Wireless Research and Technologies

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❖Some Historical Milestones

- 1979-81: Trellis coded modulation
- 1984: CDMA multi-user detection
- 1989: Cellular CDMA
- 1993: Turbo coding, iterative receivers
- 1995-98: MIMO, space-time coding, BLAST
- What is next ???

❖ $$$$ Research Funding – University Perspective

- 1990s: Industrial and government research funding was plentiful.
- 2000: The Millennium crash …
  - Industrial research funding in Telecom in sharp decline.
  - Government research funding continues in some countries, USA
- 2001: The War on Terror and the Iraq War …
  - NSF funding is cut.
  - US citizenship requirement placed on DARPA funding.
  - US government funding shifted to Department of Defense, Homeland Security and Department of Energy.
- Today: Lean and Focused …
  - Industrial research funding is recovered, but not to pre-2000 levels.
- Future:
  - Biotechnologies
  - Transportation
  - Homeland security and defense related programs

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❖3G & 4G Cellular Technologies

- 3G operators are heavily invested in new UMTS, cdma2000 infrastructures.
  - January 2006: 170 3G systems deployed with 250M subscribers.
- LTE: OFDM considered "revolutionary" by some 3G operators.
  - Develop 4G (OFDM) in parallel with optimized 3G (CDMA).
- Optimized HSDPA (HSPA+) is "evolutionary"
  - Achieve the data rates of LTE in 5 MHz with HSPA+
    - Receiver diversity
    - Equalization and Interference cancellation
    - MIMO
    - High-order signal constellations
  - Video broadcast on HSPA carriers.

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❖IEEE802 family of standards

- IEEE801.11b/a/g is a success
  - Integrate with 3G cellular for true simultaneous network participation
    - Power drain due to WLAN searching.
    - Fast WLAN-to-cellular handoff.
  - IEEE801.11n has excellent near term potential
    - MIMO for 2x54Mb/s
- IEEE802.16 sees slow or no deployment
  - Competing solutions
    - ADSL, Satellite, Cable, 3G cellular (HSDPA, cdma2000 EV-DO), Licensed proprietary systems, Power line communications.
- IEEE802.15 sees moderate success
  - Bluetooth widely deployed, but slow start (1994→)
  - Ultra Wideband – Fullerton (Time Domain Systems) 1989 patent.
    - The HYPE: you can get gigabits anywhere and everywhere!!
    - The REALITY: but only over very short distances (<5m)

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❖ Cognitive radio (IEEE802.22)

- Private licensed spectrum: Nobody can use MY spectrum!
  - Cognitive radio very difficult to deploy in private licensed bands.
- Public licensed spectrum: commercial TV gets spectrum for free!
  - Cognitive radio
    - Overlay services on commercial TV bands (occupied by DTV and wireless microphones)
    - IEEE 802.16e is a likely candidate.
  - Challenges:
    - Fast and accurate detection of incumbent signals.
    - Emission limits (broadcasters are a powerful lobby).
    - Poor coverage in dense metro areas.

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❖Vehicular Technologies

- Dedicated short range communications (DSRC)
  - Vehicle-to-vehicle and vehicle-to-roadside communications
- 3G Cellular
  - Advanced traveler information systems (ITS)
  - Transportation control and cellular networks can be symbiotic
    - Position, speed, moving direction are useful for both.
    - Cross optimization of transportation and cellular systems.