



Beyond 3G Wireless

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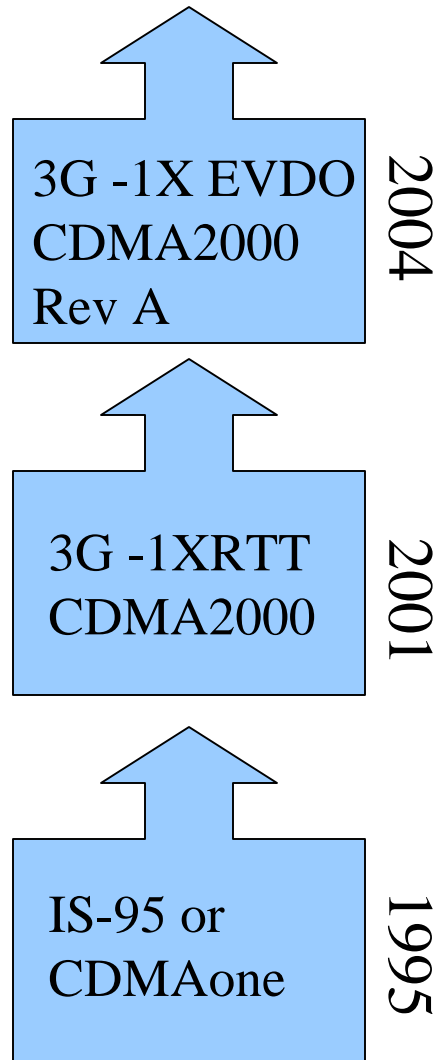


IEEE 3G Deployments today



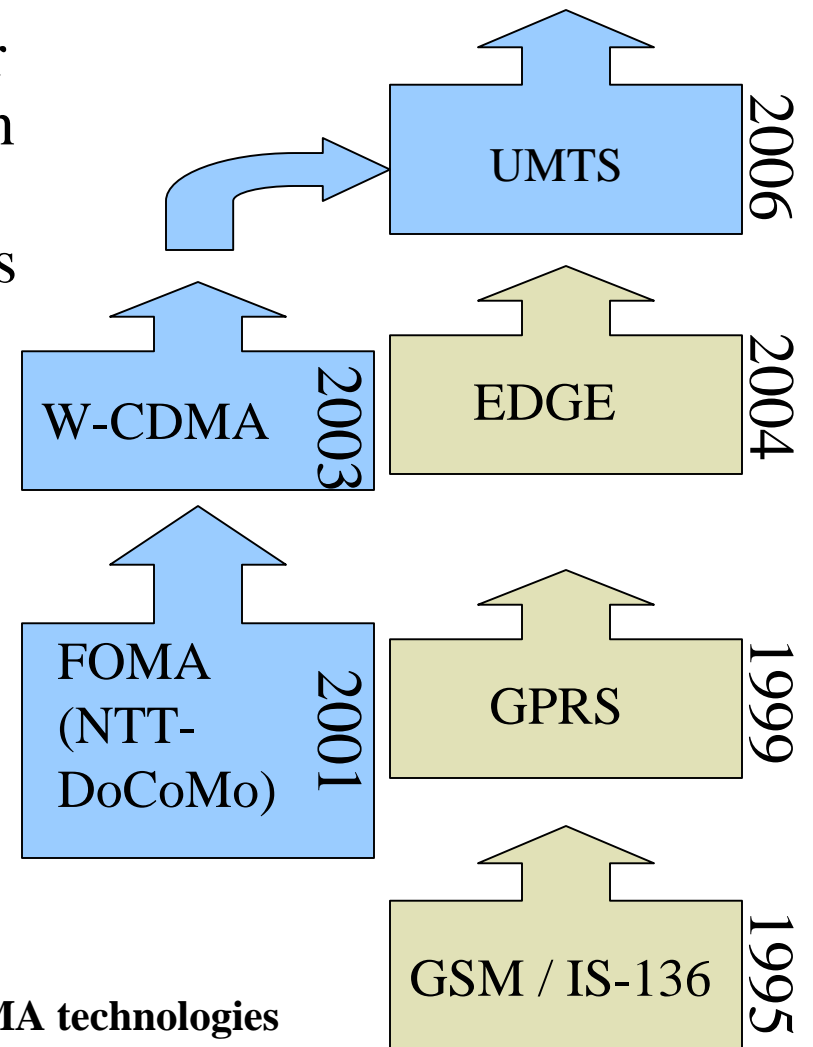
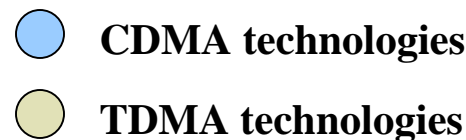
Rev C?

HSDPA?



- A decade of cellular evolution resulted in CDMA as the basic 3G technology – has over a billion users

- Move from TDMA to CDMA and new spectrum has cost heavily to service providers who did not choose CDMA technology in 1995



Merging of the two worlds

PC (Computing world)

Home network has made the PC as a single entity for info & entertainment. PC supports applications using a variety of on-line transactions, graphics and multimedia. The Internet generation is comfortable with the PC / laptop but perceive it as bulky and tethered.

Cell-phone (Voice world)

The cell phone today is the primary communication device for voice. It offers mobility, very high security and small size (fits into the pocket / purse). It uses limited power and memory (a few Giga today) and a small screen. It adapts applications from the PC but on-line access is slow.

- Merging of these two will be like an ideal marriage 😊

3G and the Internet - limitations

- All 3G standards try for good data rates for Internet access. Peak and sustainable data rates, latency, transition times, edge data rates, error correction, subscriber capacity per sector / carrier and availability are factors that limit the data rate performance.
- Vehicular speeds set the limits on data rates, since the cellular air interface was built-in using FEC* at the physical layer to take care of mobility.
- Core network preserves the existing telecom infrastructure for voice but uses separate interfaces at the MSC for the Internet, multi-media and other related applications (adds to delay).

*Forward Error Correction

Mobility – its Impact

Mobility – in engineering terms it means:

- Correction for Doppler shift (motion, its direction)
- Error Correction or adjustment for dropped packets / frames (due to Raleigh fading) – using FEC* codes and convolution techniques to recover data.
- ✓ These two corrections dictate the complexity of additional codes at the physical layer frame. This affects the entire design (format, sub-frames etc.,).
- ✓ In order to incorporate these corrections, additional bandwidth is needed (typical requirement is 25% to 40% of total BW, based on expected quality - BER).

*Forward Error Correction



IEEE



Strengths - CDMA and OFDM

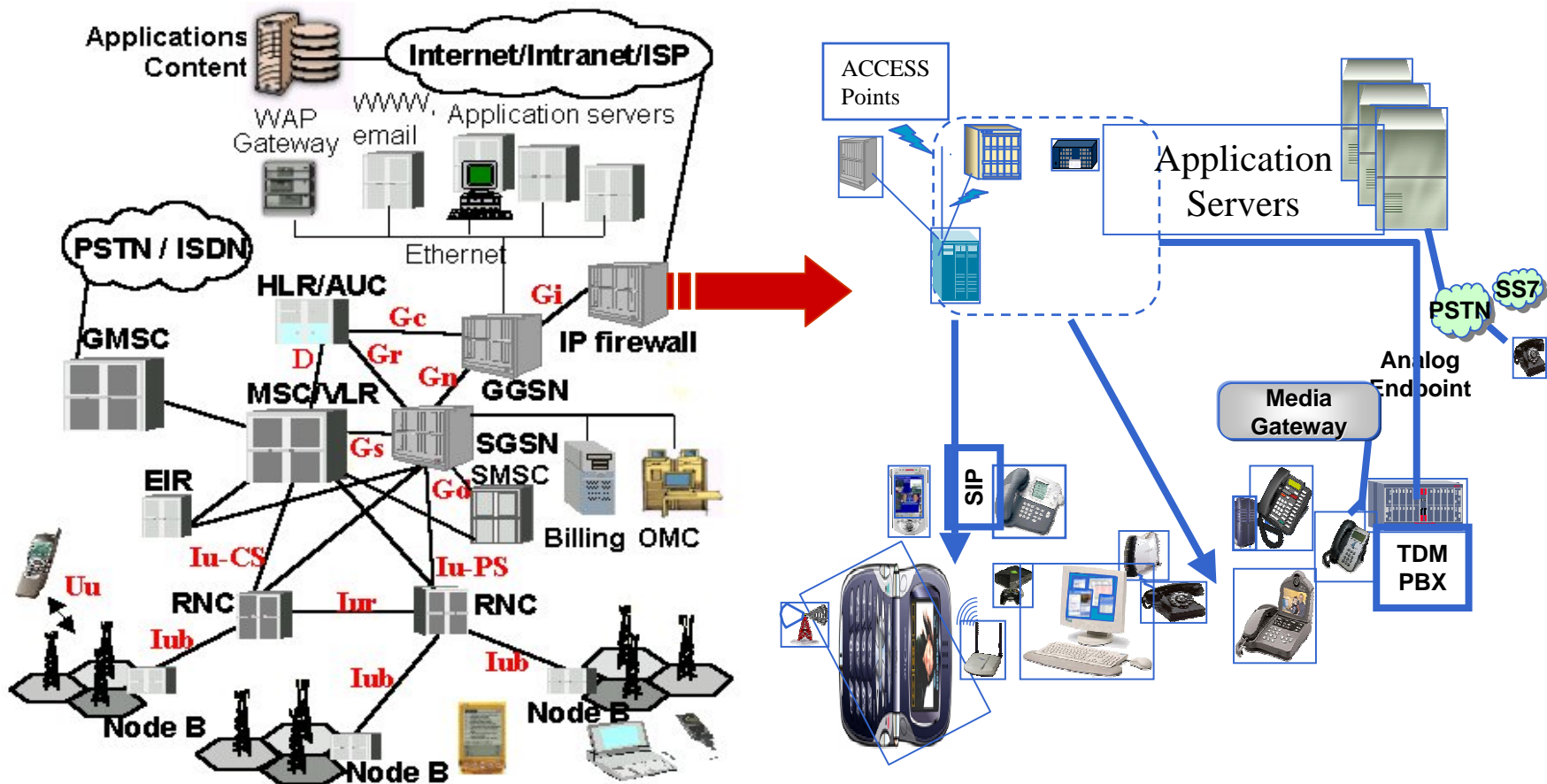
- **CDMA** inherently provides a very high level of security, irrespective of cellular infrastructure (cellular systems use powerful authentication algorithms). It has proved more secure than any existing wireline system. Hence, “A wireless call is more secure than a wireline call”.
- **OFDM** brings the high data rate performance, known to WiFi users. It is less susceptible to multipath with good spectral efficiency (Bits /Sec/ Hz). It offers robust performance when incorporated into cellular networks.
- **Integration attempts**: CAVE (Cellular Authentication and Voice Encryption) and similar algorithms are the mainstay of “higher security” offered by the entire cellular industry. In 2005 wireless standards of US and Europe introduced some of the powerful authentication concepts into 802.11 standard through **802.11i**

New Technologies – OFDM/WiMax

- **OFDM** can become a technology common to WiFi and Cellular. It can serve both markets. It performs very well under urban mobility conditions. Handoff between OFDM (802.11 or WLAN) and CDMA (both the UMTS and 3G1x technologies) was demonstrated in 2001. **This is a prerequisite** for integration of any new technology into existing cells. OFDM is also used in digital audio and TV broadcasts.
- **WiMax** started as an access technology for suburban neighborhood where DSL / Cable is not practical. Adding Mobility to WiMax recently (via 802.16e) is an attempt to provide wireless MAN (Metropolitan Area Network). The aspects related to handoff (common in cellular systems) is lacking but WiMax is useful when customer is at home.

Evolving Cellular and WLAN

- For Data – use OFDM, Bypass Telecom Core
- For Voice – use CDMA, include Telecom Core



Evolving Cellular and WLAN

- For Data – use OFDM, Bypass Telecom Core
- For Voice – use CDMA, include Telecom Core
- **Replacing an existing ubiquitous Telecom infrastructure with a limited WLAN / WiMax infrastructure is NOT PRACTICAL (Fork lifting major network equipment worldwide is not acceptable to wireless service providers).**
- **Also, voice circuits that link rural / remote regions need continued support from the existing telecom network.**

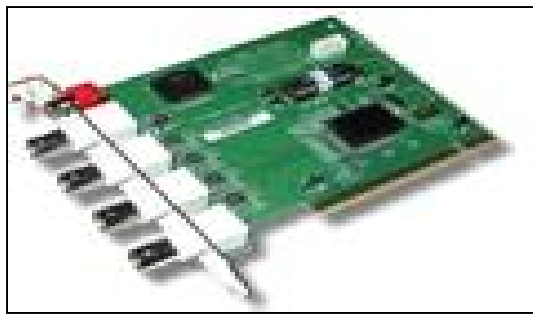
What Cellular Providers want

- Service Providers need channel cards of OFDM technology that can plug into an existing CDMA base station (causes minimal disruption to 3G-1xEVDO or UMTS – no forklift, just a card replacement).
- Allow the service providers to configure a base station based on their local traffic patterns – they should configure it based on data and voice demand in each region
- New technology must use the same RF carriers - to avoid bureaucratic delays.

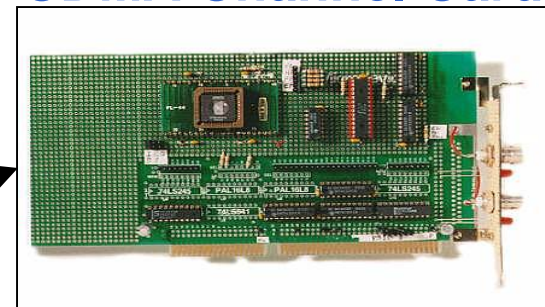
Cellular Providers - Solution

- Equipment manufacturers must offer complete support for CDMA and OFDM cards on existing Base Station racks.

OFDM Channel Card



CDMA Channel Card



- CDMA and OFDM cards that plug into an existing base station chassis – it provides the flexibility to use either a CDMA or an OFDM carrier as needed, at each base station.



This is
possible
today.

What Cellular users want



- Not ANOTHER toy to juggle around!!

Cellular users - Solution

- Users need a new technology that integrates well into cell-phone type of handsets (easy to use, not bulky, not a PCM-CIA card, good talk time and long standby time, uses SIM card). **This is possible with the technology available today.**
- The handset should route voice calls on CDMA and data calls on OFDM. This will provide excellent voice quality and high data rates. Both calls get excellent authentication support from cellular infrastructure (very high security).
- It should be possible to handoff calls between the two, for multiple call scenarios.



Future - Why consider 802.20

- IEEE 802.20 standards group stems from a Cellular background – it incorporates FEC (for mobility) from the start. It expands on the knowledge of cellular handoff using vehicular traffic patterns and integrates it with the broadband capability of WLAN.
- It may be the right next step in terms of cellular evolution, that can build on a infrastructure of CDMA and move on to OFDM (assume handoff between these two technologies).
- There is no hurry to move to a new standard – even if IEEE 802.20 takes time, it is better than quick and dirty attempts to include mobility.

Future – other proposals

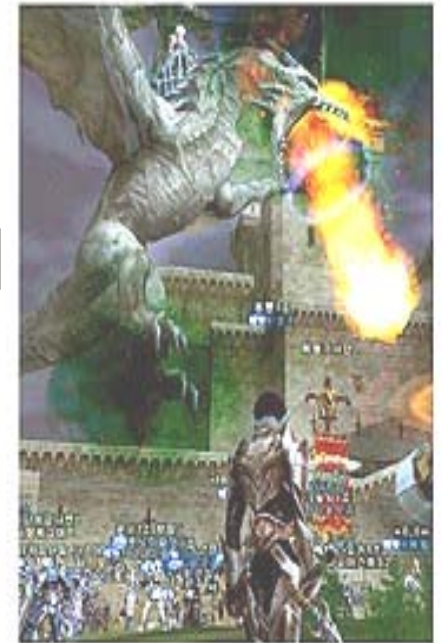
There are several proposals from the cellular world on “beyond 3G”. Some of these are:

TD-CDMA: Proposed by China. Limited data rate performance since Transmit and Receive must be time multiplexed.

HSDPA

What about Games

- The biggest hindrances for Games are access delay (air interface -100 ms) plus the telecom core network delay 100 – 150 ms.
- The access delay is reduced (<50 ms) in Flash OFDM technology and its radio router eliminates the core delay - Good for games.



What about VoIP

- The first issue for VoIP is access delay (air interface -100 ms) plus the telecom core network delay 100 – 150 ms.
- The second issue is development of Voice Coder that can match the quality of “CDMA voice” today
- ✓ The access delay is reduced (<50 ms) in Flash OFDM technology and its radio router eliminates the core delay.
- ✓ However, Voice coder for VoIP in wireless may need additional developments and it is therefore best to use CDMA voice even beyond 3G (gives enough time to trial VoIP and compare its quality with various voice-coders in use today).

Some Social Impacts

- Users are skeptical of jargons such as 4G or others. The enormous expectation set by 3G and the subsequent delays in its deployment had a negative impact - this must be noted.
- It would be best to provide a gradual, smooth integration of newer technologies into 3G but not give it new names. The benefits to both service providers and end users must remain incremental and effective (**unlike 3G - no big promises and equally big disappointments**)
- Teenagers may not care for “Toll quality voice” but they do care for CDMA voice 😊



Conclusion

- Cellular 3G and WLAN have both established themselves as separate wireless technologies. WLAN has low mobility, high throughput while cellular 3G has high mobility but lower throughput.
- A Common approach between these two technologies is needed – either integration or a partitioned operation. Integration is a better approach and is achievable today with OFDM.
- Going forward, 802.20 would be a better approach since it is based on 802.11 broad band, yet it uses the mobility principles (such as FEC, handoff) that are well established in cellular systems.
- In the long term merger of PC and Cell phone into a single device will become a reality.