EDGE, HSPA and LTE:

The Mobile Broadband Advantage

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Full white paper available for free download at www.3gamericas.org

Key Conclusions (1)

- GSM/UMTS has an overwhelming global position in terms of subscribers, deployment, and services. Its success will marginalize other wide-area wireless technologies.
- GSM/UMTS will comprise the overwhelming majority of subscribers over the next five to ten years, even as new wireless technologies are adopted.
- OFDMA approaches may provide high spectral efficiency and high peak rates. However, HSPA+ systems can almost match OFDMA-based approaches in spectral efficiency and peak data rates in 5+5 megahertz (MHz) radio allocations through the use of equalizers, interference cancellation techniques, and Multiple Input Multiple Output (MIMO).
- HSPA Evolution provides a strategic performance roadmap advantage for incumbent GSM/UMTS operators. HSPA+ (in 5+5 MHz radio allocations) with 2x2 MIMO, successive interference cancellation, and 64 Quadrature Amplitude Modulation (QAM) is more spectrally efficient than Worldwide Interoperability for Microwave Access (WiMAX) Wave 2 with 2x2 MIMO and One Carrier Evolved Data Optimized (EV-DO) Revision B.

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Key Conclusions (2)

- LTE specifications are being completed, and the 3GPP OFDMA approach matches or exceeds the capabilities of any other OFDMA system.
- The deployment of LTE and its coexistence with UMTS/HSPA will be analogous to the deployment of UMTS and its coexistence with GSM.
- WiMAX is maturing and gaining credibility, but it will still only represent a very small percentage of wireless subscribers over the next five to ten years. Meanwhile, GSM/UMTS operators are much more likely to migrate to LTE.
- The 3GPP roadmap provides operators maximum flexibility in deploying and evolving their networks. It is comprised of three avenues: the continued evolution of GSM system capabilities, UMTS evolution, and 3GPP LTE. Each of these technologies is designed to coexist harmoniously with the others.
- Compared to UMTS/HSPA/LTE, competing technologies have no significant deployment cost advantages.
- EDGE technology has proven extremely successful and is widely deployed on GSM networks globally. Advanced capabilities with Evolved EDGE will more than quadruple current EDGE throughput rates.

Key Conclusions (3)

- UMTS/HSPA represents tremendous radio innovation and capability, which allows it to support a wide range of applications, including simultaneous voice and data on the same devices.
- The high spectral efficiency of HSPA for data and WCDMA for voice provides UMTS operators an efficient high-capacity network for all services. In the longer term, UMTS allows a clean migration to packet-switched voice.
- In current deployments, HSDPA users under favorable conditions regularly experience throughput rates well in excess of 1 megabit per second (Mbps). Planned HSDPA enhancements will increase these peak user-achievable throughput rates, with vendors already measuring in excess of 3 Mbps on some commercial networks.
- HSUPA users under favorable conditions will initially experience peak achievable rates in excess of 1 Mbps in the uplink.
- 3GPP is developing an LTE technology path with the goal of initially deploying next-generation networks in the 2009 timeframe. Peak theoretical rates are 326 Mbps. LTE uses OFDMA on the downlink and Single Carrier Frequency Division Multiple Access (SC-FDMA) on the uplink.
- With relative ease, operators can transition their UMTS networks to HSDPA/HSUPA and, in the future, to HSPA+ and LTE.

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Key Conclusions (4)

- With a UMTS multiradio network, a common core network can efficiently support GSM, WCDMA, and HSPA access networks. Meanwhile, EPS provides a new core network that supports both LTE and interoperability with legacy GSM/UMTS radio-access networks.
- Various innovations such as EPS and UMTS one-tunnel architecture will “flatten” the network, simplifying deployment and reducing latency.
- Voice over Internet Protocol (VoIP) with HSPA will eventually add to voice capacity and reduce infrastructure costs. In the meantime, UMTS enjoys high circuit-switched voice spectral efficiency, and it can combine voice and data on the same radio channel.
- LTE assumes a full Internet Protocol (IP) network architecture, and it is designed to support voice in the packet domain.
- Ongoing 3GPP evolution includes significant enhancements with each new specification release. Among these enhancements are higher throughput rates, enhanced multimedia support, and integration with other types of wireless networks.

Good and Questionable Uses of Wireless/Wireline

Key

- Good use
- Questionable use

		Local Area	Wide Area
Wireless	Good use	Cordless telephony, wireless headsets, Wi-Fi and fixed-mobile convergence	Mobile broadband, **EDGE, HSPA, LTE** Developing countries access
	Questionable use	Backbone networks, e.g., enterprise server connections	Direct competition with wireline broadband
Wireline	Good use	High-capacity links, e.g., gigabit Ethernet	Fixed broadband services, e.g., IPTV
	Questionable use	Telephony, mobile computer networks	

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Deployments as of August 2007

- Over 2.5 billion GSM subscribers
- Most GSM networks now support EDGE
- More than EDGE 309 operators
- 136 million UMTS customers worldwide across 181 commercial networks,
- 135 operators in 63 countries offering HSDPA services
- Additional 75 operators committed to the technology

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Wireless Approaches

Approach	Technologies Employing Approach	Comments
TDMA	GSM, GPRS, EDGE, Telecommunications Industry Association/Electronics Industry Association (TIA/EIA)-136 TDMA	First digital cellular approach. Hugely successful with GSM. New enhancements being designed for GSM/EDGE.
CDMA	CDMA2000 1xRTT, CDMA2000 EV-DO, WCDMA, HSPA, Institute of Electrical and Electronic Engineers (IEEE) 802.11b	Basis for nearly all new 3G networks. Mature, efficient, and will dominate wide-area wireless systems for the remainder of this decade.
OFDM/OFDMA	802.16/WiMAX, Flarion Fast Low-Latency Access with Seamless Handoff OFDM (Flash OFDM), 3GPP LTE, IEEE 802.11a, IEEE 802.11g, IEEE 802.20, Third Generation Partnership Project 2 (3GPP2) UMB, 3GPP2 Enhanced Broadcast Multicast Services (EBCMCS), Digital Video Broadcasting-H (DVB-H), Forward Link Only (FLO)	Effective approach for broadcast systems, higher bandwidth radio systems, and high peak data rates in large blocks of spectrum. Also provides flexibility in the amount of spectrum used. Well suited for systems planned for the next decade.

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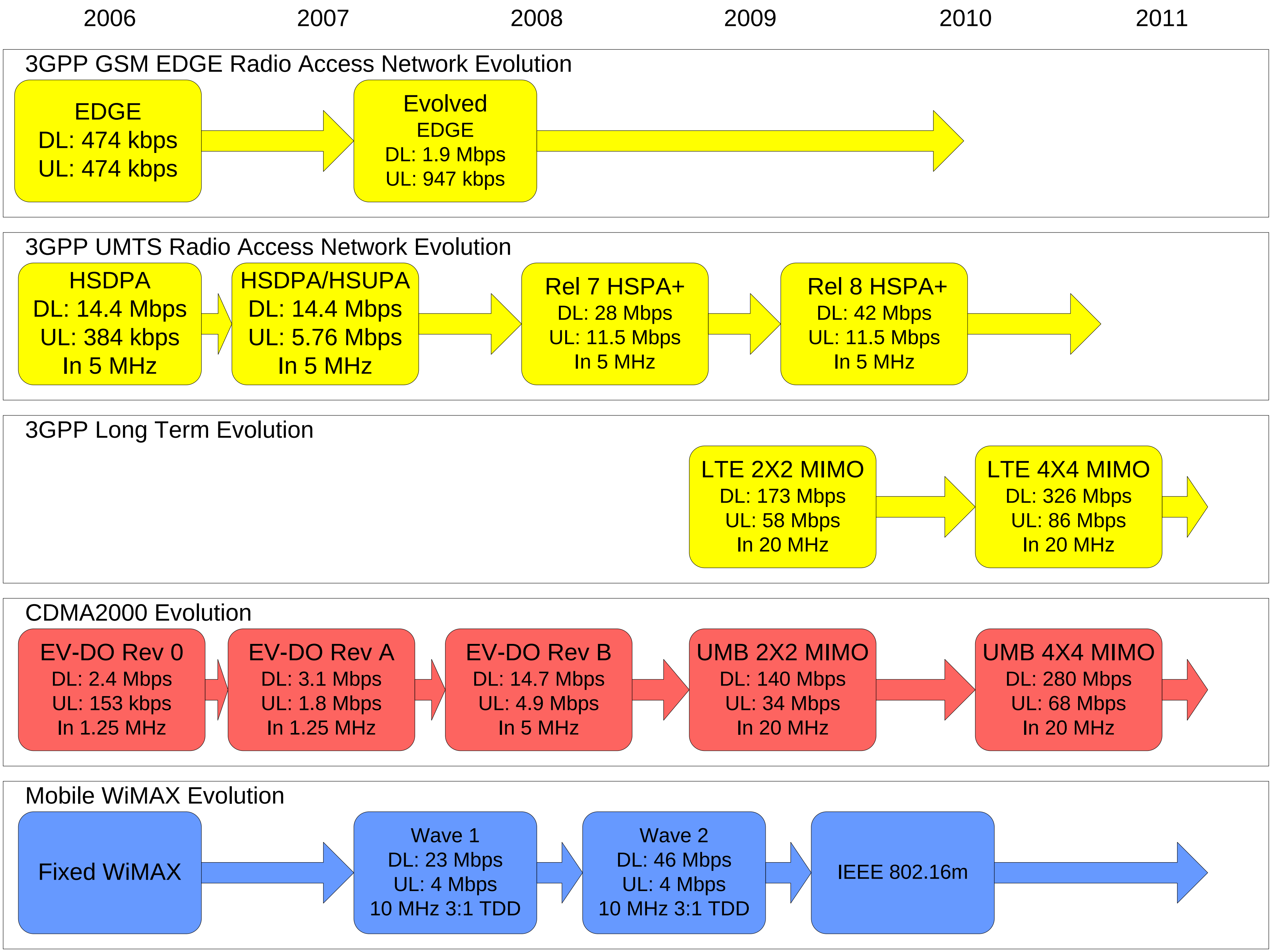

Note: Throughput rates are peak network rates. Radio channel bandwidths indicated.
Dates refer to initial network deployment except 2006 which shows available technologies that year.

3GPP Releases

- **Release 99:** Completed. First deployable version of UMTS. Enhancements to GSM data (EDGE). Majority of deployments today are based on Release 99. Provides support for GSM/EDGE/GPRS/WCDMA radio-access networks.
- **Release 4:** Completed. Multimedia messaging support. First steps toward using IP transport in the core network.
- **Release 5:** Completed. HSDPA. First phase of IMS. Full ability to use IP-based transport instead of just Asynchronous Transfer Mode (ATM) in the core network. In 2007, most UMTS deployments are based on this release.
- **Release 6:** Completed. HSUPA. Enhanced multimedia support through Multimedia Broadcast/Multicast Services (MBMS). Performance specifications for advanced receivers. WLAN integration option. IMS enhancements. Initial VoIP capability.
- **Release 7:** Completed. Provides enhanced GSM data functionality with Evolved EDGE. Specifies HSPA Evolution (HSPA+), which includes higher order modulation and MIMO. Also includes fine-tuning and incremental improvements of features from previous releases. Results include performance enhancements, improved spectral efficiency, increased capacity, and better resistance to interference. Continuous Packet Connectivity (CPC) enables efficient “always-on” service and enhanced uplink UL VoIP capacity as well as reductions in call setup delay for PoC. Radio enhancements include 64 QAM in the downlink DL and 16 QAM in the uplinks.
- **Release 8:** Under development. Further HSPA Evolution features such as simultaneous use of MIMO and 64 QAM. Specifies OFDMA-based 3GPP LTE. Defines EPS, previously called System Architecture Evolution (SAE).

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WCDMA/HSPA Spectrum

	Up to	
2600	190 MHz	New 3G Band
2100	2x60 MHz	Mainstream WCDMA band
1900	2x60 MHz	U.S. and Americas
1700/2100	2x45 MHz	New 3G band in U.S.
1800	2x75 MHz	Europe, Asia, Brazil
1700	2x30 MHz	Japan, China
900	2x35 MHz	Europe, Asia, Brazil
800, 850	2x25 MHz	Americas, Japan, Asia
700	TBD	New band in the U.S.

Expected UMTS/LTE Features and Capabilities

Year	Features
2007	HSDPA devices up to 7.2 Mbps peak network rates Release 6 HSUPA-capable networks and devices Radio enhancements such as mobile equalization possibly combined with receive diversity that increase peak speeds and network capacity Initial IMS-based services (for example, video sharing) Initial FMC offerings (IMS, UMA, femtocells)
2008	HSPA VoIP networks available through Release 7, QoS, IMS Enhanced IMS-based services Networks and devices capable of Release 7 HSPA+, including MIMO, boosting HSPA peak speeds to 28 Mbps Evolved EDGE capabilities to significantly increase EDGE throughput rates Greater availability of FMC
2009	LTE introduced for next-generation throughput and latency performance using 2X2 MIMO Advanced core architectures with EPS, primarily for LTE but also for HSPA+ HSPA+ peak speeds increased to peak rates of 42 Mbps with Release 8 Most new services implemented in the packet domain over HSPA+ and LTE
2010 and later	LTE enhancements such as 4X2 MIMO and 4X4 MIMO

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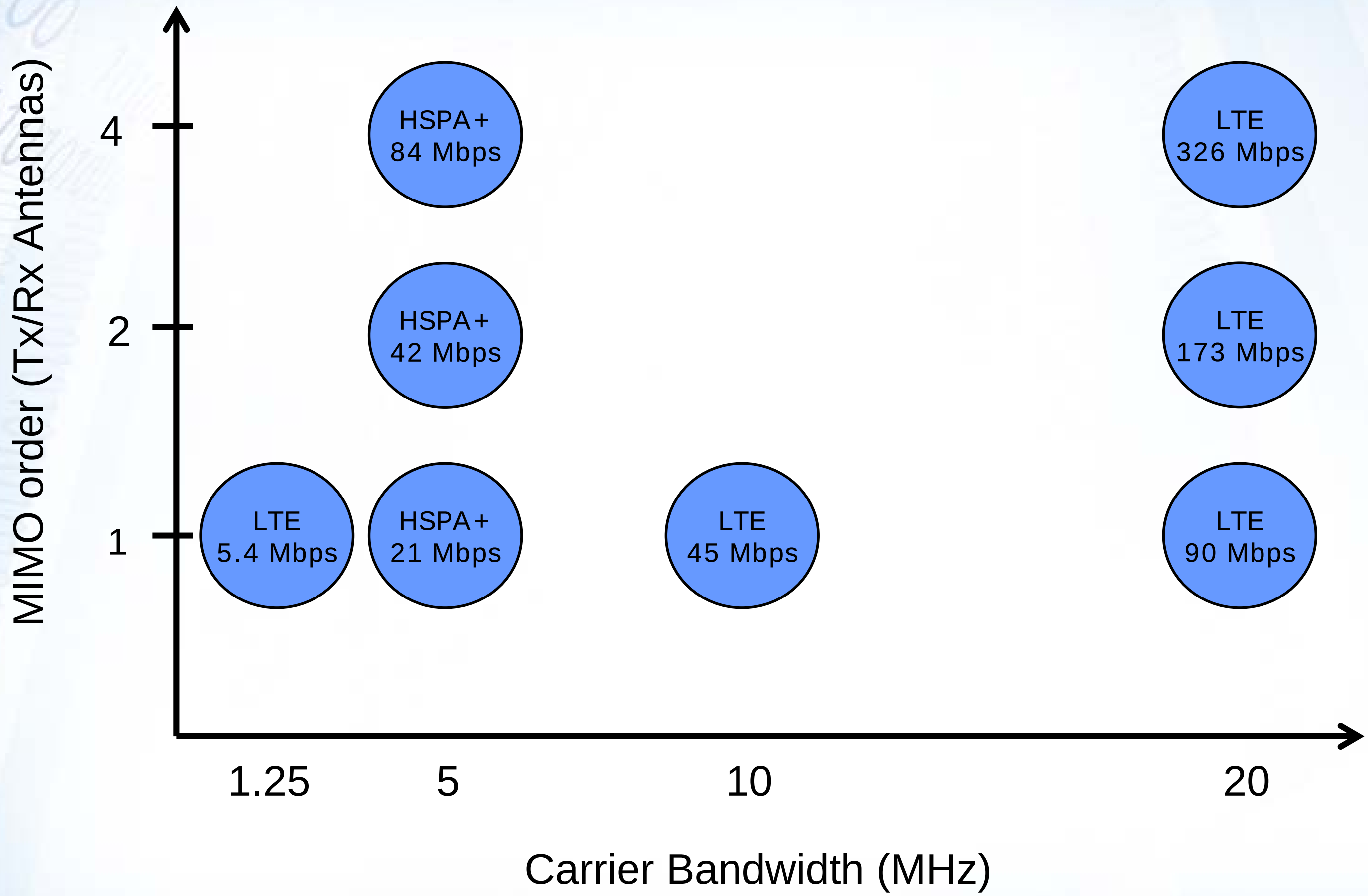
HSPA+, LTE Downlink Throughputs



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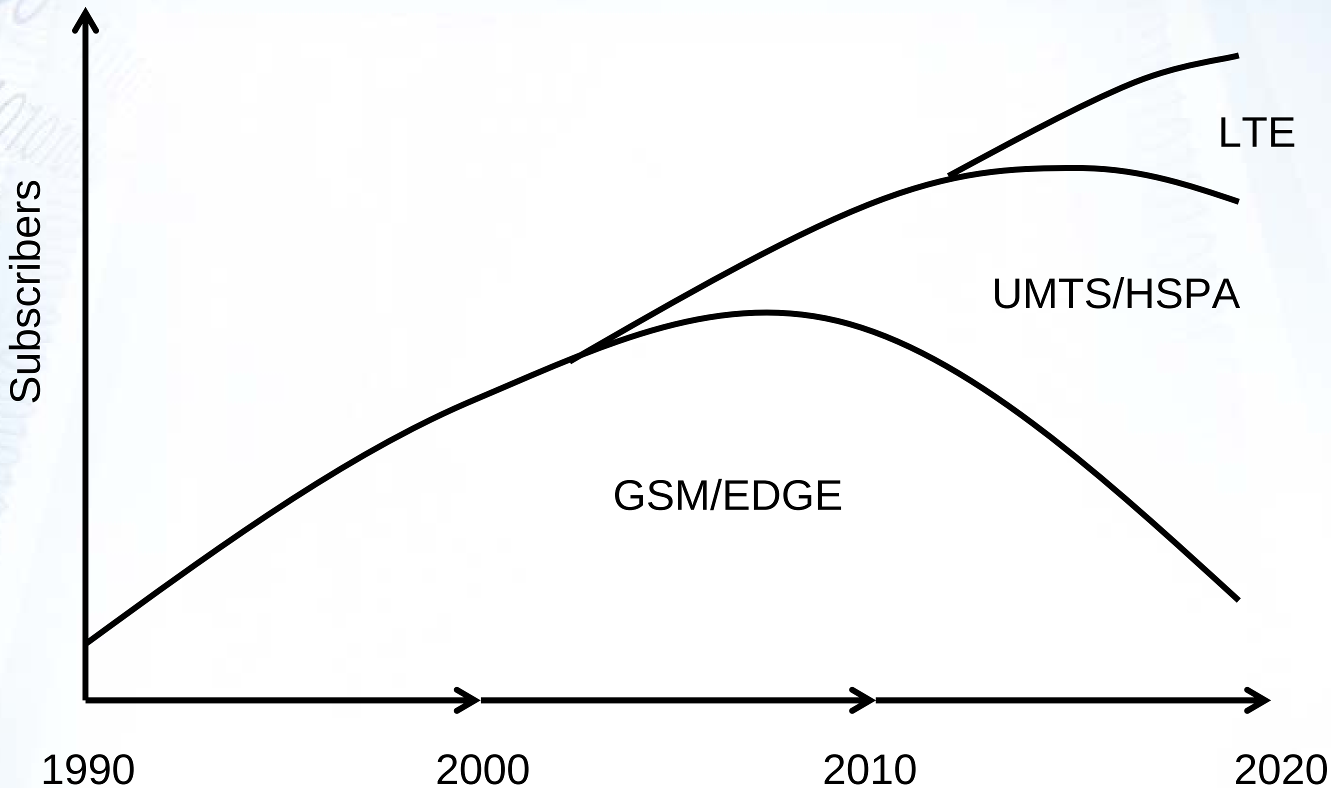
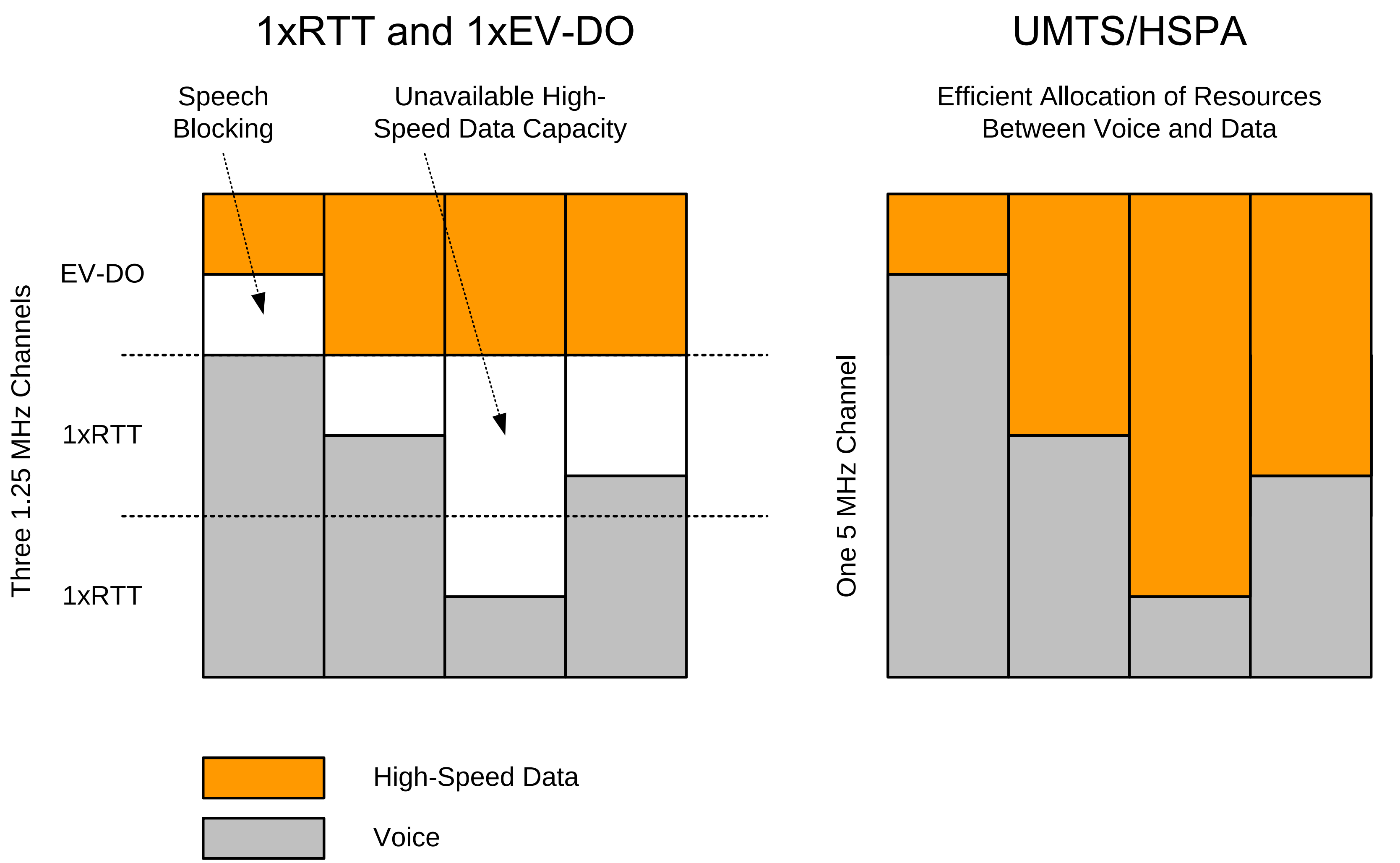
GSM, UMTS, LTE Adoption



Radio Resource Management
1xRTT/1xEV-DO versus UMTS/HSPA



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Throughput Comparison

	Downlink		Uplink	
	Peak Network Speed	Peak Achievable User Rate	Peak Network Speed	Peak Achievable User Rate
EDGE (type 2 MS)	473.6 kbps		473.6 kbps	
EDGE (type 1 MS)	236.8 kbps	200 kbps	236.8 kbps	200 kbps
Evolved EDGE (type 1 MS)	1184 kbps		473.6 kbps	
Evolved EDGE (type 2 MS)	1894.4 kbps		947.2 kbps	

Blue indicates theoretical peak rates

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Throughput Comparison Continued

	Downlink		Uplink	
	Peak Network Speed	Peak Achievable User Rate	Peak Network Speed	Peak Achievable User Rate
UMTS WCDMA Rel'99	2.048 Mbps		768 kbps	
UMTS WCDMA Rel'99 (Practical Terminal)	384 kbps	350 kbps	384 kbps	350 kbps
HSDPA Initial Devices (2006)	1.8 Mbps	> 1 Mbps	384 kbps	350 kbps
HSDPA Current Devices	3.6 Mbps	> 2 Mbps	384 kbps	350 kbps
HSDPA Emerging Devices	7.2 Mbps	> 3 Mbps	384 kbps	350 kbps
HSDPA	14.4 Mbps		384 kbps	
HSPA Initial Implementation	7.2 Mbps	> 4 Mbps	1.46 Mbps	1 Mbps
HSPA Future Implementation	7.2 Mbps		5.76 Mbps	
HSPA	14.4 Mbps		5.76 Mbps	

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Throughput Comparison Continued

	Downlink		Uplink	
	Peak Network Speed	Peak Achievable User Rate	Peak Network Speed	Peak Achievable User Rate
HSPA+ (2X2 MIMO, DL 16 QAM, UL 16 QAM)	28 Mbps		11.5 Mbps	
HSPA+ (2X2 MIMO, DL 64 QAM, UL 16 QAM)	42 Mbps		11.5 Mbps	
LTE (2X2 MIMO)	173 Mbps		58 Mbps	
LTE (4X4 MIMO)	326 Mbps		86 Mbps	

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Throughput Comparison Continued

	Downlink		Uplink	
	Peak Network Speed	**Peak Achievable User Rate**	**Peak Network Speed**	**Peak Achievable User Rate**
CDMA2000 1XRTT	153 kbps	130 kbps	153 kbps	130 kbps
CDMA2000 1XRTT	307 kbps		307 kbps	
CDMA2000 EV-DO Rev 0	2.4 Mbps	> 1 Mbps	153 kbps	150 kbps
CDMA2000 EV-DO Rev A	3.1 Mbps	> 1.5 Mbps	1.8 Mbps	> 1 Mbps
CDMA2000 EV-DO Rev B (3 radio channels MHz)	9.3 Mbps		5.4 Mbps	
CDMA2000 EV-DO Rev B Theoretical (15 radio channels)	73.5 Mbps		27 Mbps	
Ultra Mobile Broadband (2X2 MIMO)	140 Mbps		34 Mbps	
Ultra Mobile Broadband (4X4 MIMO)	280 Mbps		68 Mbps	
802.16e WiMAX expected Wave 1 (10 MHz TDD DL/UL=3, 1X2 SIMO)	23 Mbps		4 Mbps	
802.16e WiMAX expected Wave 2 (10 MHz TDD, DL/UL=3, 2x2 MIMO)	46 Mbps		4 Mbps	
802.16m	TBD		TBD	

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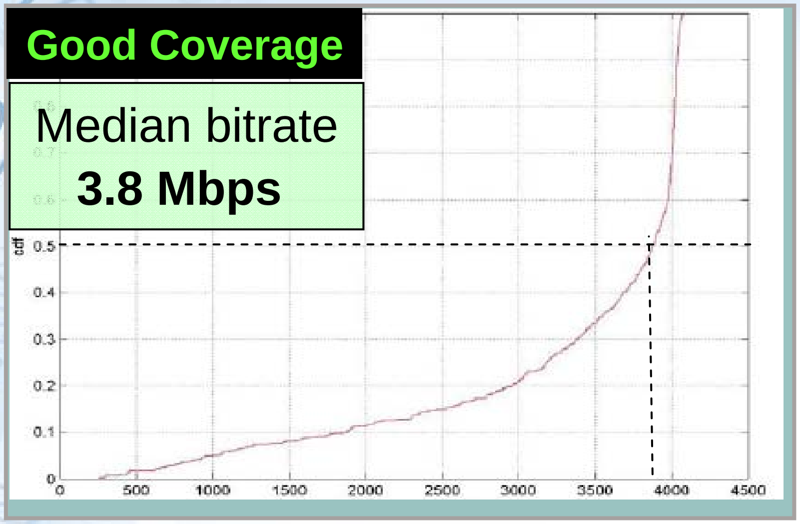
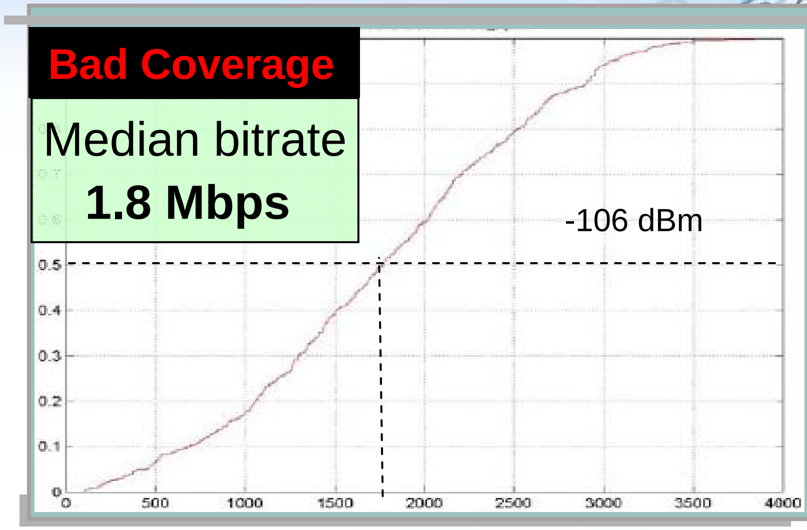
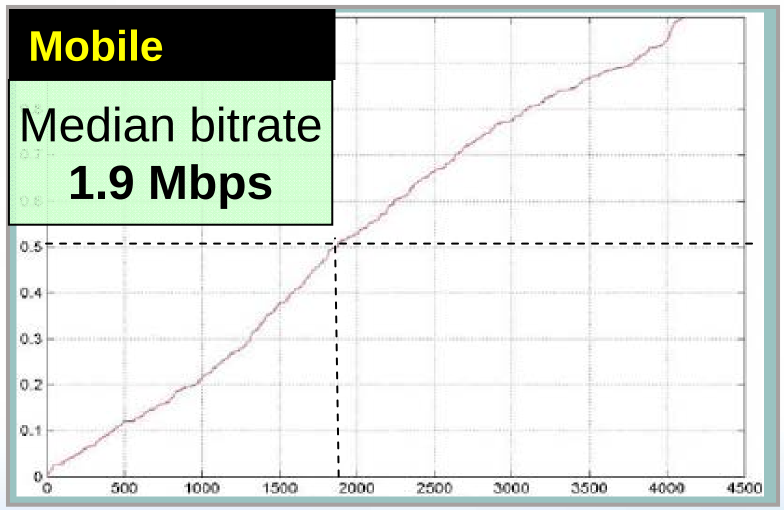
HSDPA Performance in 7.2 Mbps Network

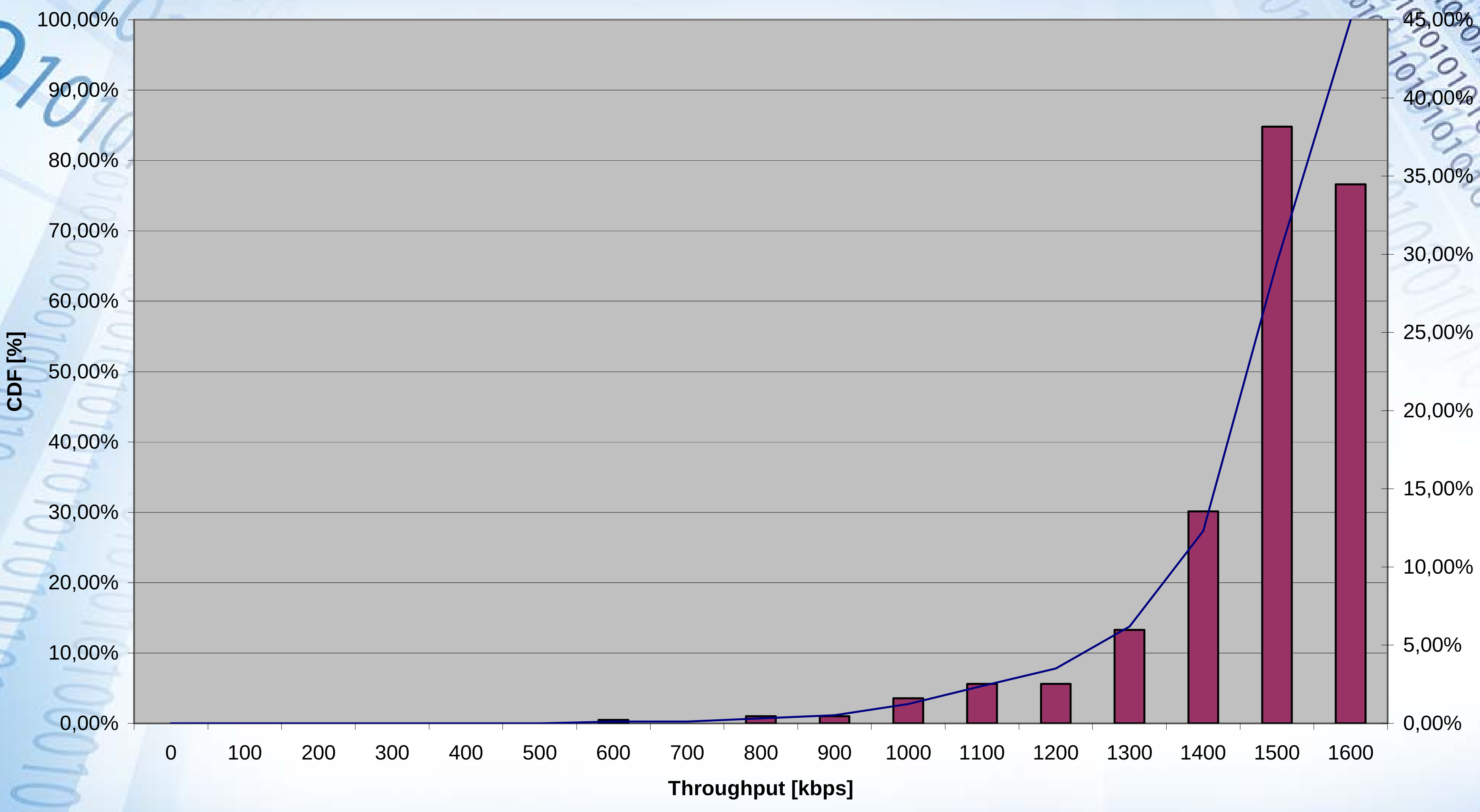






Performance measured in a commercial network

Histogram of HSDPA Throughput, Favorable Radio Conditions with 1.8 Mbps Device



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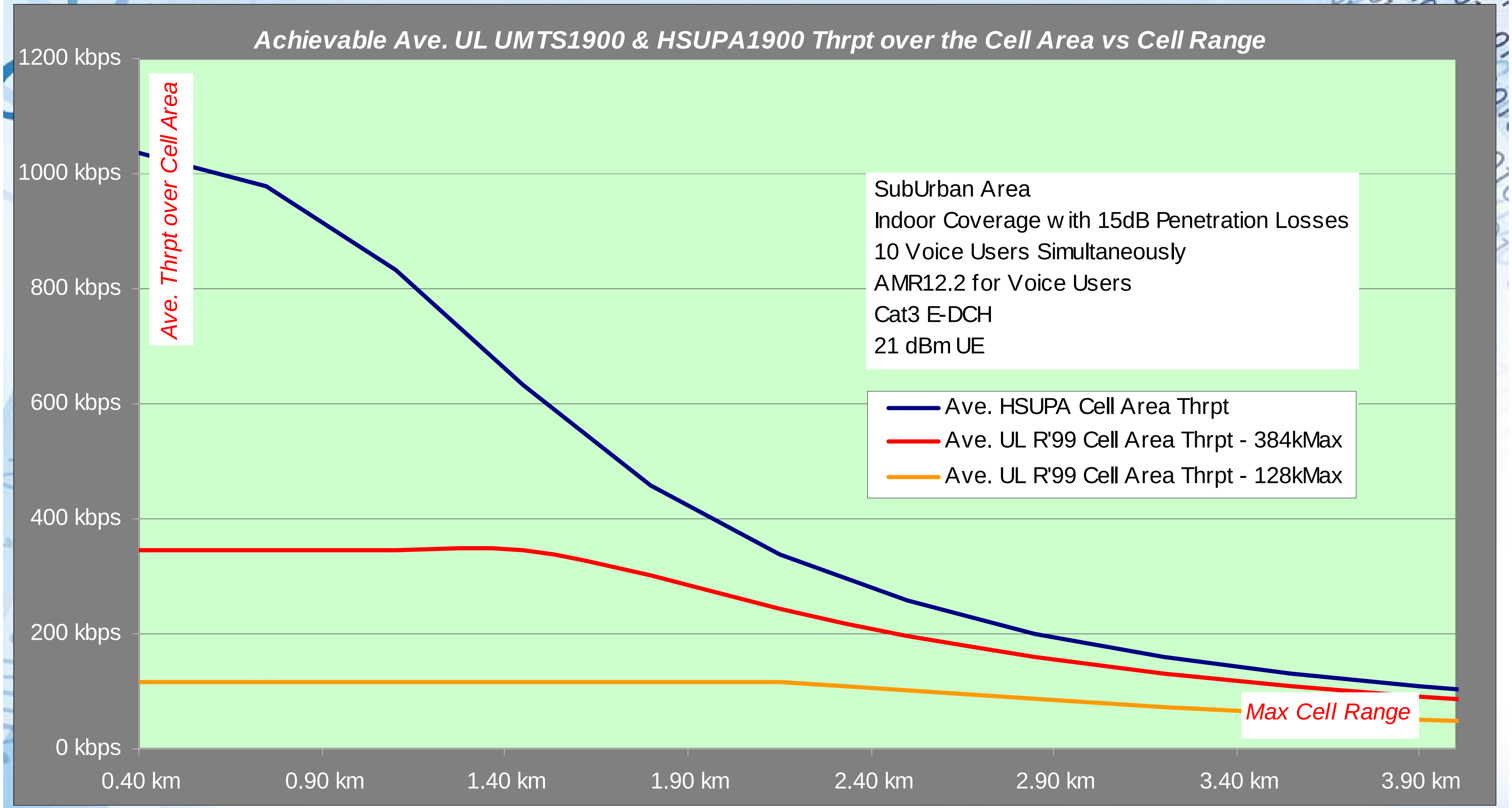
Average Release 99 Uplink & HSUPA Throughput



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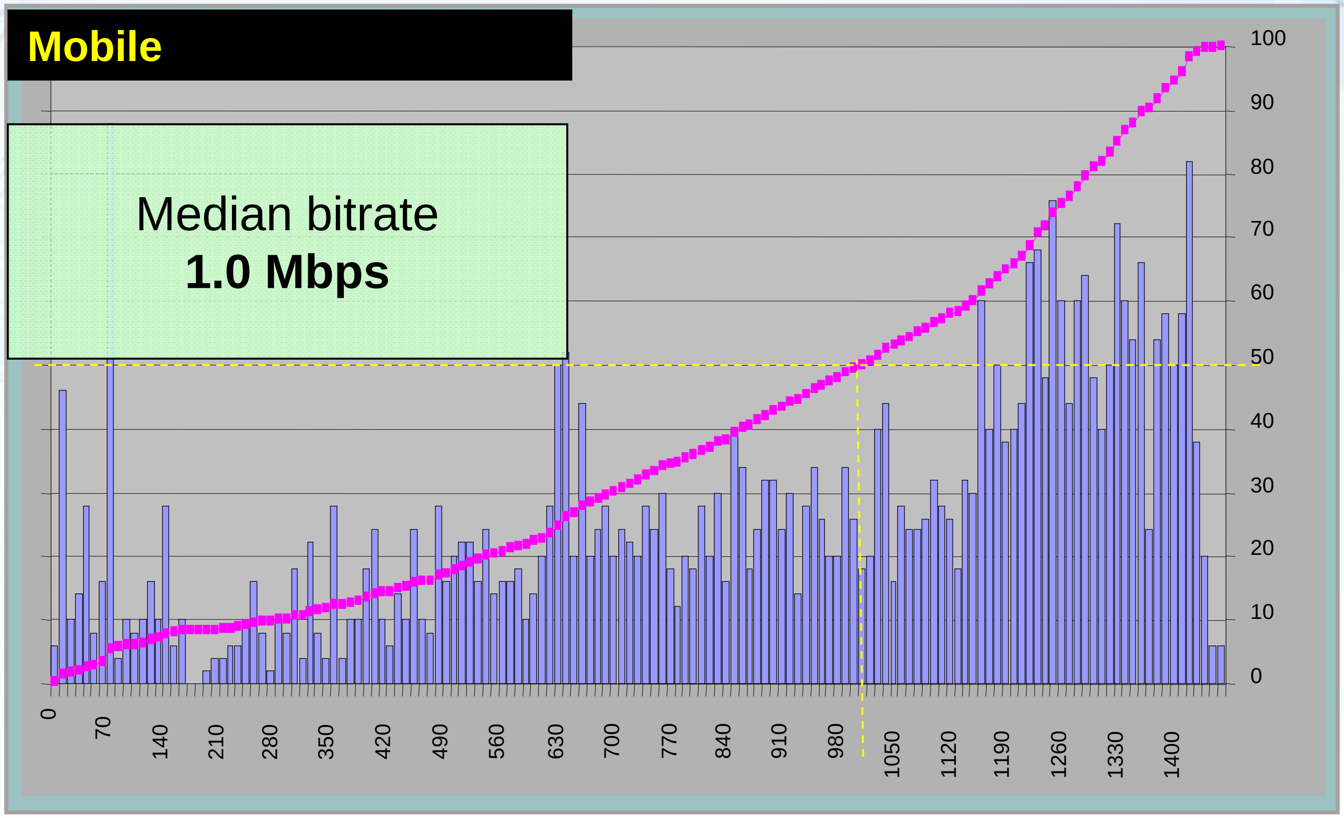
HSUPA Performance in a Commercial Network



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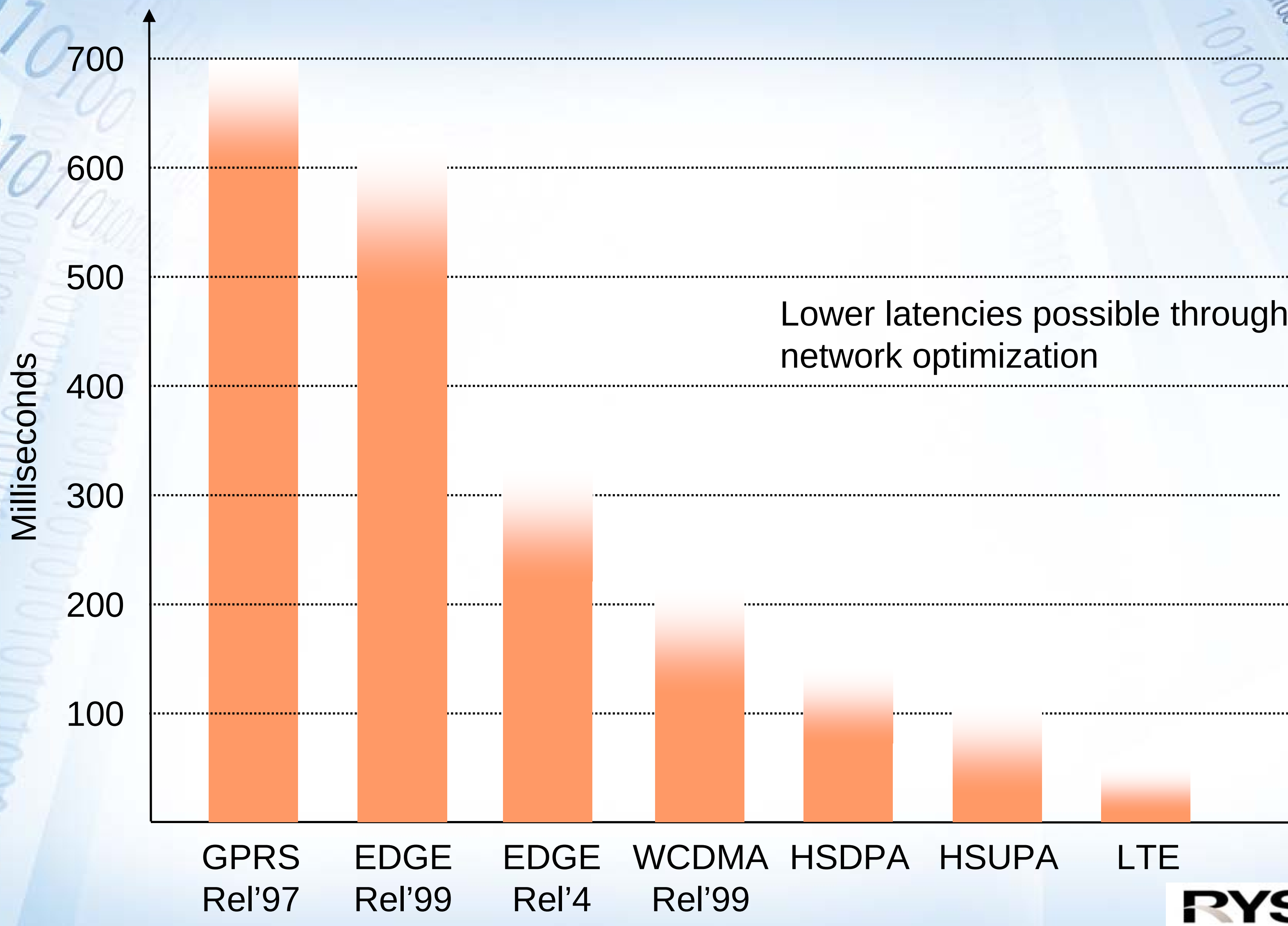
Latency Comparison



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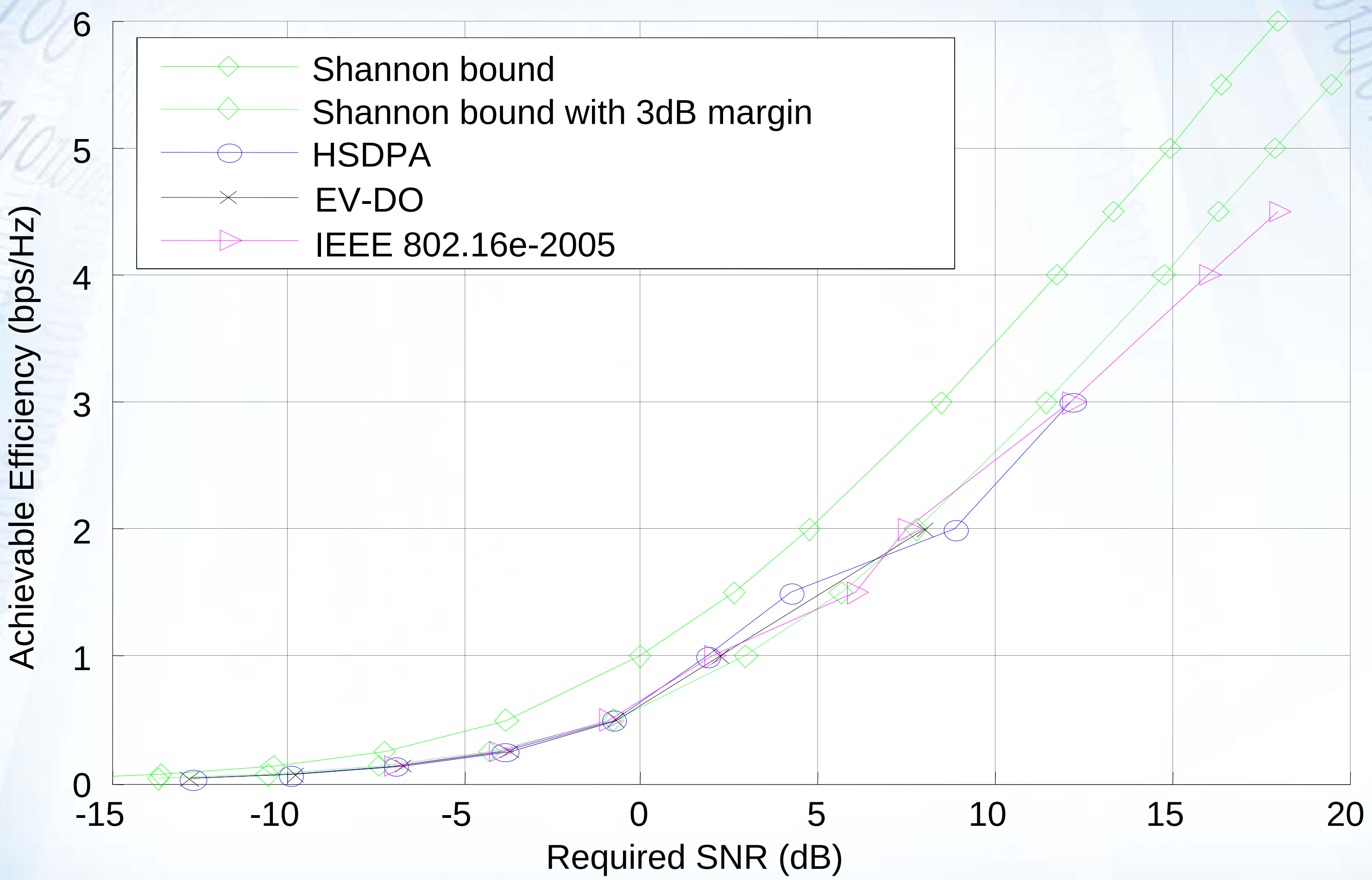
Performance Relative to Theoretical Limits



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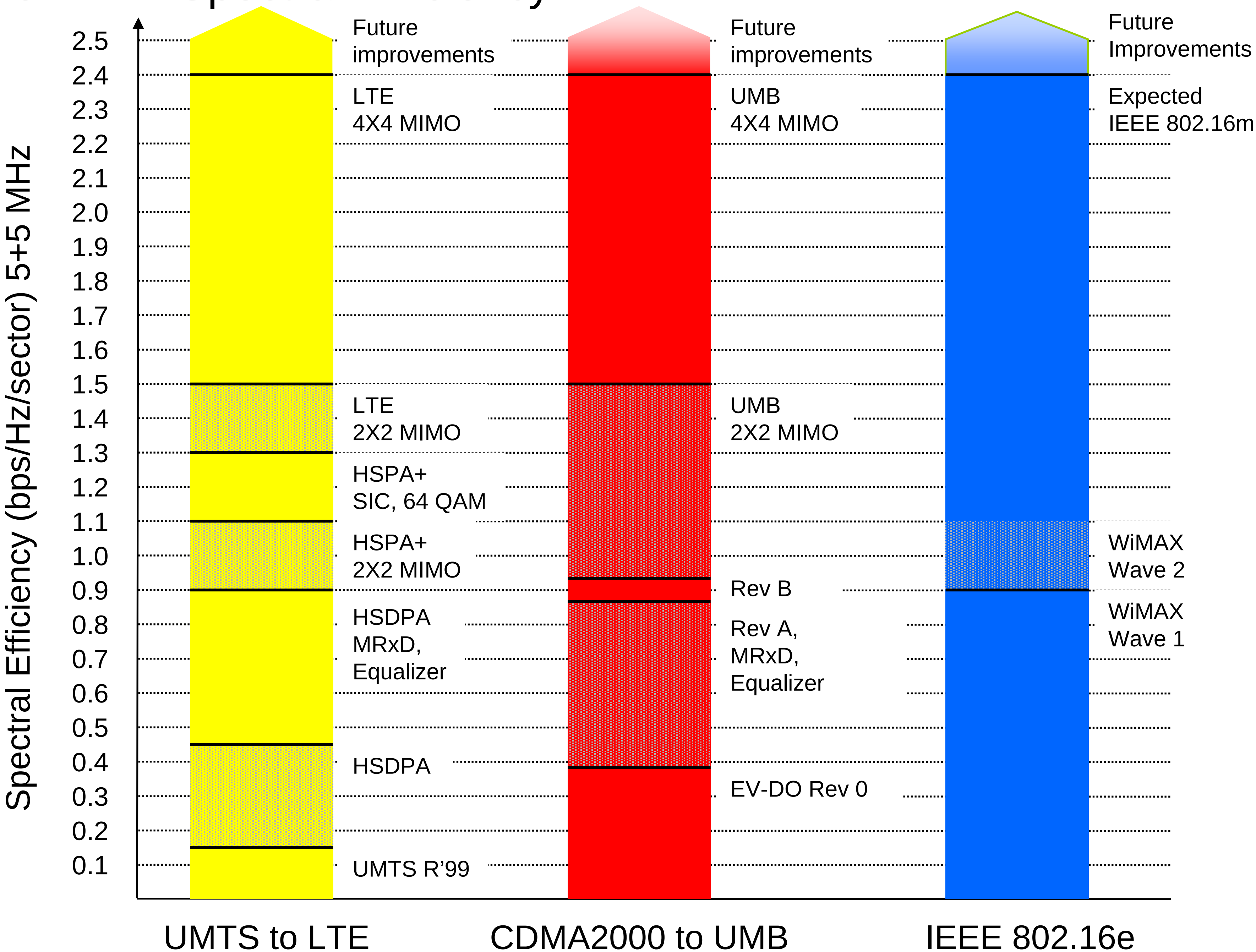
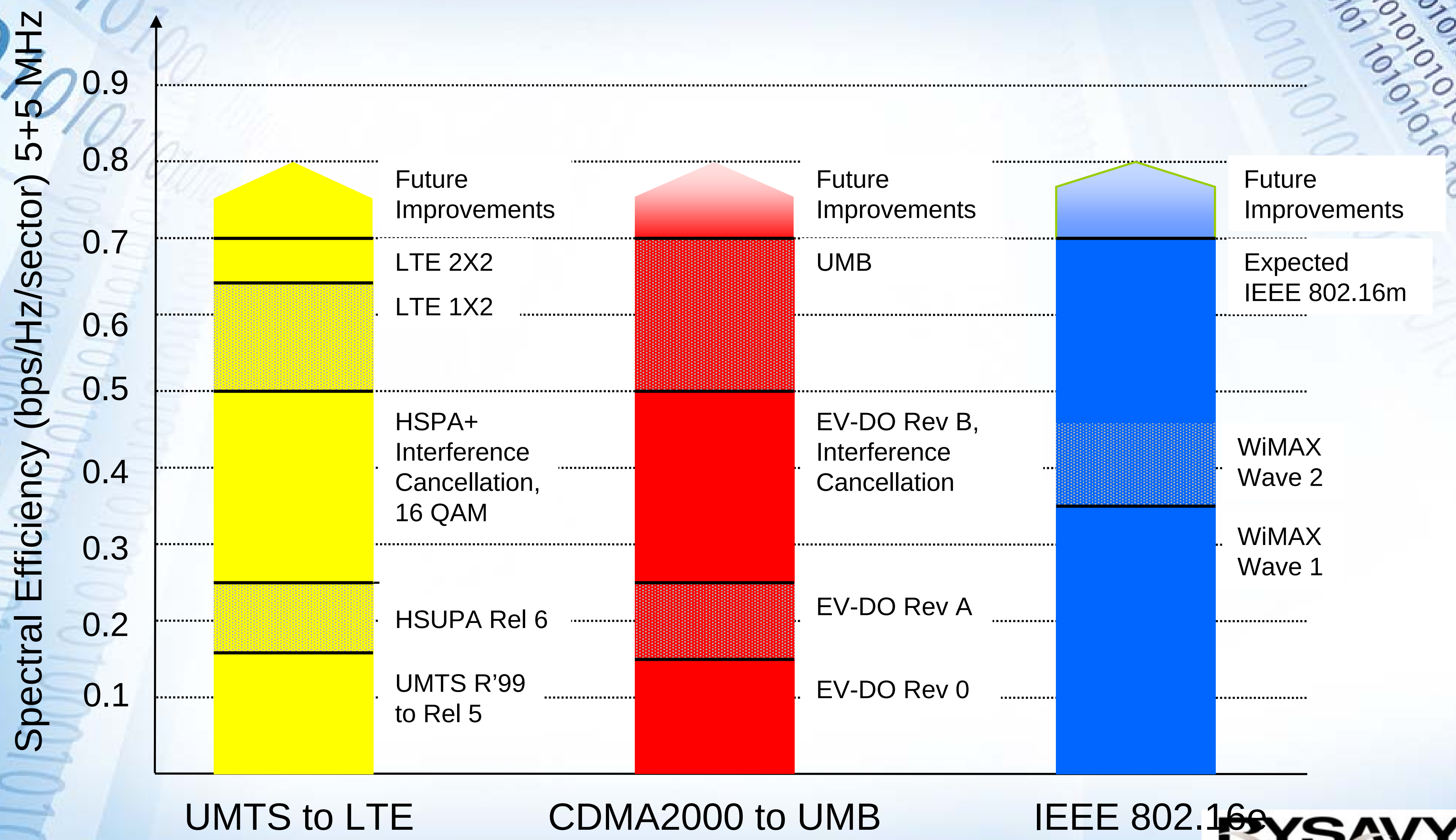
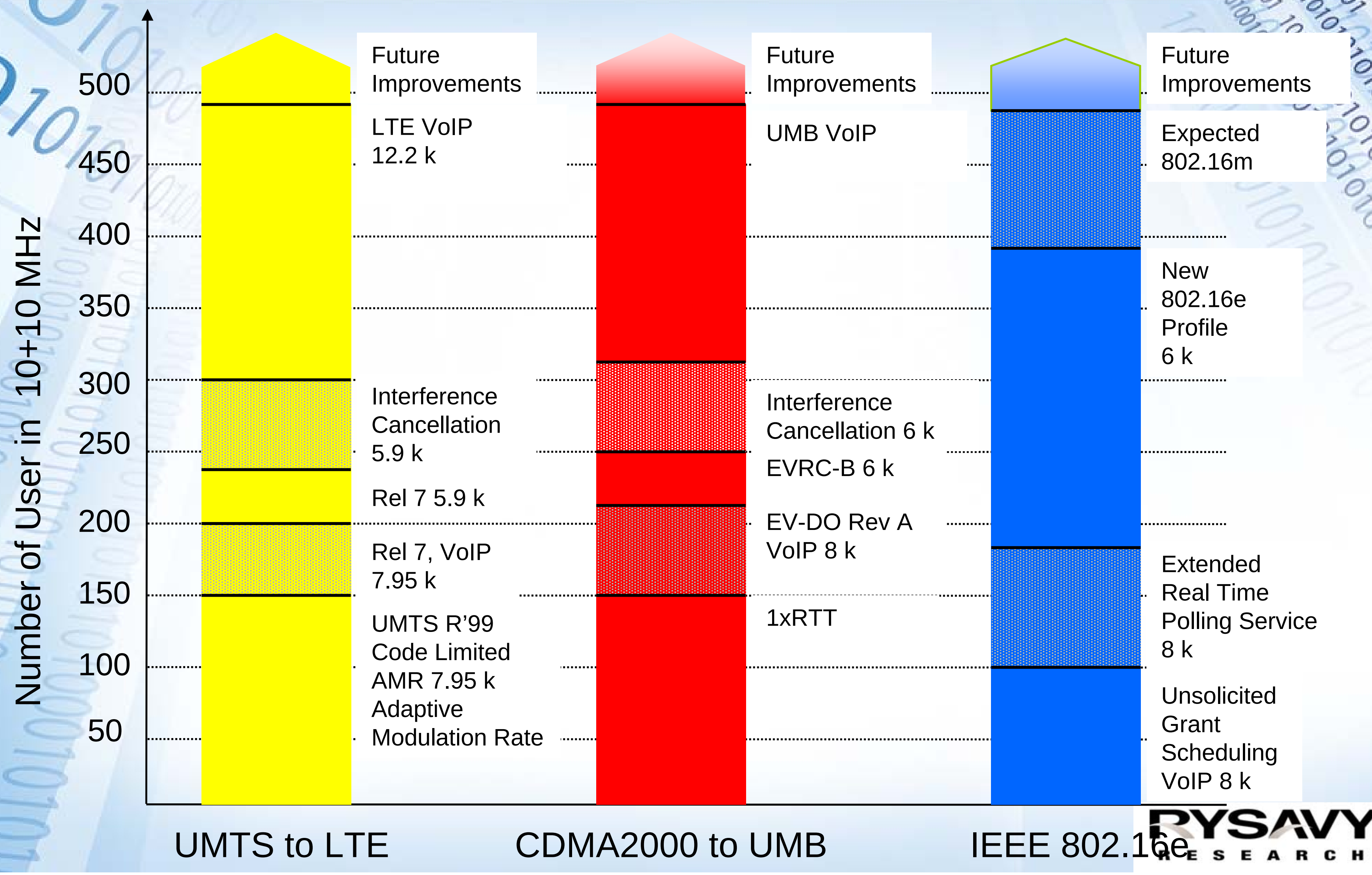
Downlink Spectral Efficiency



Uplink Spectral Efficiency



Voice Spectral Efficiency



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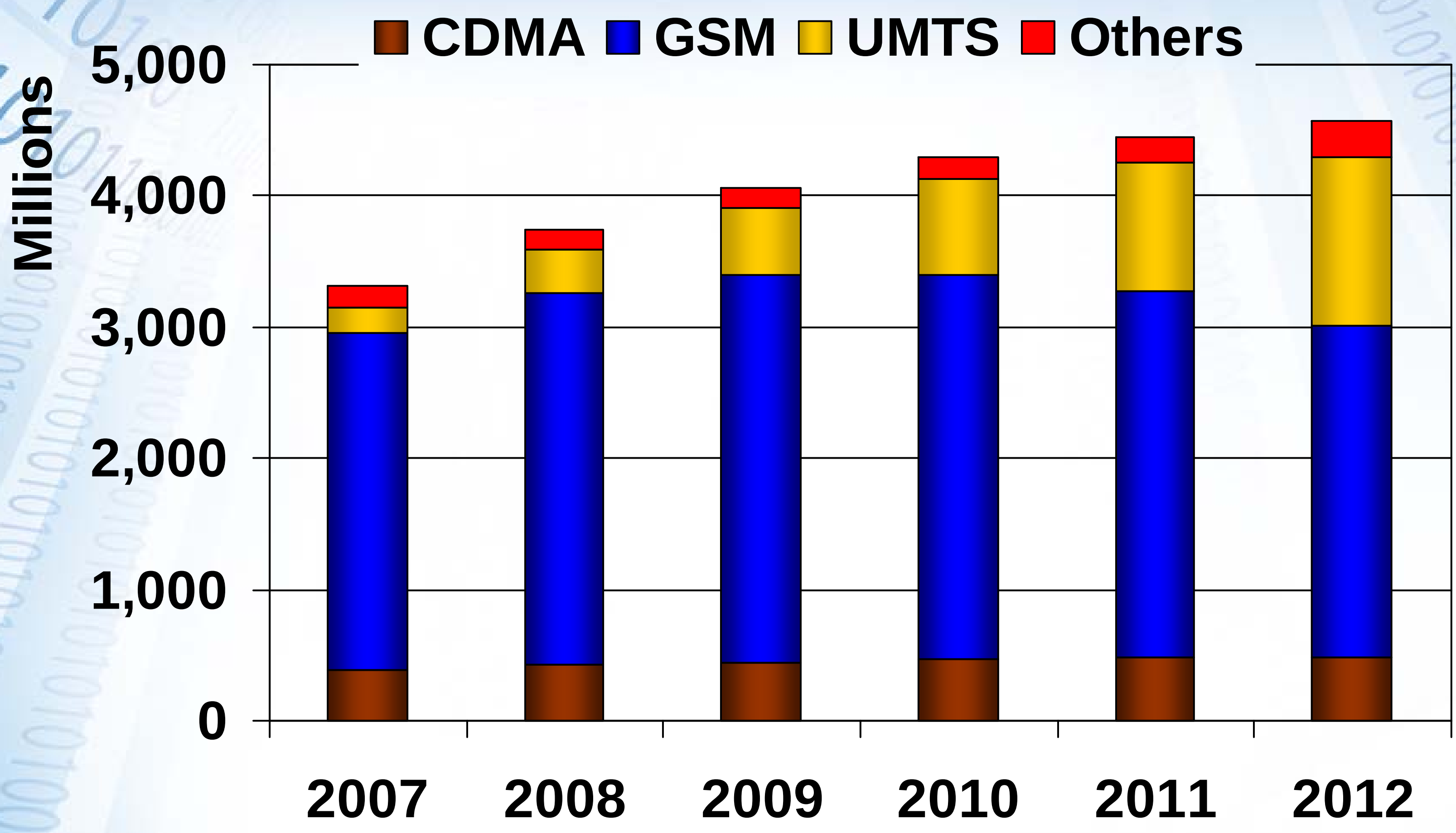
Volume of Subscribers Across Technologies



Source: Informa Telecoms & Media, WCIS Forecast, July 2007

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Throughput Requirements for Applications

- Microbrowsing (e.g., Wireless Application Protocol [WAP]): 8 to 128 kilobits per second (kbps)
- Multimedia messaging: 8 to 64 kbps
- Video telephony: 64 to 384 kbps
- General purpose Web browsing: 32 kbps to more than 1 Mbps
- Enterprise applications, including e-mail, database access, and VPNs: 32 kbps to more than 1 Mbps
- Video and audio streaming: 32 to 384 kbps

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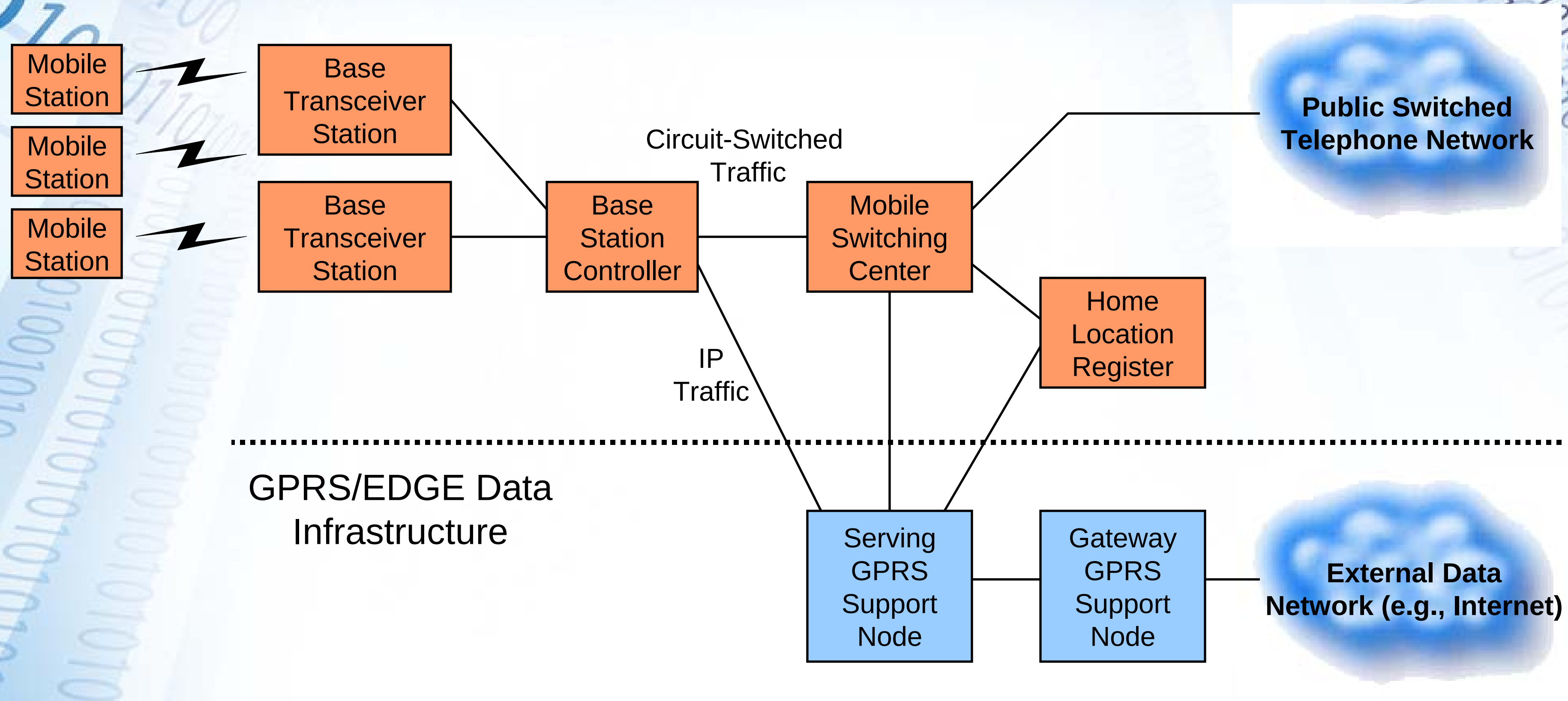
GPRS/EDGE Architecture



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Example of GSM/GPRS/EDGE Timeslot Structure

4.615 ms per frame of 8 timeslots

577 µS per timeslot

	0	1	2	3	4	5	6	7
Possible BCCH carrier configuration	BCCH	TCH	TCH	TCH	TCH	PDTCH	PDTCH	PDTCH
Possible TCH carrier configuration	PBCCH	TCH	TCH	PDTCH	PDTCH	PDTCH	PDTCH	PDTCH

BCCH: Broadcast Control Channel – carries synchronization, paging and other signalling information
TCH: Traffic Channel – carries voice traffic data; may alternate between frames for half-rate
PDTCH: Packet Data Traffic Channel – Carries packet data traffic for GPRS and EDGE
PBCCH: Packet Broadcast Control Channel – additional signalling for GPRS/EDGE; used only if needed

EDGE Modulation and Coding Schemes

Modulation and Coding Scheme	Modulation	Throughput per Time Slot (kbps)
MCS-9	8-PSK	59.2
MCS-8	8-PSK	54.4
MCS-7	8-PSK	44.8
MCS-6	8-PSK	29.6
MCS-5	8-PSK	22.4
MCS-4	GMSK	17.6
MCS-3	GMSK	14.8
MCS-2	GMSK	11.2
MCS-1	GMSK	8.8

Throughput per time slot at radio-link control layer

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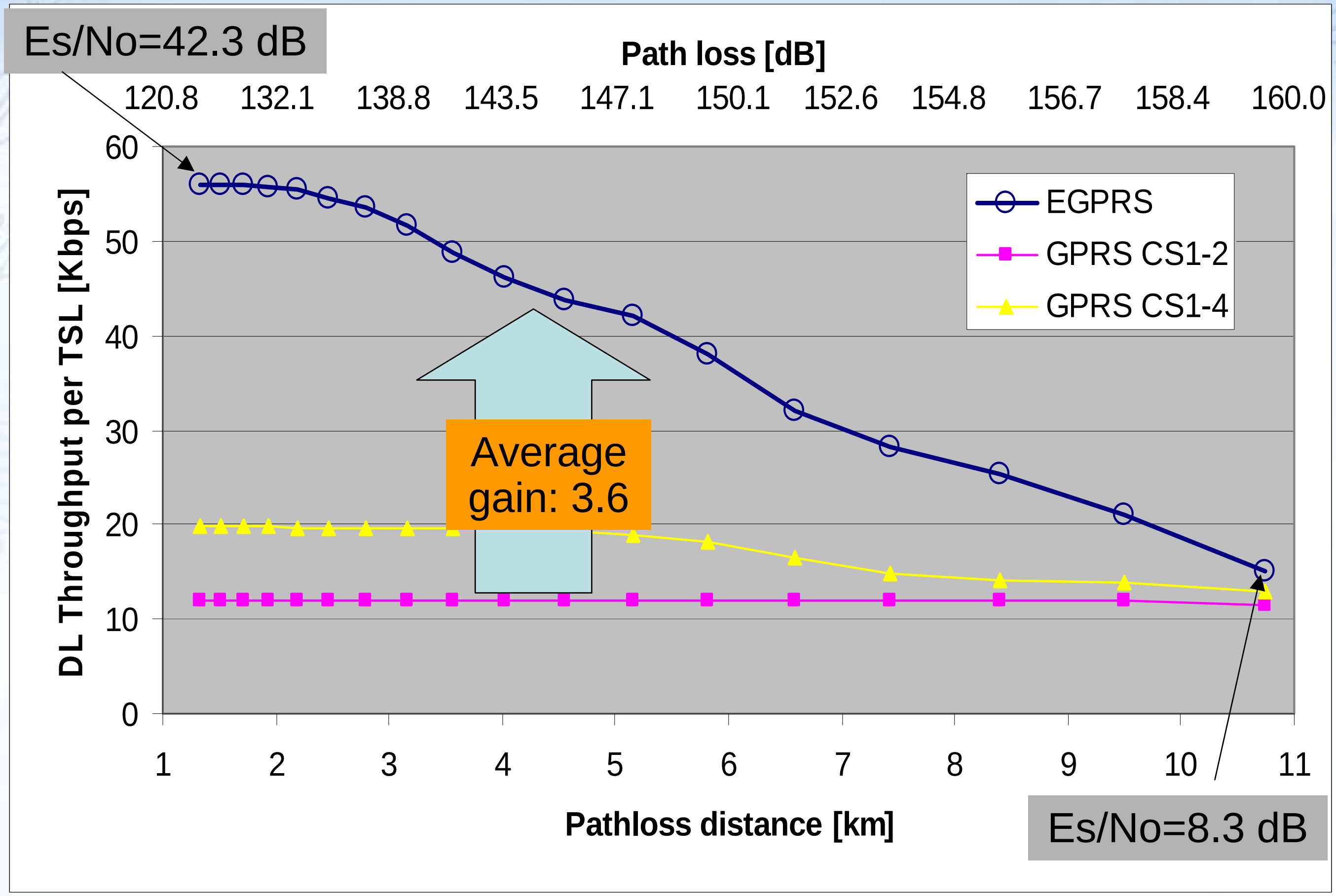
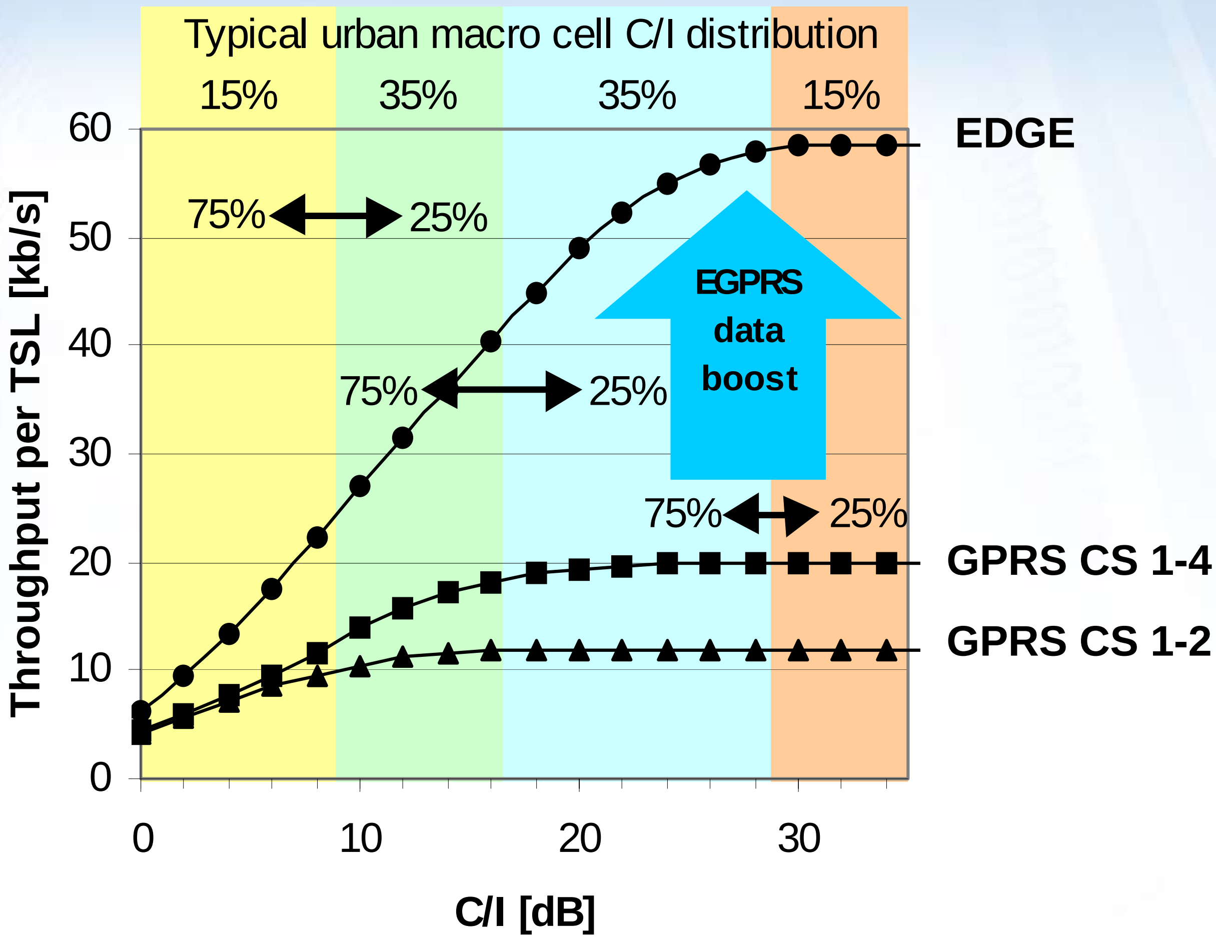
EDGE Throughput versus Distance



Throughput per time slot. Appreciable gains over large distance.

EDGE Performance Gain Relative to C/I Ratio



85% of cell coverage area experiences significant performance gain.

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Reasons to Deploy EDGE with UMTS

- EDGE provides a high-capability data service in advance of UMTS.
- EDGE provides average data capabilities for the “sweet spot” of approximately 100 kbps, enabling many communications-oriented applications.
- EDGE has proven itself in the field as a cost-effective solution and is now a mature technology.
- EDGE is very efficient spectrally, allowing operators to support more voice and data users with existing spectrum.
- Operators can maintain their EDGE networks as a complementary service offering, even as they deploy UMTS/HSPA.
- EDGE provides a cost-effective wide-area data service that offers continuity and that is complementary with a UMTS/HSDPA network deployed in high traffic areas.
- Evolved EDGE will increase capabilities and make the technology viable for years to come

Evolved EDGE Objectives

- A 100 percent increase in peak data rates.
- A 50 percent increase in spectral efficiency and capacity in C/I-limited scenarios.
- A sensitivity increase in the downlink of 3 dB for voice and data.
- A reduction of latency for initial access and round-trip time, thereby enabling support for conversational services such as VoIP and PoC.
- To achieve compatibility with existing frequency planning, thus facilitating deployment in existing networks.
- To coexist with legacy mobile stations by allowing both old and new stations to share the same radio resources.
- To avoid impacts on infrastructure by enabling improvements through a software upgrade.
- To be applicable to DTM (simultaneous voice and data) and the A/Gb mode interface. The A/Gb mode interface is part of the 2G core network, so this goal is required for full backward-compatibility with legacy GPRS/EDGE.

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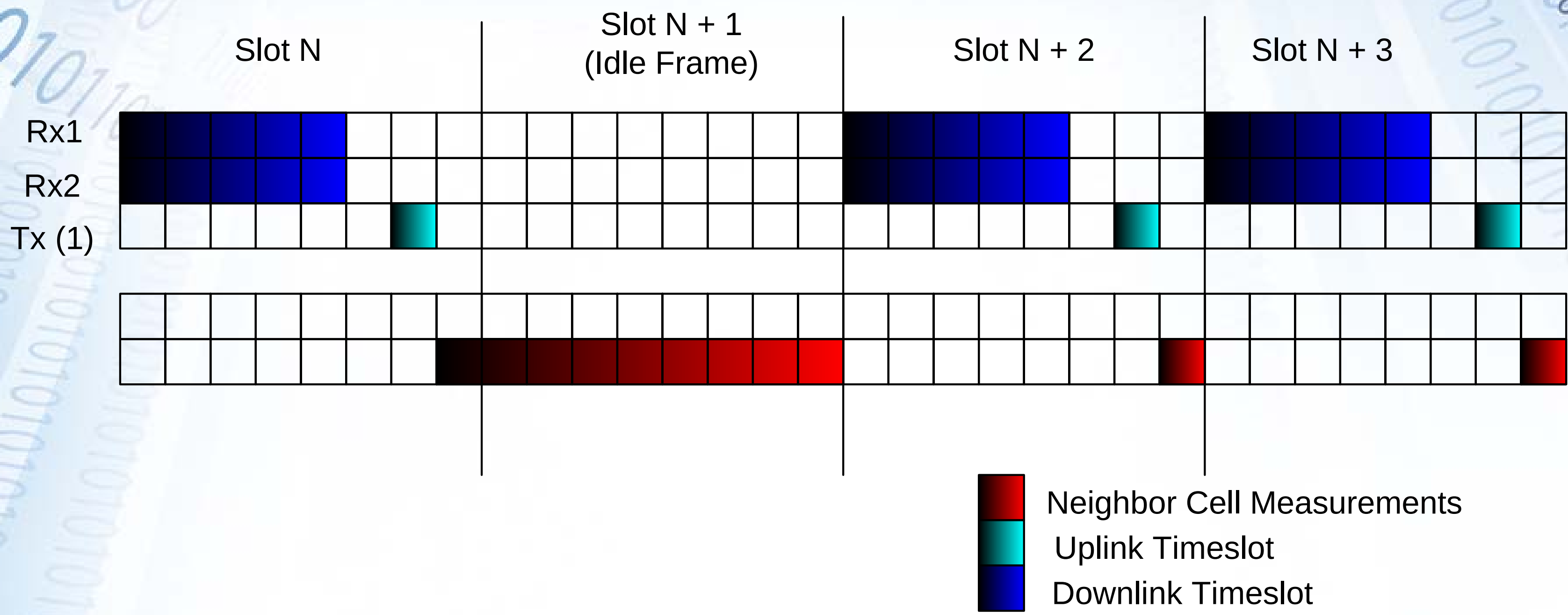
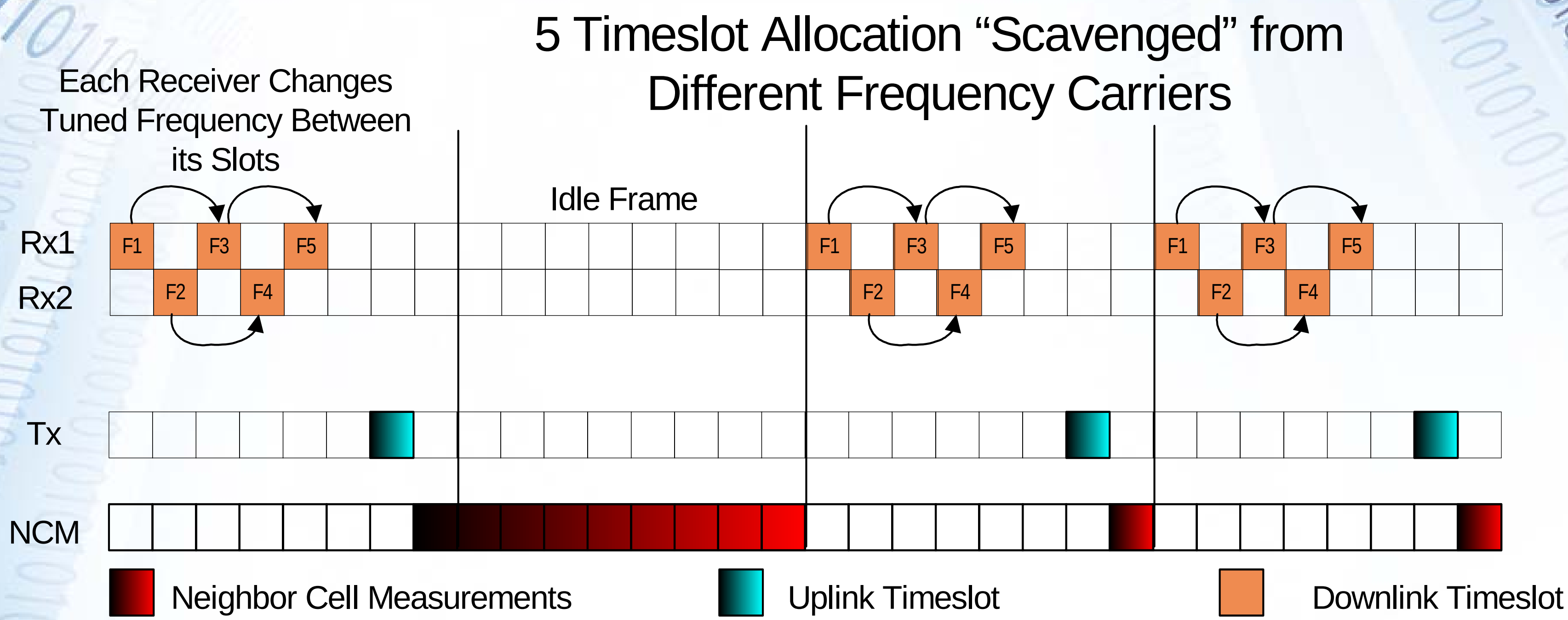
Evolved EDGE Methods in Release 7

- Downlink dual-carrier reception to increase the number of timeslots that can be received from four on one carrier to 10 on two carriers for a 150 percent increase in throughput.
- The addition of Quadrature Phase Shift Keying (QPSK), 16 QAM, and 32 QAM as well as an increased symbol rate (1.2x) in the uplink and a new set of modulation/coding schemes that will increase maximum throughput per timeslot by 38 percent. Currently, EDGE uses 8-PSK modulation. Simulations indicate a realizable 25 percent increase in user-achievable peak rates.
- The ability to use four timeslots in the uplink (possible since release).
- A reduction in overall latency. This is achieved by lowering the TTI to 10 msec and by including the acknowledge information in the data packet. These enhancements will have a dramatic effect on throughput for many applications.
- Downlink diversity reception of the same radio channel to increase the robustness in interference and to improve the receiver sensitivity. Simulations have demonstrated sensitivity gains of 3 dB and a decrease in required C/I of up to 18 dB for a single cochannel interferer. Significant increases in system capacity can be achieved, as explained below.

Evolved EDGE Two-Carrier Operation



Optimization of Timeslot Usage Example



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Evolved EDGE Theoretical Rates

- Type 2 mobile device (one that can support simultaneous transmission and reception) using HTCS-8-B as the MCS and a dual-carrier receiver can achieve the following performance:
  - Highest data rate per timeslot (layer 2) = 118.4 kbps
  - Timeslots per carrier = 8
  - Carriers used in the downlink = 2
  - Total downlink data rate = 118.4 kbps X 8 X 2 = 1894.4 kbps
- This translates to a peak network rate close to 2 Mbps and a user-achievable data rate of well over 1 Mbps!

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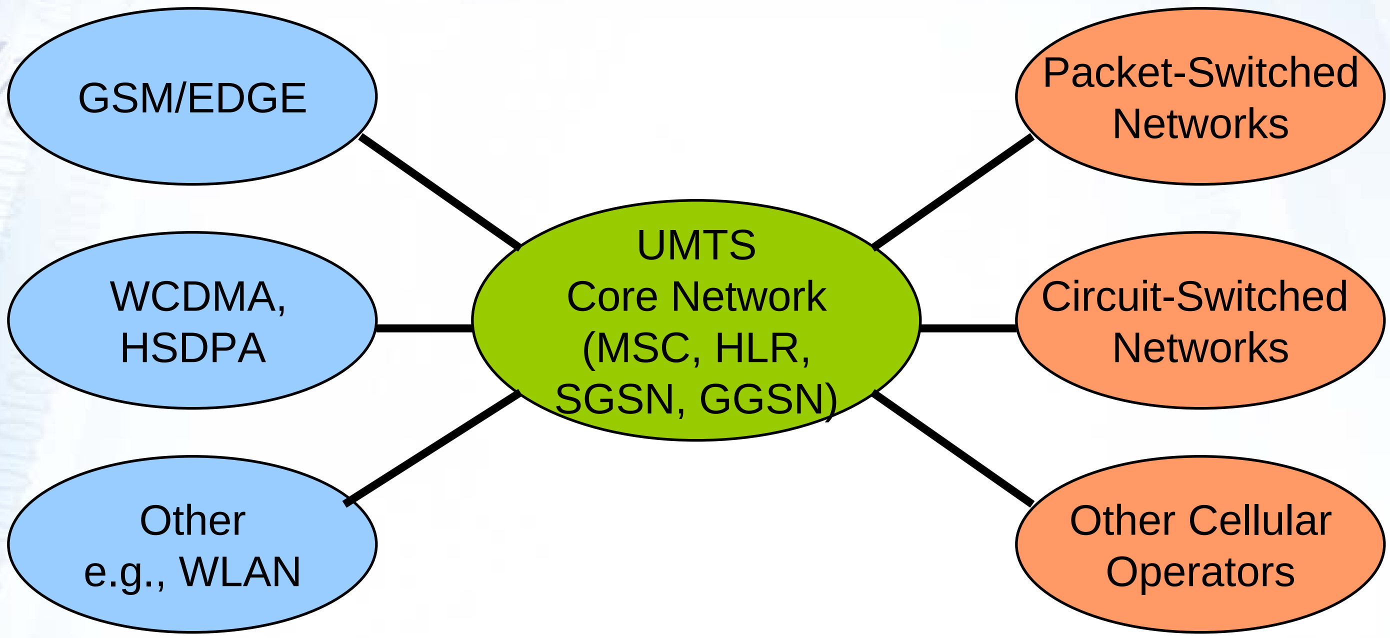
UMTS Multi-Radio Network



Common core network can support multiple radio access networks

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High Speed Downlink Packet Access

- High speed data enhancement for WCDMA/UMTS
- Peak theoretical speeds of 14 Mbps
- Initial devices supported 1.8 Mbps and 3.6 Mbps peak rates
- 7.2 Mbps now available
- Methods used by HSDPA
  - High speed channels shared both in the code and time domains
  - Short transmission time interval (TTI)
  - Fast scheduling and user diversity
  - Higher-order modulation
  - Fast link adaptation
  - Fast hybrid automatic-repeat-request (HARQ)

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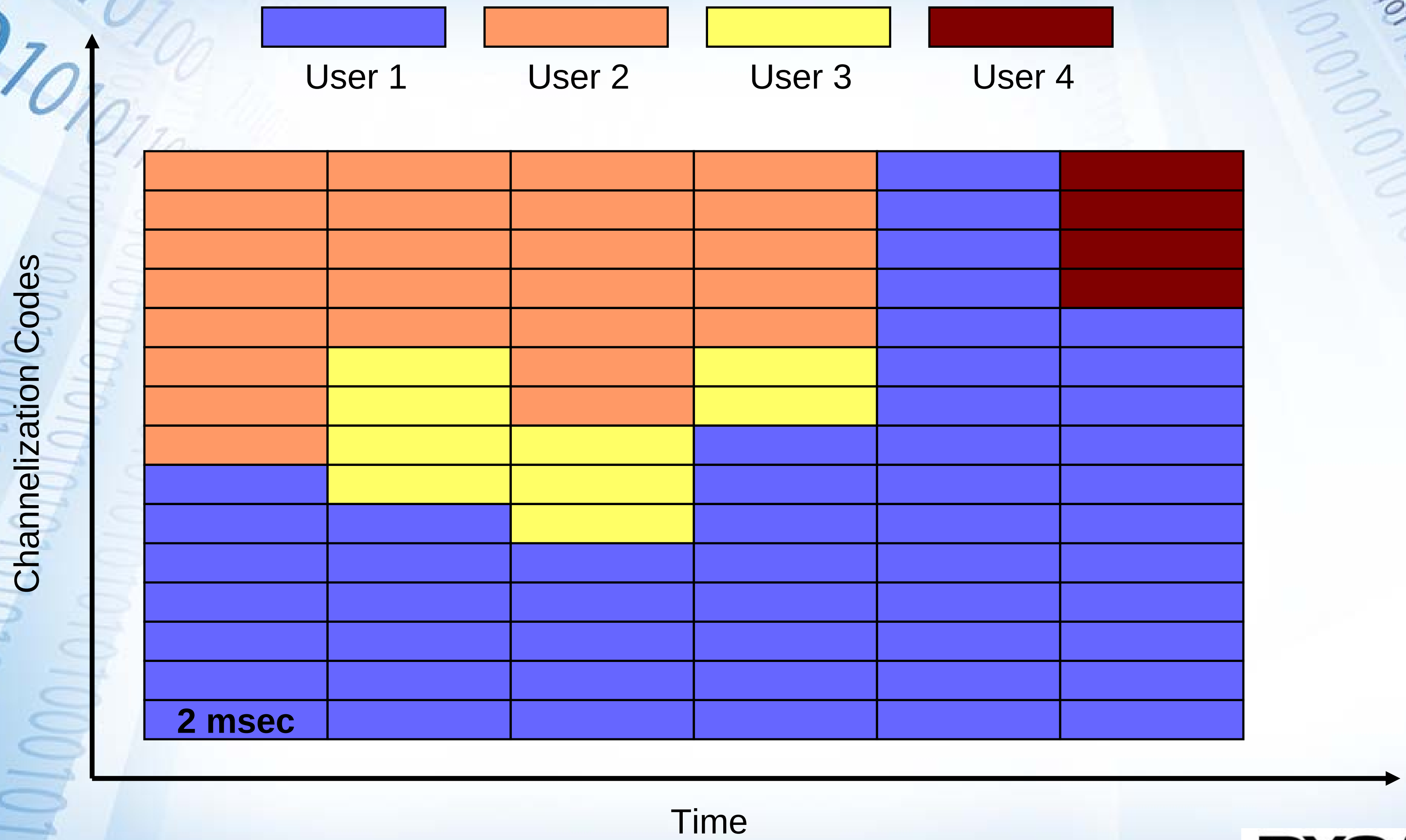
HSDPA Channel Assignment - Example



Radio resources assigned both in code and time domains

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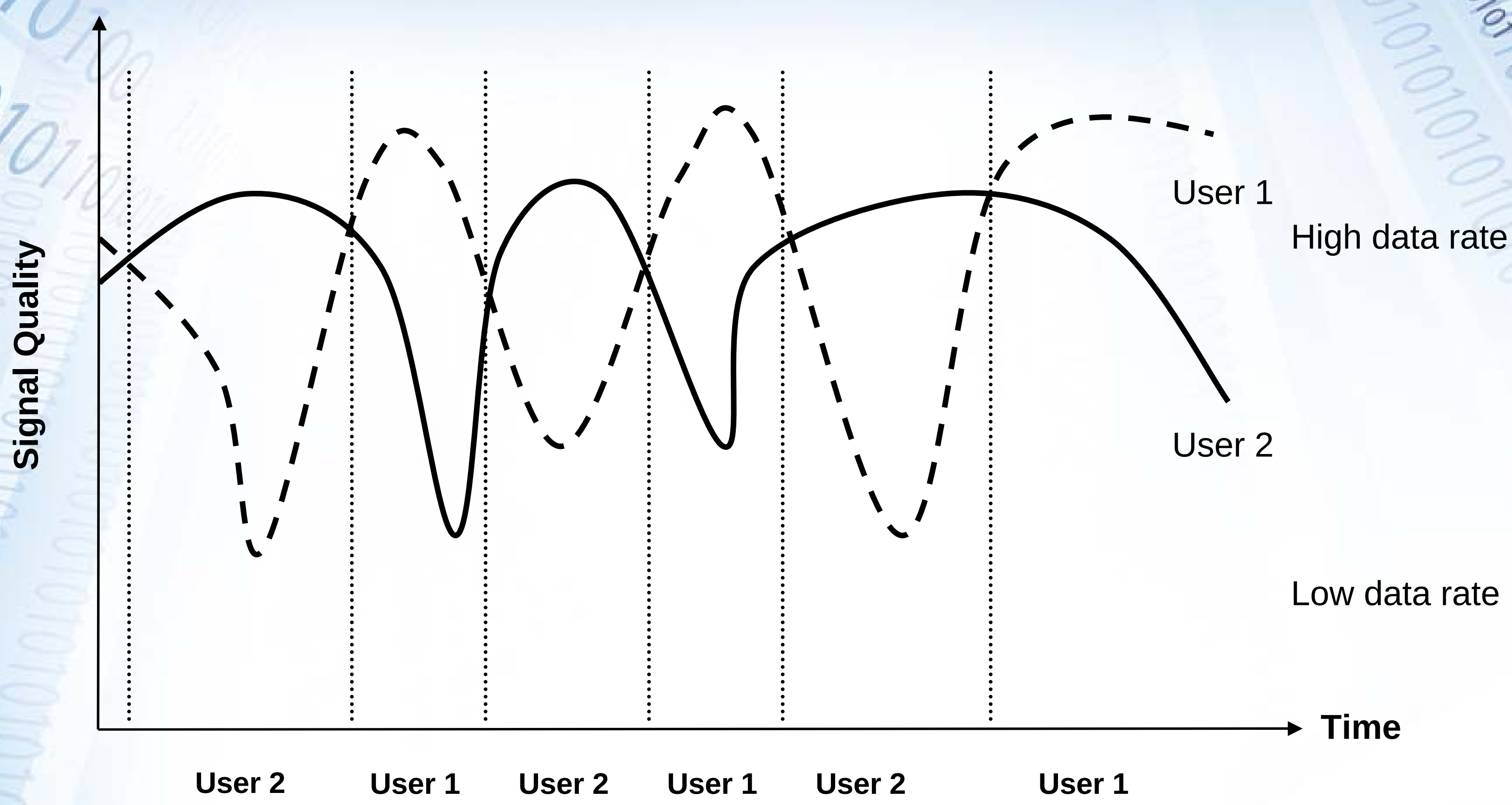
HSDPA Multi-User Diversity



Efficient scheduler favors transmissions to users with best radio conditions

HSDPA Device Categories

HS-DSCH Category	Maximum number of HS-DSCH codes	L1 Peak Rate (Mbps)	QPSK/ 16QAM	Soft Channel Bits
Category 1	5	1.2	Both	19200
Category 2	5	1.2	Both	28800
Category 3	5	1.8	Both	28800
Category 4	5	1.8	Both	38400
Category 5	5	3.6	Both	57600
Category 6	5	3.6	Both	67200
Category 7	10	7.2	Both	115200
Category 8	10	7.2	Both	134400
Category 9	15	10.2	Both	172800
Category 10	15	14.4	Both	172800
Category 11	5	0.9	QPSK	14400
Category 12	5	1.8	QPSK	28800

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High Speed Uplink Packet Access

- 85% increase in overall cell throughput on the uplink
- Achievable rates of 1 Mbps on the uplink
- Reduced packet delays to as low as 30 msec
- Methods:
  - An enhanced dedicated physical channel
  - A short TTI, as low as 2 msec, which allows faster responses to changing radio conditions and error conditions
  - Fast Node B-based scheduling, which allows the base station to efficiently allocate radio resources
  - Fast Hybrid ARQ, which improves the efficiency of error processing

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HSUPA Rates Based on Category

HSUPA Category	Codes x Spreading	TTI	Transport Block Size	Data Rate
1	1 x SF4	10	7296	0.73 Mbps
2	2 x SF4	10	14592	1.46 Mbps
2	2 x SF4	2	2919	1.46 Mbps
3	2 x SF4	10	14592	1.46 Mbps
4	2 x SF2	10	20000	2 Mbps
4	2 x SF2	2	5837	2.9 Mbps
5	2 x SF2	10	20000	2 Mbps
6	2xSF2 + 2xSF4	10	20000	2 Mbps
6	2xSF2 + 2xSF4	2	11520	5.76 Mbps

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HSPA+ Objectives

- Exploit the full potential of a CDMA approach before moving to an OFDM platform in 3GPP LTE.
- Achieve performance close to LTE in 5 MHz of spectrum.
- Provide smooth interworking between HSPA+ and LTE, thereby facilitating the operation of both technologies. As such, operators may choose to leverage the EPS planned for LTE.
- Allow operation in a packet-only mode for both voice and data.
- Be backward-compatible with previous systems while incurring no performance degradation with either earlier or newer devices.
- Facilitate migration from current HSPA infrastructure to HSPA+ infrastructure.

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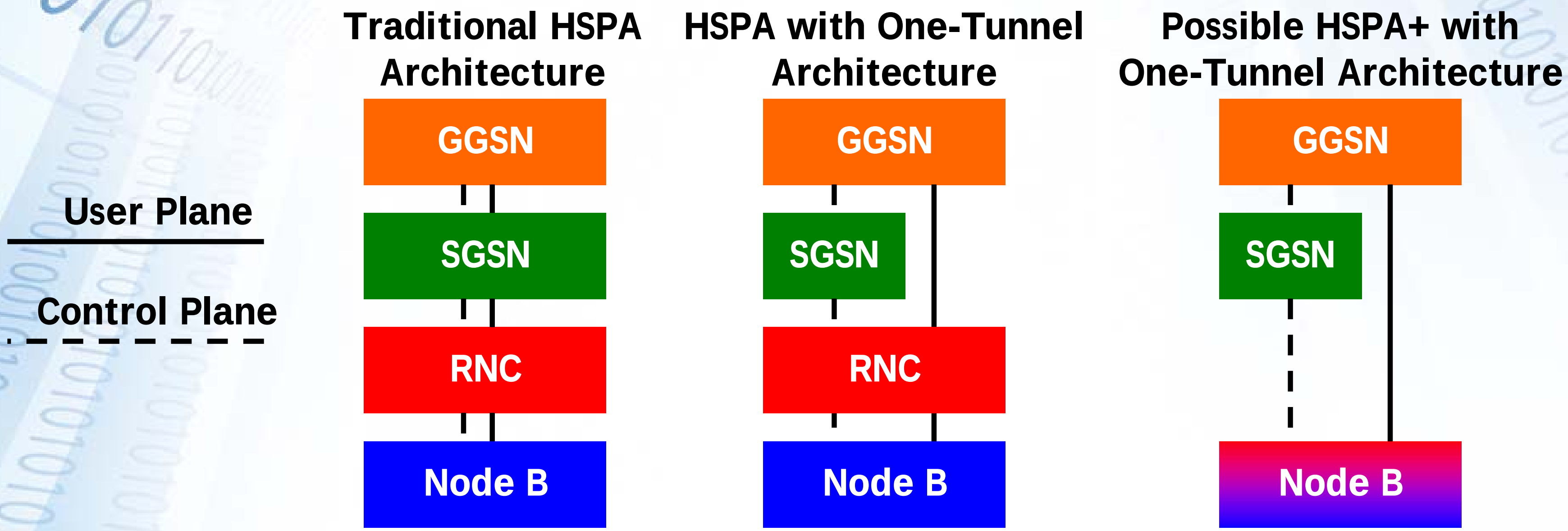
HSPA/HSPA+ One-Tunnel Architecture



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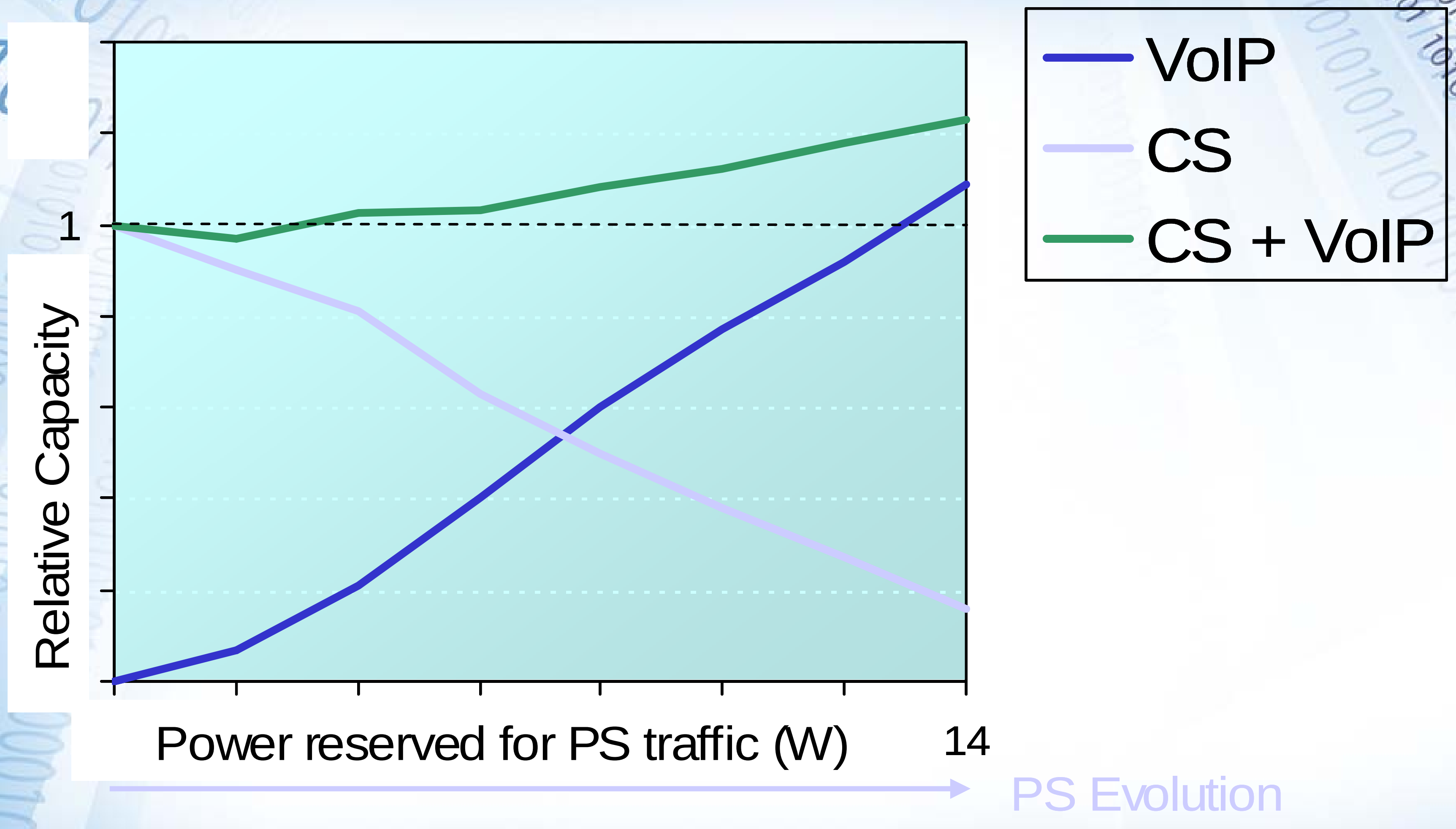
Smooth Migration to VoIP over HSPA



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LTE Capabilities

- Downlink peak data rates up to 326 Mbps with 20 MHz bandwidth
- Uplink peak data rates up to 86.4 Mbps with 20 MHz bandwidth
- Operation in both TDD and FDD modes.
- Scalable bandwidth up to 20 MHz, covering 1.25, 2.5, 5, 10, 15, and 20 MHz
- Increased spectral efficiency over Release 6 HSPA by a factor of two to four
- Reduced latency, to 10 msec round-trip time between user equipment and the base station, and to less than 100 msec transition time from inactive to active

LTE Configuration	Downlink (Mbps) Peak Data Rate	Uplink (Mbps) Peak Data Rate
Using 2X2 MIMO in the Downlink and 16 QAM in the Uplink	172.8	57.6
Using 4X4 MIMO in the Downlink and 64 QAM in the Uplink	326.4	86.4

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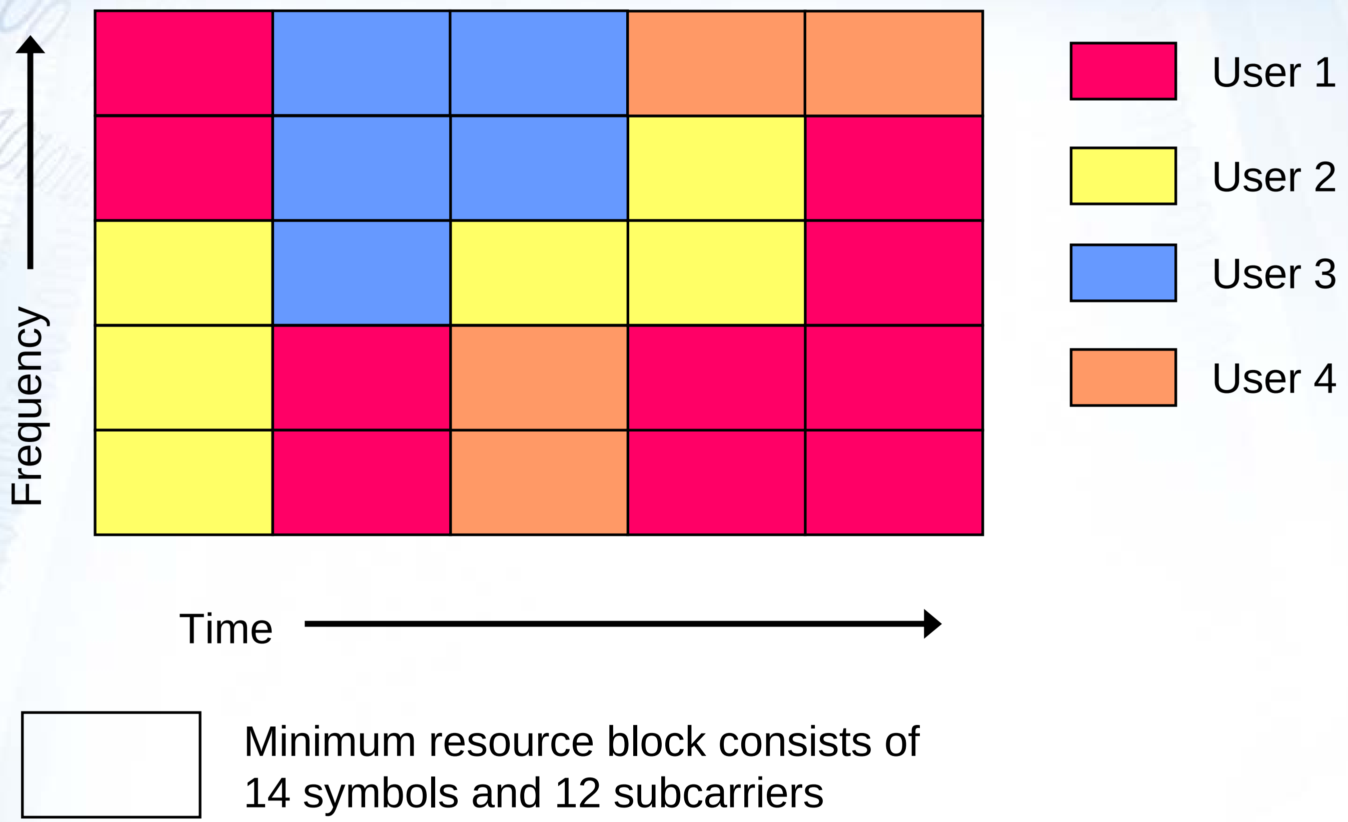
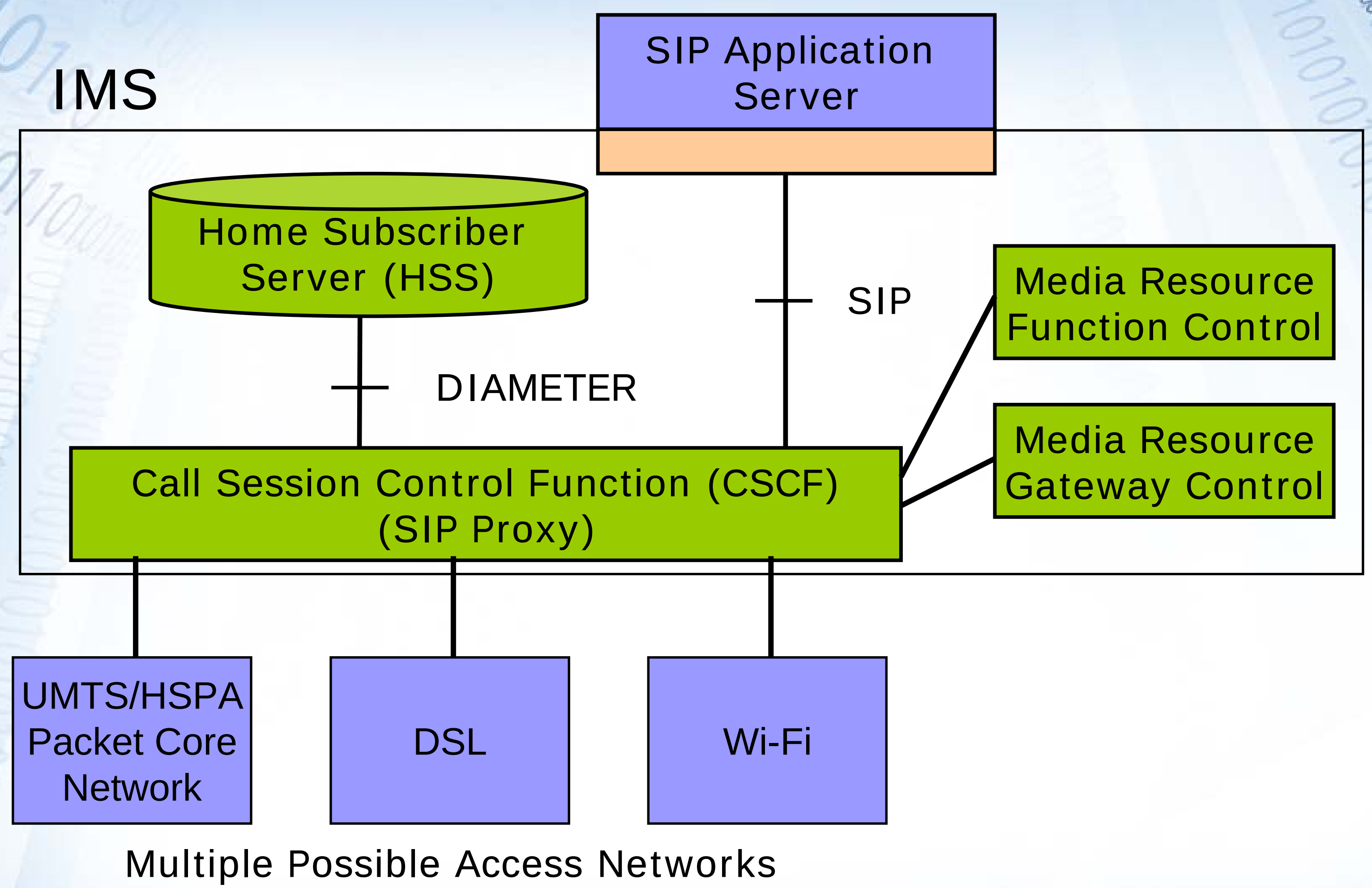
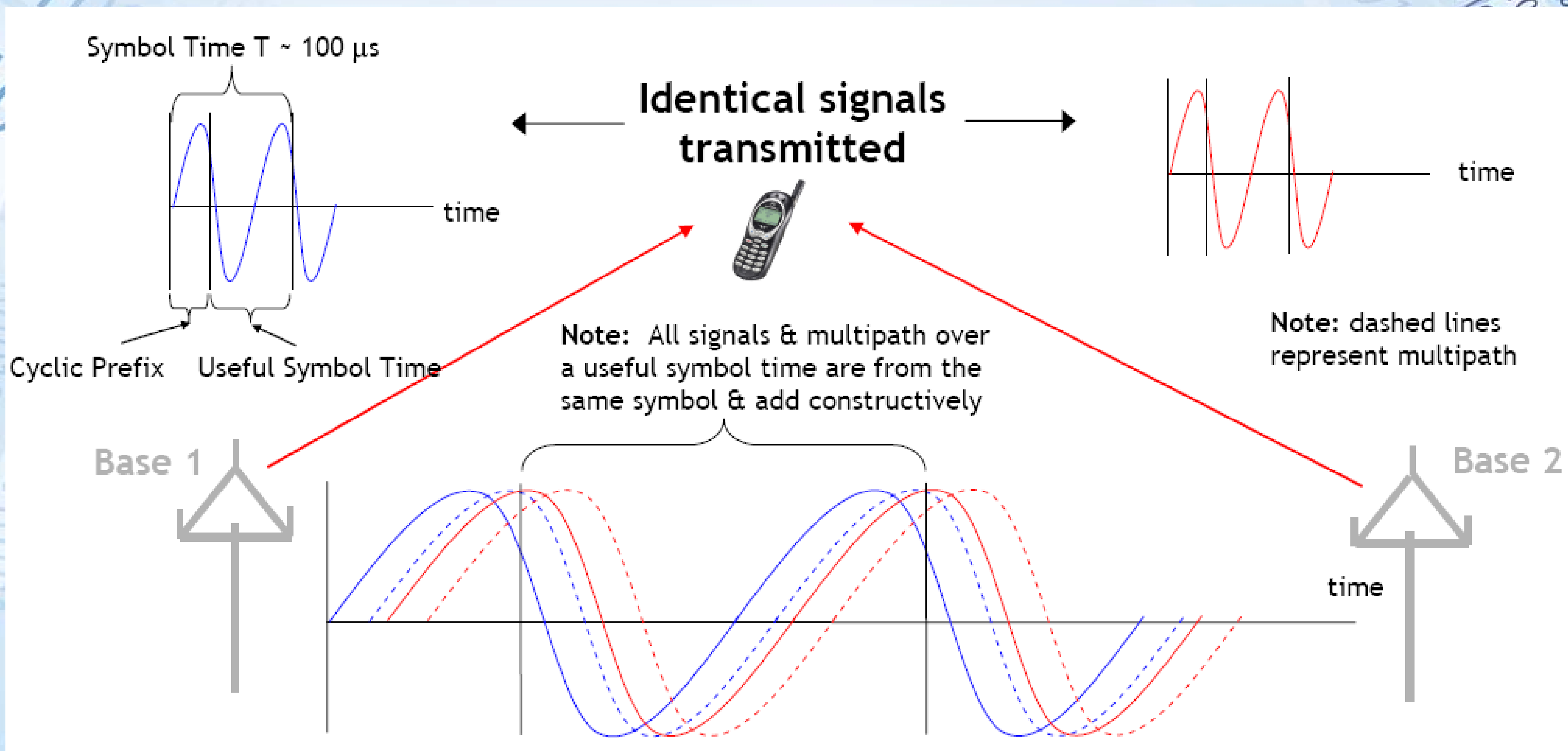
LTE OFDMA Downlink Resource Assignment in Time and Frequency



IP Multimedia Subsystem

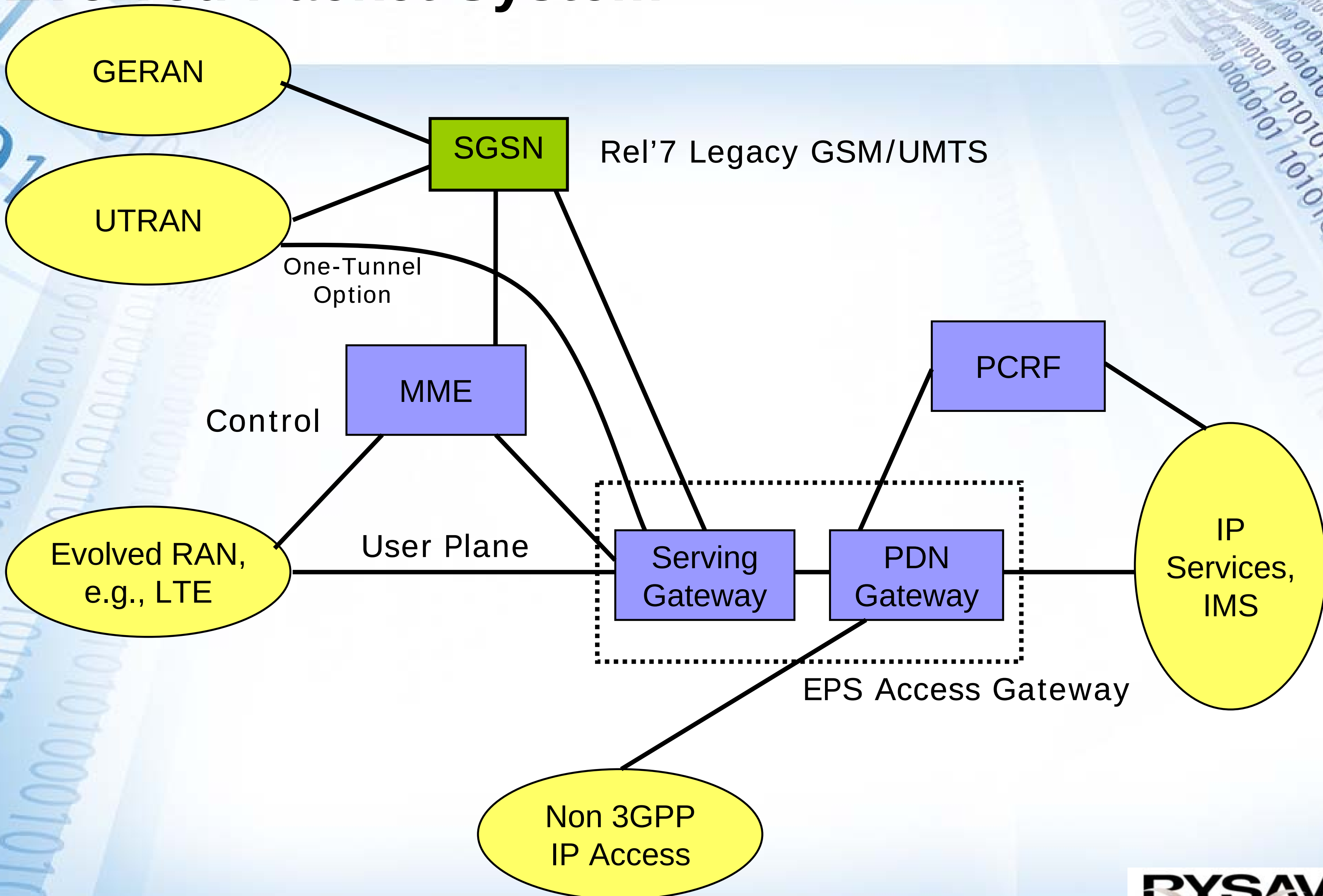


Efficient Broadcasting with OFDM



LTE will leverage OFDM-based broadcasting capabilities

Evolved Packet System



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Evolved Packet System Elements

- Flatter architecture to reduce latency
- Support for legacy GERAN and UTRAN networks connected via SGSN.
- Support for new radio-access networks such as LTE.
- The Serving Gateway that terminates the interface toward the 3GPP radio-access networks.
- The PDN gateway that controls IP data services, does routing, allocates IP addresses, enforces policy, and provides access for non-3GPP access networks.
- The MME that supports user equipment context and identity as well as authenticates and authorizes users.
- The Policy Control and Charging Rules Function (PCRF) that manages QoS aspects.

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Conclusion

- The EDGE/HSPA/LTE family provides operators and subscribers a true mobile broadband advantage
- EDGE is a global success story
- Evolved EDGE will achieve peak rates of over 1 Mbps
- HSDPA offers the highest peak data rates of any widely available wide-area wireless technology, with peak user-achievable rates of over 1 Mbps in many networks and now over 3 Mbps in some 7.2 Mbps networks
- HSUPA will increase uplink speeds to peak achievable rates of 1 Mbps
- HSPA+ has peak theoretical rates of 42 Mbps, and in 5 MHz will match LTE capabilities
- LTE will provide an extremely efficient OFDMA-based platform for future networks
- EDGE/HSPA/LTE is one of the most robust portfolios of mobile-broadband technologies and is an optimum framework for realizing the potential of the wireless-data market

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