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 performance degradation: multipath dispersion, shadowing, background noise.
- 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.

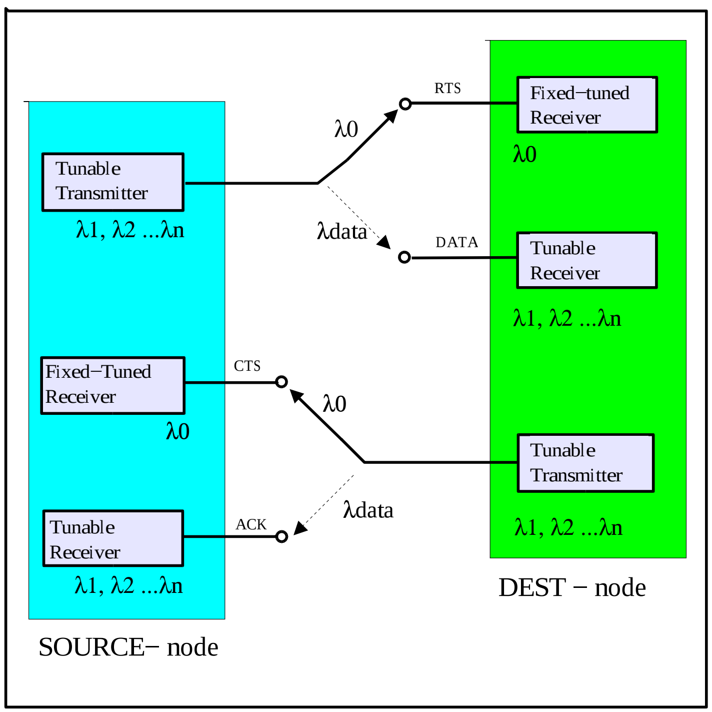
Reference Protocol Stack

NETWORK LAYER : AdHoc Routing Protocol	**AODV**
DATA LINK LAYER : WDMA Protocol	**WLAN−MC/IEEE802.11**
PHYSICAL LAYER : Infrared	**PPM**

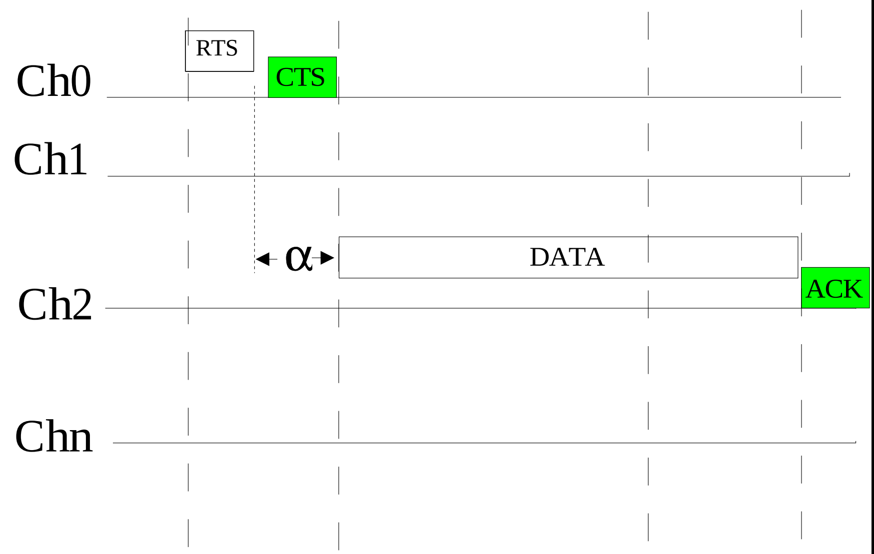
Key Motivations for Reference Architecture

- 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



DATA TRANSFER CYCLE

WLAN-MC NODE PROCESSING

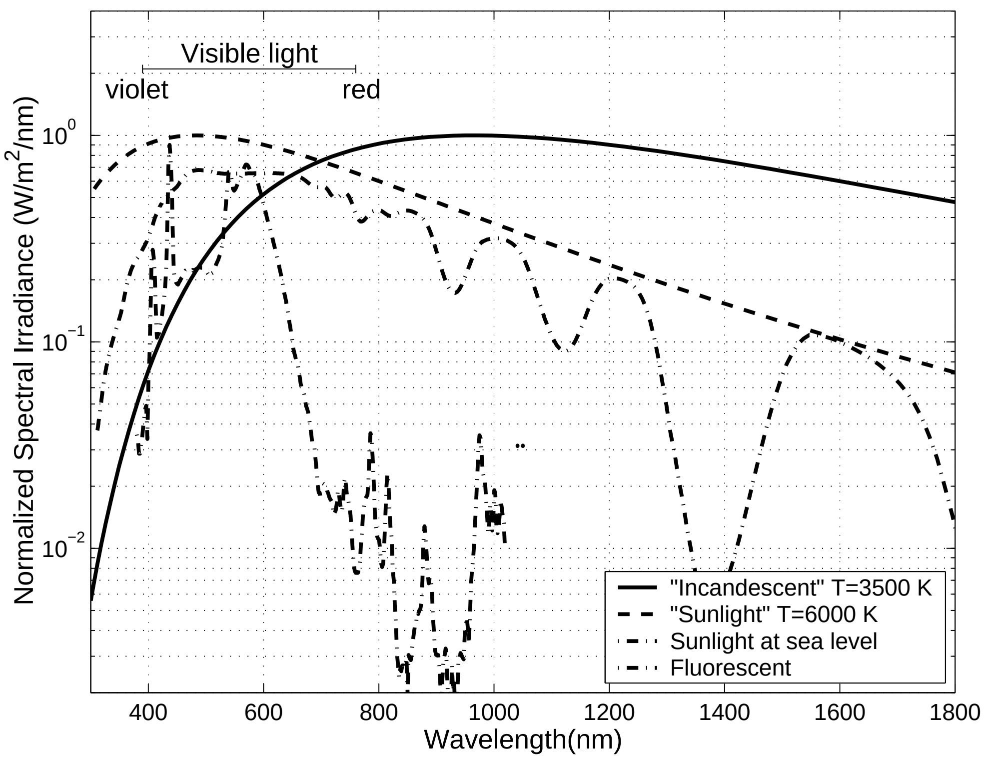
- Reservation packet contains: **ch2**, **dst**, length of transfer (L)
- Nodes maintain entries in busy tables for **ch**, **dst**
  - At start of cycle: $L + \alpha + \tau_{ACK}$ to **ch2** counter, L to **dst** counter. Where α represents max transceiver tuning time.
  - Both counters decremented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

Control Channel Characteristics

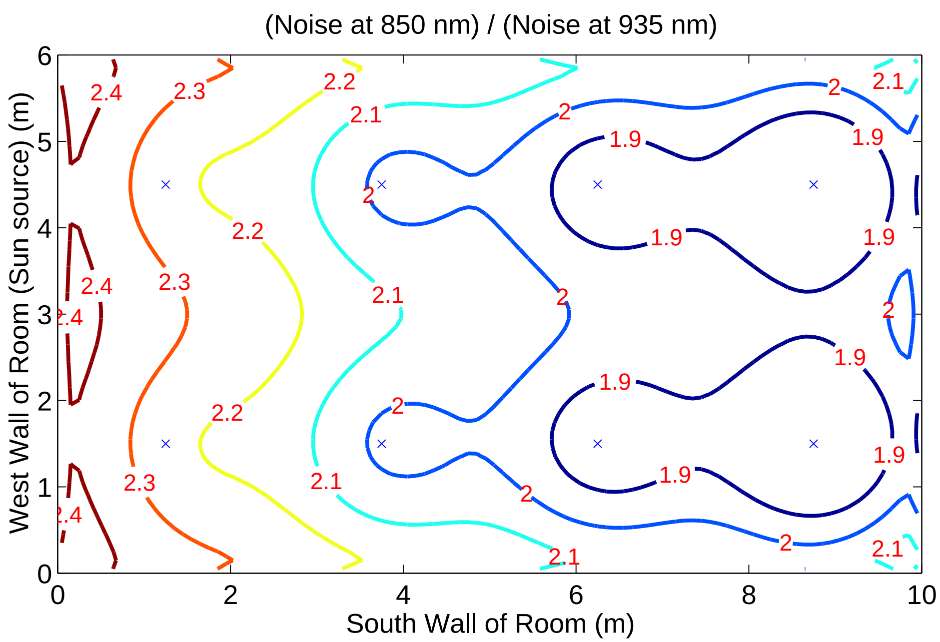
- IEEE802.11 for contention resolution.
- By design more robust than data channels.
- Available for next reservation after **CTS** transmitted.
- Possible to completely overlap transceiver tuning time depending on the ratio of α to τ_{CTS}.

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 λ_0
  - reservation data channels at λ_1 through λ_{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.