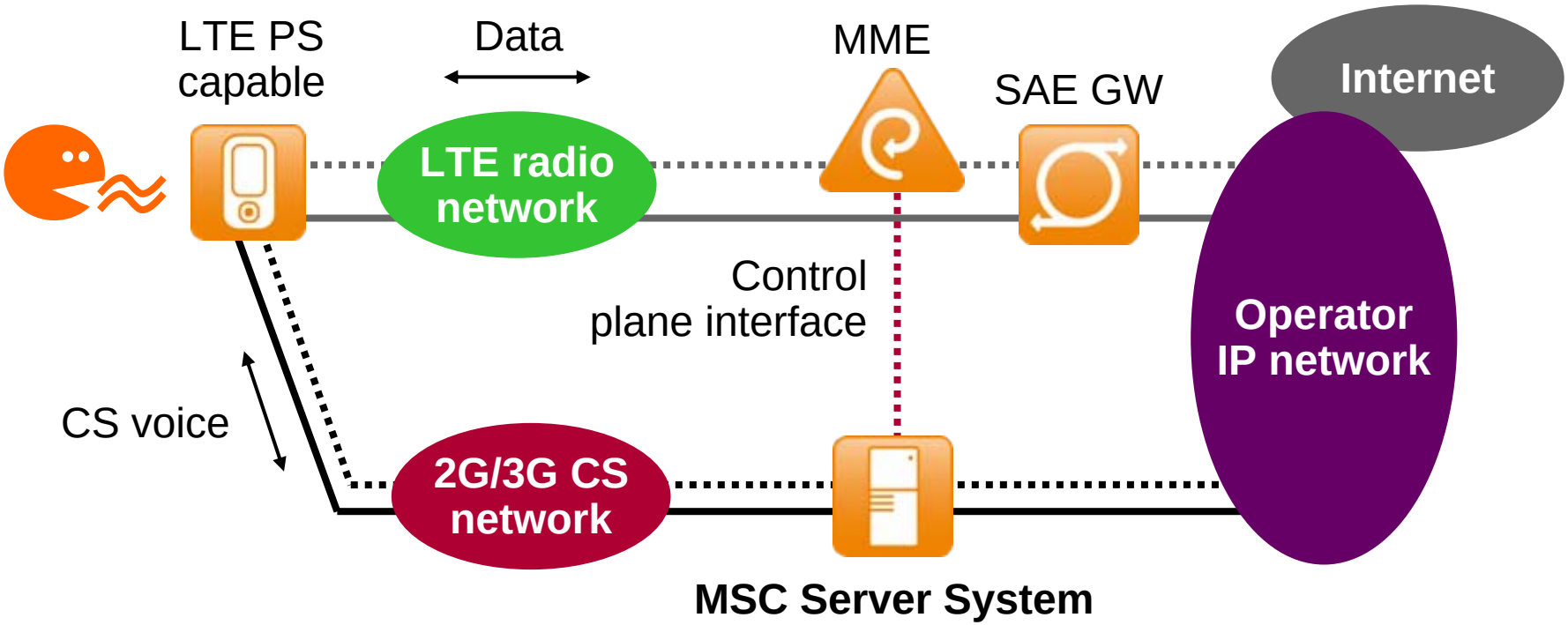
LTE used for high speed packet data access only

Operator voice service provided over CS network



- LTE network is applied to provide high speed packet data access
- LTE network can be accessed with laptop data cards
- Operator provided voice service is implemented with 2G/3G CS network
- Subscribers may use Internet based VoIP services over LTE
  - Similar limitations as with Internet VoIP apply (limited QoS capabilities, no handover to 2G/3G)

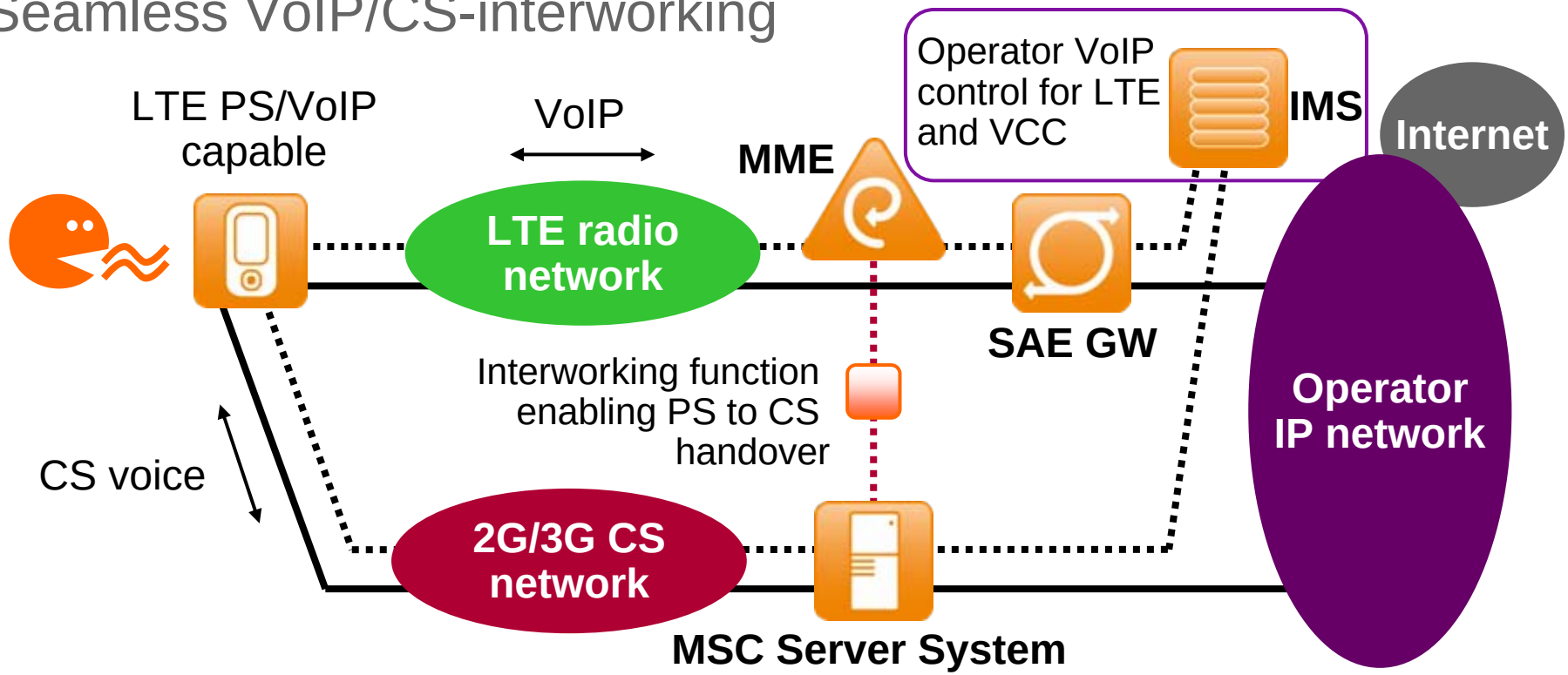
Fallback to CS voice outside of LTE coverage



- Terminal is simultaneously attached to both LTE and 2G/3G CS radio networks
- Terminal automatically uses 2G/3G CS network when the user initiates a voice call via operator network
- When the user receives a voice call, the UE is moved from LTE to 2G/3G CS network before the call is set up
  - Procedure is standardized in 3GPP Rel 8

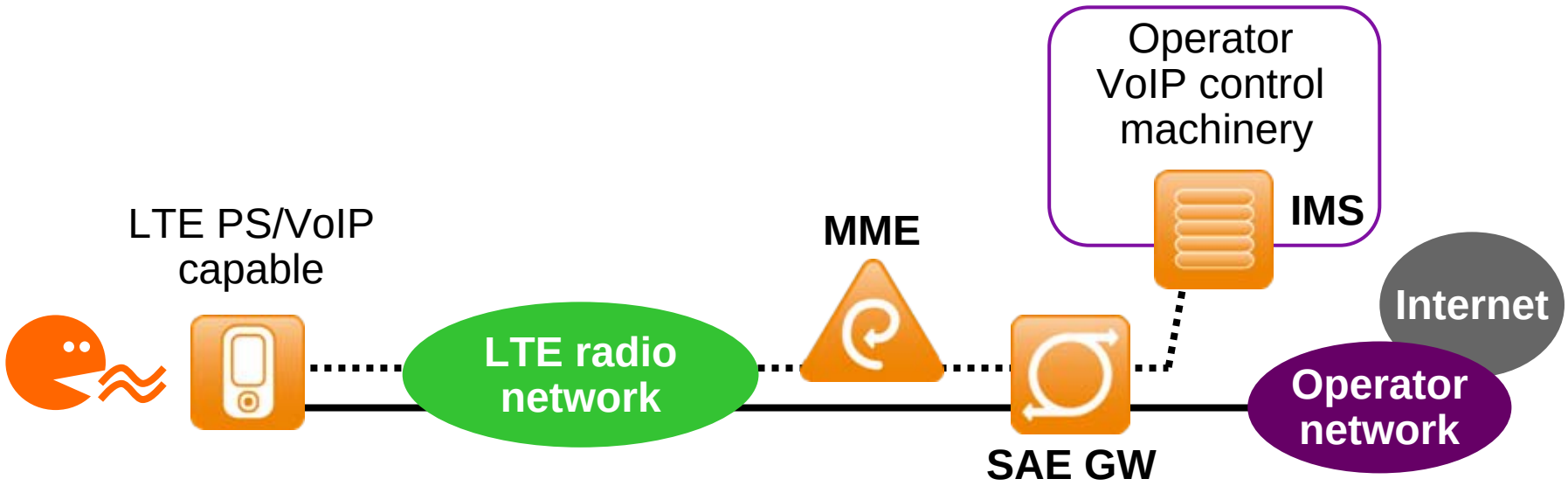
Single Radio Voice Call Continuity (SRVCC)

Seamless VoIP/CS-interworking



- IMS is the 3GPP standardized connectivity control machinery for voice and multimedia sessions
- MME makes a handover for PS voice session
- Interworking function is needed between MME and MSS
- Voice session is handed over to 2G/3G CS voice, procedure is standardized in 3GPP Rel-8
- Simulatenous voice and data sessions can be supported:
  - In 3G network when multi-RAB is enabled
  - In 2G network when Dual Transfer Mode is enabled

All-IP network – VoIP over LTE everywhere



- All-IP network can be any 3GPP or non-3GPP access network that is able to provide support for operator VoIP
- IMS is the 3GPP standardized connectivity control machinery for voice and multimedia sessions