Presentation Credits

- Professor Andrea Goldsmith,Stanford University,USA

NOTE

- Read from the Chapter 1 of Wireless Communication Book by Andrea Goldsmith to refer for this topic in detail
- This presentation covers few diagrams and points not included there.

Advantages of Wireless

- Constant connection
- Access to up-to-date information
- Minimum installation issues
- Freedom to roam/move
- Scalability
- No cables
- Extensibility e.g remote areas with satellite

Disadvantages of Wireless-Technical Issues

- Radio Spectrum-Scarce Resource
- Nature of Wireless Channel
- Security and Safety
- Spectrum regulation and licensing
- Design of wireless terminals

Disadvantages of Wireless-Technical Issues

- Planning of network design
- Fair/Efficient allocation of resources
- Poor data rates
- Cost (domain dependant)

Why is Wireless different than Wired?

- Noisy, time-varying channel
  - BER varies by orders of magnitude
  - Enviromental conditions affect transmission
- Shared medium
  - Other users create interference
  - Must develop ways to share the channel
- Bandwidth is limited
  - FCC determines the frequency allocation
  - ISM band for unlicensed spectrum (902-928 MHz, 2.4-2.5 GHz, 5.725-5.875 GHz)
- Requires intelligent signal processing and communications to make efficient use of limited bandwidth in error-prone environment

Design Challenges

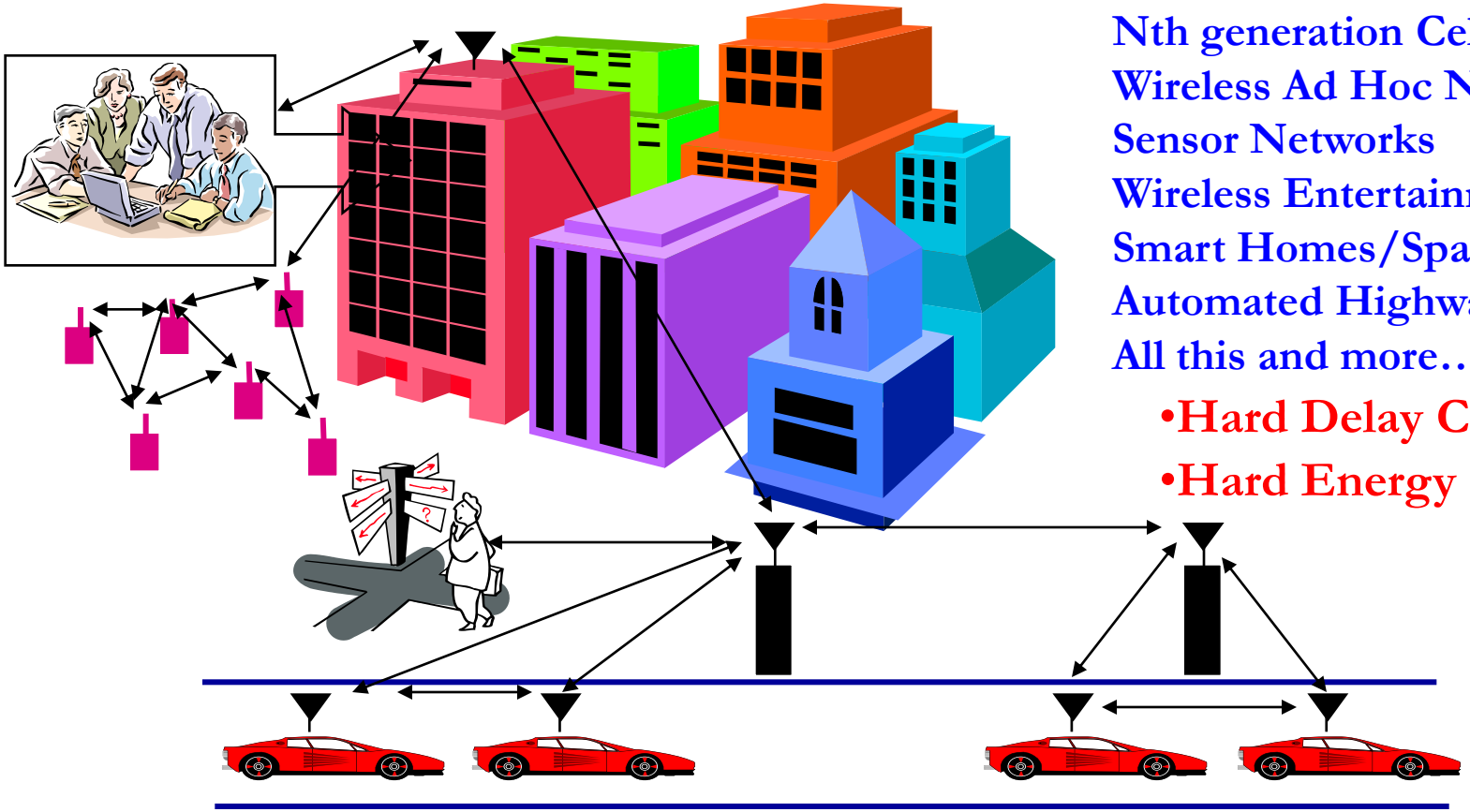
- Wireless channels are a difficult and capacity-limited broadcast communications medium
- Traffic patterns, user locations, and network conditions are constantly changing
- Applications are heterogeneous with hard constraints that must be met by the network
- Energy and delay constraints change design principles across all layers of the protocol stack

Quality-of-Service (QoS)

- QoS refers to the requirements associated with a given application, typically rate and delay requirements.
- It is hard to make a one-size-fits all network that supports requirements of different applications.
- QoS for all applications requires a cross-layer design approach.

Future Wireless Networks

Ubiquitous Communication Among People and Devices



Wireless Internet access
Nth generation Cellular
Wireless Ad Hoc Networks
Sensor Networks
Wireless Entertainment
Smart Homes/Spaces
Automated Highways
All this and more…

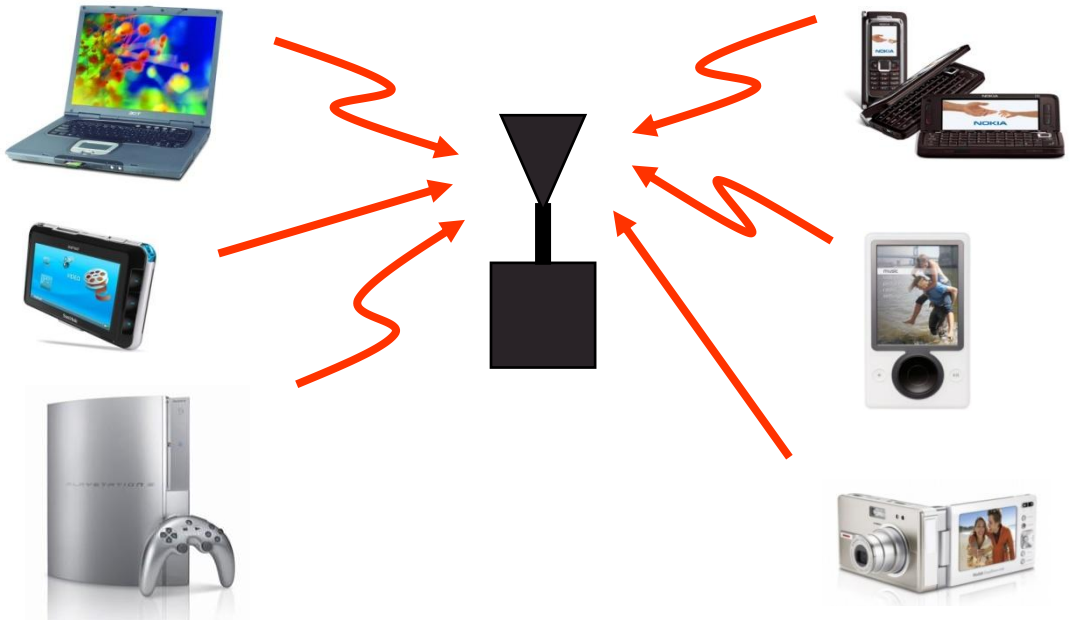
- Hard Delay Constraints
- Hard Energy Constraints

Multimedia Requirements

	Voice	Data	Video
Delay	<100ms	-	<100ms
Packet Loss	<1%	0	<1%
BER	10^{-3}	10^{-6}	10^{-6}
Data Rate	8-32 Kbps	1-100 Mbps	1-20 Mbps
Traffic	Continuous	Bursty	Continuous

One-size-fits-all protocols and design do not work well

Coexistence Challenge:
Many devices use the same radio band



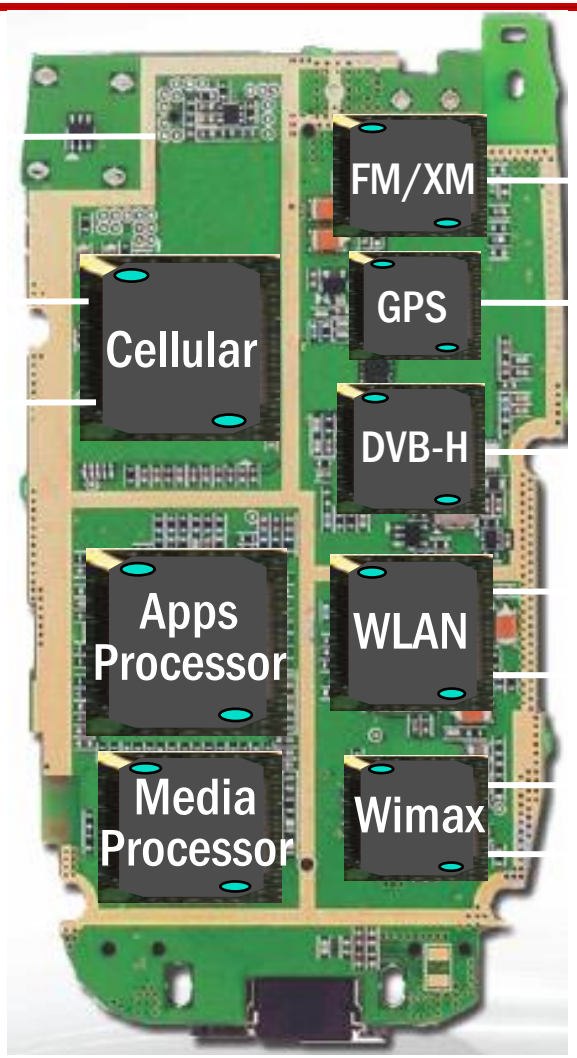
- Technical Solutions:
  - Interference Cancellation
  - Smart/Cognitive Radios

Next-Generation Devices

Everything Wireless in One Device

Multiradio Integration Challenges

- RF Interference
- Where to put antennas
- Size
- Power Consumption

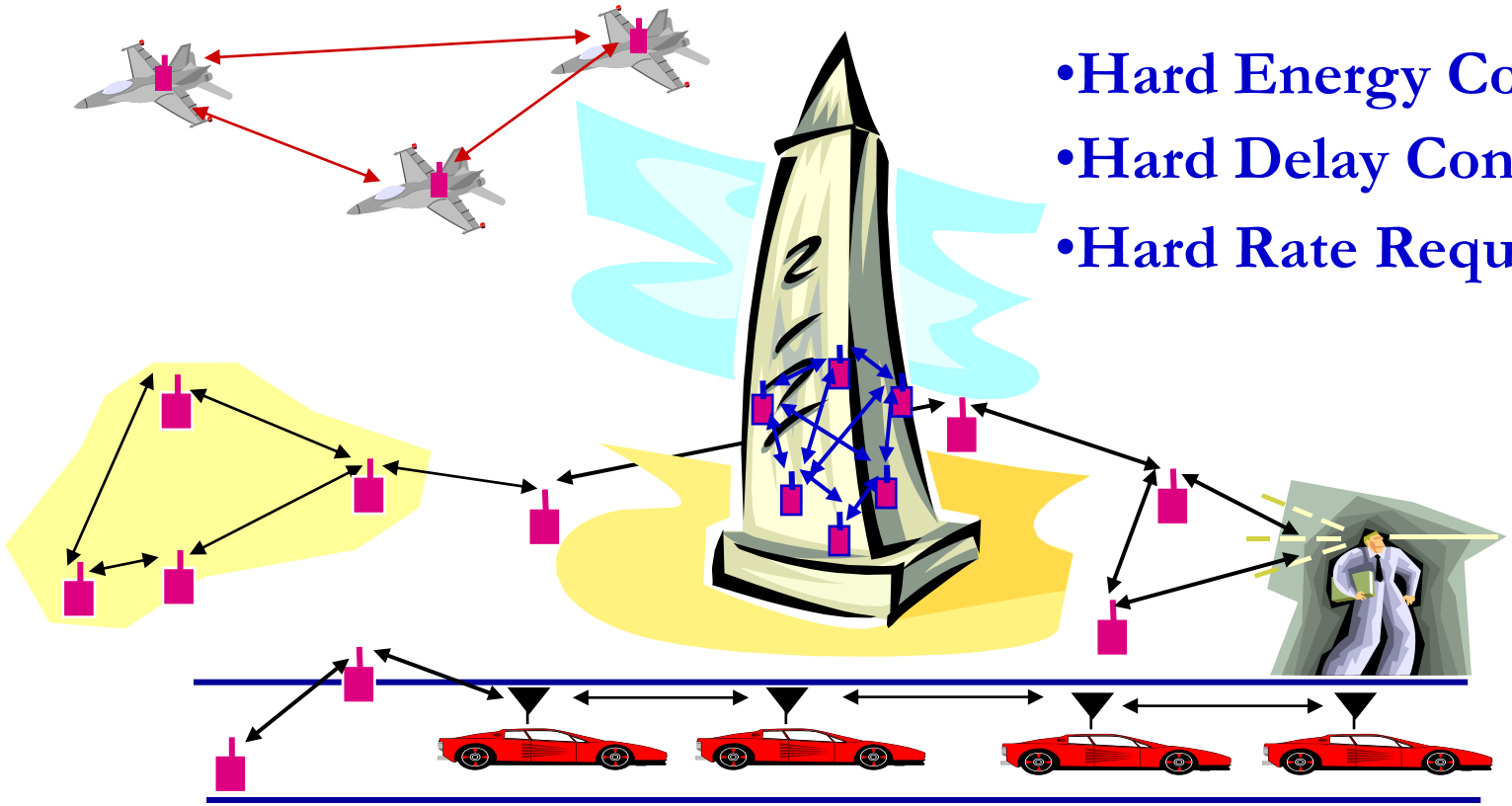


Ad-Hoc/Mesh Networks Design Issues

- Ad-hoc networks provide a flexible network infrastructure for many emerging applications.
- The capacity of such networks is generally unknown.
- Transmission, access, and routing strategies for ad-hoc networks are generally ad-hoc.
- Crosslayer design critical and very challenging.
- Energy constraints impose interesting design tradeoffs for communication and networking.

Wireless Sensor Networks

Data Collection and Distributed Control



- Hard Energy Constraints
- Hard Delay Constraints
- Hard Rate Requirements

Nodes can cooperate in transmission, reception, compression, and signal processing.

Cross layer design

- The use of mobile phones is shifting its focus from voice-only applications to multimedia streaming, Internet browsing, file downloading, etc. The network protocols use the layered structure known from the open systems interconnection (OSI) model. This layered structure facilitates development of protocol components by abstraction such that a particular layer only has to concern itself with the interfaces to the layer above it and the layer below it. It also means that a particular layer only has to communicate with the corresponding layer at the other end of the link/network

Cross layer design

- The existing layered network protocols were mainly developed for cabled networks and work very well with these. However, the wireless medium has very different properties in terms of for example channel fading and interference. We expect that cross-layer design will provide several benefits in optimization of network protocols for wireless access. Cross-layer design is an important part in relation to flexibility and adaptivity of the network protocol stack.

Cross layer design

- Cross-layer design is a means by which one can get specific knowledge across the protocol stack between separate layers.
- Cross-layer design allows exploiting flexibility in the protocol stack by using it to enable adaptivity - controlling specific features jointly across multiple protocols and layers.
- Cross-layer design extends the layered protocol by alteration of interfaces compared to the traditional architecture and it extends the architecture by communicating between non-adjacent layers.
- From a layered architecture point of view, cross-layer means enabling new interactions between non-adjacent layers and exchanging information and control between layers that was not possible in the original architecture.

Cross Layer design

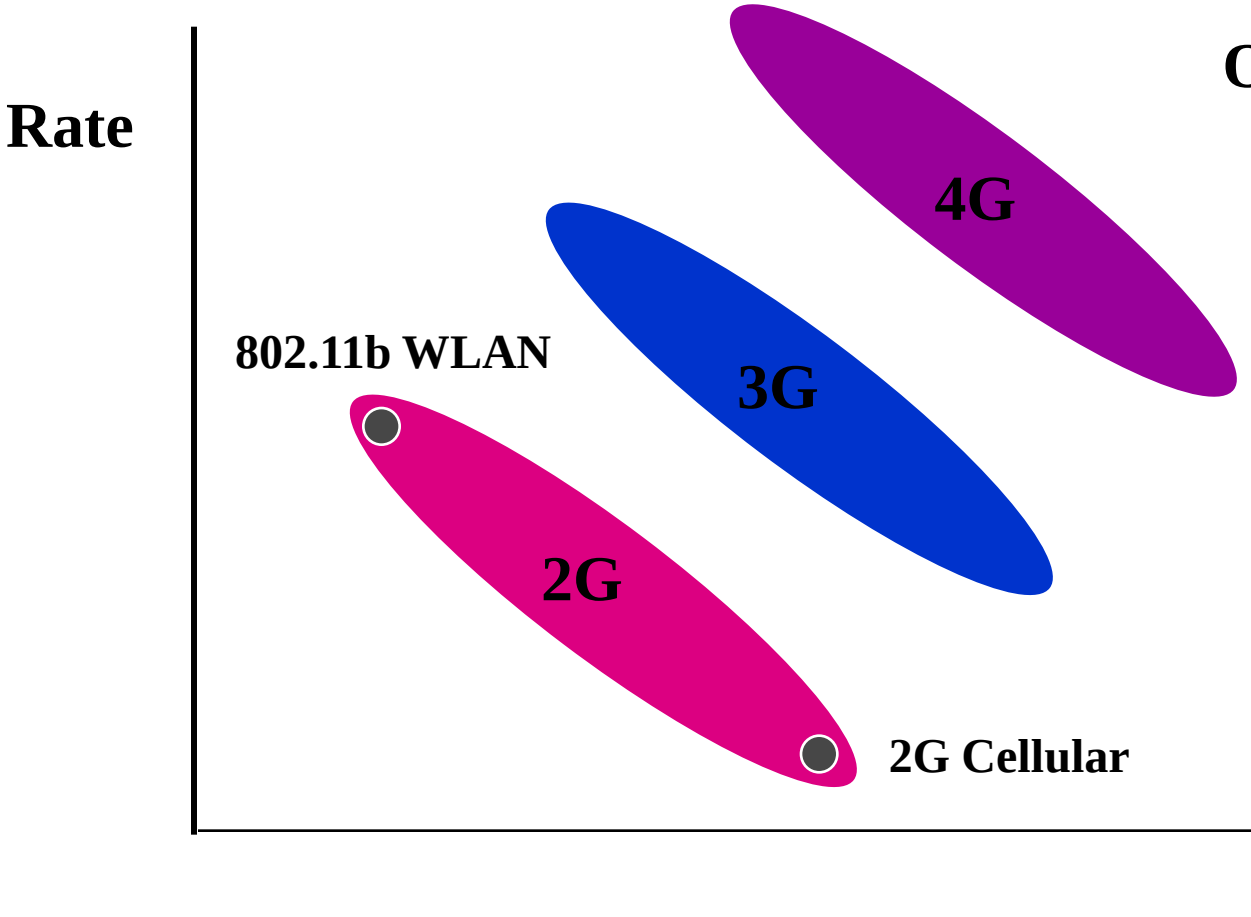
- This makes it possible to optimize the operation of the protocol stack in a joint manner taking aspects of multiple layers into account.

Crosslayer Design

- Application
- Network
- Access
- Link
- Hardware

Delay Constraints
Rate Constraints
Energy Constraints

Future Generations



Other Tradeoffs:

- **Rate vs. Coverage**
- **Rate vs. Delay**
- **Rate vs. Cost**
- **Rate vs. Energy**

Fundamental Design Breakthroughs Needed