



Media Reliability Considerations

John S. Howard

Senior Architect

Intel Corporation



Agenda

- Problem Overview
- Transmit Power Control
- Transmit Bit Rate Adjustments
- Dynamic Adjustments to Packet Payloads
- Migrating to alternate PHY Channels



Problem Overview

- USB 2.0 packet error rate : 10^{-9}
 - Wire is pretty constant over time
- UWB packet error rate : $\sim 10^{-3}$
 - Varies, depending on conditions,... sometimes much higher, sometimes, much lower
- Wireless is not as reliable as a Wire
 - Losses will occur
- Hosts need different “Tools” to mitigate poor channel condition
 - The ‘right’ tool, depends on the interference



Problem Overview (cont.)

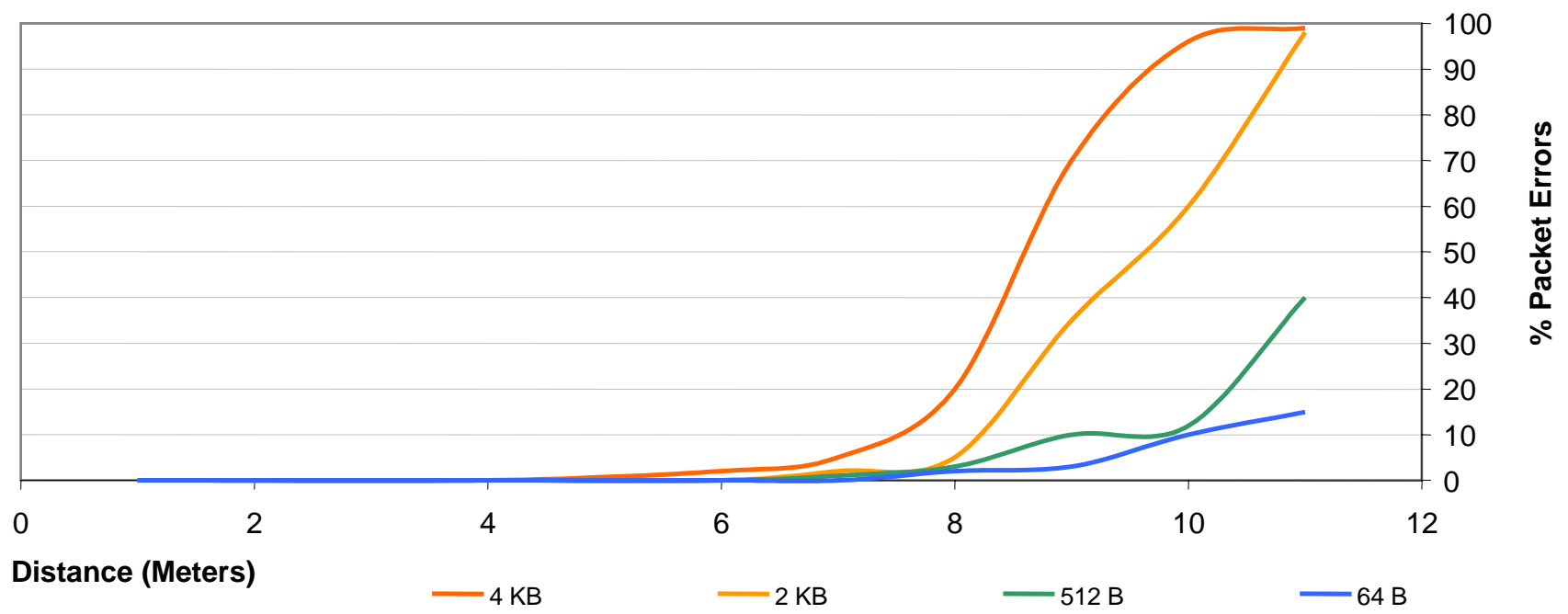
- Example Tools:
 - Decreasing packet payloads may decrease PER and increase throughput in some situations
 - Decreasing the Transmit Bit Rate (increasing the encoding) may decrease PER
 - Etc.

Problem Overview (cont.)



- Example effect of Distance on Packet Error Rate

% Packet Errors vs Distance



Transmit Power Control

TPC Overview



- A host can make TPC level adjustments for device transmissions on the WUSB channel and for directed packet transmissions
 - These adjustments don't effect other applications that may be implemented on the device
- WUSB Host TPC level controls provided for:
 - Device level management
 - Transaction level management
- WUSB Host will use lowest TPC level required to sustain acceptable PER for data stream
 - Best Neighbor behavior; allows better spatial re-use



Transmit Power Control

TPC Overview (Nominal Levels)

- Nominal Power Levels & Accuracy Requirements

 Required Support

Power Control Setting	TFI Channel Power Level		FFI Channel Power Level	
	Nominal values	Accuracy requirement	Nominal values	Accuracy requirement
0	TFI_BASE	TFI_BASE	FFI_BASE	FFI_BASE
1	TFI_BASE - 2 dB	TFI_BASE - (1 to 3) dB	FFI_BASE - 2 dB	FFI_BASE - (1 to 3) dB
2	TFI_BASE - 4 dB	TFI_BASE - (3 to 5) dB	FFI_BASE - 4 dB	FFI_BASE - (3 to 5) dB
3	TFI_BASE - 6 dB	TFI_BASE - (4.8 to 7.2) dB	FFI_BASE - 6 dB	FFI_BASE - (4.8 to 7.2) dB
4	TFI_BASE - 8 dB	TFI_BASE - (6.4 to 9.6) dB	FFI_BASE - 8 dB	FFI_BASE - (6.4 to 9.6) dB
5	TFI_BASE - 10 dB	TFI_BASE - (8 to 12) dB	FFI_BASE - 10 dB	FFI_BASE - (8 to 12) dB
6	TFI_BASE - 12 dB	TFI_BASE - (9.6 to 14.4) dB	FFI_BASE - 12 dB	FFI_BASE - (9.6 to 14.4) dB
7	TFI_BASE - 14 dB	TFI_BASE - (11.2 to 16.8) dB	FFI_BASE - 14 dB	FFI_BASE - (11.2 to 16.8) dB



Transmit Power Control

TPC - Device-level Management

- Host selects the TPC level a device must use for packet transmissions
 - Applies only to WUSB-related packet transmissions
- Device-level Packet Types Control for TPC:
 - Beacons / TX Packet
 - Device Notifications
 - Set via SetWUSBData(Transmit Power)



Transmit Power Control

Transaction-Level Management

- Host provides TPC level for all device transmitted packets in a data/handshake protocol time slot
- W_{DT} CTA. Transmit Power field
 - Host must ONLY use values supported by device
 - Device capabilities reported in WUSB Device Capabilities on UWB descriptor (*bmTFITXPowerInfo*)
- Device must use TPC level indicated by host for all packet transmissions during time slot
- Host may change TPC on every W_{DT} CTA



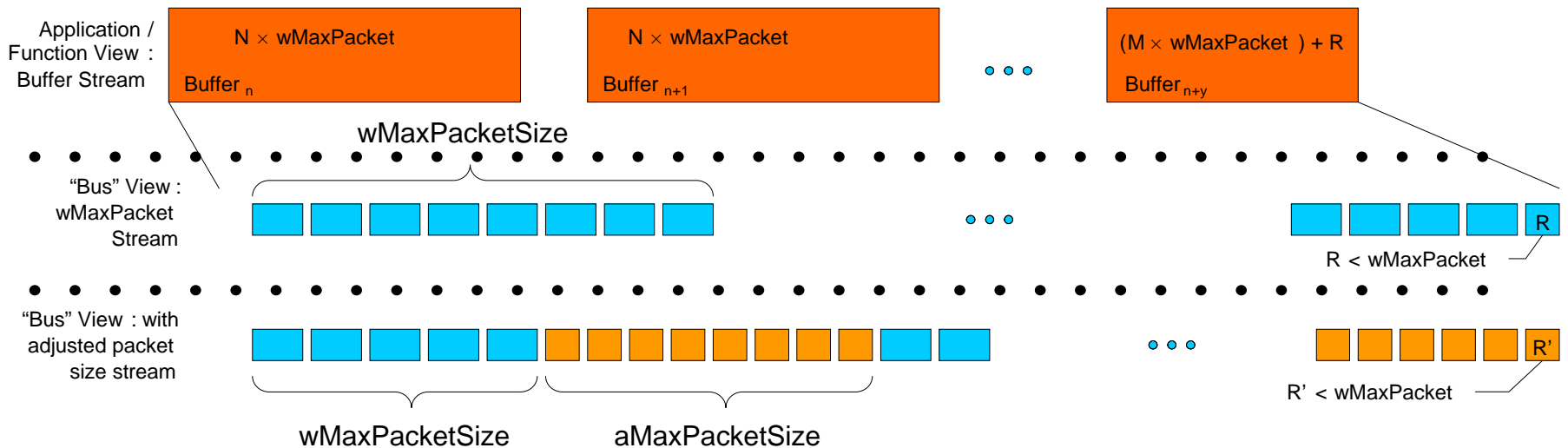
Transmit Bit Rate

Transaction-Level Management

- Host provides the TBR for all device transmitted packets in a data or handshake protocol time slot
- $W_{DTCTA.PHY_TXRate}$ field
 - Host must ONLY use values supported by device
 - Device capabilities reported in WUSB Device Capabilities on UWB descriptor (*wPHYRates*)
- Device must use TBR indicated by host for all packet transmission during the time slot
- Host may change TBR on every W_{DTCTA}

Adjustable Max Packet Size

- Changes to data payload size can occur
 - on transaction boundaries
 - on contiguous-burst boundaries
- Host cannot adjust burst size if there are out-of-order data packets
 - Data packets that must be retried
- Note: this control motivated change in bus-level handling of short packets





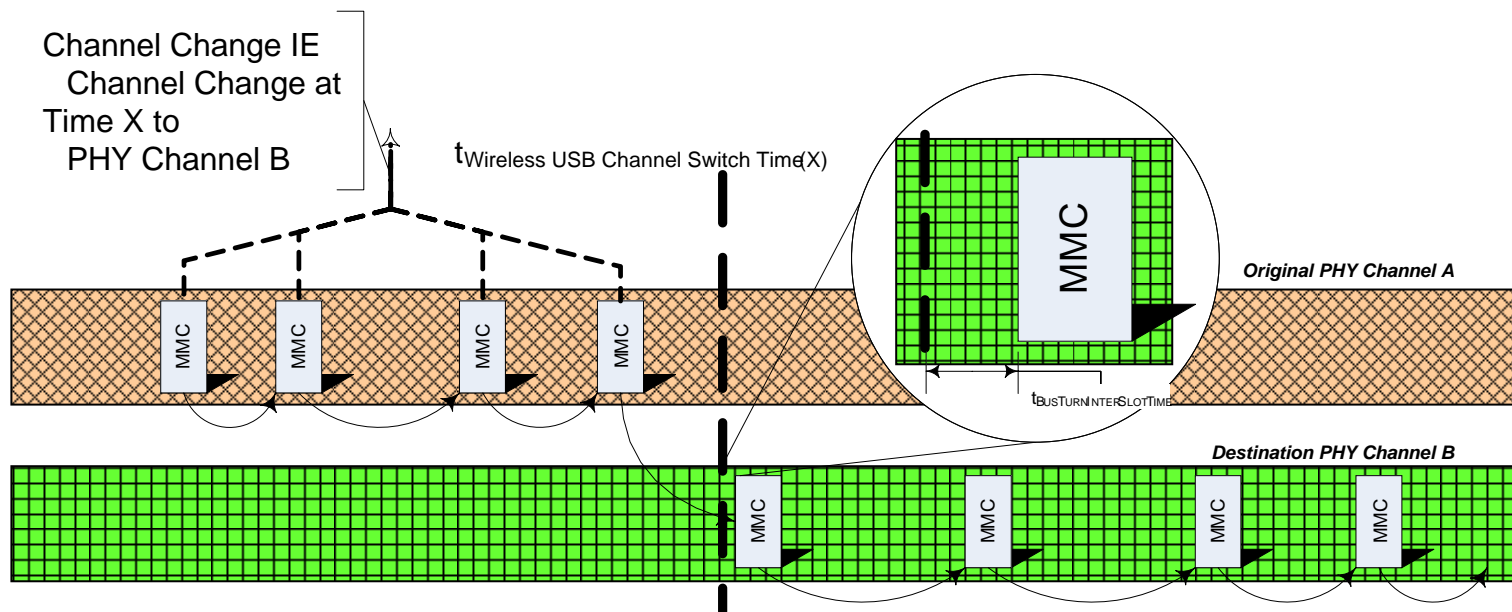
Change the PHY Channel

- Under some circumstances, best thing for host to do is move cluster to another PHY channel
- Methods for establishing the alternate channel are host-implementation specific
- Devices must follow host if they desire to remain connected to the host

Change the PHY Channel

Example Mechanism

- Host keeps WUSB Channel active
- Host simply notifies cluster members when channel change will occur
 - Including destination channel
- Devices simply listen for 'next' MMC on new channel after the channel change time





Summary

- Wireless is an unreliable data transmission media
- Protocol, etc. have been designed to deal with unreliability
- Set of additional tools are defined to allow a host to make both Macro and Micro-adjustments to mitigate interference
- Devices should be designed to do what hosts tell them to do,
 - Should not make assumptions about when the host is going to tell them when to do something



Questions