

EDGE

- A Technical Review -

(or "what, why and how...")

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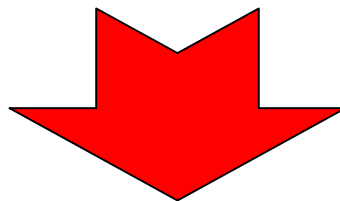
Common misunderstandings about EDGE:

- **GPRS and EDGE are two different technologies**
- **EDGE uses a modulation that is very sensitive to poor radio conditions**
- **EDGE and GPRS have almost the same throughput**
- **EDGE needs more sites than GSM/GPRS due to worse coverage performance**
- **EDGE requires major network upgrades**
- **There is no need for EDGE in Europe where WCDMA is being deployed**

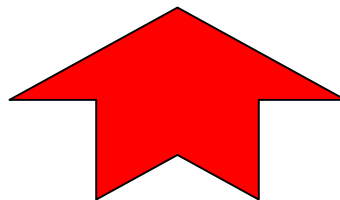
**”GPRS and EDGE are two
different technologies” ...**

The Abbreviation

GPRS = General Packet Radio System



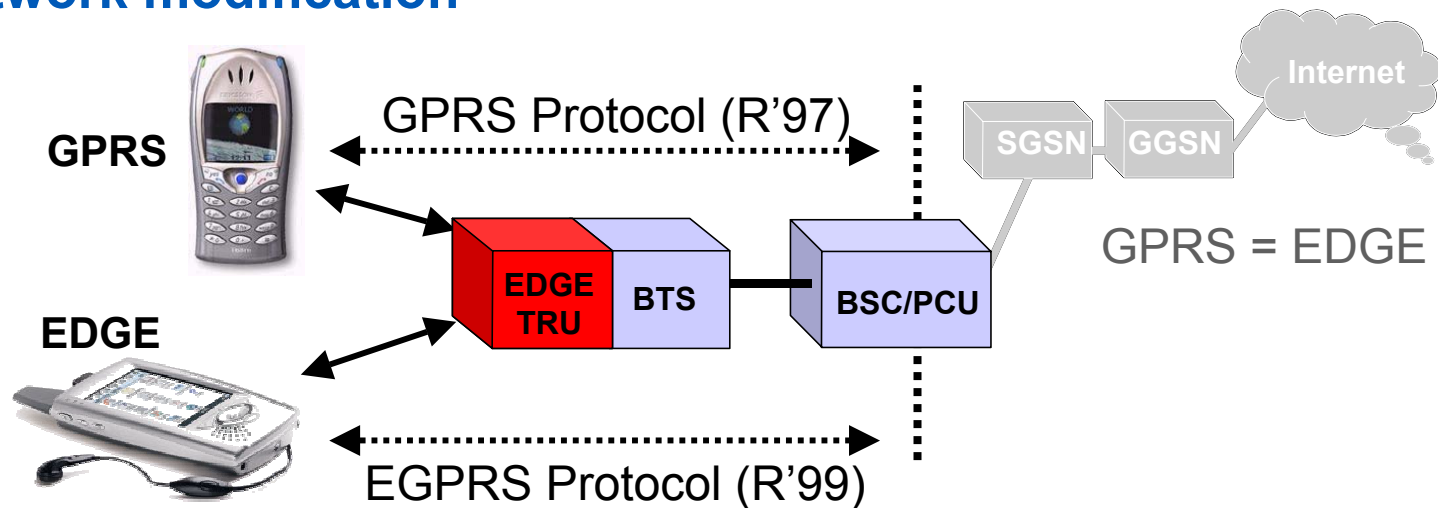
EGPRS = GPRS + EDGE modulation



EDGE = Enhanced Data rates for Global Evolution

EDGE – a standard evolution of GPRS

Minor network modification

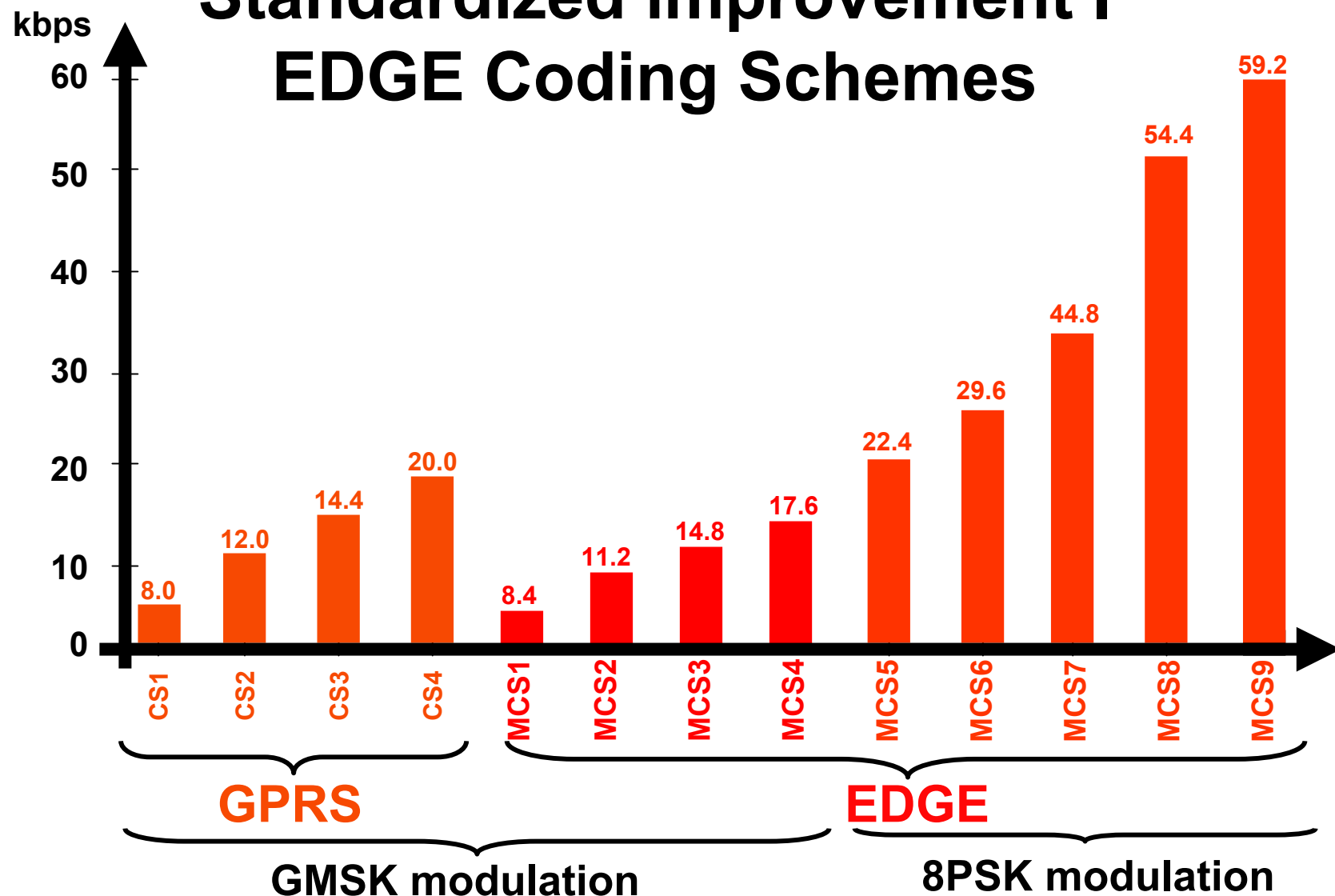


Protocol enhancements

- Higher bit rate modulation (8PSK)
- More robust radio protocol
- Link Quality Control (combined LA and IR)

Standardized improvement I

EDGE Coding Schemes



Standardized improvement II

- Packet Re-transmission -

GPRS (R'97)



Re-transmission with another CS **not** possible

EDGE (R'99)



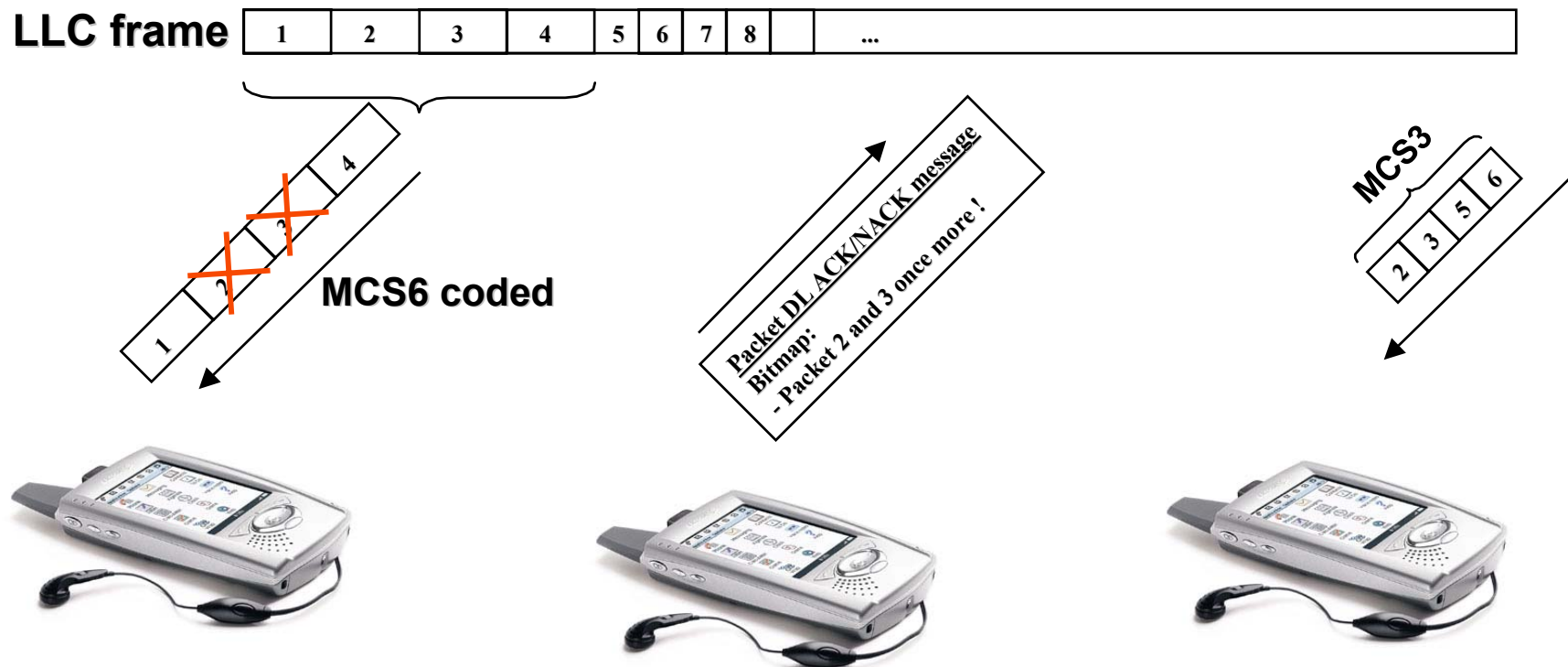
Re-transmission with another MCS **possible**

- Example GPRS -



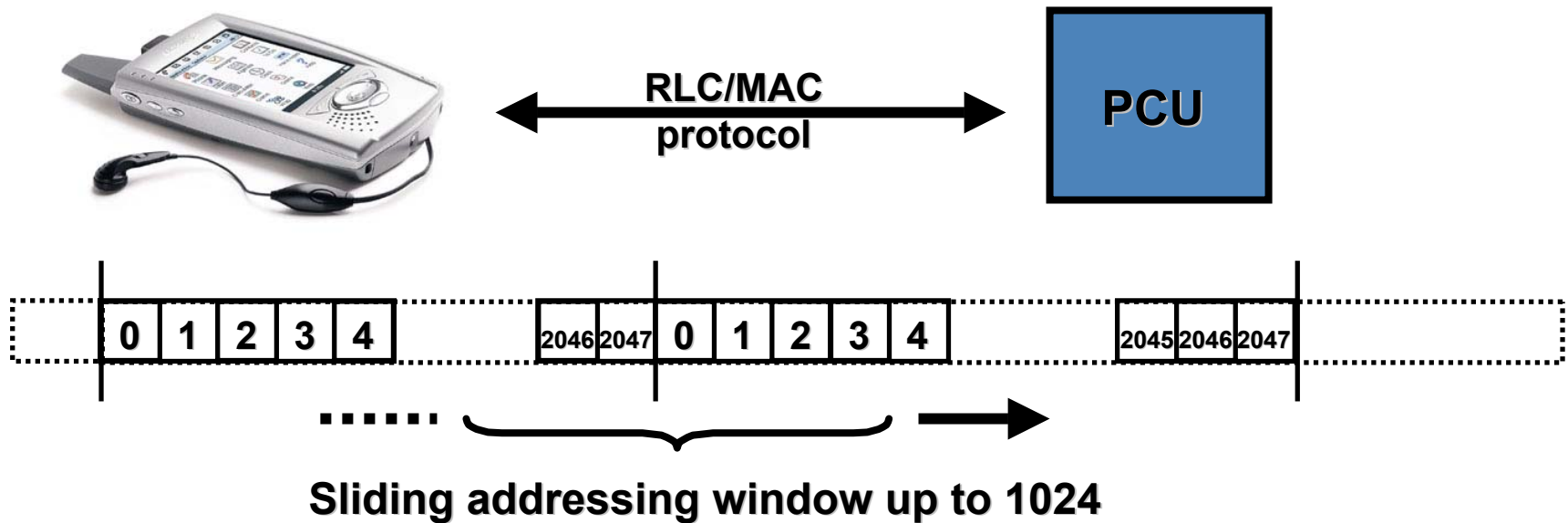
Packet Transfer and re-transmission

- Example EGPRS -



Standardized improvement III

- EGPRS addressing window ...



... increased from **64** to **1024** to avoid protocol stalling !!!

Standardized improvement IV

- Measurement Reporting -

GPRS (R'97)



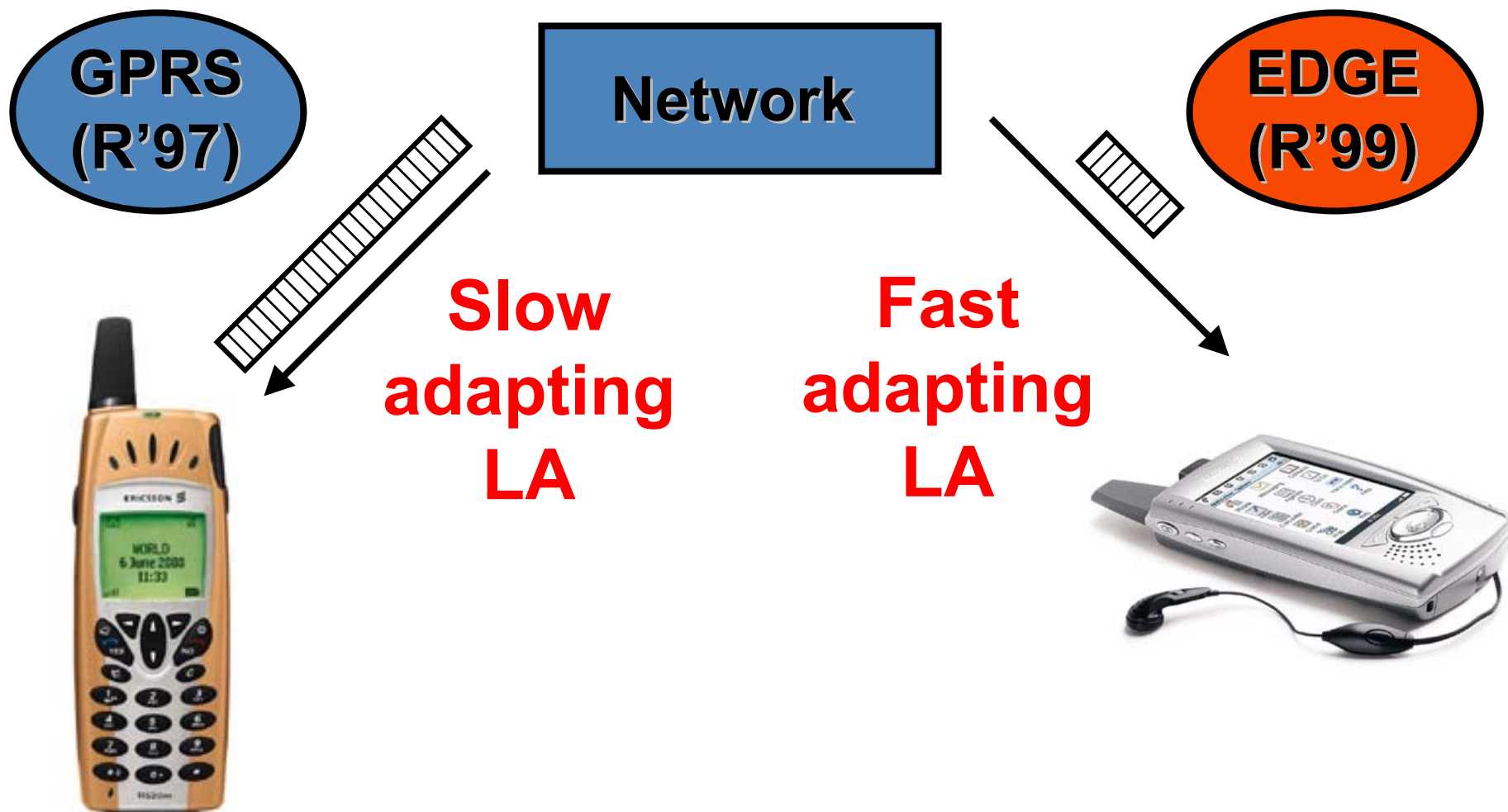
**Quality report
based on GSM
channel structure analysis
(Carrier strength,
Bit Error Rate ...)**

EDGE (R'99)



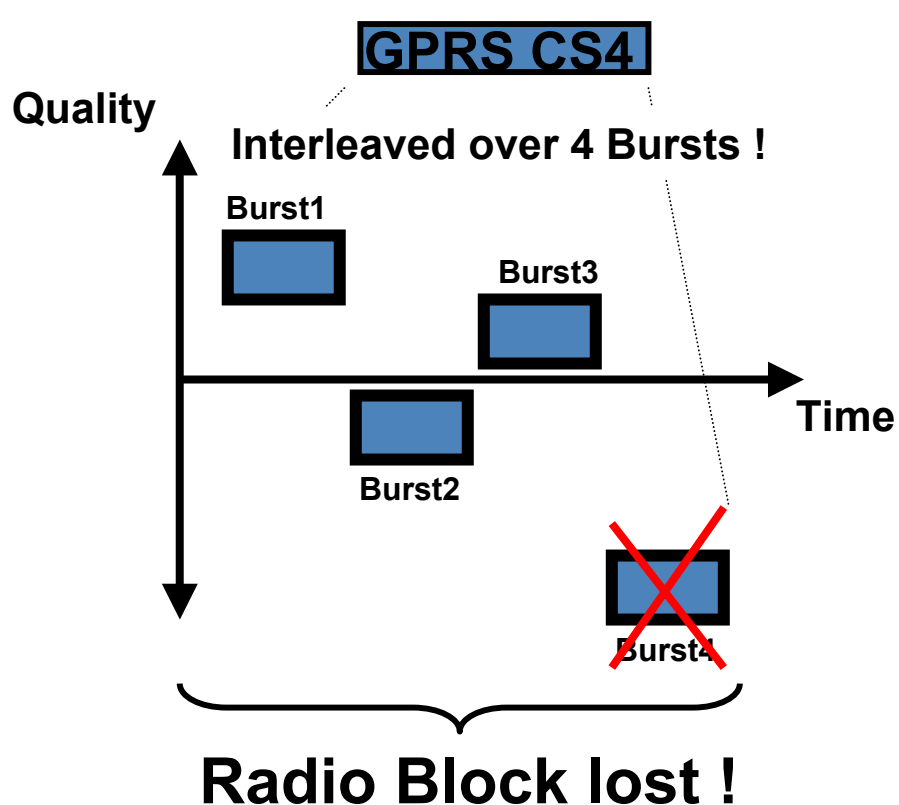
**Quality report
based on
burst analysis
(**B**it **E**rror **P**robability)**

The Effect

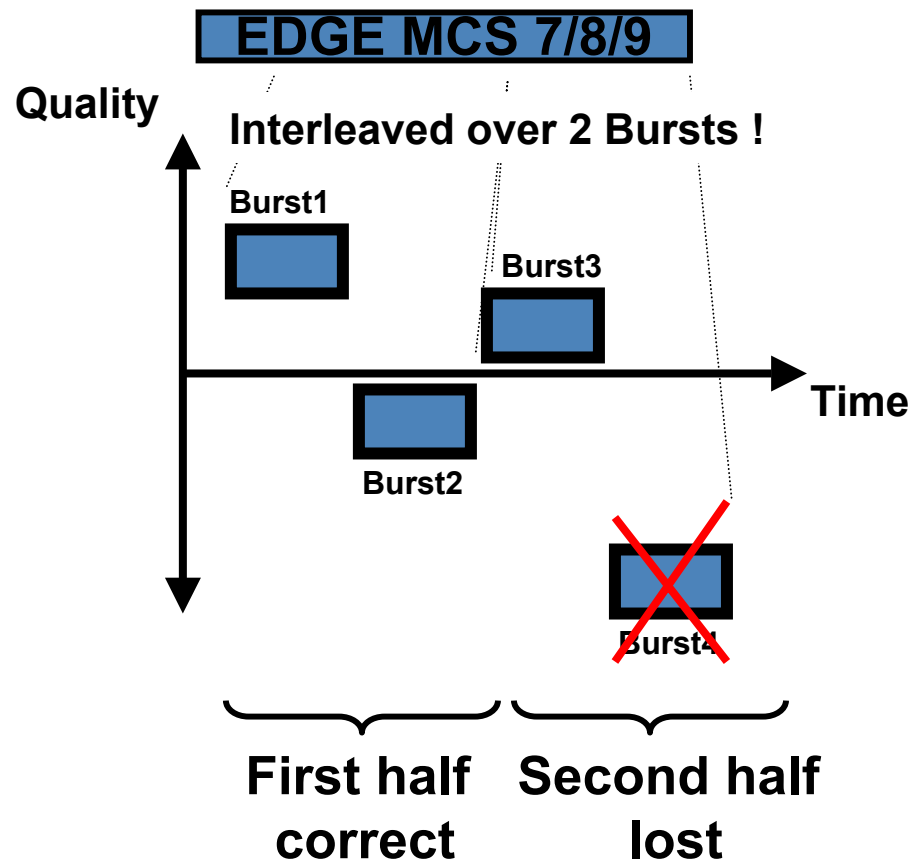


Standardized improvement V

- Interleaving -



Retransmission of lost Block necessary

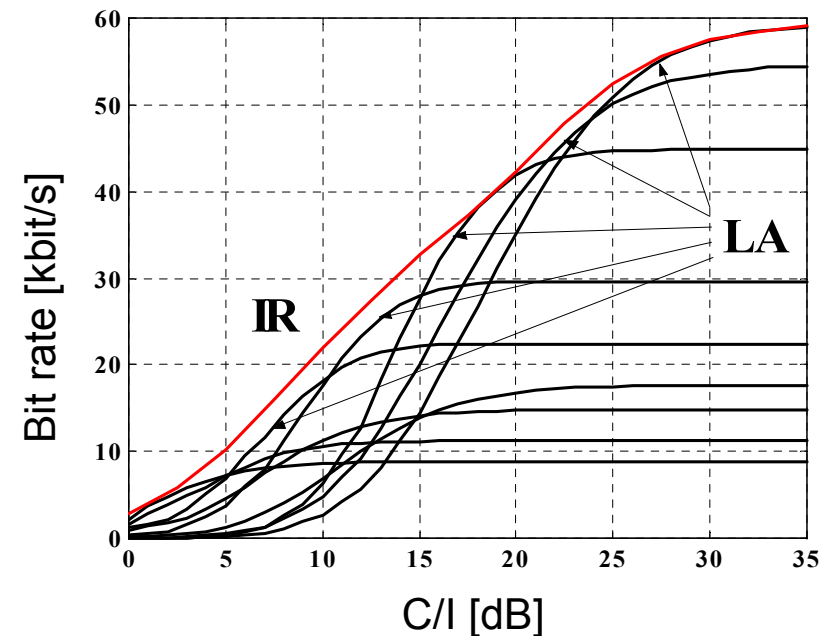


Retransmission of second half only

Standardized improvement VI

- Link Quality Control for EDGE -

- Link Adaptation (LA)
 - Extensive set of modulation and coding schemes
- Incremental Redundancy (IR)
 - Code combining of transmission attempts
- LA and IR can be combined



Reliable link quality and efficient use of radio resources!

Link Adaptation

- Use optimum MCS for the radio environment

**L
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Scheme	Modulation	Maximum rate [kbps]	Code Rate	Octets	Blocks per 20 ms	Family
MCS-9	8PSK	59.2	1.0	2*74	2	A
MCS-8		54.4	0.92	2*68	2	A
MCS-7		44.8	0.76	2*56	2	B
MCS-6		29.6	0.49	74	1	A
MCS-5		22.4	0.37	56	1	B
MCS-4	GMSK	17.6	1.0	44	1	C
MCS-3		14.8	0.85	37	1	A
MCS-2		11.2	0.66	28	1	B
MCS-1		8.8	0.53	22	1	C

Incremental Redundancy

- Transmit more coding if needed

Use same MCS for retransmissions

MCS-9 achieves similar robustness and bitrate as MCS-5

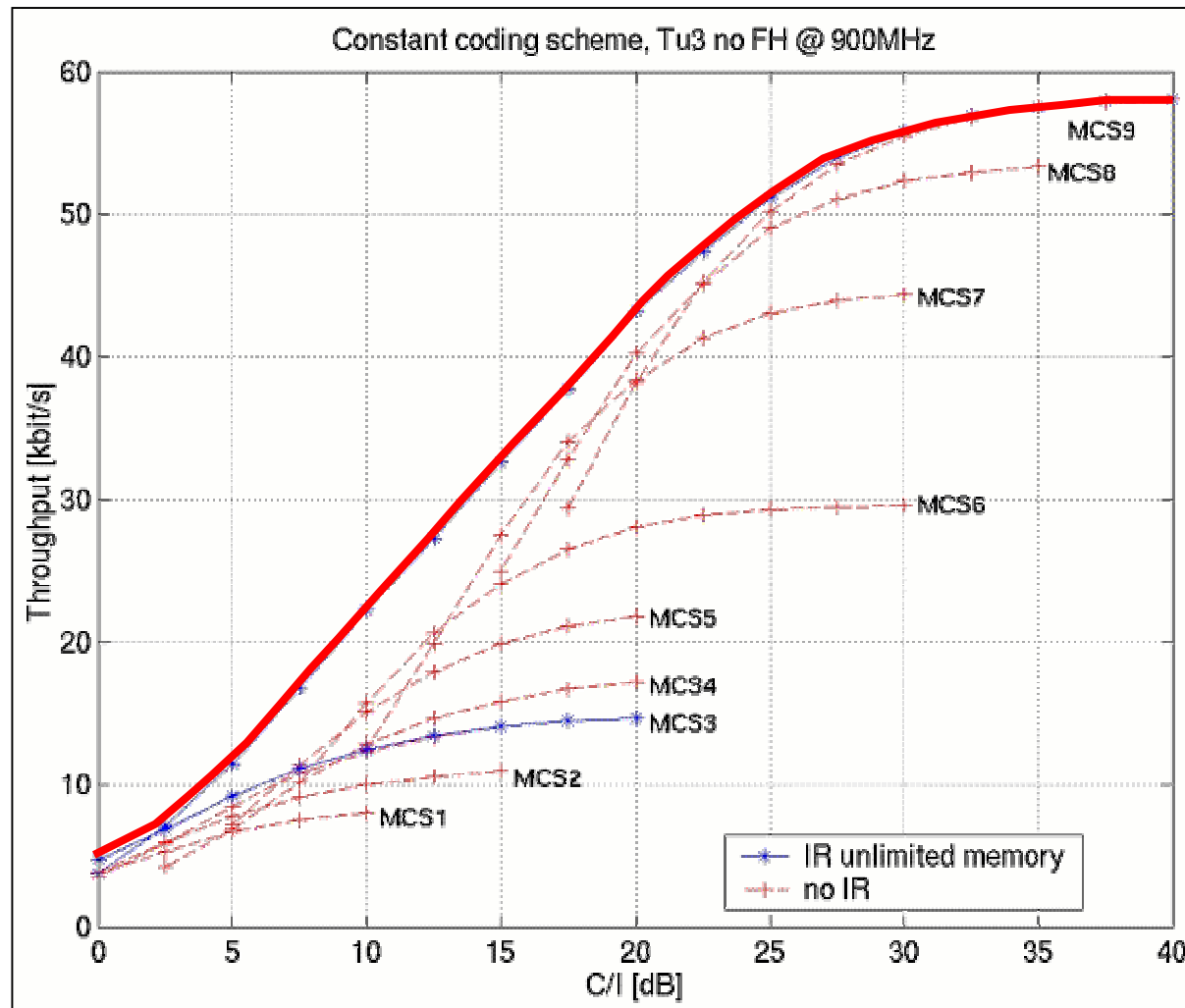
Scheme	Modulation	Maximum rate [kbps]	P1	P1+P2	P1+P2+P3
MCS-9	8PSK	59.2	1.0	0.5	0.33
MCS-8		54.4	0.92	0.46	0.31
MCS-7		44.8	0.76	0.38	0.25
MCS-6		29.6	0.49	0.24	-
MCS-5		22.4	0.37	0.19	-
MCS-4	GMSK	17.6	1.0	0.5	0.33
MCS-3		14.8	0.85	0.42	0.28
MCS-2		11.2	0.66	0.33	-
MCS-1		8.8	0.53	0.26	-

EDGE Radio Link Performance

Link level simulations with Ericsson system algorithm

Assumptions:

- MCS-9 and MCS-3 with incremental redundancy, IR (unlimited memory)
- MCS-1 to MCS-9 without IR (no memory)
- Downlink
- TU3 channel
- No frequency hopping
- Co-channel interference
- No adjacent channel interference



"EDGE uses a modulation that is very sensitive to poor radio conditions" ...

"GPRS and EDGE have almost the same throughput" ...

"EDGE needs more sites than GSM/GPRS due to worse coverage performance" ...

GPRS/EDGE Performance in the radio environment

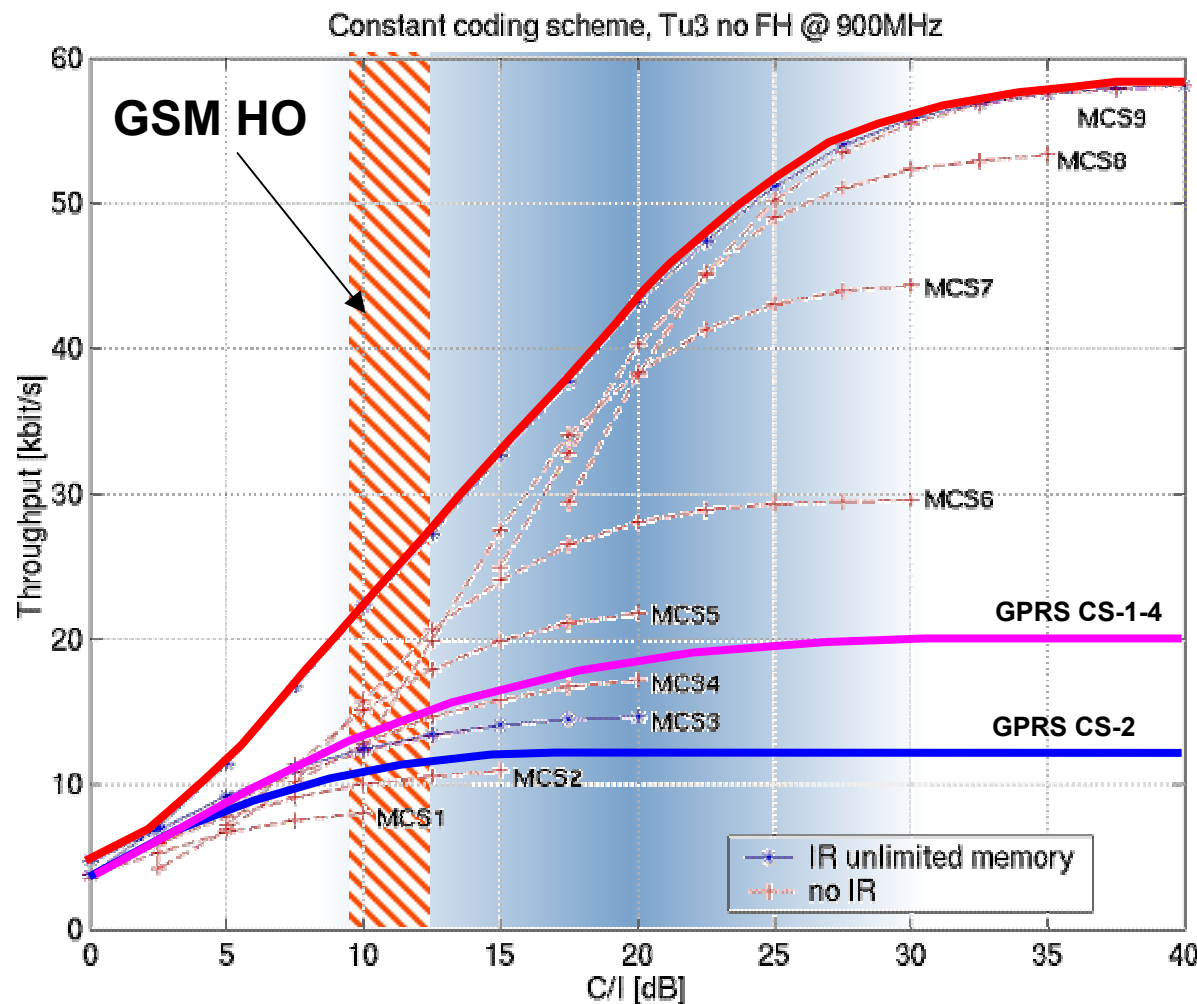
Comparing robustness GPRS – EDGE:

- CS-1 ~ MCS-1
- CS-2 ~ MCS-2
- CS-3 ~ MCS-3
- CS-4 ~ MCS-4

Voice

Typical C/I distribution

- Cell border ~10-12 dB
- Mean C/I ~18 dB



Note. GPRS CS-2 and CS-1-4 superimposed for indicative comparison only

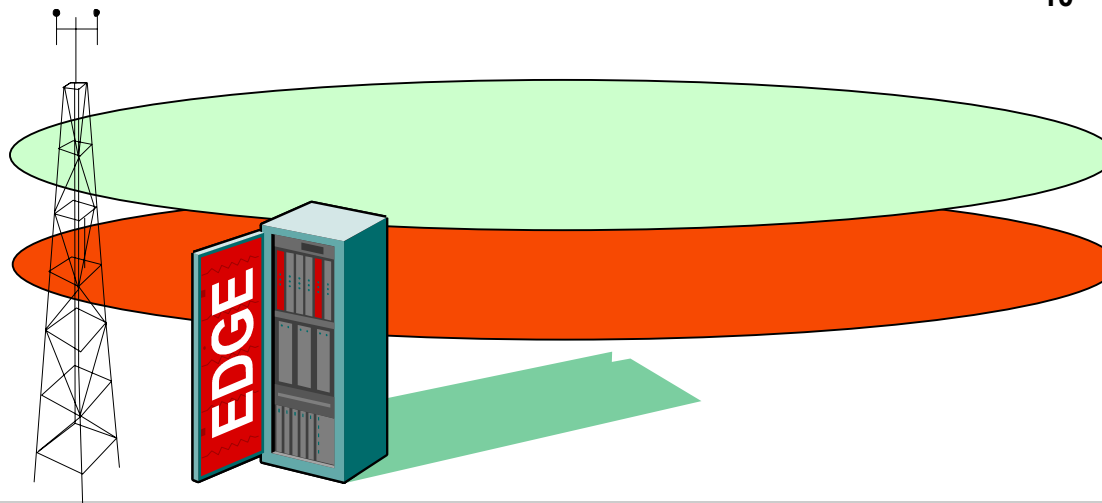
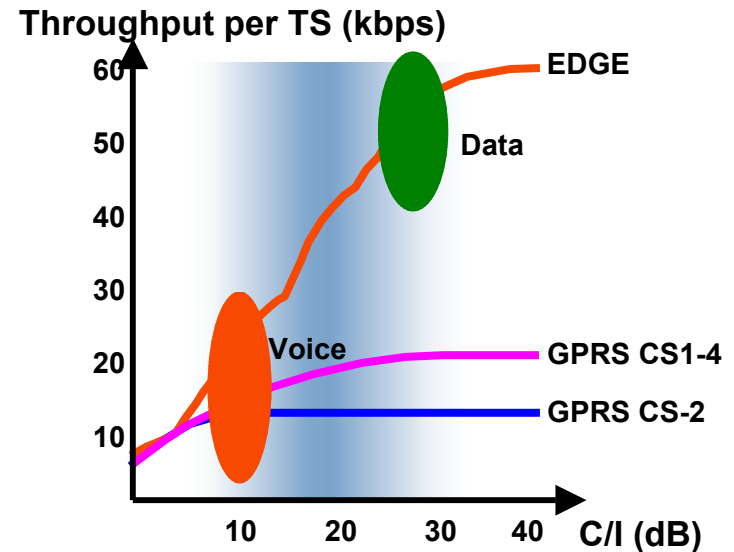
Conclusions from system simulations and confirmed in trials

- EDGE performs well in a wide range of network scenarios
 - FH and no FH
 - BCCH and non-BCCH frequencies
 - Different reuse configurations
- In very tight reuse scenarios (e.g. 1 reuse), FH is essential



Optimizing EDGE throughput in a tight network

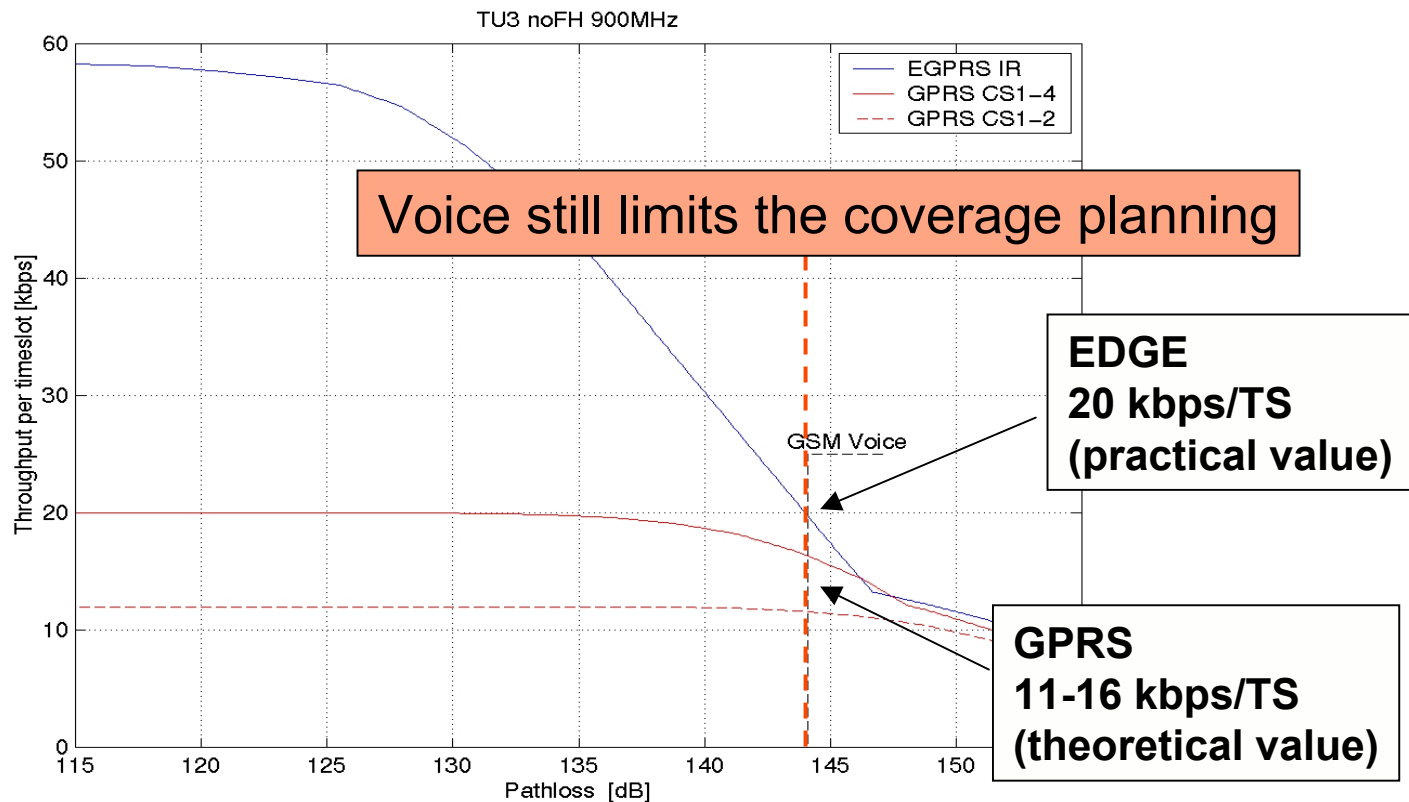
Separate channel groups for voice
and EDGE (and CS-3&4)
→ Higher throughput at cell border!



EDGE: >25 dB C/I

Voice: ~10 dB C/I

EDGE Coverage

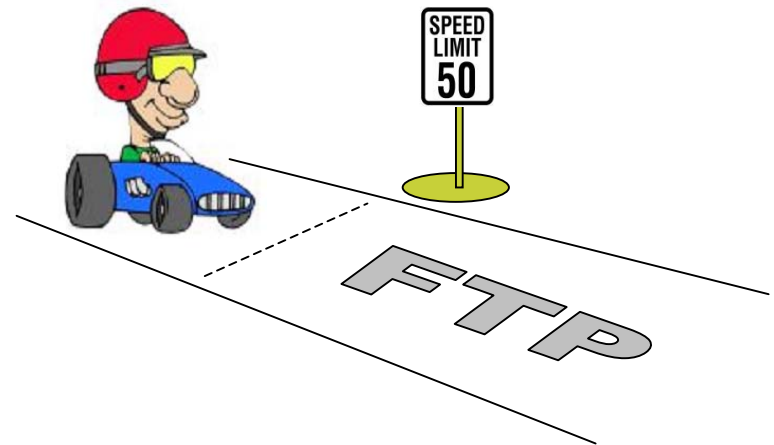


➡ EDGE application coverage always better than GPRS and voice

GPRS/EDGE Performance Aspects

- *Throughput versus Latency*

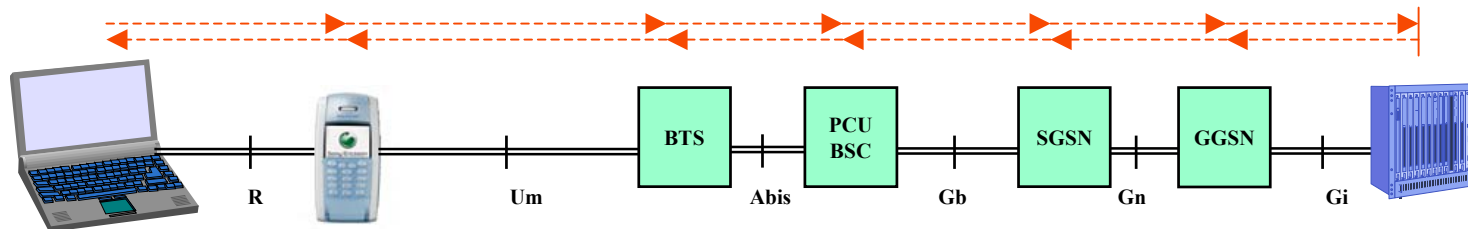
- Handshaking and signaling affects perceived data speed!
 - E.g. emails and web browsing



Laptop measurements include:

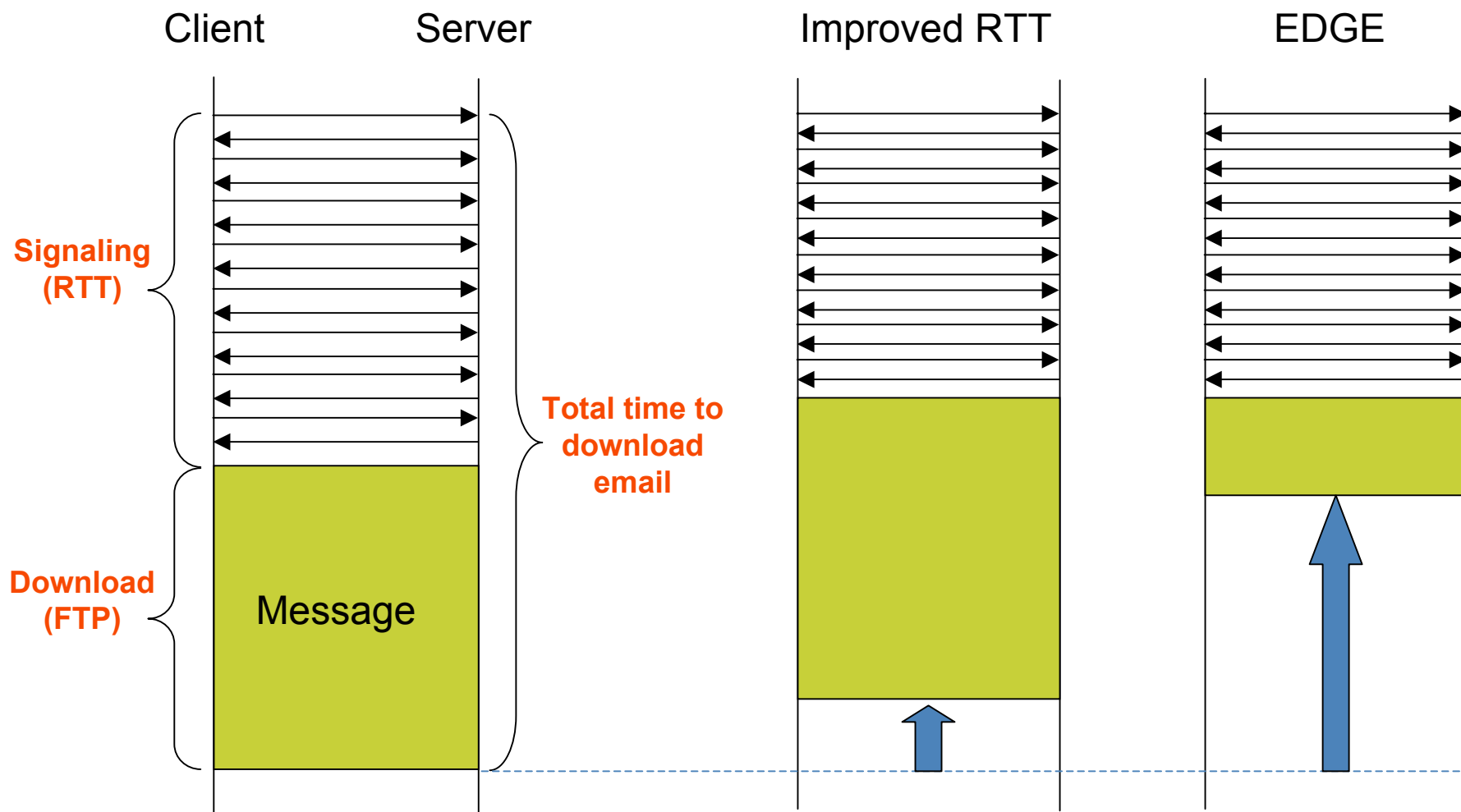
1. Transfer time PC – MS interface (IR, Bluetooth, ...)
2. MS internal processing
3. Wait to send channel req
4. Transfer time in BSS, CN, and out on the Internet...

- Typical RTT values: ~500-600 ms
- Network dependent
- Measurement setup dependent

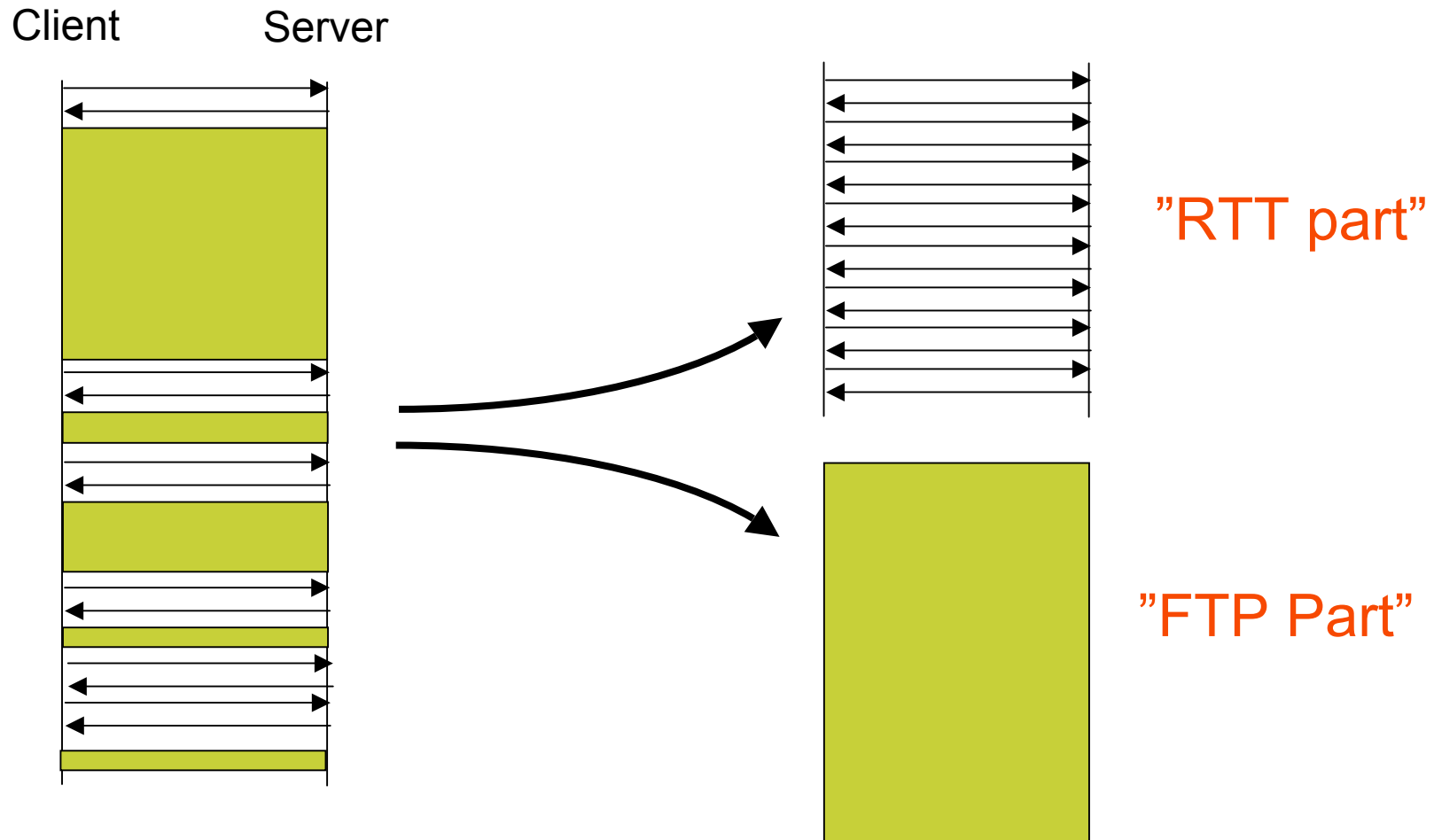


Example: Email

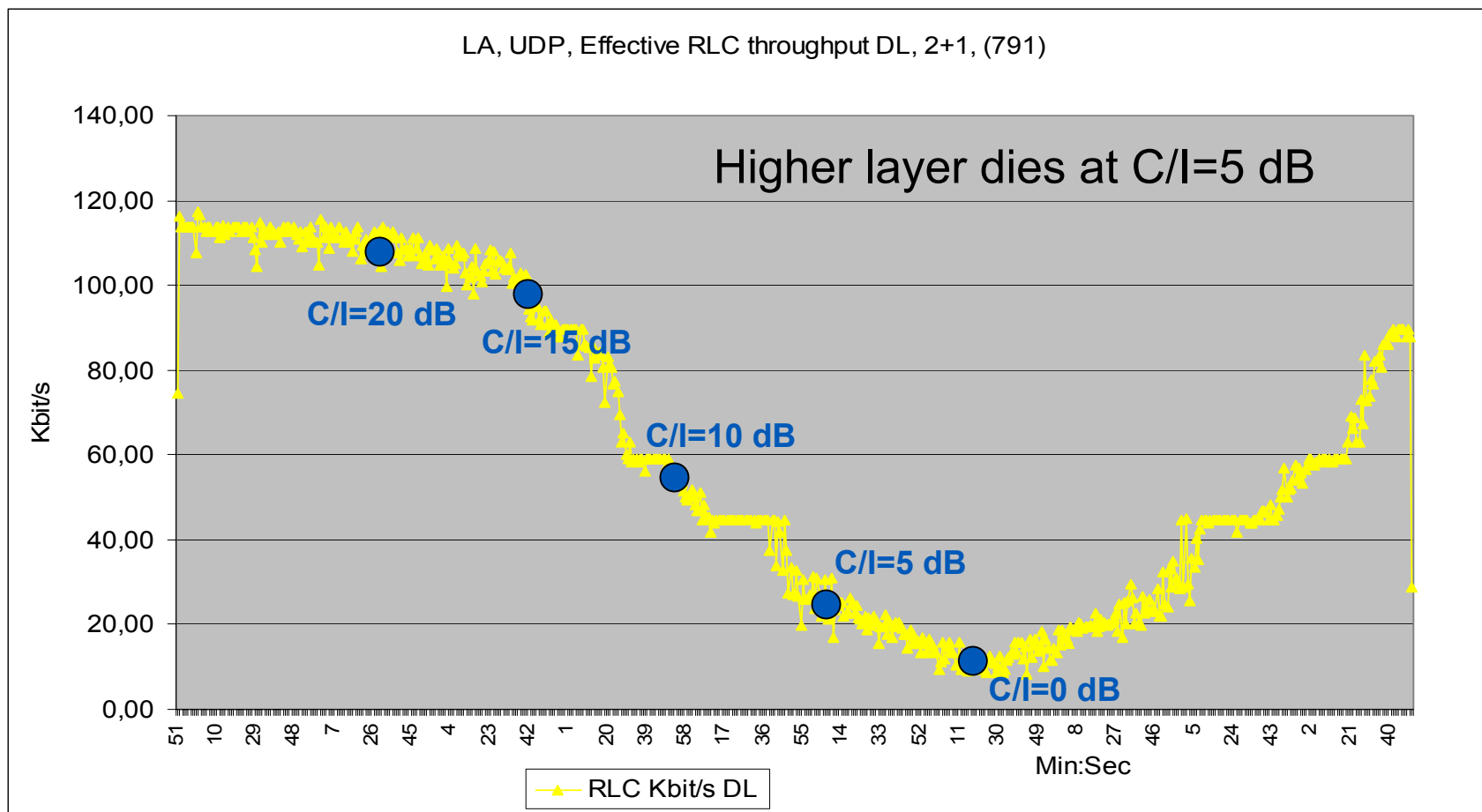
- Receive (POP3) and Send (SMTP)



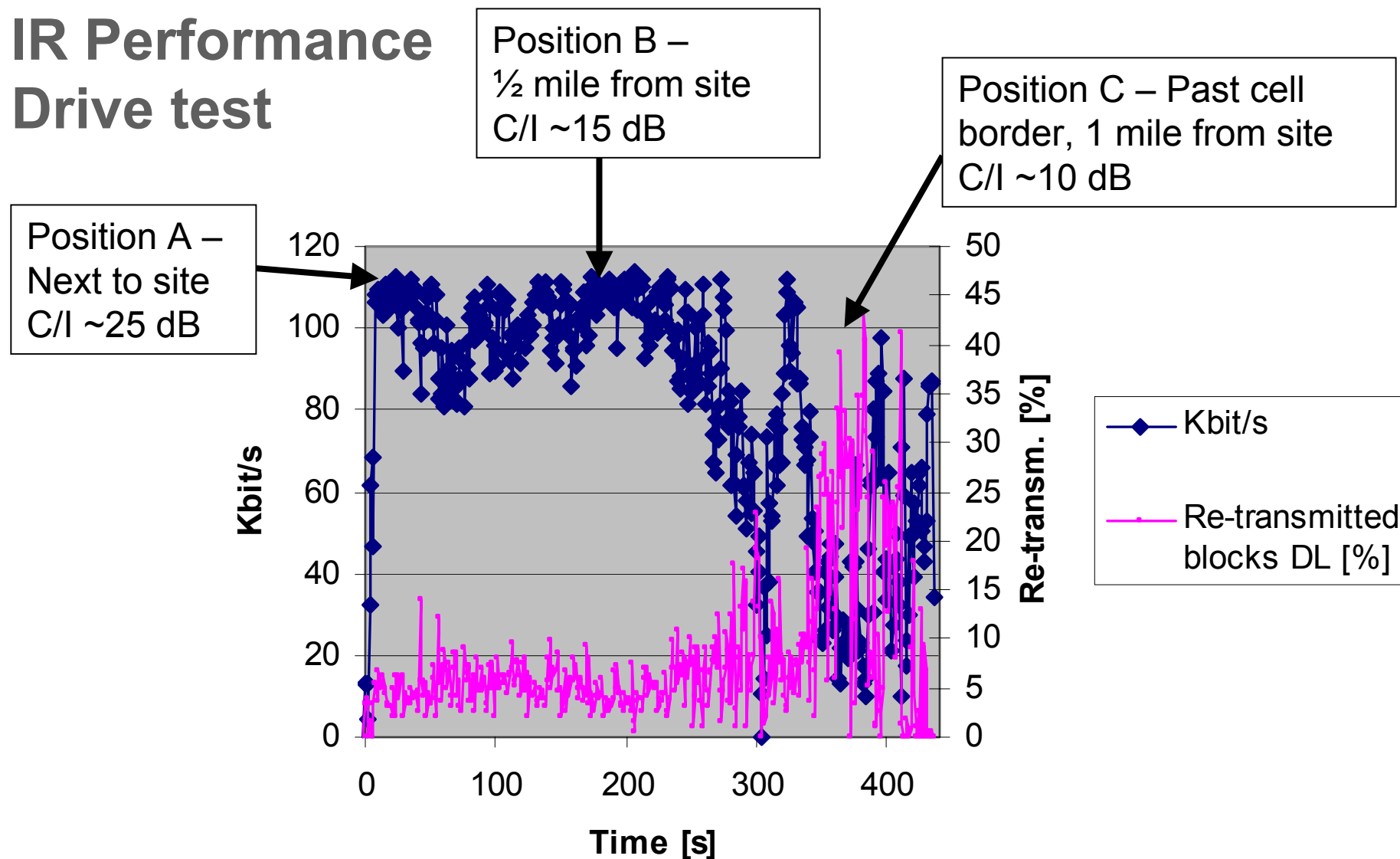
Example: Web browsing



Ericsson lab results of EDGE performance



IR Performance Drive test

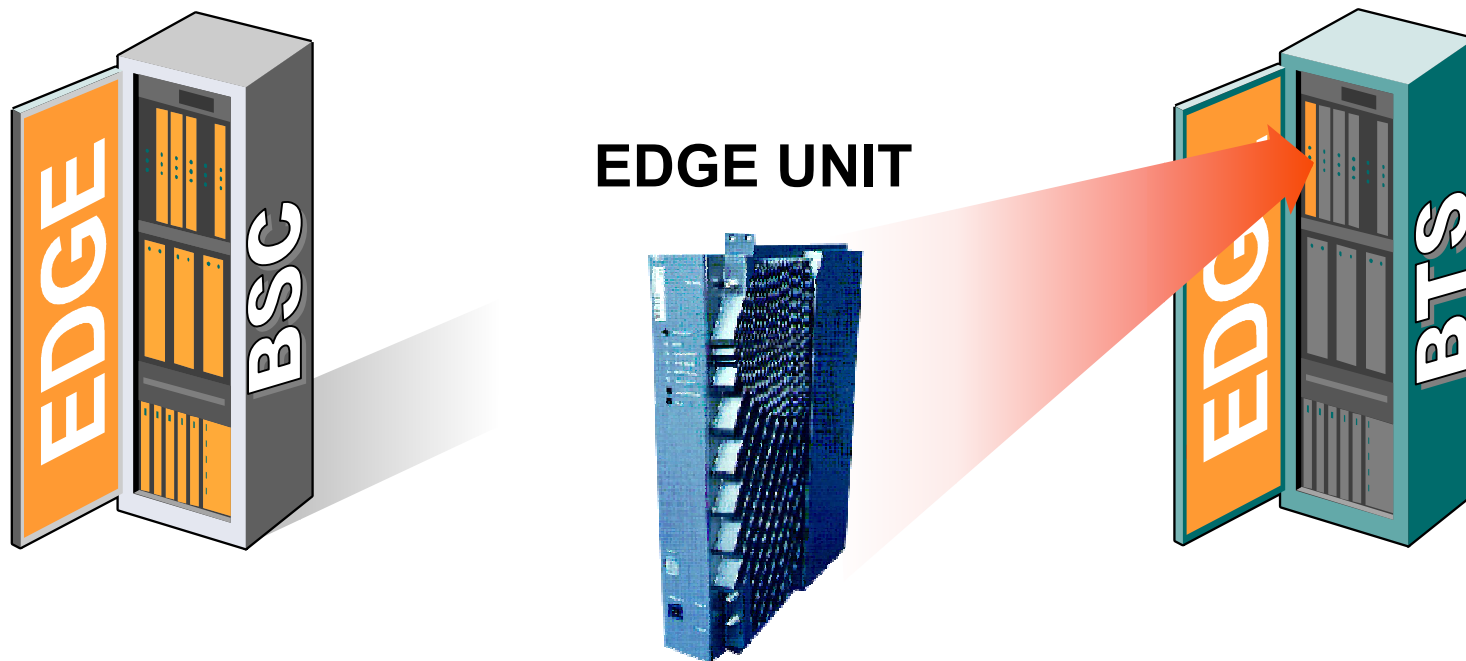


**"EDGE requires major
network upgrades" ...**

Upgrading to EDGE

	Inherited from GPRS	Additions
Competence: TCP/IP & Radio	☒	
Performance management: Counters, Alarms, processes, OSS, ...	☒	
Core Network: GSNs, DNS & Radius servers, HLRs, backbone NW, ...	☒	
BSC/PCU HW	☒	☐
BTS HW	☒	☒
BSS SW	☒	☒
Radio Network design, dimensioning	☒	Optional ☒

Upgrading to EDGE



BTS HW



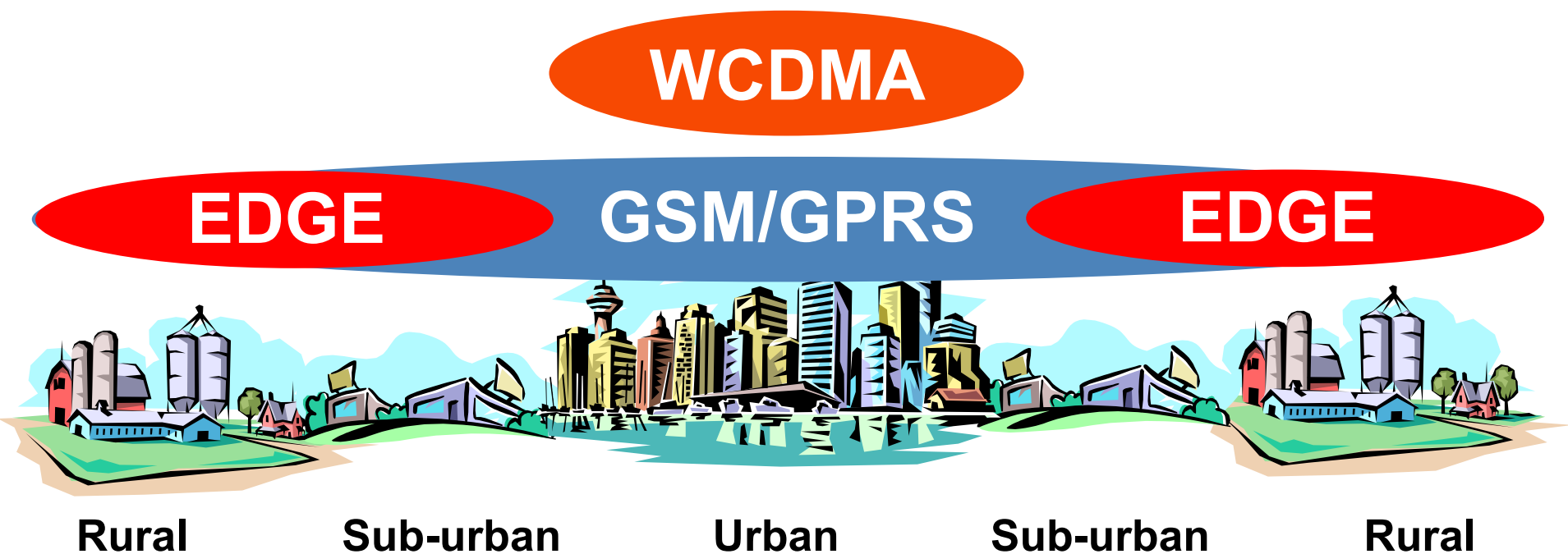
BSS SW



"There is no need for EDGE in Europe where WCDMA is being deployed"

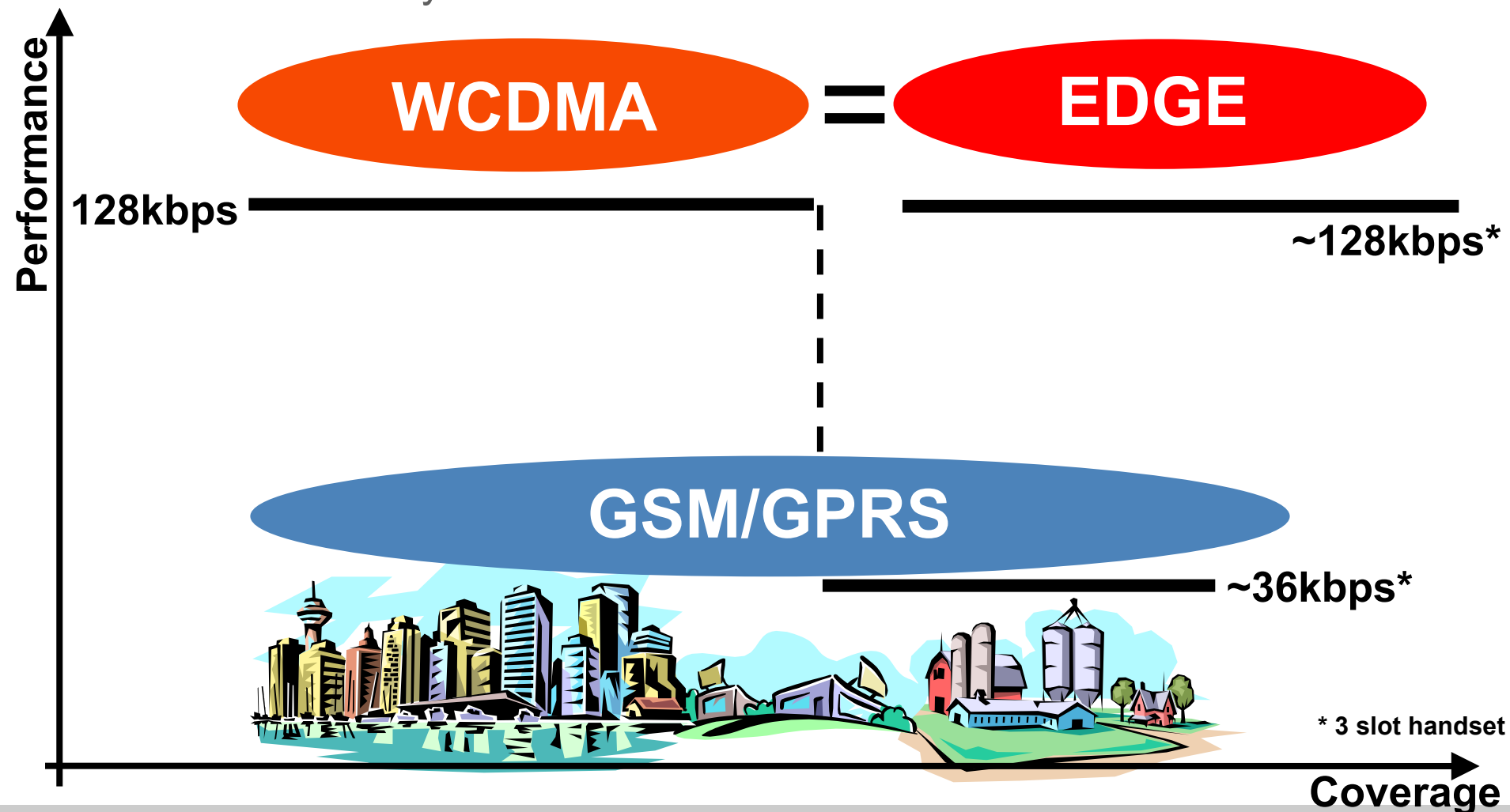
GSM operator with WCDMA spectrum

Roll-out scenario



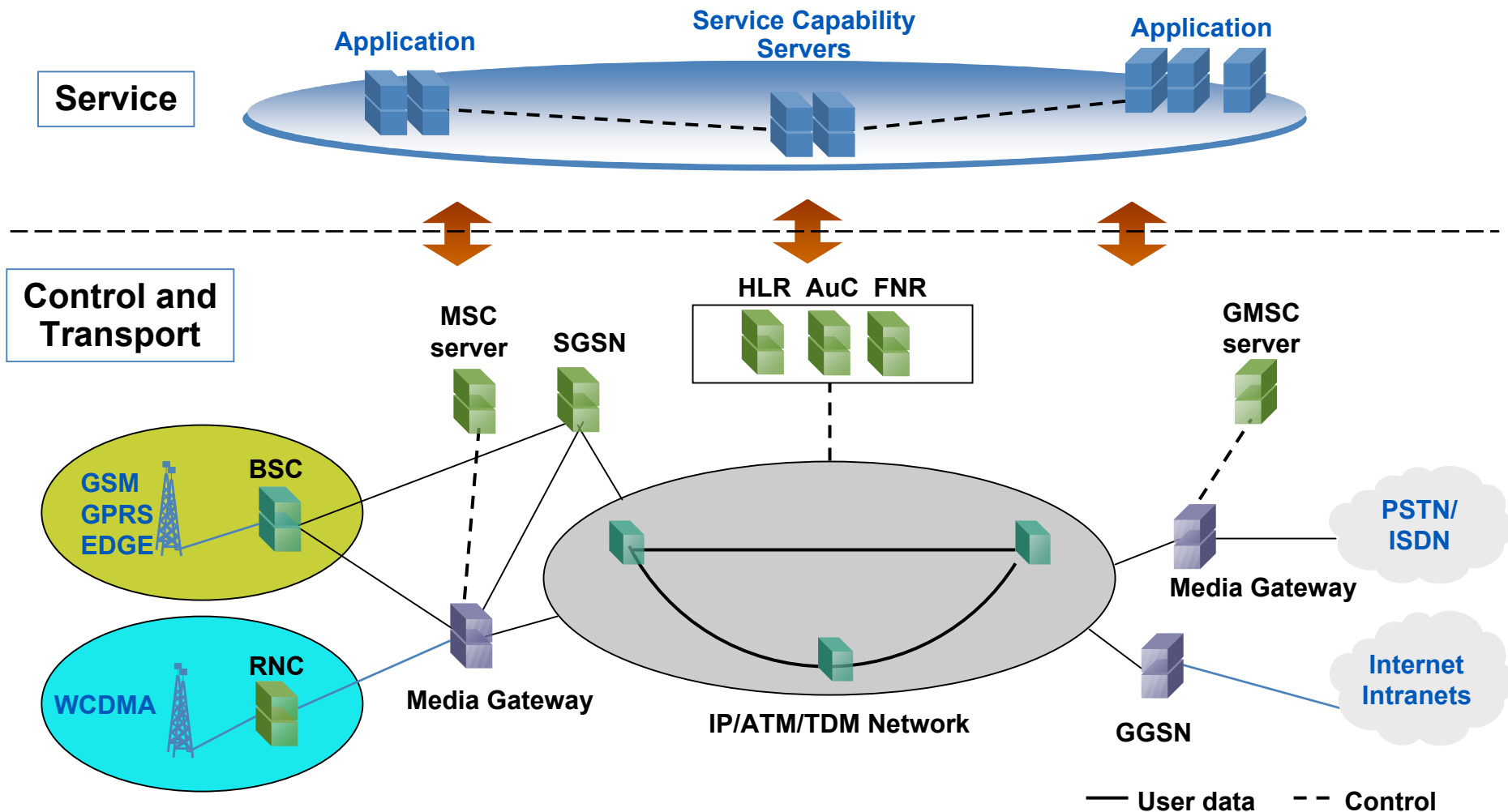
End-user experience in focus

Service Continuity WCDMA – GSM



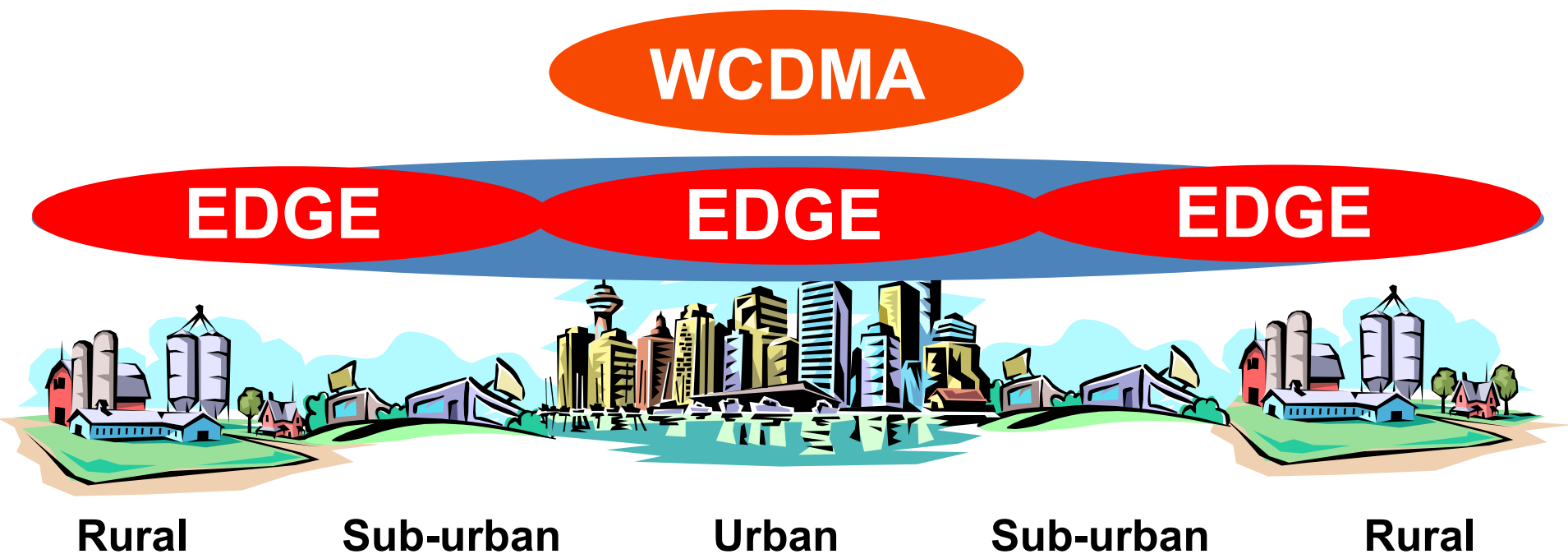
Coverage

Combined GSM/GPRS/EDGE/WCDMA Network



GSM operator with WCDMA spectrum

Roll-out scenario



Capacity

Assumptions:

10MHz spectrum

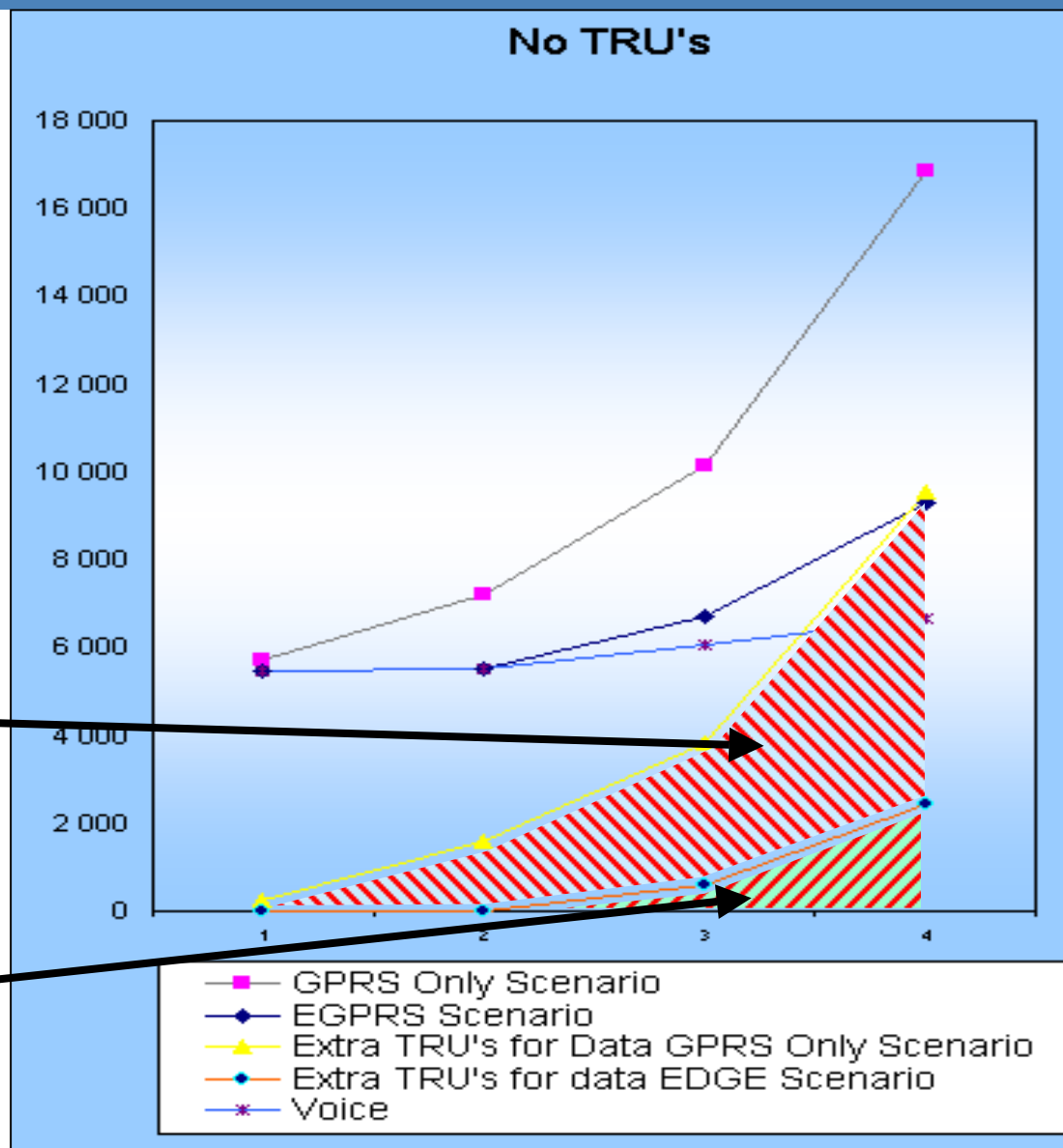
1 Mio subscribers

Annual growth 10%

EDGE handset penetration
after 5 years = 70%

**~9000 extra TRUs
due to GPRS !**

**~2000 extra TRUs
with EDGE !
→ 78% saving !**



Capacity

Assumptions:

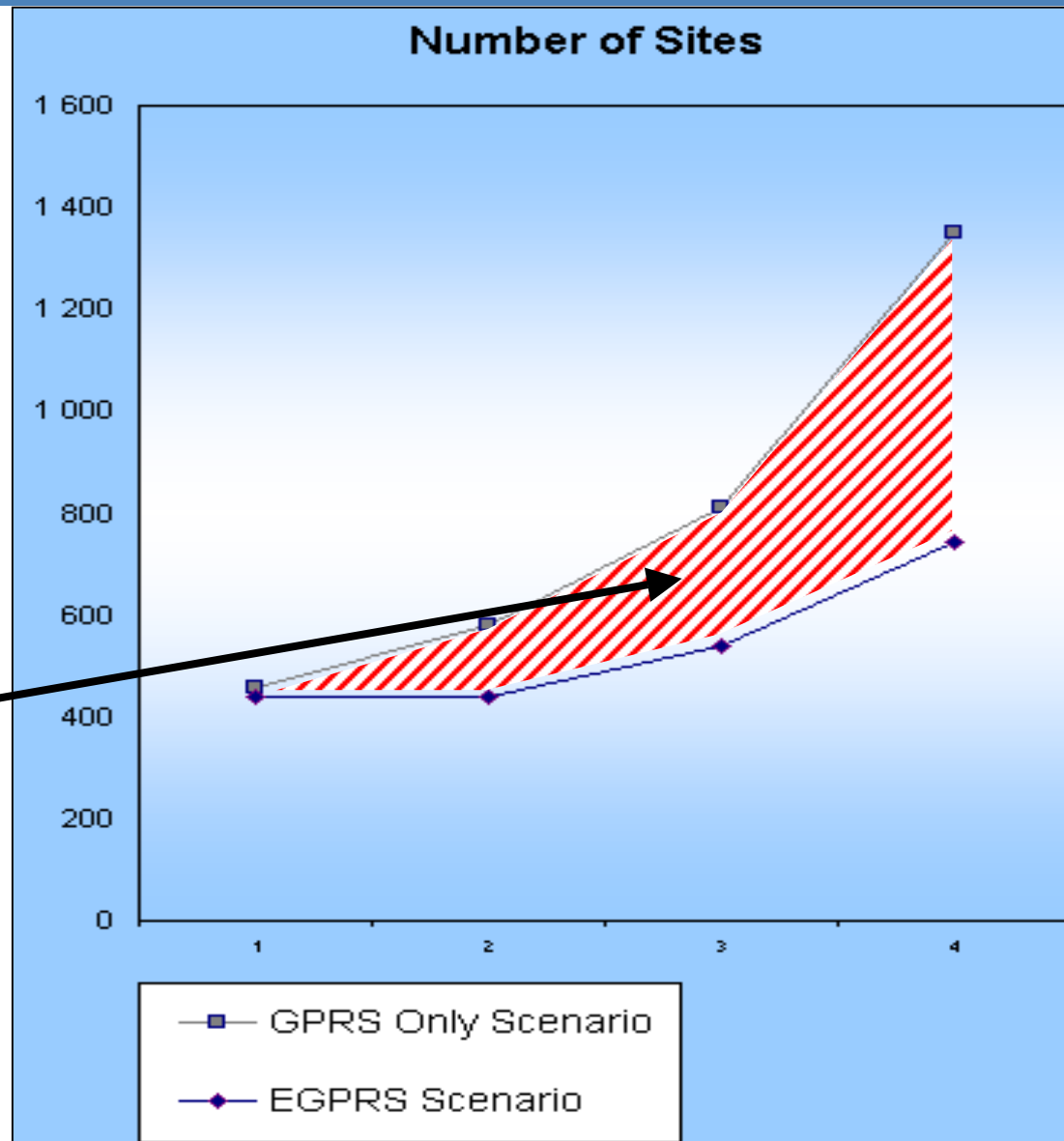
10MHz spectrum

1 Mio subscribers

Annual growth 10%

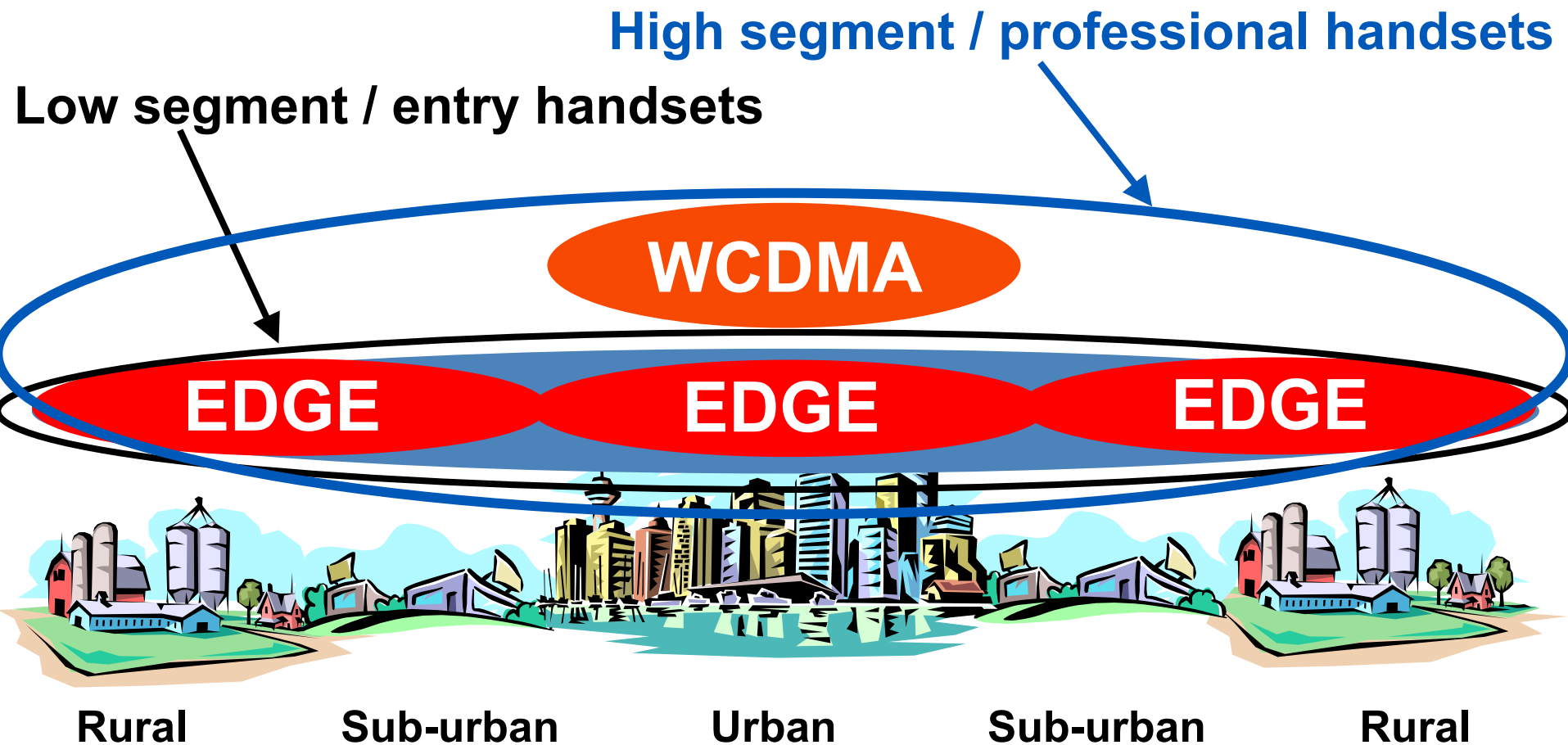
EDGE handset penetration
after 5 years = 70%

Site splits reduced
from ~1300 to ~600
→ 50% saving !



GSM operator with WCDMA spectrum

Roll-out scenario



Conclusions

- **EDGE is a standard evolution of the GPRS radio interface**
 - Release 97 → Release 99
 - 3 times higher bit rate modulation, more robust radio protocol
- **EDGE performs well in lab and live tests**
 - 100 kbps achieved in live network using 2 TS
 - Significant performance benefits in all practical radio environments
 - Coverage planning limited by voice only
- **EDGE requires minor network modification**
 - Fast rollout – one EDGE TRU per cell plus BSS SW upgrade
- **EDGE complements WCDMA**
 - Enhanced end-user experience
 - Increased data capacity in existing GSM spectrum

