Subset PHY: Cost and Power Analysis

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Overview

- Over the last few meetings and during the tutorials some power savings numbers and mechanisms were discussed for Subset PHY
- The goal of this contribution is to give more detail and connect the numbers to the proposal using a 10GBASE-T PHY and Subset PHY as an example
  - Will lay out assumptions
  - Show power drivers comparison
  - Summarize with additional observations

Assumptions

- Analysis using 10GBASE-T Subset PHY example outlined in tutorial
  - http://www.ieee802.org/802_tutorials/july07/IEEE-tutorial-energy-efficient-ethernet.pdf (Slide 49)
- Power consumption for 10GBASE-T Base PHY
  - ~50% from Analog vs. ~50% from Digital
    - Analog: TX (line drive & associated circuitry) + RX analog circuitry
    - Digital: Shared resources + Channel dependent resources
  - Analog power equally divided into 4 channels
    - Each channel thus contributes 0.5 * 0.25
  - Digital shared resources include MAC service interface, control etc.
  - Balance of digital resources divided into equal portions between each channel
- Power consumption for 10GBASE-T Subset PHY
  - Analog TX/RX: Turn OFF 3 of the 4 Channels (0 out contribution)
  - Analog TX: PAM-16 -> PAM-4 and use lowest PAM-4 levels
    - Link partner will be able to resolve lowest levels
  - Digital: Turn off internal logic associated with OFF Channels

10GBASE-T PHY Power Drivers

Subsystem & Associated Relative Power							Description	Power Contribution
Analog	0.5						Line drive & assoc. A circuitry	
		RX	0.25					
				Channel 0	0.25	Example Line Item Calc (0.5*0.25*0.25 = 0.03125 or 3.13%) <=		3.13%
				Channel 1	0.25			3.13%
				Channel 2	0.25			3.13%
				Channel 3	0.25			3.13%
		TX	0.75					
				Channel 0	0.25			9.38%
				Channel 1	0.25			9.38%
				Channel 2	0.25			9.38%
				Channel 3	0.25			
						All PAM Levels	1	9.38%
Digital	0.5						Line drive & assoc. D circuitry	
		Shared	0.25				Shared Resources	12.50%
		Channel	0.75				Channel dependent digital circuitry	
				Channel 0	0.25			9.38%
				Channel 1	0.25			9.38%
				Channel 2	0.25			9.38%
				Channel 3	0.25			9.38%
Total Power								**100.00%**

10GBASE-T Subset PHY Power Drivers

Subsystem & Associated Relative Power							Description	Power Contribution
Analog	0.5						Line drive & assoc. A circuitry	
		RX	0.25					
				Channel 0	0	Example Line Item Calc (0.5*0.25*0 = 0 or 0.00%) <=		0.00%
				Channel 1	0			0.00%
				Channel 2	0			0.00%
				Channel 3	0.25			3.13%
		TX	0.75					
				Channel 0	0			0.00%
				Channel 1	0			0.00%
				Channel 2	0			0.00%
				Channel 3	0.25			
						Lower 4 PAM Levels	0.0625	0.59%
						Prop to envelope V^2		
Digital	0.5							
		Shared	0.25				Shared Resources	12.50%
		Channel	0.75				Channel dependent digital circuitry	
				Channel 0	0			0.00%
				Channel 1	0			0.00%
				Channel 2	0			0.00%
				Channel 3	0.25			9.38%
Total Power								**25.59%**

Observations

- First order analysis intended to “connect the dots” between proposal and power numbers noted earlier
- Subset PHY at ~25% of 10GBASE-T PHY
- Approach benefits from improvements to power consumption of 10GBASE-T PHY
  - Subset PHY power will always benefit from technology curve improvements for 10GBASE-T PHY
  - Thus not just a 1-time gain
- Very conservative analysis
  - Does not assume improvements to active channel
    - For example elimination of unnecessary cancellers
  - Does not assume any additional potential improvements
    - For example optimization of Shared Resources
- Very simple approach
  - Involves turning OFF existing circuitry
  - Technique applies to lower rate PHYs also

Cost Analysis and Observations

- Very simple approach
  - Involves turning OFF existing circuitry
  - Some trivial additional control circuitry to turn OFF/ON 10GBT logic
- Assuming about 30K digital gates for control
- Based on presentations from 802.3an, increase in digital gate count
  - ~8.5M (4.7M * 1.8) Digital Gates => ~0.35% increase to digital section
    - Ref http://www.ieee802.org/3/an/public/may04/mcclellan_1_0504.pdf
  - ~6M Digital Gates => ~0.50% increase to digital section
    - Ref http://www.ieee802.org/3/an/public/jul04/rao_1_0704.pdf
- To first order, cost increment to 10GBASE-T should be negligible
  - Intuitively consistent with DSP heavy 10GBT PHYs
  - ~0.35% - 0.50% increase in digital section
  - When incorporated with Analog <<0.50% increase!

10GBASE-T PHY

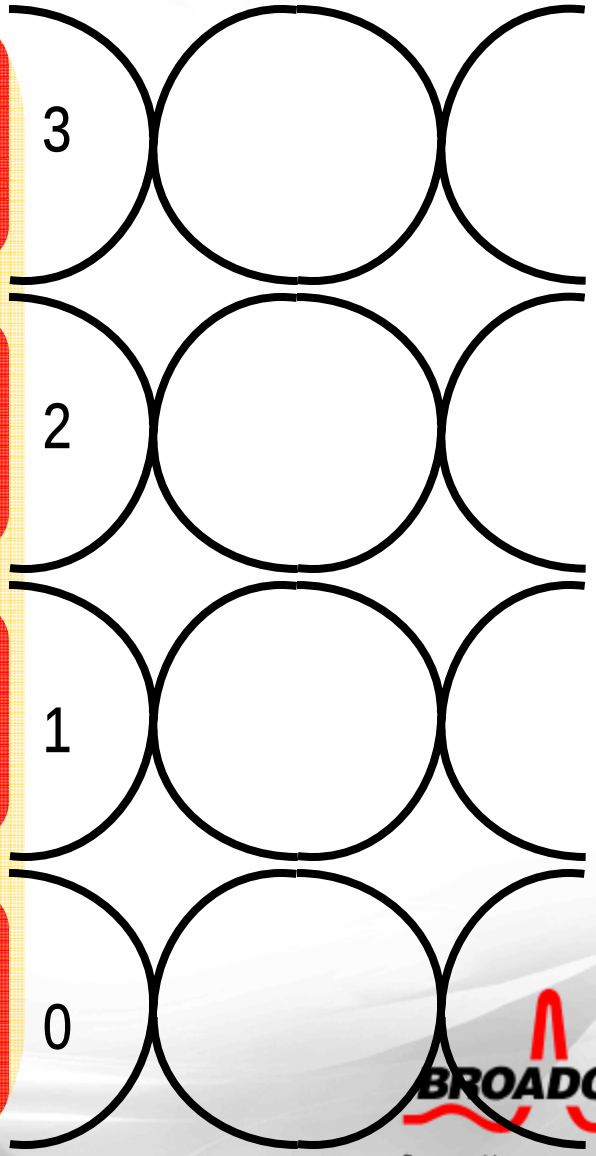
SHARED DIGITAL

CHANNEL RESOURCES (ANALOG AND DIGITAL)

CHANNEL RESOURCES (ANALOG AND DIGITAL)

CHANNEL RESOURCES (ANALOG AND DIGITAL)

CHANNEL RESOURCES (ANALOG AND DIGITAL)



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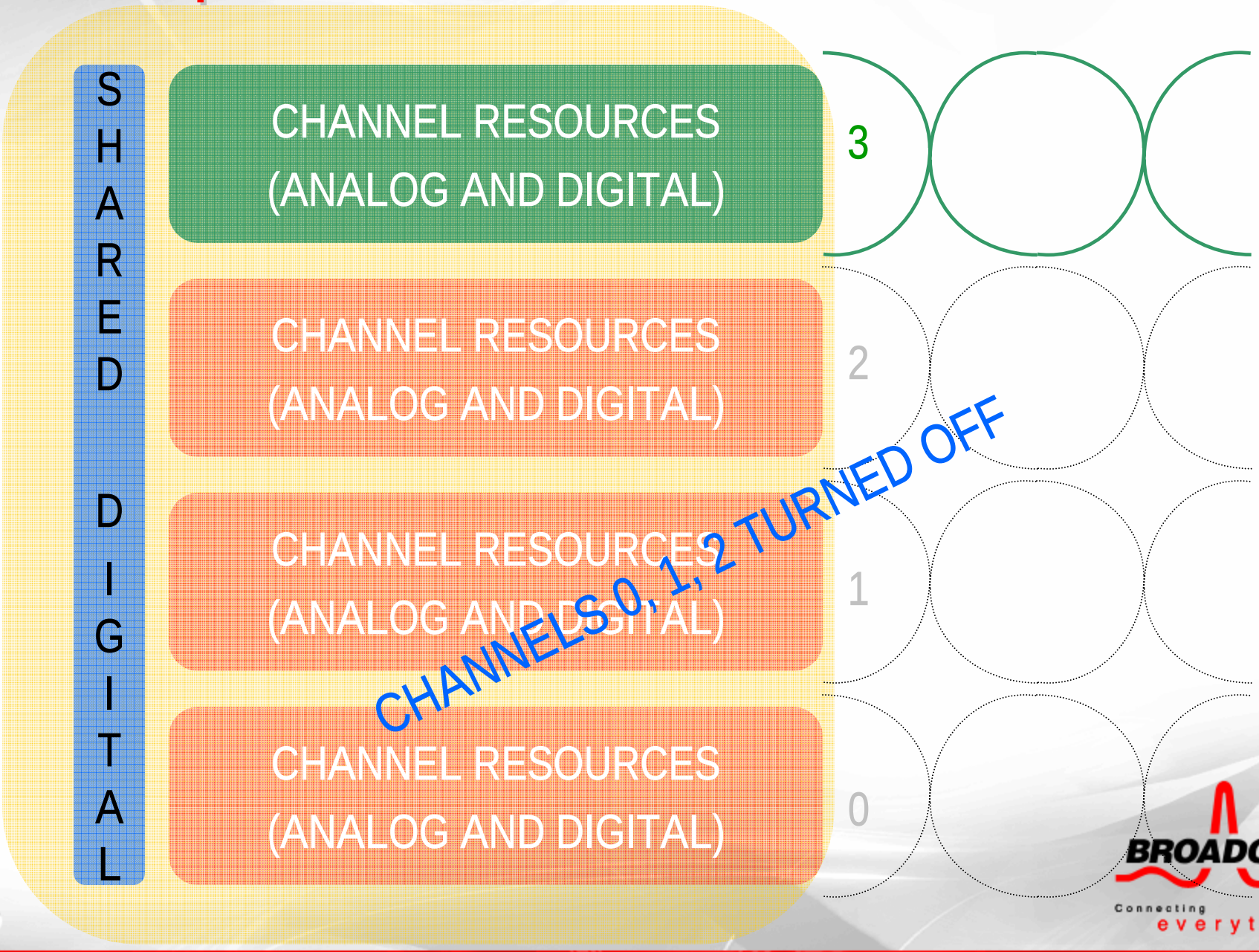
Simple 10GBASE-T Subset PHY



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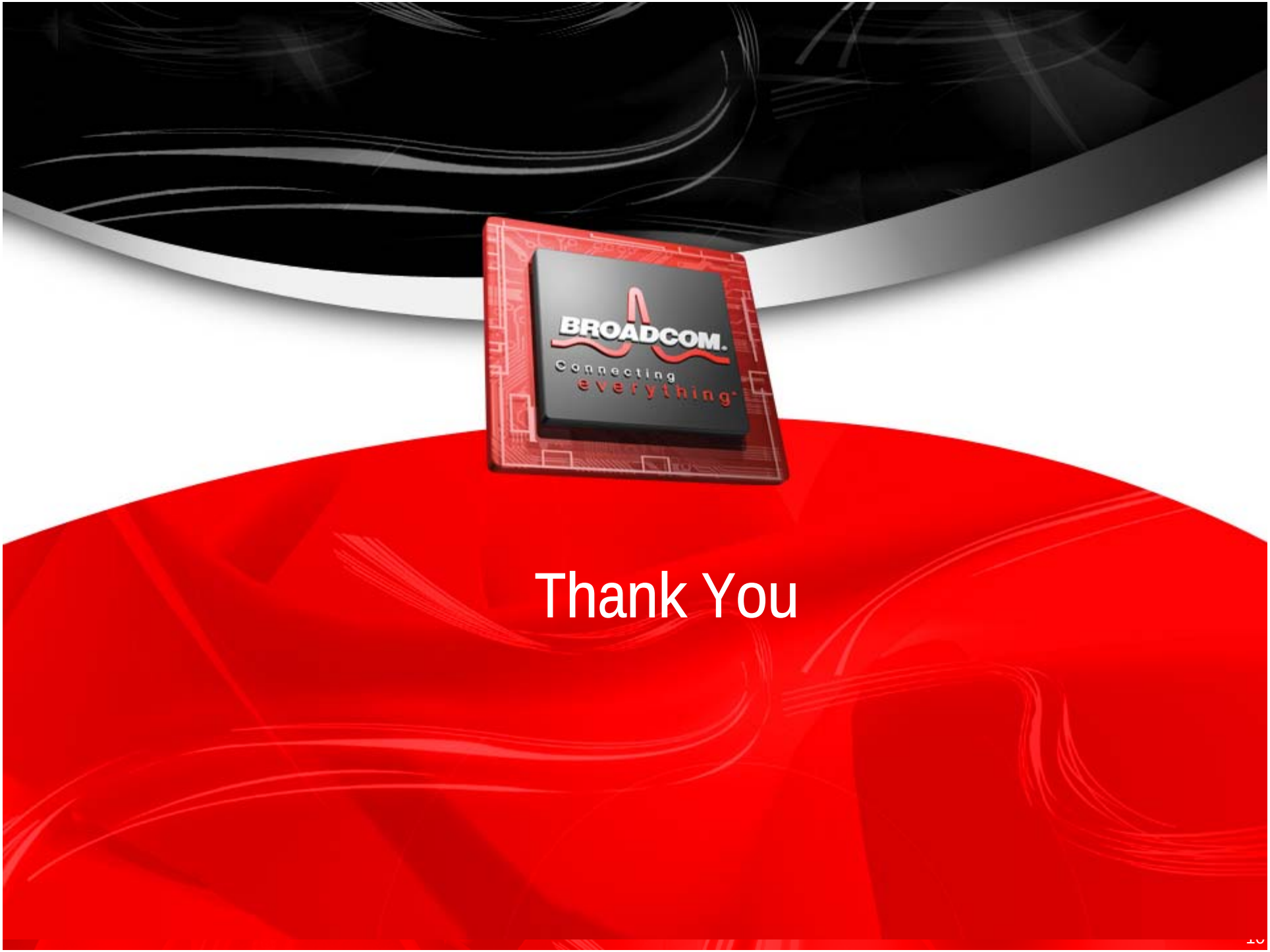

Thank You