A Multichannel Broadband Infrared Wireless LAN

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Talk Outline

- Motivation
- Reference Architecture
- Noise Mitigation
- Conclusions
Goals and Motivation

• Current WLANs operate at data rates below 54 Mb/s.
• Goal is to develop techniques that can be used to design a WLAN capable of delivering greater than 100 Mb/s to users.
• We take a systems approach to the problem and seek solutions at the lowest three network layers (Network, MAC, and Physical layers).
Steps Toward Broadband Performance

- Utilize bandwidth rich (> 75 THz) IR radiation as the transmission medium.
- Assume the existence of small, low-cost, tunable IR transceivers.
- Develop a Multichannel network architecture using tunable transceivers to realize the bandwidth potential of the IR medium in WLANs.
- Utilize this architectural framework to develop and evaluate techniques that enhance performance at various layers of the network.
Indoor IR Communications

- Photo detectors used as receiving antennas, LEDs and lasers as transmitters.
- Intensity mod/direct detection (IM/DD) used in transceivers.
- Major sources of background noise: sunlight, incandescent light, fluorescent light.
- Typical cell size 10 meters.
- Flickering of fluorescent lighting seen as modulation by DD receivers.
Reference Protocol Stack

NETWORK LAYER:
AdHoc Routing Protocol

DATA LINK LAYER:
WDMA Protocol

PHYSICAL LAYER:
Infrared

AODV

WLAN–MC/IEEE802.11

PPM
Key Motivations for Reference Architecture

- Wide WDM channels present no practical limitation on data rate available to users.
  - Limiting factor is interface components.

- N channel system operating at rate $R_b < R_{max}$ can provide aggregate performance close to that of single channel system operating at $R_{max}$.
  - Easier to implement system.

- Tunability can be used to reduce the effects of background noise relative to single channel system
  - select best channel at the receiver for data transmission.

- Ad-hoc topology helps mitigate shadowing problem by allowing nodes to bounce signals off neighbors.
WLAN-MC Multichannel MAC Protocol

REQUIRED OPTICAL HARDWARE

SOURCE—node

Fixed−tuned Receiver

λ0

CTS

λ0

DATA

λdata

Tunable Transmitter

λ1, λ2 ... λn

Tunable Receiver

DEST − node

Fixed−tuned Receiver

DATA

λ1, λ2 ... λn

Tunable Transmitter

DATA TRANSFER CYCLE

RTS

CTS

DATA

ACK

Ch0

Ch1

Ch2

Chn

Reference Architecture 7 September 28, 2001
WLAN-MC NODE PROCESSING

- Reservation packet contains: \textbf{ch2}, \textbf{dst}, length of transfer (L)
- Nodes maintain entries in busy tables for \textbf{ch}, \textbf{dst}
  - At start of cycle: $L + \alpha + \tau_{ACK}$ to \textbf{ch2} counter, L to \textbf{dst} counter. Where $\alpha$ represents max transceiver tuning time.
  - Both counters decremented periodically.
  - Both resources available when counters = 0.
Control Channel Characteristics

- IEEE802.11 for contention resolution.
- By design more robust than data channels.
- Available for next reservation after CTS transmitted.
- Possible to completely overlap transceiver tuning time depending on the ratio of $\alpha$ to $\tau_{CTS}$. 
Noise spectra with Atmospheric Absorption (sun)

- Shows nulls at 850, 1100, and 1380nm
Room Noise ratio 850nm/935nm
Conclusions

• An architecture has been developed which is expected to provide broadband performance in a wireless LAN environment.
  – shared control channel at $\lambda_0$
  – reservation data channels at $\lambda_1$ through $\lambda_{N-1}$

• Certain features of this architecture may be used to reduce the effects of background noise in an infrared LAN.

• More performance characterization, through simulation and analysis, is planned for the future.