Universal Radio: Making new spectrum! (sort of)

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Radio Spectrum: A precious resource

- Governments sell it
- Allocation is now a huge international issue
  - WRC 2003
- Licensed spectrum predominates
  - But purchasing it is risky
  - Always a fight between commercial, civil, military
- Unlicensed is attractive to commercial
  - Small barrier to entry into market
  - Poses large interference problem

So nobody wants to pay for it, but everybody wants the reliability offered by clear spectrum!

How do you share spectrum?

- Power
- Frequency
- Time
- Code
- Space

The goal? To make every transmission from A to B reliable

We have made some advances….

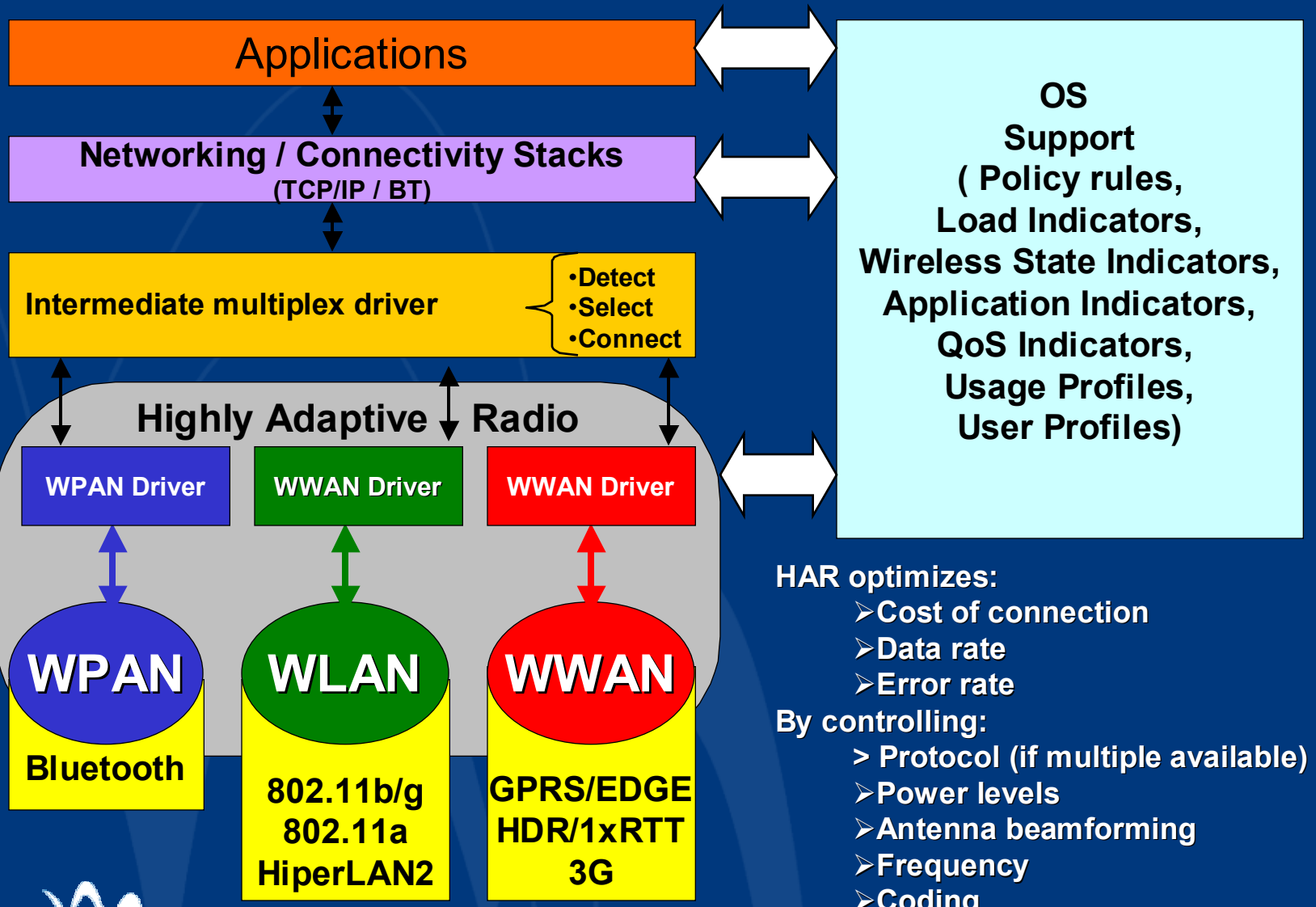
- UWB?
  - Maybe it's not really an advance – it's Marconi's spark gap generator!
  - Radical change in regulatory policies required
- OFDM
  - Currently the favorite for emerging WLAN/WWAN systems
  - Works well with long delay spread
  - Combined with QAM, gets high data rates with good spectral efficiency
- Shannon always gets in the way….

Moore's Law doesn't apply to spectrum!!

The Highly Adaptive Radio (HAR)

- Combines
  - Multiple standards (WPAN/WLAN/WWAN)
  - Power control (closed loop)
  - Smart antennas (SDMA)
  - Coding (FEC + CDMA)
  - Frequency adaptation (FDMA + DFS)
  - Time coordination (TDMA)

HAR in a current environment



HAR optimizes:

- Cost of connection
- Data rate
- Error rate

By controlling:

- Protocol (if multiple available)
- Power levels
- Antenna beamforming
- Frequency
- Coding
- Timing

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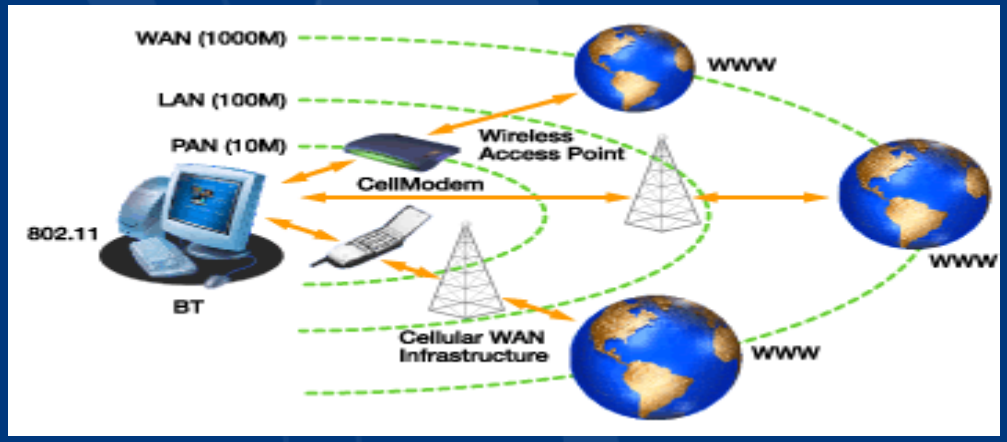
Technologies needed for HAR

- Software defined radio
  - Adapts protocol, modulation, and packets
- Smart antennas – cheap
- Research in optimization of link quality management
  - Optimize data rate and quality of service (delay and/or latency) under the constraints of:
    - Packet size
    - Coding
    - Modulation
    - Eb/N0
    - Antenna beamwidth

Example

- Device scans environment (DETECT phase)
  - Could be WPAN, WLAN, WWAN
- Makes decision about wireless system to use based on policy (SELECT phase)
  - One policy: always use highest speed untariffed
  - Another: Prefer WLAN, then WPAN, then WWAN
- Use all tools available to establish robust link (CONNECT phase)
  - Use smart antenna to form beam to tower/AP
  - Use minimum power to maintain BER/FER/QoS
  - Change data rate/FEC to maintain BER/FER/QoS
  - Adaptive coding (if possible)
  - Vary packet size to suit interference/QoS needs
  - Best available channel selection (AFH/DFS/spectral shaping)



Summary

- Users don't care about radio – they want information
  - The layers below the application should deliver the information in the "best way possible" that meets bandwidth and QoS requirements
  - Users don't care about alphabet soup…they only see applications
- Spectrum is a precious resource
  - Not being managed as well as it could be
  - Much smarter radios can manage the spectrum better and deliver better service
    - Relaxed regulations allow better "micro" area wireless service while providing lower "macro" area interference

"Real estate" management means "zoning" + consumer focus

For more info:

Detailed white papers at:
www.mobilian.com/whitepaper_frame.htm

Other information available at:
www.bluetooth.com
www.wi-fi.org

End