



## Many Thoughts on ManyCores

John D. McCalpin, Ph.D.  
Principal Scientist: Acceleration Technologies  
Computational Solutions Group Design Engineering  
Advanced Micro Devices

# Tools and Libraries

- MultiCore implementations exist to attempt to continue growth in end-user **“Value”** over time without increasing end-user **“Cost”**
  - **“Value”**: What do I obtain from doing this computation? (as opposed to not doing it)
  - **“Cost”**: What do I give up by choosing to do this computation? (both explicit and opportunity costs)
- **“Optimization”** consists of minimizing or maximizing some objective function based on **“Value”** and **“Cost”**
- Tools and Libraries should be assessed based on their abilities to contribute to these optimizations



# Important Categories

- Applications that can run now, but would provide more “Value” if faster (at the same cost)
- Applications that can run now, but would provide more “Value” if cheaper (at comparable performance)
- Applications that cannot be run now because existing systems provide inadequate performance to meet required time-to-solution bounds
- Applications that cannot run now because existing systems cost too much (either Bill of Material cost or Power cost for mobile devices) to provide the minimum performance for the target market to afford



# Classification of Business Potential by Market Sensitivity to Improvements

Performance

<b>High:</b> large improvements required to create new market	Potentially Disruptive	Potential Growth	Dangerous: double risk
<b>Medium:</b> increases add value	Moving to Commodity	Mainstream Sustaining Markets	Potential Growth
<b>Low:</b> current technology is "good enough"	Commodity	Moving to Commodity	Potentially Disruptive
	<b>Low:</b> current technology is "good enough"	<b>Medium:</b> reductions increase value	<b>High:</b> large improvements required to create market

Price



# Strategy by Business Classification

<b>Highly Attractive Market</b>	Consider Investment to Improve Offering	Invest	Exploit with minimal investment
<b>Moderately Attractive Market</b>	Withdraw	Monitor with minimal investment	Invest
<b>Unattractive Market</b>	Withdraw	Withdraw	Consider Investment to Retarget Offering
	<b>Uncompetitive Offering</b>	<b>Moderately Competitive Offering</b>	<b>Strongly Competitive Offering</b>



# ManyCore Cost/Performance Modeling

$$T = \frac{W_{serial}}{R_{serial}} + \frac{W_{CPUparallel}}{N \times R_{CPU}} + \frac{W_{BW}}{R_{BW}} + \frac{W_{overhead} (N^\alpha)}{R_{overhead}}$$

$$C = C_{base} + \$_{CPU} R_{CPU} + \$_{BW} R_{BW}$$

- Price/Performance is proportional to Cost\*Time
  - W = Work
  - R = Rate
  - N = #cores
  - C = Cost
  - \$ = Cost per unit performance
- Cost\*Time has lots of terms that cannot be neglected



# Tools and Libraries

- Tools are needed to
  - Identify the Application Work components quickly and easily so that the Application can be targeted to an appropriate platform
  - Identify “performance mistakes” that can be fixed at low cost
- Libraries are needed to
  - Encapsulate domain-specific expertise for algorithm choices
  - Encapsulate architecture-specific expertise for performance tuning
  - Encapsulate system-specific expertise for run-time support
    - Scheduling, failure tolerance, etc

