From Standard WLAN's to Wireless ATM

Technology for Multimedia Communications

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Outline

- What is a “standard WLAN”?
- Performance goals and expectations
- Architectures and applications
  - from LAN to Multimedia and Wireless ATM
- Market perspective
- Regulatory issues - unlicensed spectrum in US and Europe
- Products and technology demonstrators - proprietary solutions, standards initiatives and EC-sponsored projects
- HIPERLAN and 802.11
- Quality-of-Service concerns
- Propagation environment - power, attenuation and multipath
- Wireless ATM in the NII/SUPERNet band
- Simple Asynchronous Multiple Access as etiquette and protocol

What is a “standard WLAN”?

Infrared - history and IrDA (Infrared Data Association), laser links outdoors

- ISM - FCC Part 15 Spread spectrum 902-928; 2400-2483; 5725-5825
  - 1 watt, mandatory spreading
  - secondary use, must accept interference
  - Part 15.249 unrestricted for EIRP below .75 mW
  - “Garbage band” problems - rules practically unenforceable
  - need for robustness, survival
- WinData duplex ISM Ethernet 2.4 GHz and 5.7 GHz, wire replacement concepts rather than mobility
- 900 MHz WaveLAN from NCR, Proxim, Xircom and others
  2.4 GHz systems - proprietary as well as 802.11 1997?),
  advertised 2 Mbps for direct sequence or hopper or hybrid possible

What is a "standard WLAN"? (cont'd)

- "Narrow band" licensed and unlicensed
  - Motorola-Codex project, spectrum not allocated
  - Altair in 1990, wire replacement concepts rather than mobility,
  - Olivetti wireless LAN based on DECT
  - DECT branch formed in 1991 for wireless LAN leading to RES10, 5.150 GHz to 5.3 GHz, 17.1 to 17.3 GHz
- New unlicensed spectrum
  - WINForum for 2 GHz — UPCS
  - WINForum for 5 GHz — NII/SuperNet
  - mmWave Etiquette Group for 60 GHz

Performance goals and expectations

- Coexistence with wireline LANs - interfacing with competition
- Ethernet 802.3
  - 25 Mbps ATM
  - 30 Mbps cable (asymmetric?)
  - 100 Mbps
  - Gigabit movement
- Sidelined wired LANs
- Data rate
  - ISM
  - narrowband
- Wireless ATM
  - RES10 talks about 50,000 ATM cells per second

Architectures and applications -

from LAN to Multimedia and Wireless ATM

- Packet radio, half-duplex (TDD),
- Hand-over and forwarding (HIPERLAN)
- Perceived cost of infrastructure
- Centralized control (“access point”)
  - Altair, IEEE 802.11 (BSS)
- Peer-to-peer
  - WaveLAN, HIPERLAN (“Type 1”)
- Point-to-point, point-to-multipoint

Market perspective

- Hope for "horizontal"
  - Metricom (wide-area network)
- Limited "vertical" markets so far
  - computer maintenance (ARDIS - really a WAN) - ,
  - point of sale applications warehouses, fleet management
  - hence proprietary approaches are doing fine
- What limits commercial success so far?

  commonly advanced explanations:
  - price, range,
  - low speed,
  - limited functionality,
  - no "killer apps"

Market perspective - cont'd

- Conjectures on how the wireless LAN market will develop:
  - access to Internet
  - multimedia notebook computers
  - will PDAs take off?
  - returning motivation: cable replacement, this time for portables - Open Office
  - tetherless nomadicity rather than fully mobile multimegabit communications
- Expectations of the market:
  - plug-and-play for RF naive, misguided, ignorant or just oblivious users -
  - higher expectations in-building than outdoors
- Will there ever be the "year of the Wireless LAN"?
  - It will take a few years just as LAN networking

Regulatory issues

- World Radio Congress;
- Unlicensed spectrum in US and Europe;
- FCC and CEPT;
- coexistence with terrestrial microwave and satellite communications
- UPCS
  - for 1910-1930 one end needs to be tied - until microwave users are relocated, hence suitable only for wireless PBX or such
  - 2390 same spectrum etiquette as 1910-1920
  - coexistence for non-interoperable systems
- 5 GHz first chance for world-wide market

Products and technology demonstrators
- proprietary solutions, standards initiatives

- "Mature" products:
  - 900 ISM proprietary systems
  - 2400 ISM proprietary systems
  - Proxim initiative (open air interface as an alternative to 802.11)
- Standards-oriented developments
- European projects:
  - LAURA pre-HIPERLAN test bed
  - HIPERION feasibility of HIPERLAN
  - Magic Wand Wireless ATM
  - ACTS
  - MEDIAN

HIPERLAN

ETSI RES10, 5.15-5.3 GHz, 17.1-17.3 GHz

- Motivation: *faster is better*
- Process:
  - Transmission Techniques Group (TTG)
  - Control Techniques Group (CTG)
  - Consensus
- 5 channels in 5 GHz
  - 5176.468 MHz lowest center frequency
  - 23.5294 MHz separation
  - 10 ppm

HIPERLAN

equipment classes

Table 28: Permissible combinations of transmitter and receiver classes

	Transmitter class A (+ 10 dBm)	**Transmitter class B (+ 20 dBm)**	**Transmitter class C (+ 30 dBm)**
Receiver class A (- 50 dBm)	Permissible	Not permissible	Not permissible
Receiver class B (- 60 dBm)	Permissible	Permissible	Not permissible
Receiver class C (- 70 dBm)	Permissible	Permissible	Permissible
NOTE: The figures in parentheses indicate the nominal transmitted power (EIRPEP)or receiver sensitivity associated with each class.			

HIPERLAN

- Data burst structure
  - High-bit-rate training sequence (450 bits GMSK at 23,529 4 Mbps)
  - Low-bit-rate header (FSK at 1.4706 Mbps or 1:16)
  - High-bit-rate data (GMSK)
  - 47 or fewer blocks of 496 (416 net) bits per packet
- CSMA - Non-Pre-Emptive Priority Multiple Access (NPMA)
  - immediate access if sensed idle for 1700 bit times
  - channel access resolution otherwise
    - » prioritization
    - » elimination
    - » yield

HIPERLAN

- Quality-of-Service provisions
  - "Best effort" basis
  - Priority
  - Packet lifetime
- Uni-cast and multi-cast
- Path discovery and forwarding
- Power saving provisions
  - scheduling for *p-saver* and *p-supporter*
  - LBR header

IEEE 802.11

standard for 2400 to 2483.5 MHz (2471 to 2497 in Japan)

- Physical layer
  - Frequency hopper (FH) 79 hopping frequencies (23 in Japan)
  - Direct sequence (DS) processing gain of 11
  - Infrared (IR)
- SCMA/CA channel access
- Hopping pattern selection
  - sets of 26 hopping patterns
- Spreading signal
  - 11 center frequencies defined (US)

IEEE 802.11

- Power management
- Narrowband interferers
- Microwave ovens
- Quality-of-Service concept
  - Bandwidth guarantee
  - Data integrity
  - Delay
  - Delay variance
- Quality-of-Service provisions
  - Time-bounded services
  - Hidden-node effect mitigation

Quality-of-Service Concerns

- Data integrity
  - ARQ
  - FEC
- Time-bounded services
  - Real-time voice
  - Video
  - Audio
- Latency
- Latency variance
- Will “Standard WLAN’s” work?
  - Reservations re throughput with short packets
  - Long packet increase “jitter”

Propagation environment
power, attenuation and multipath

- Inverse relationship between distance and data rate
- Power constraints
- Antenna gain constraints- definitions
- Models of attenuation indoors
  - exponent 3 to 4
  - free space and walls
- Optical analogy increasingly applicable with higher frequencies

WATM for NII/SUPERNet
5.100-5.350 and 5.725-5.875 GHz

- Proposals from WINForum and Apple not restrictive
- Notice of Proposed Rule Making FCC 96-193 opens dialogue
- Spectrum sharing etiquette expectations:
  - enabling high QoS systems
  - flexibility for multi-media communications
- Need for alternatives to support Wireless ATM
  - ATM cell: *the byte of the 90's*
  - individual ATM cells
  - trains of ATM cells

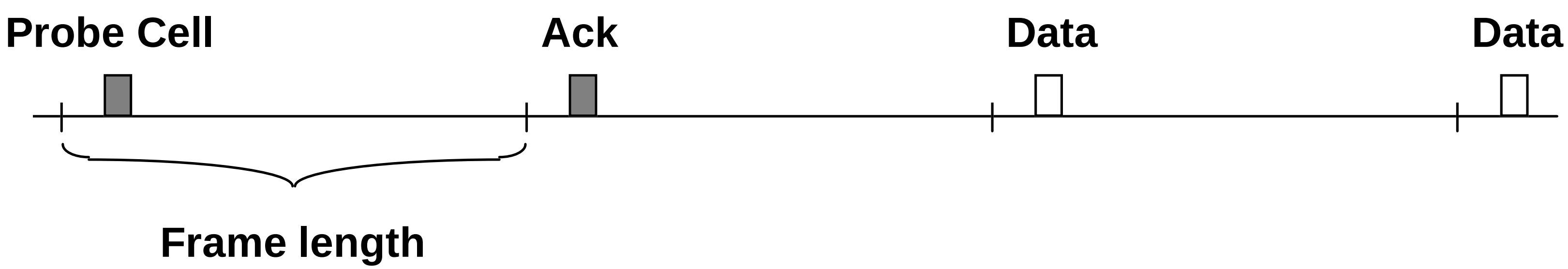
Assumptions

- A radio channel is most efficiently shared among users with CBR requirements.
- Over any sufficiently short period of time (*Tc*), any bandwidth requirement is CBR.
- The practical lower limit to *Tc* is the amount of time and overhead required to re-acquire bandwidth.
- Statistical multiplexing, within a multi-service device, increases *Tc*.
- Multi-Media devices will require protocols that support both infrastructure based (centrally controlled) and non-infrastructure based (ad-hoc) networks.

Desired Qualities

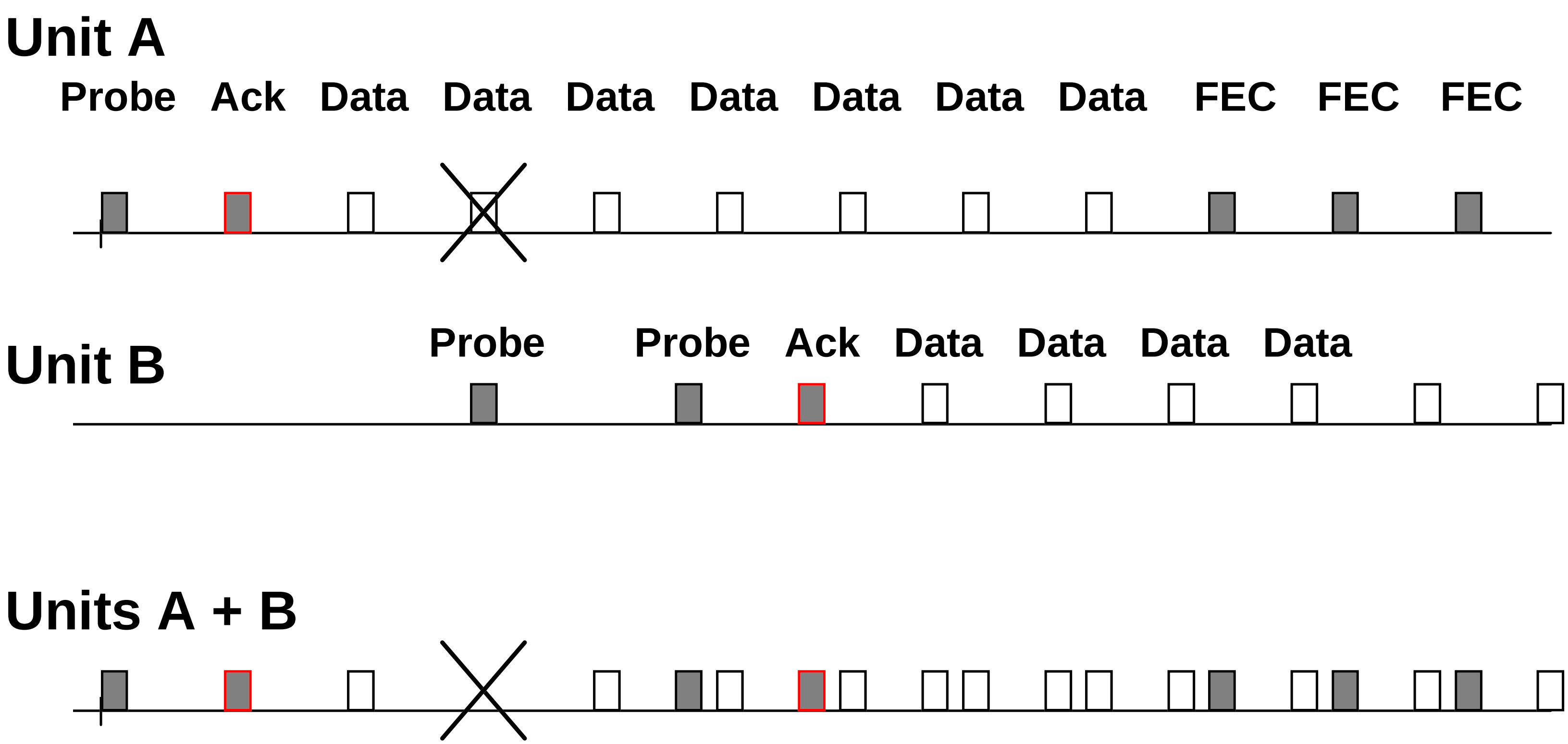
- Provide a simple bandwidth setup mechanism
- Support for devices with widely varying bit rates
- Reduce the number of “collisions”
- Support the development of both ad-hoc and centrally controlled protocols.

Simple Asynchronous Multiple Access (SAMA)

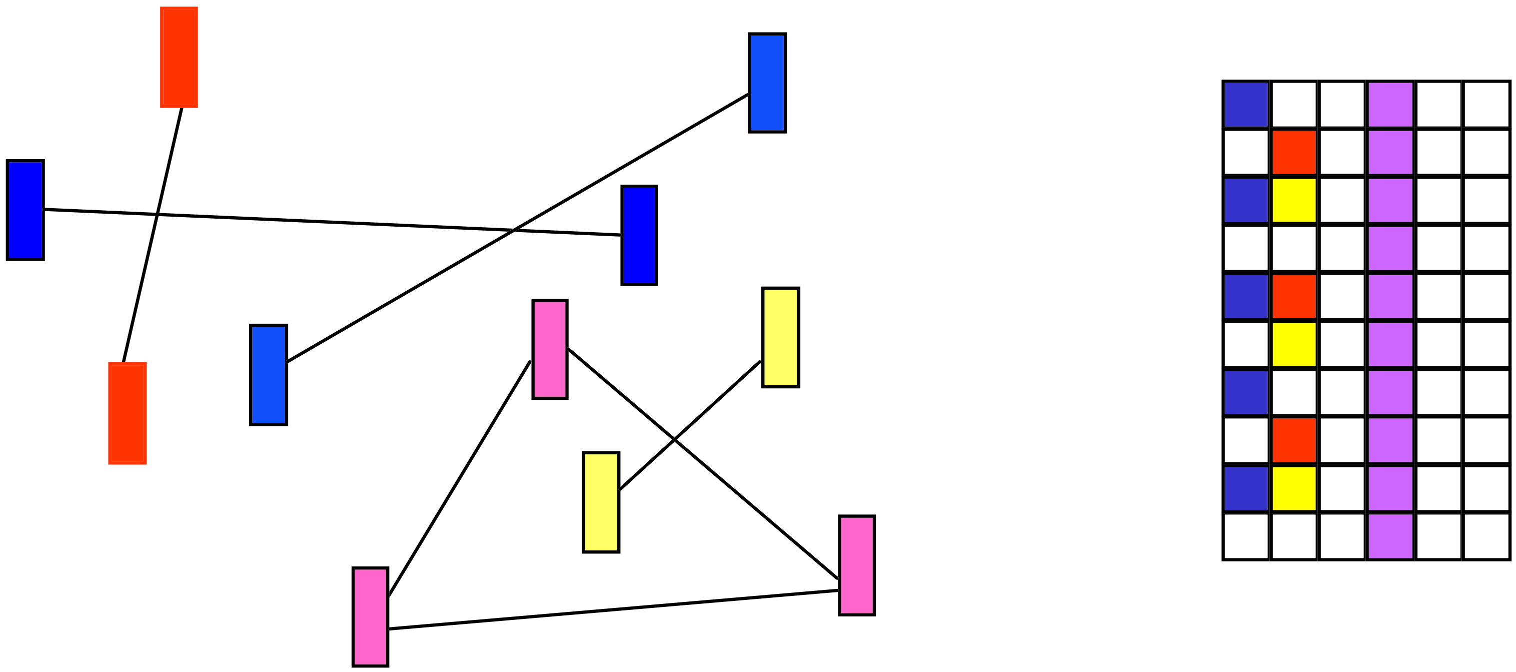


- There is no "bandwidth set up" phase.
- Every unit observes the same frame size.
- Each transmission burst is divided into cells of the same time duration.

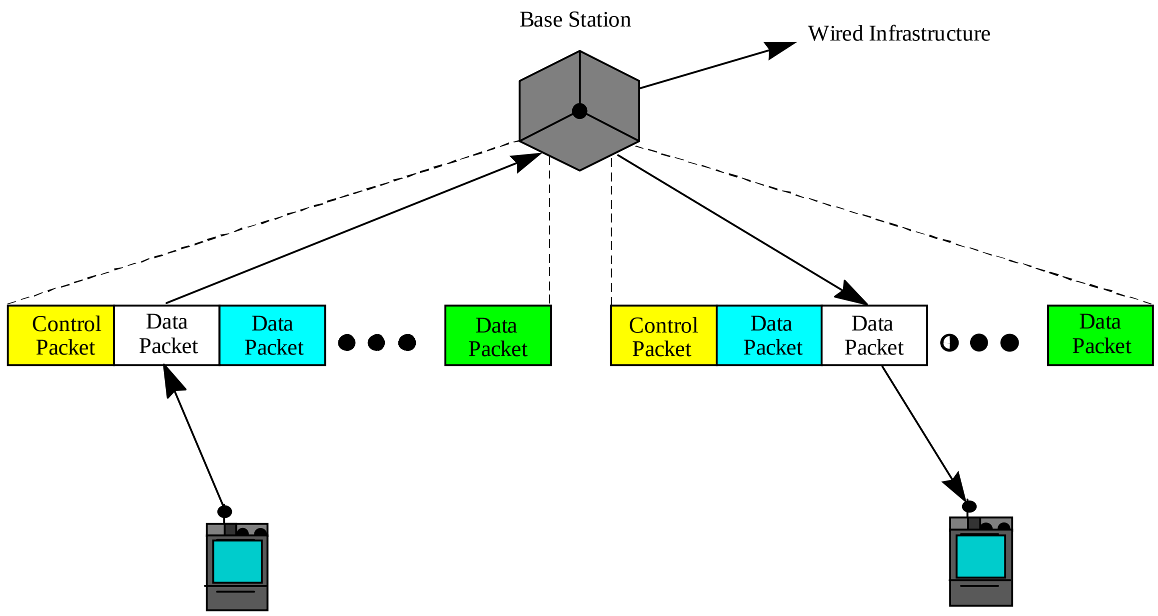
Probing for Channel Access

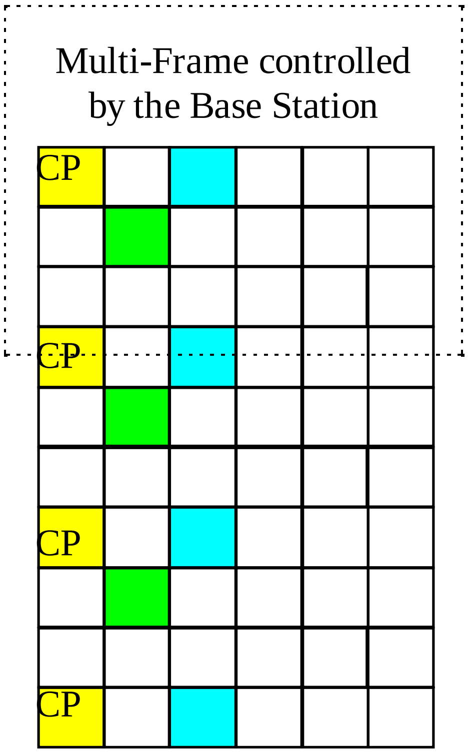


SAMA
Ad-Hoc Networking

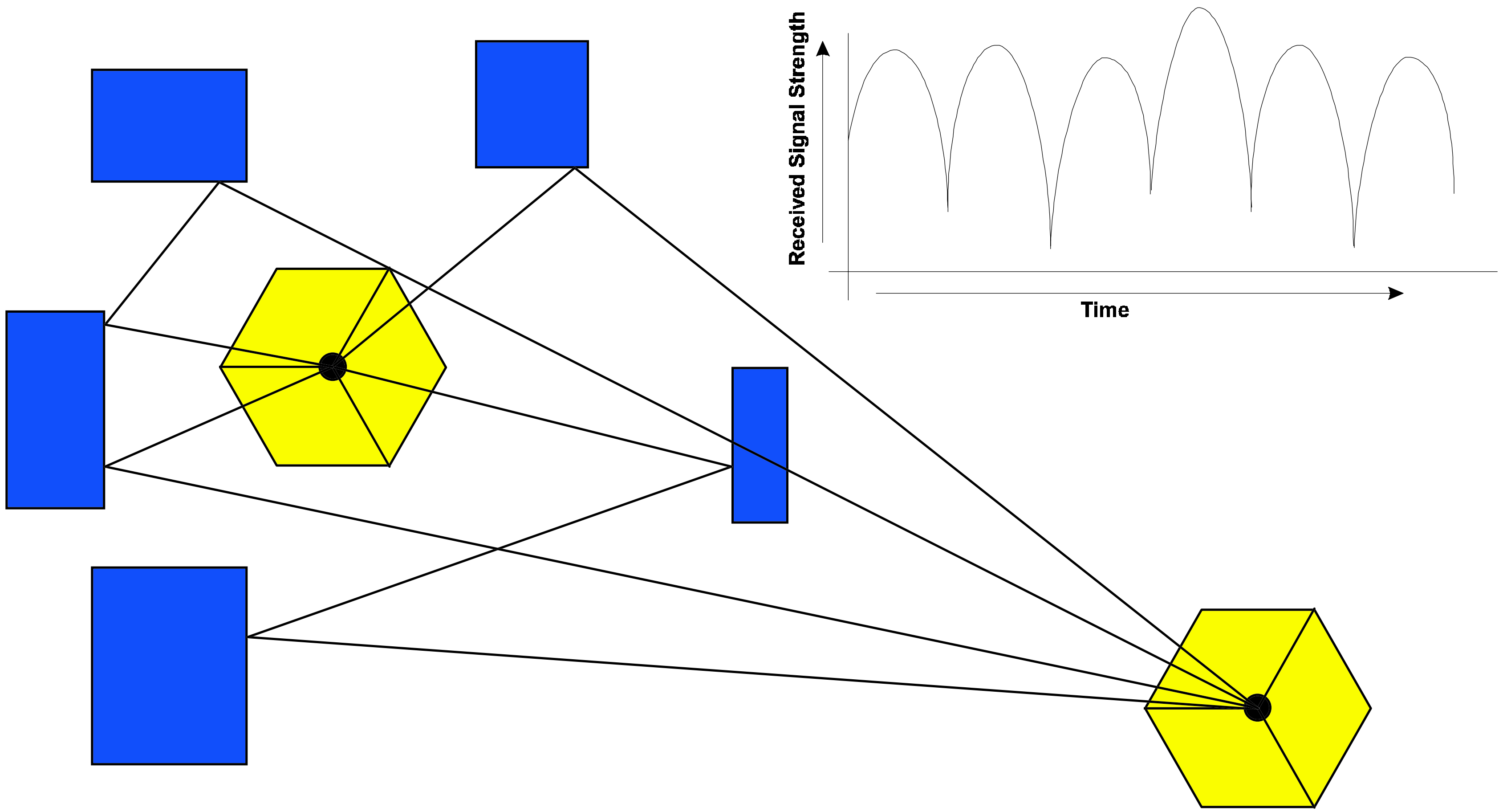


SAMA
Centrally Controlled Network

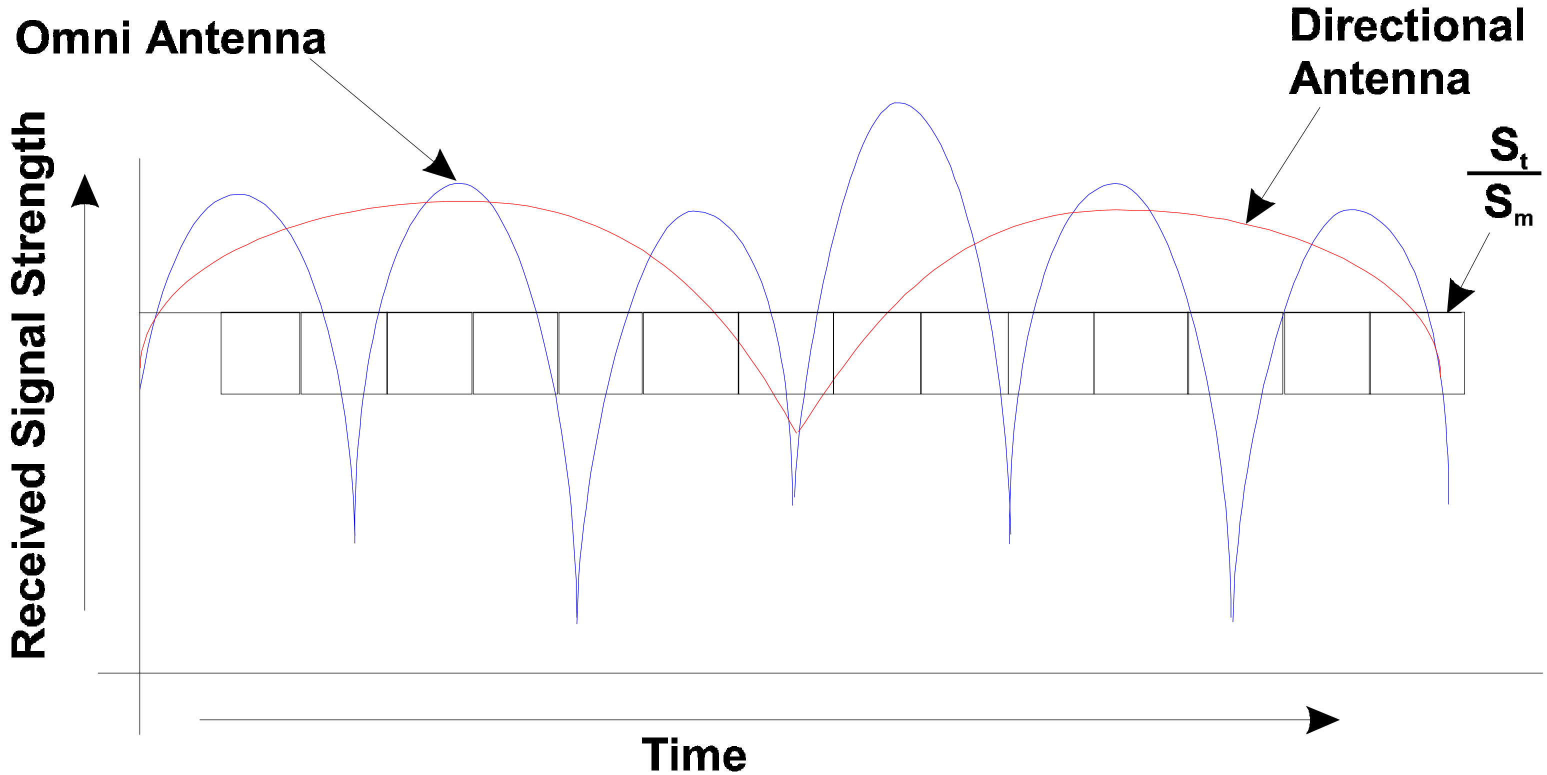




RF Fading Environment

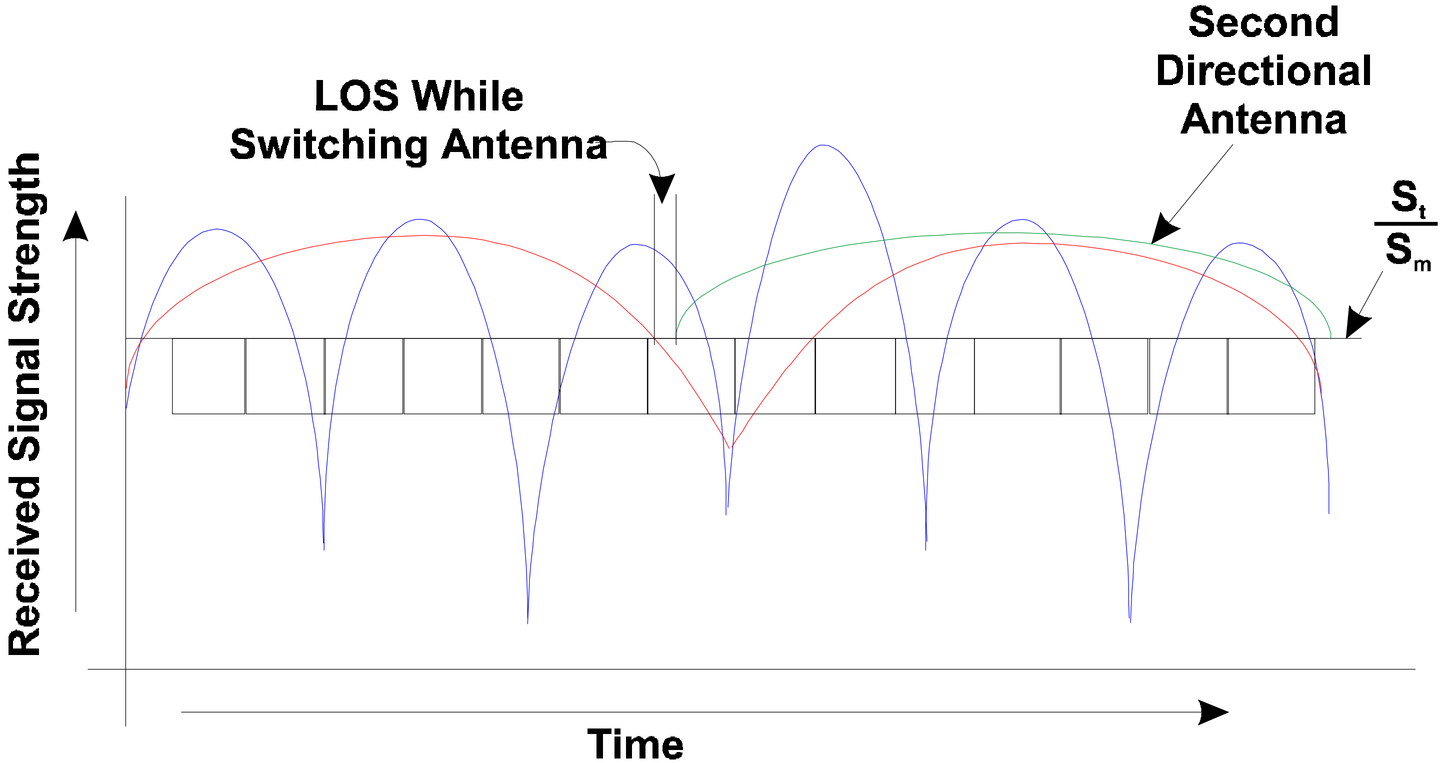


Fading Patterns
Omni vs. Directional Antenna

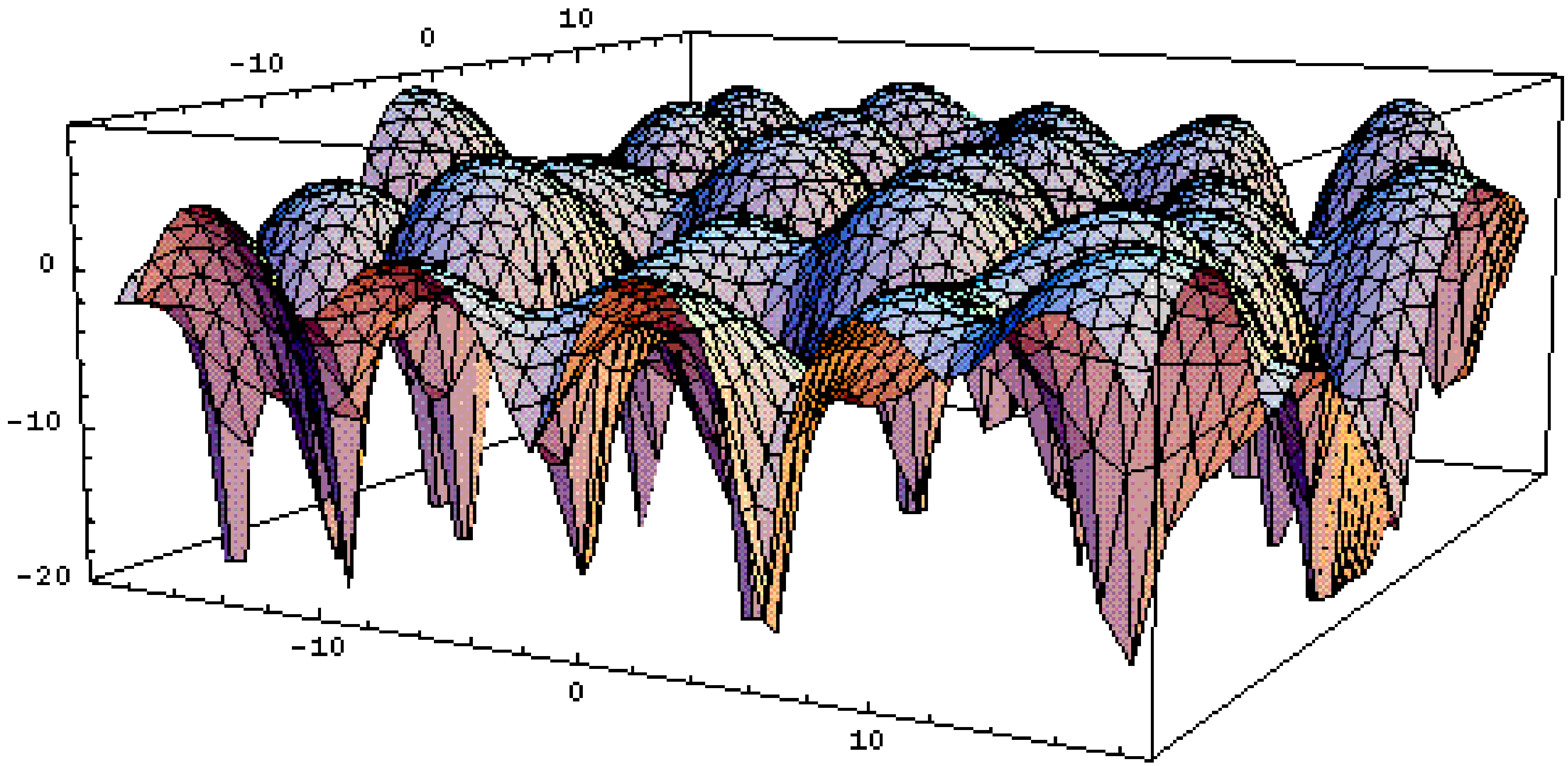


Effect of Switching Antenna on Fading

(Short packets will get through more often)



Omni Antenna
Received Signal Strength



Directional Antenna