

# The AFRL-UNM High End Reconfigurable System: Analyses of a Reconfigurable Multiprocessor Architecture for Space Missions

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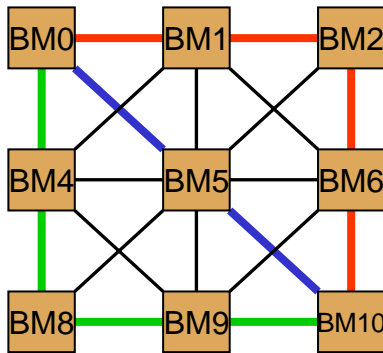


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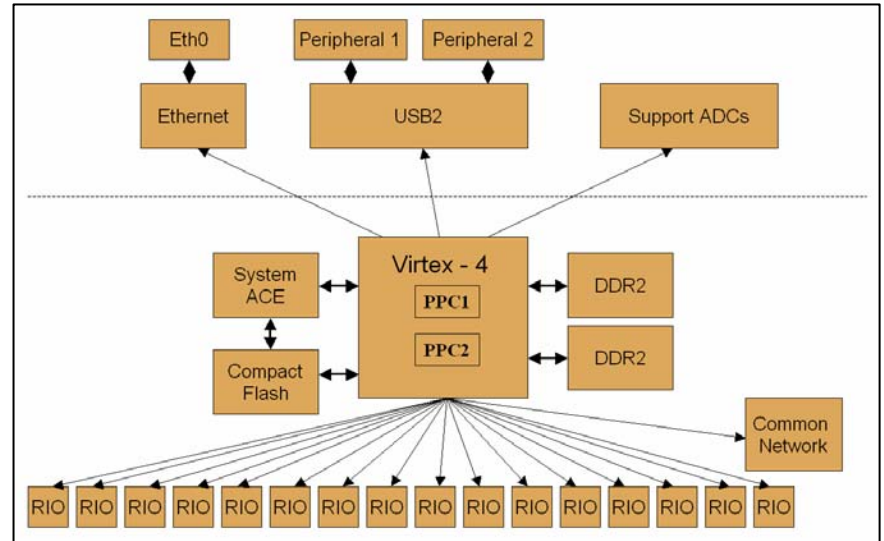
**Space Vehicles Directorate**  
**Air Force Research Laboratory**



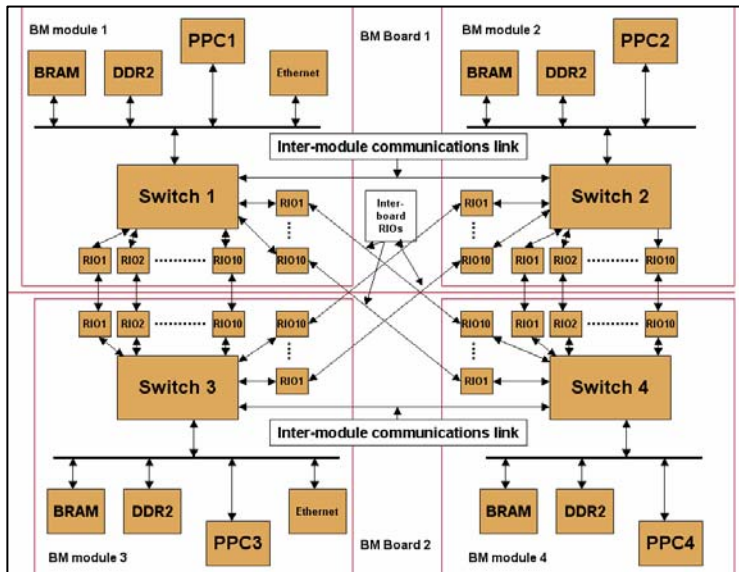
# ARCHITECTURE AND INTERCONNECTION



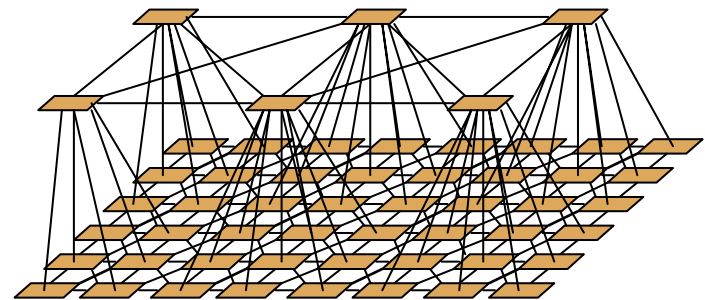
Basic Modules in a Full Mesh interconnection



Blocks Diagram of a Basic Module

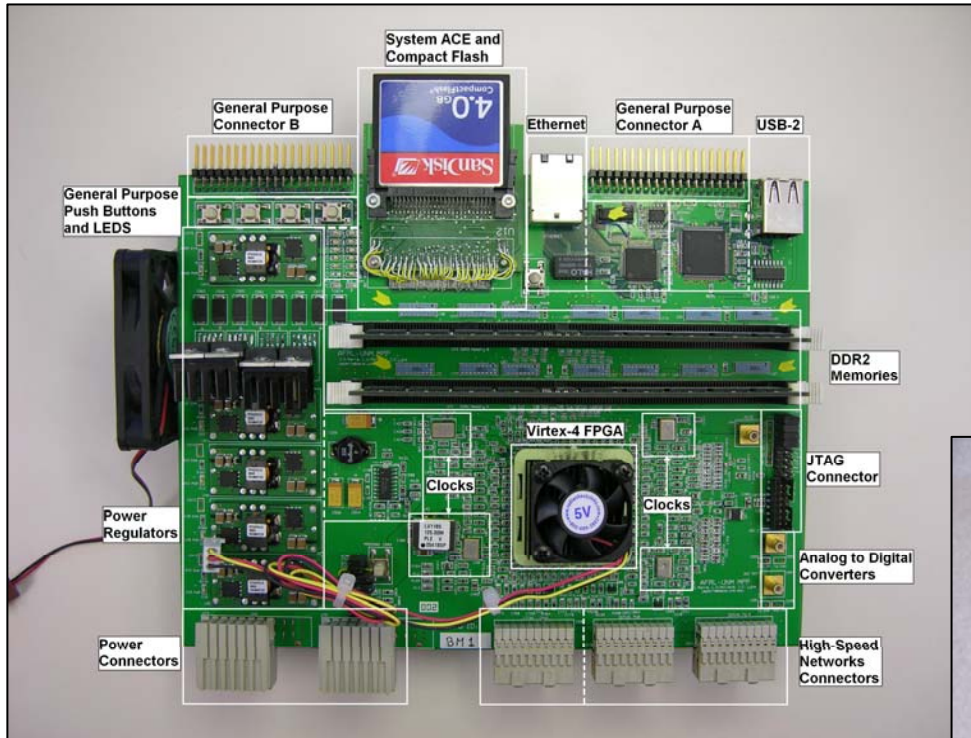


Network support for four BMs



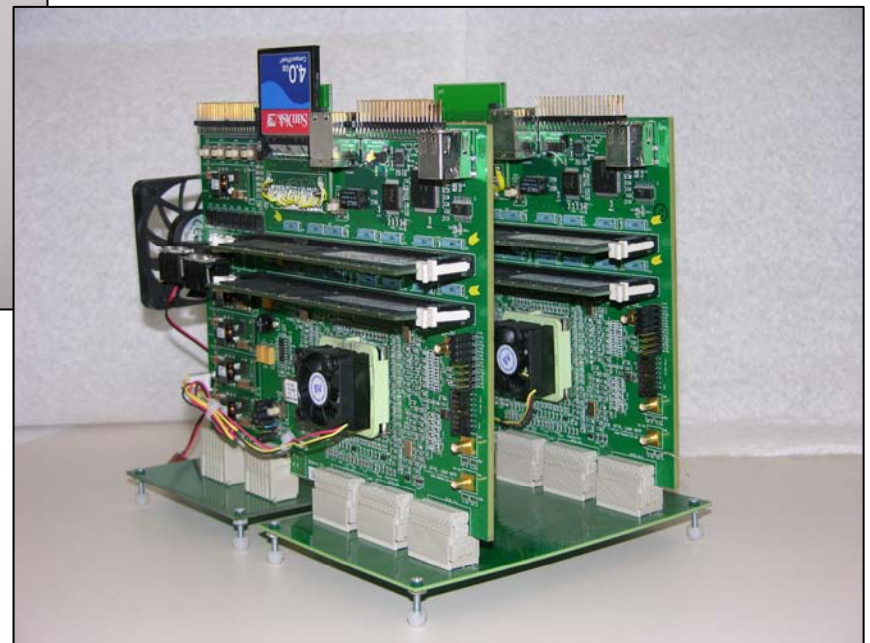
High-dimensional interconnections

# PROTOTYPE OF THE AFRL-UNM HERC

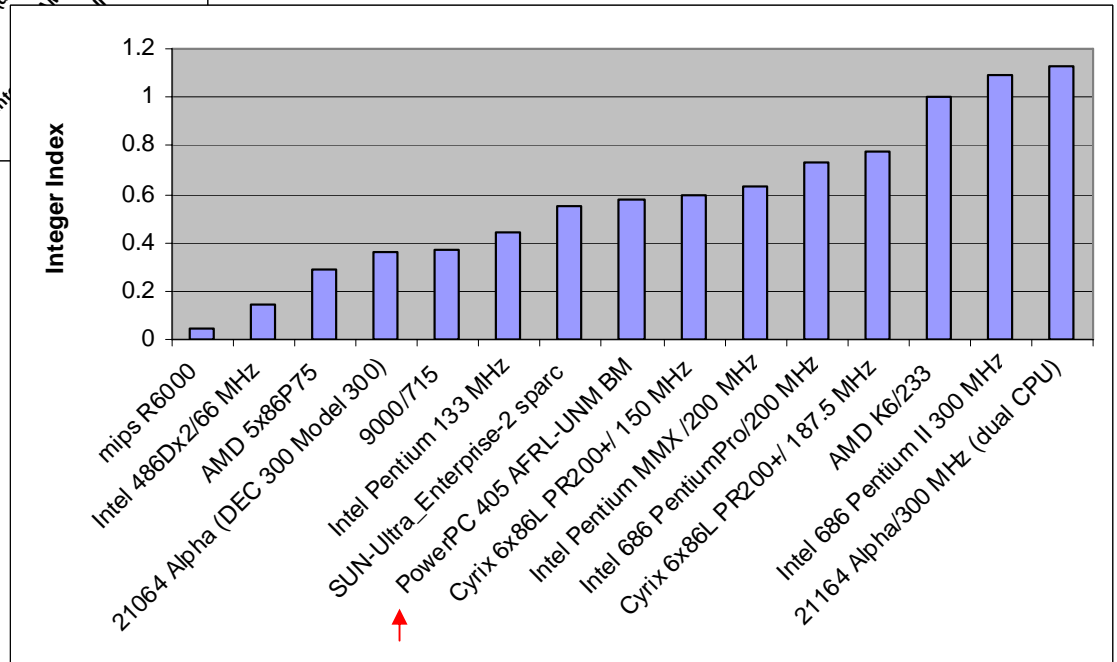
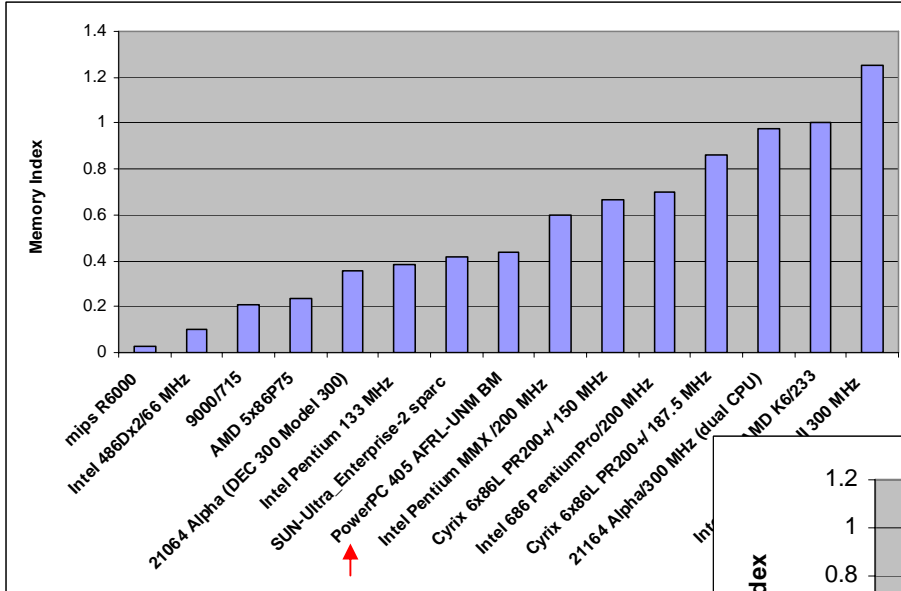


Prototype of a Basic Module

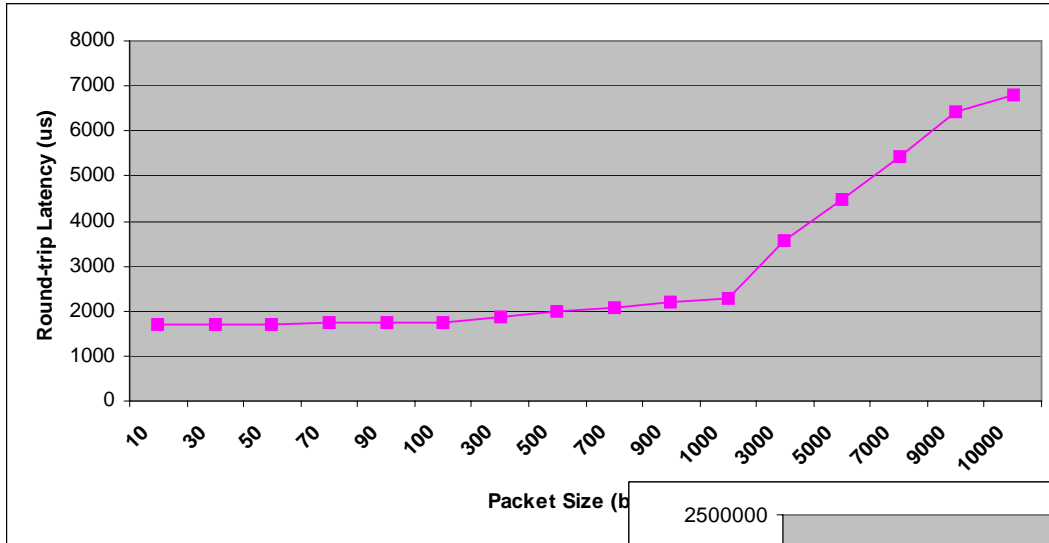
Prototype of a HERC with Two Fully-Interconnected BMs



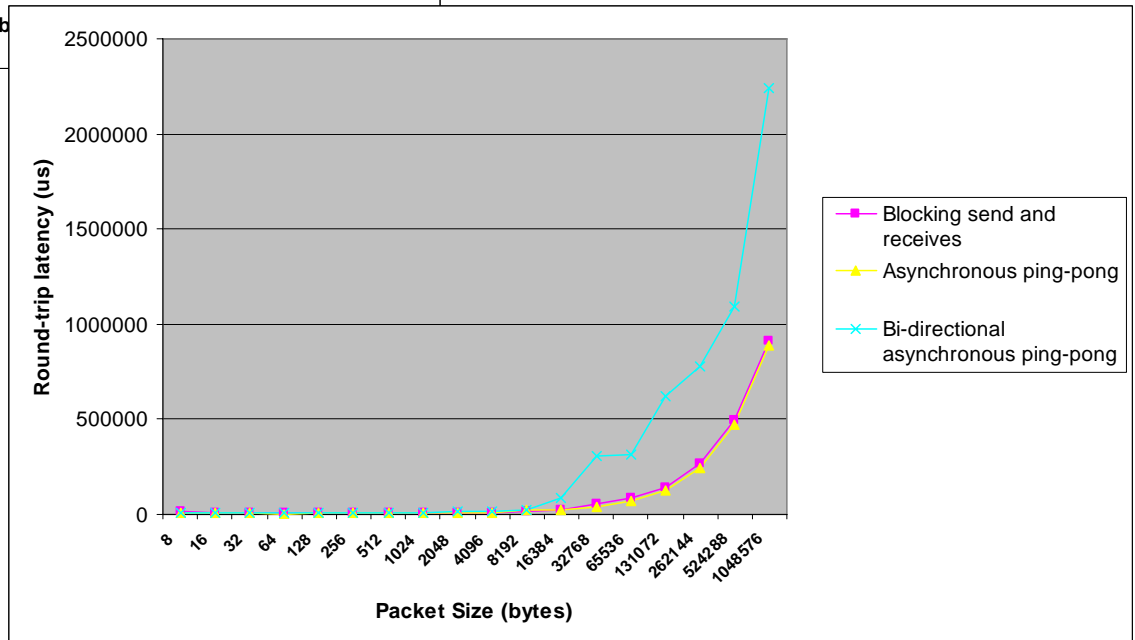
# PERFORMANCE COMPARISON OF THE AFRL-UNM BM WITH OTHER SYSTEMS (UNIPROCESSOR CASE)



# COMMUNICATION PERFORMANCE (MPI CASES)



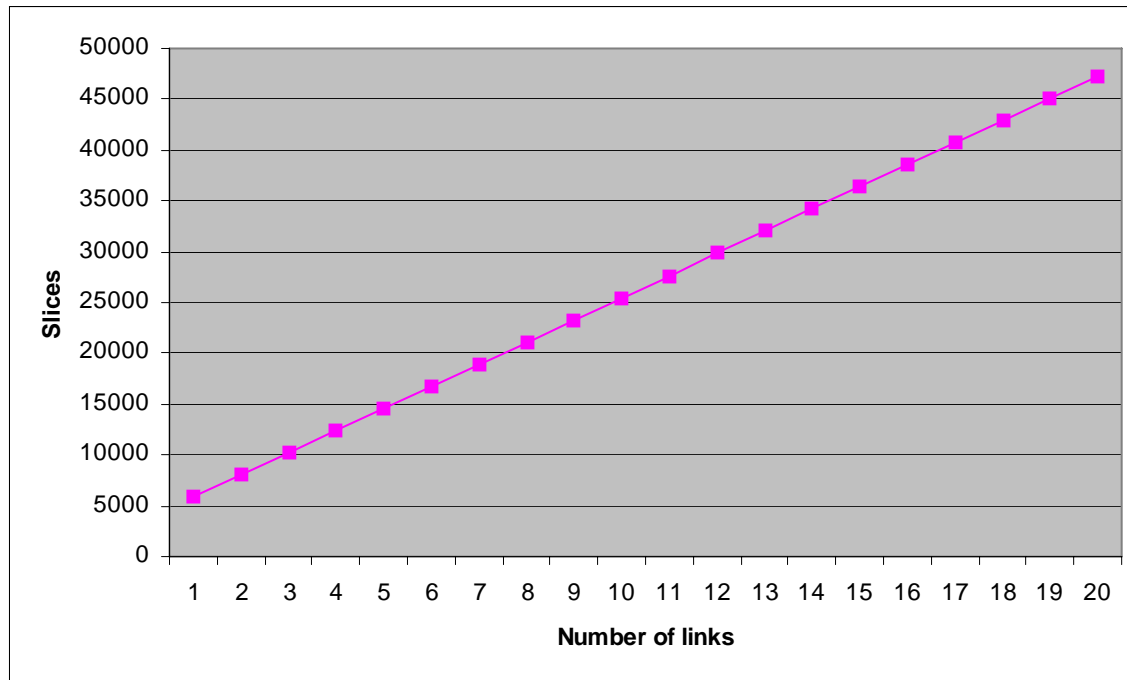
**MPI-ping benchmark results in two nodes of the AFRL-UNM HERC**



**Results of running MPI-Ping-Pong in the UNM-AFRL HERC**

# FPGA RESOURCES CONSUMPTION

	BUFGs	Slices	DCM_ADVs	llogic	Ologic	RAM16s	SliceM	Added
<b>System I</b>	28%	8%	33%	9%	14%	17%	2%	
<b>System II</b>	34%	13%	33%	11%	16%	18%	2%	Ethernet
<b>System III</b>	21%	22%	16%	19%	30%	35%	4%	Multiproc
<b>System IV</b>	21%	22%	16%	19%	30%	36%	23%	Inter-core



Number of Ethernet links vs. slices consumed in their implementation

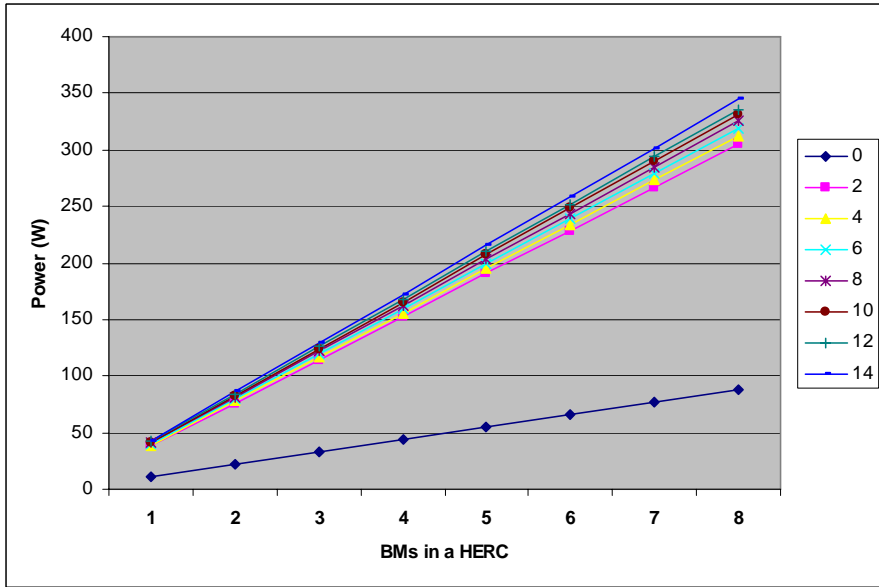
# HERC POWER (SINGLE BM)

Benchmark Tested		Number of BMs	Power before Test (W)	Power during test (W)
<u>Fhourstones</u>		1	10.7	11.6
<u>Nbench</u>	Numeric Sort	1	10.7	11
	String Sort			
	<u>Bitfield</u>			
	FP Emulation			
	Fourier			
	Assignment			
	IDEA			
	Huffman			
	Neural Net			
<u>LU Decom</u>				
MPI-Ping (Ethernet)		2	21	23.25
MPI-Ping (Internal link)		1	10.9	13
MPI-Pong (Ethernet)		2	21.3	22.9

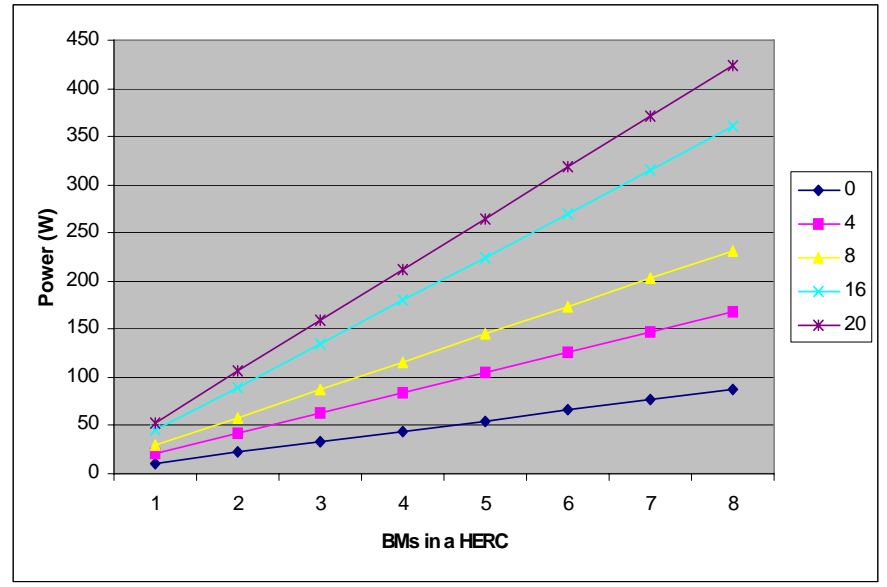
**Power Consumption of the AFRL-UNM  
HERC with application benchmarks**

Space Vehicle	Size	Power
<u>Cibola</u> (2006)	Small	110W
Agile (2007)	Medium-Small	460W
Hubble Telescope	Medium-Big	2800W
International Space Station (Harmony Module)	Big	80000W

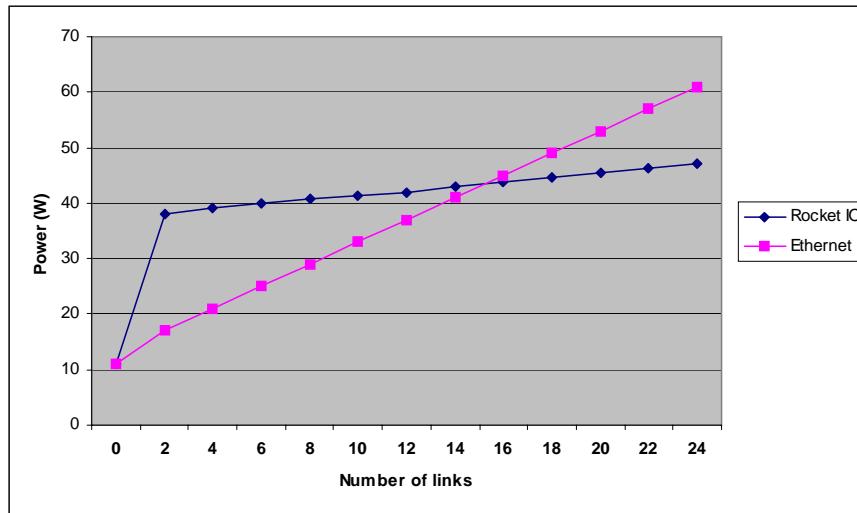
**Power capabilities of some Space Vehicles. Taken from [Nasa, 2004], [STScI, 2008], and [LANL, 2006]**



**Power estimates for HERCs with a variable number of BMs and Rocket IO links**



**Power estimates for HERCs with a variable number of BMs and Ethernet links**



**Power consumed by a single BM with different amounts of Rocket IO and Ethernet links**