

# Future-Generation Wireless Networks: Opportunities and Challenges

Session: New Technologies

by

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# Introduction

- Mobile communications systems (cellular or satellite) are the realisation of the “anytime, anywhere, anyone” concept.
- Initial systems were for voice and for complementing fixed telephone systems.
- Wireless network subscription has increased due to:
  - ◆ continuous development of new technologies
  - ◆ expansion of service areas
  - ◆ introduction of compact terminals
  - ◆ increased popularity of mobile communications
- Availability of data services has had a major impact on people’s lifestyles.
- Status of mobile communications is changing from “complementary” to “requisite”.

# General Trends

- An increasing portion of wireless traffic is data traffic, e.g. SMS messages.
- 2001 was year of world-wide introduction of data-capable third-generation (3G) wireless systems.
- New wireless services can be classified as:
  - ◆ Social communication and safety, e.g., video-telephony, photo messaging, alarm notification
  - ◆ Time saving and empowerment, e.g., online shopping and banking, remote control of home
  - ◆ Fun and pleasure, e.g., games, music, sports information
- Milestones in wireless networking aim at faster bit rates and wider service areas.

# Wireless Networking Generations

- A currently debated item is a 4G of wireless networks envisaged available in about a decade.
- The generation characteristics include:
  - ◆ **1G**: deployed in the 1980s was based on analog FM transmission technologies.
  - ◆ **2G**: introduced on market in 1991 applied digital technologies such as TDMA, GSM, cdmaOne. 2G systems offered higher capacity and lower costs for network operators as well as short messages and low-rate data services for users.

## Wireless Networking Generations [2]

- **“2.5G”**: introduced ability to use packet switched (vs circuit switched) radio connections over the air. For GSM systems, this is the General Packet Radio Service (GPRS). GPRS offers users the opportunity to always be online but only be charged for data transferred.
- **3G**: achieves a maximum bit rate of 2 Mbps and offers packet-switched multimedia services (data, video, etc.) as well as circuit-switched voice services. GSM/TDMA operators can evolve towards EDGE or WCDMA with higher and variable bit rates and improved spectrum efficiency. cdmaOne operators can evolve to cdma2000.

# Wireless Networking Generations [3]

- **4G:** Expected to build upon 3G and evolved 3G systems.
- Scenarios to consider:
  - ◆ *Anything Goes:* possibility of cheap co-existing products from the telecommunication companies
  - ◆ *Big Brother:* personal integrity and privacy as more personal information is readily available online
  - ◆ *Pocket Computing:* reduction of the digital divide with everyone having the opportunity for some level of computing.

# Working Assumptions for 4G

- *Telepresence*: applications that create virtual meetings between individuals and provide full stimulation of all senses required to provide the illusion of actually being somewhere else.
- *Information anywhere, anytime*: virtually seamless connection to a wide range of information services.
- *Intermachine communication*: e.g. the cooker informing the fuel station that it is out of gas.
- *Security*: data integrity and protection against unauthorized access for reliable banking, electronic payment, and handling of personal information.

# Working Assumptions for 4G [2]

- *One-stop shopping*: for all hardware and software needs.
- *Non-homogenous infrastructure*: digital-based transparent/seamless internetworking.
- *Mixed public and private access*: variable quality and bandwidth available e.g. urban vs. rural, home vs. office.
- *Ad-hoc, unlicensed operation*: for ready/spontaneous deployment and self-planning in designated unlicensed bands (5, 60 GHz bands).

# Working Assumptions for 4G [3]

- *Multimode access ports*: available in public systems to accommodate a wide range of terminals.
- *Terminals with a wide range of bandwidths*: from less than 10 Kbps (simple appliances) to 100 Mbps (telepresence terminals).

# Wireless Transmission Characteristics

- *Transmission bit rate*: The 3G system achieves at most 2 Mbps which may decrease in vehicular-speed environments. For 4G systems, more than 30 Mbps should be available in indoor/pedestrian environment dropping to 20 Mbps in vehicular environments.
- *Spectrum*: Significant frequency resources will be required - likely beyond 3 GHz since lower frequency bands are already heavily utilized. For example, the satellite Ka-band of 30/20 GHz.

## Wireless Transmission Characteristics [2]

- *Coverage area*: similar to 2G coverage area of approximately 100% of populated areas. But 4G systems will experience significantly higher propagation losses.
- *Hierarchical service areas*: Intermediary terminals/systems will be required as it may be difficult for small devices to be directly connected to the 4G system due to power consumption and antenna size.

# Conclusion

- New generations of wireless networking (terrestrial wireless [cellular] or satellite) will result in higher rate integrated communications.
- The complexity of the management of network resources (e.g. bandwidth, power, capacity) will be significant with increasing generation or evolution.

# References

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