Technologies for Broaband Wireless

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Content

- Main Wireless Technologies
  - CDMA, HSPA, LTE
  - WiMAX and WiFi
- Selecting the right technology
  - Frequency
  - Coverage and Capacity
  - Low Cost Infrastructure

Main Wireless Technologies

Cellular Access

3GPP / 3GPP2

GSM/GPRS/EDGE

UMTS/ HSPA/HSPA+

CDMA 20001xEvDO RevA, RevB

UMTS –TDD, TD-SCDMA

LTE

Wireless Access

IEEE Standards

WiFi (IEEE 802.11 a,b,g,n)

WiMAX (IEEE 802.16 d,e)

Flash OFDM (Flarion)
WiBro (South Korea)
iBurst (ArrayComm)

Broadcasting

DVB-H, DVB-SH
T-DMB, S-DMB
Media Flo

Short range

UWB
RFID
Bluetooth

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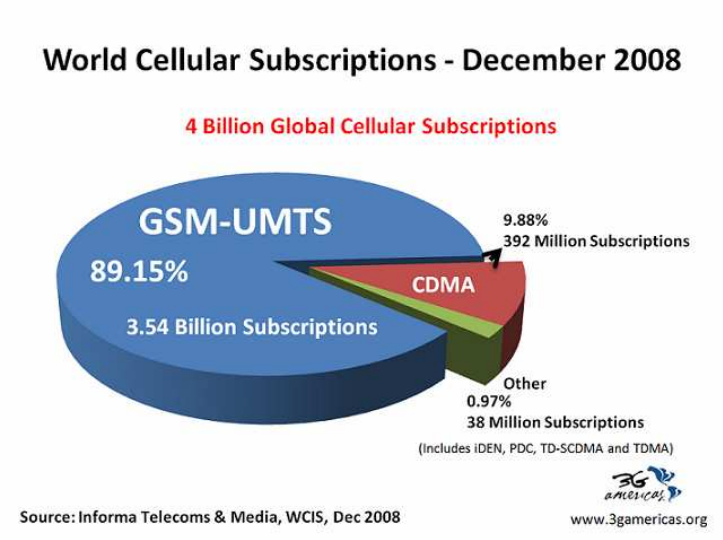
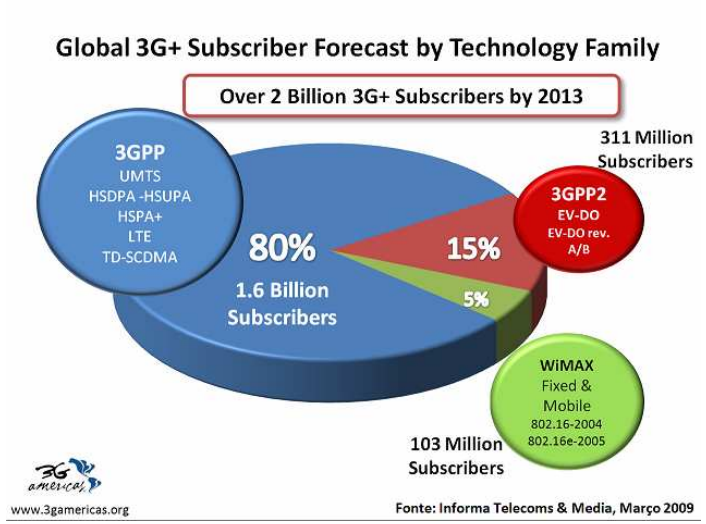
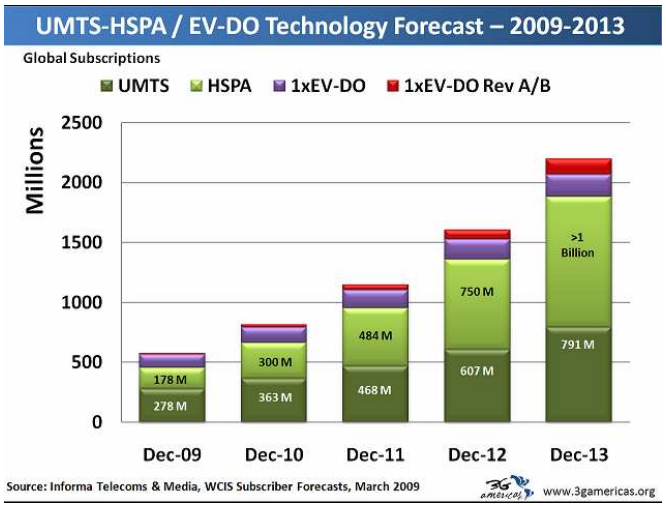
Worldwide Cellular Market





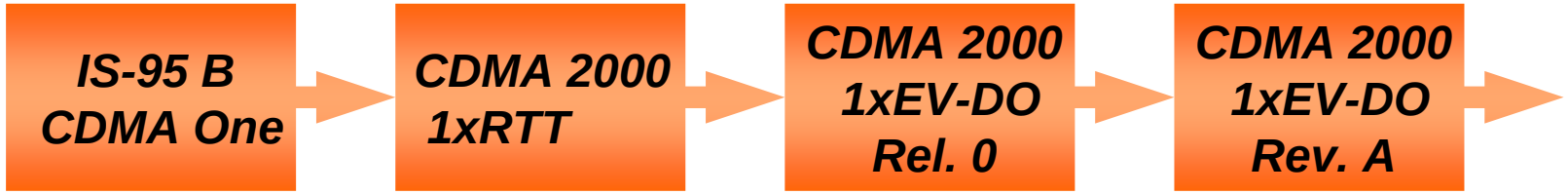


- 3G/3G+ statistics:
  - 287 Million UMTS/HSPA susbcribers (4Q 2008, source: GSA www.gsacom.com)
  - 112 Million CDMA 2000 1xEVDO subscribers (4Q 2008 ,source: CDG www.cdg.org)

Source : www.3Gamericas.org

CDMA 2000 1xEVDO RevA

- 3GPP2 standard
- Evolution of CDMA2000 1xRTT
- Can evolve to multicarrier EvDO or EVDO RevB
- Deployed in 800/1900MHz and in 450MHz
- 1.25MHz bandwidth



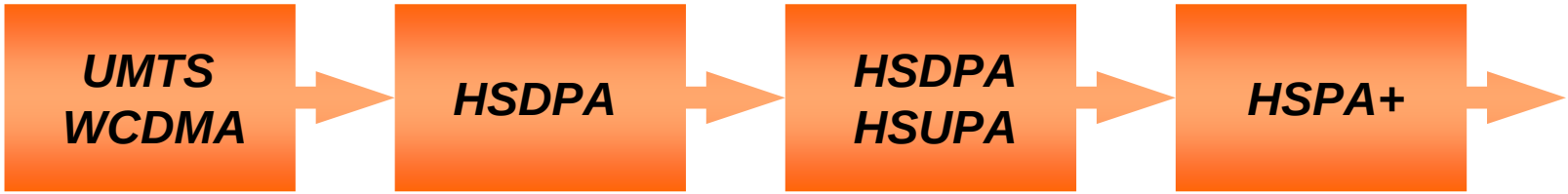
Peak Data Rate	153.6 (307) kbps	UpLink: 153.6 kbps DownLink: 2.4 Mbps	UL: 1.8 Mbps DL: 3.1 Mbps
Typical Data Rate (source cdg.org)	60-100 kbps	UL: 70-90 kbps DL: 300-700 kbps	UL: 300-400 kbps DL: 450-800 kbps

CDMA 2000 1xEVDO RevA

- April 2009 (Source: CDG www.cdg.org):
  - Networks:
    - **106 1xEvDO Rel0** commercial networks and 40 in deployment 538 1xEvDO Rel0 devices
    - **62 1xEvDO RevA** commercial networks (16 CDMA 450) and 37 in deployment (18 CDMA 450)
    - **16** 1xEvDO RevA **CDMA 450** commercial networks and 18 in deployment
  - Devices:
    - **118 1xEvDO RevA** devices
    - **13 1xEVDO RevA CDMA 450** devices

HSPA: HSDPA/HSUPA

- 3GPP standard (Release 5 and 6)
- Evolution of UMTS W-CDMA
  - Usage of Adaptive Modulation & Coding, H-ARQ, Fast Scheduling, 2ms/10ms Transmission Time Interval
- Can evolve to HSPA+
- Deployed in 2100 and 850/900MHz
- 5MHz bandwidth , can support voice and data on the same carrier

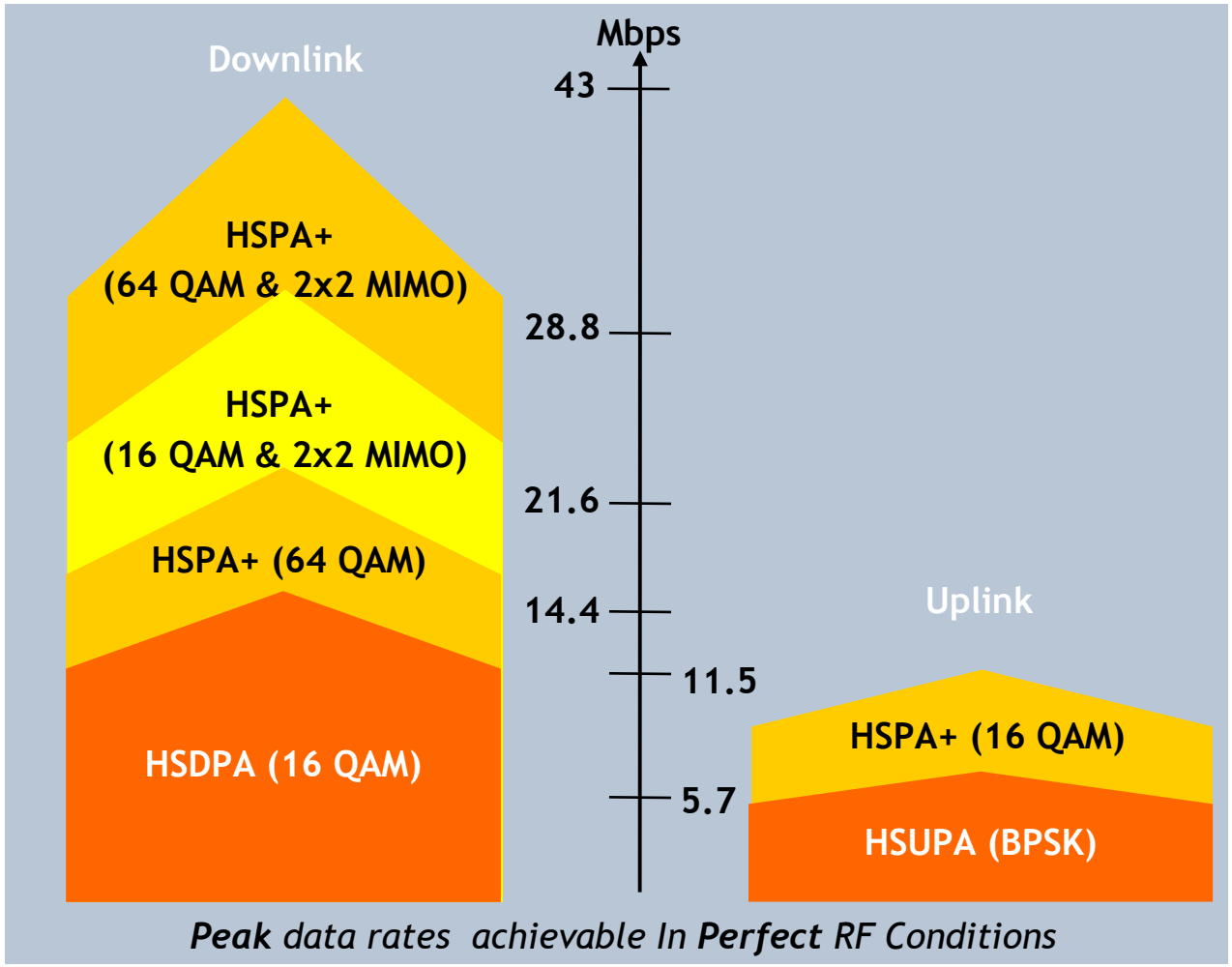


Peak Data Rate	UL: 128/384 kbps	UL: 1.4/2/5.7 Mbps	UL: up to 11.5 Mbps
	DL: 1.8/3.6/7.2/10.8 (14.4) Mbps		DL: up to 43 Mbps

HSPA+

Higher Order Modulation and **MIMO** significantly increase the theoretical peak rates

Only provide data rate benefits for users in **very good channel conditions** (e.g. users in line of sight conditions with good C/I)



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HSPA

- April 2009 (Source: 3G Americas www.3gamericas.org and GSA www.gsacom.com):
  - Networks:
    - 262 HSDPA commercial networks and 54 planned or in deployment
    - 77 HSUPA commercial networks and 92 planned or in deployment
    - 2 HSPA+ commercial networks and 19 commitments
    - 8 UMTS 900 commercial networks
  - Devices:
    - 1409 HSDPA devices
    - 242 HSUPA devices
    - 115 UMTS 900 HSPA devices

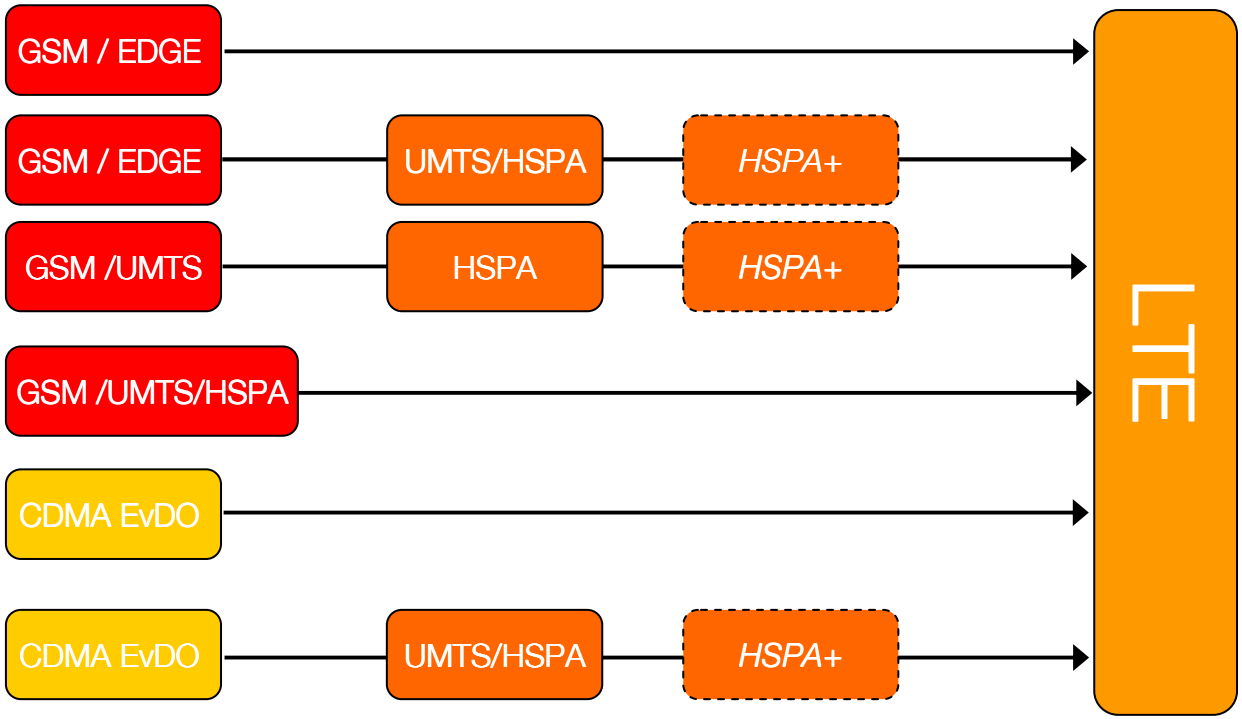
LTE

- Long Term Evolution (LTE) is 3GPP Evolution (Release 8)
- Based on **OFDM** (Orthogonal Frequency Division Multiplexing) and **MIMO** (Multiple Input Multiple Output) techniques
- **To be** deployed in various bands (**700MHz, 900MHz, 2.1GHz, 2.6GHz**)
- **FDD and TDD** mode
- **Scaleable** bandwidth: 1.4, 3, 5, 10, 15, 20MHz
- **All IP network**, simplified architecture (eNodeB and e Packet Core)
- Voice is offered through **VoIP**
- Evolution to LTE-Advanced already forecast (candidate for ITU IMT-Advanced solution)

LTE

- April 2009 (Source: GSA www.gsacom.com):
  - 31 network operators have committed to LTE deployment
  - Service launch expected for **2010**

- 3GPP2 CDMA operators committed to LTE



LTE

- Peak Data Rates:

	Bandwith					
	1.4MHz	3MHz	5MHz	10MHz	15MHz	20MHz
Uplink (16QAM)	2.9Mbps	6.9Mbps	11.5 Mbps	27.6Mbps	41.5Mbps	55Mbps
Downlink (64QAM, MIMO 2x2)	10.4Mbps	26Mbps	43 Mbps	86Mbps	130Mbps	173Mbps
Downlink (64QAM, MIMO 4x2)	19.6Mbps	49 Mbps	81Mbps	163Mbps	245Mbps	326Mbps

In line with HSPA+ peak data rates

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WiMAX

- IEEE 802.16d (fixed) and 16e (mobile)
- Based on OFDM (Orthogonal Frequency Division Multiplexing) and MIMO (Multiple Input Mulitple Output) techniques
- Currently deployed in 2.3, 2.5, 3.5GHz
- FDD and TDD mode
- All IP network, simplified architecture
- Voice is offered through VoIP
- Evolution to 802.16m under standardization (candidate for ITU IMT-Advanced)
- April 2009 (source: WiMAX Forum www.wimaxforum.org)
  - 455 network deployments in 135 countries

WiMAX vs 3GPP

	EDGE	HSPA	WiMAX	LTE
Market Maturity	☺	☺	😐	☹
VoIP support	☹	😐	☺	☺
Mobility	☺	☺	😐	☺
User data rate	😐	☺	☺	☺
Coverage	☺	☺	☹	☺
Capacity	😐	☺	☺	☺

WiFi

- IEEE 802.11 standards
- Deployed in 2.4 GHz and 5 GHz non licensed bands
- Wireless Local Area Networks:
  - Low coverage, hotspots
  - Nomadism
- Peak rate: 11 to 54Mbps
- WiFi mesh networks

Choice of the right technology

- The choice of the best technology depends on various factors:
  - **Spectrum** (frequency, bandwidth, cost of licence) available
  - **Terminal** and equipment availability
  - **Services** to be offered (contents, data rates, VoIP, mobility)
  - Required **coverage and traffic** to be supported
  - Market share (**economy of scale**) and **maturity** of the technology
  - Possible **evolutions** and **upgrades** of the technology
  - **Interoperability** with existing technology
  - Network **architecture** and **backhauling** solution
  - Total Cost of Ownership (**CAPEX, OPEX**)

Frequency

Available bands according to technology:

	Channel bandwidth (MHz)	Frequency Band (MHz)						
		450	**700**	**800/900**	**1800/1900**	**2100**	**2600**	**3500**
EDGE	0.2			✓	✓			
HSPA	5			✓	✓	✓		
CDMA2000 1x EvDO	1.25	✓		✓	✓	✓		
WiMAX	(1.25)/3.5/5/ 7/10/(20)						✓	✓
LTE	1.4/3/5/10/15 /20		✓	✓	✓	✓	✓	

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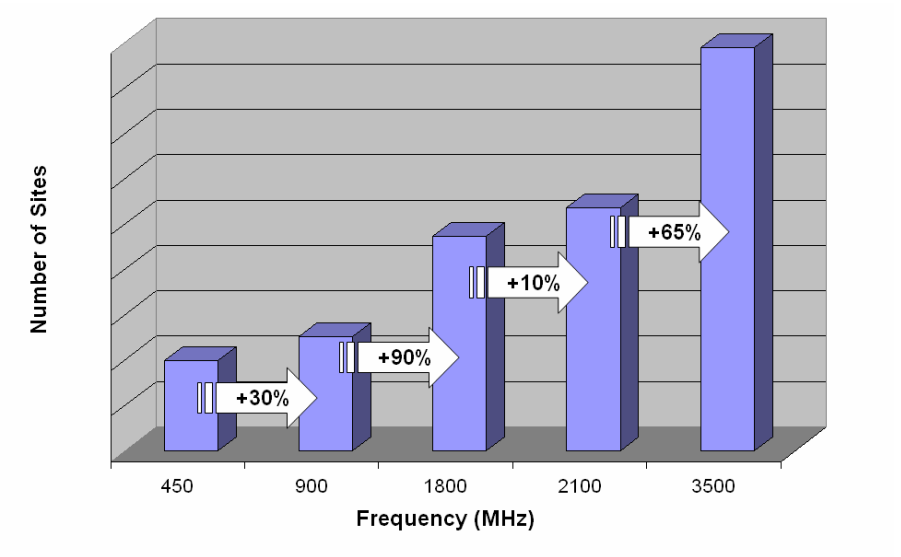
Coverage

- Link budget analysis enable to assess the **cell range** of the different systems according to their own receiver performances and the frequency used for deployment
- The coverage is extremely related to the **frequency**
  - The higher frequency,
  - The lower cell range,
  - The higher number of sites



- WiMAX is unfavoured by its high frequency (2.5, 3.5GHz)
  - Working to expand to 700MHz
- The coverage can be enhanced by using outdoor CPEs or antenna techniques (Receive Diversity, Adaptive Antennas)
  - Benefits to be assessed by CAPEX analysis
- The coverage analysis must be linked with a capacity analysis

Capacity

- The capacity analysis must be performed according to each **deployment scenario** and **marketing objectives** :
  - **Density** of subscribers
  - **Voice/Data traffic demand**: voice or data centric
  - **Data rate offer**: 128kbps, 256kbps, 512kbps, >1Mbps

- Some trends:
  - CDMA 450 will be more suitable for low density rural areas with low data rate offer (coverage-limited scenarios)
  - EDGE/HSPA/CDMA EvDO are suitable for medium cases and when mobility is required
  - WiMAX and LTE will be more suitable for high data-oriented DSL like offers (capacity-limited scenarios)

Low cost infrastructure

- Trends of the infrastructure supplier industry:
  - Propose solutions to **reduce CAPEX and OPEX**
    - Coverage/Capacity enhancement solutions to reduce the required number of sites
      - Antenna techniques
      - AMR low rates for Voice, VoIP
      - Outdoor CPEs
  - Propose solutions adapted to **low cost deployment**
    - Reduce the power consumption
    - Solar equipment
    - Multi-technology, software upgrade and Software Defined Radio (SDR) equipment
  - **Simplify network architecture** and go for flat IP

Conclusion

- Various technologies are available to offer broadband wireless: EDGE, WiFi, CDMA2000 1xEVDO, HSPA, WiMAX

- LTE is coming based on the same technology than WiMAX (OFDM and MIMO)

- The choice of the right technology depends on various factors such as the available frequency, the market scale of the technology, its performances compared to the coverage and the traffic needs


Thank you!
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