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Exascale Co-Design Paths

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Advanced Simulation & Computing™

National Nuclear Security Administration

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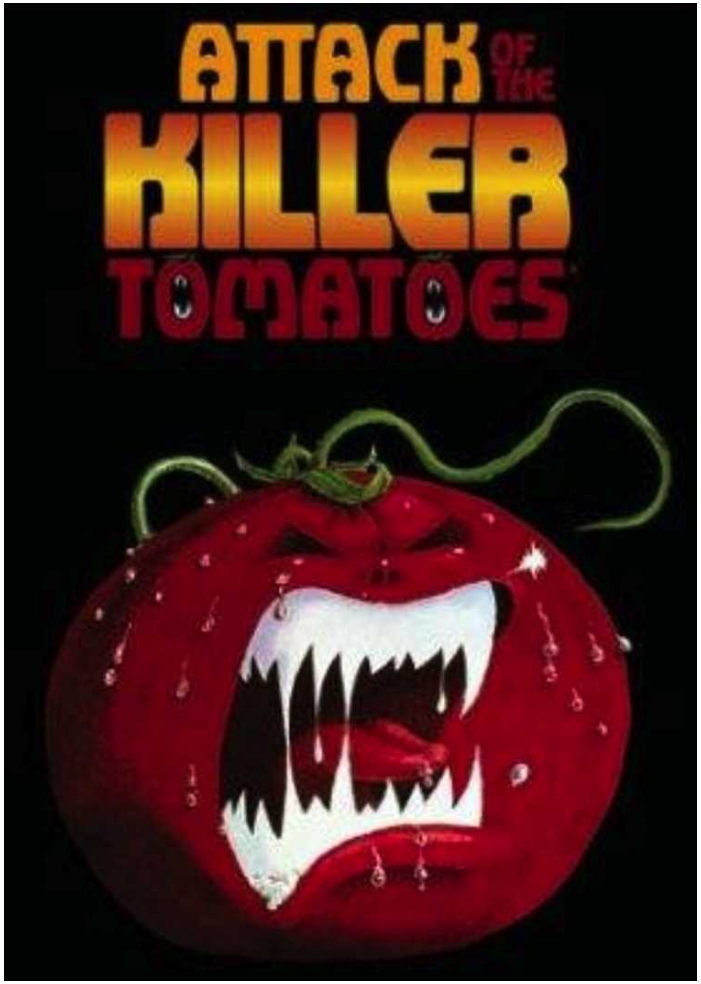
ASCI provided critical mass to the *Attack of the Killer Micros*

- Strategy based on integration of commodity computing components into large scale MPPs
- ASC(I) rode the Golden Era of Moore's Law + Dennard Scaling to increase HPC performance from Tera-scale to Peta-scale



Credit – Eugene Brooks, LLNL

Commodity Computer Technology has changed

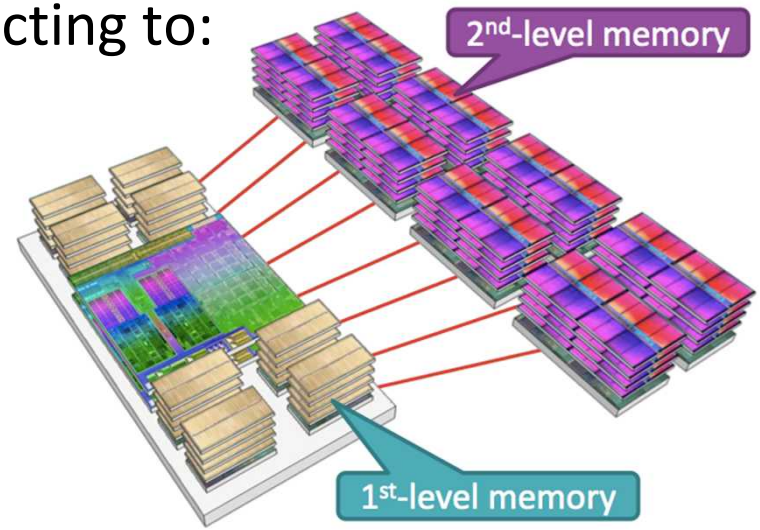
- We are in the midst of the 2nd Era of commodity processors
- Commercial workloads benefit from performance increases of multi-core processors, but most of the ASC Mission-driven Applications do not
- The strategy of creating supercomputers from the integration of COTS computing components *may be breaking down*

Three Co-design Paths

- Reactive
- Proactive
- Holistic

Reactive Co-Design

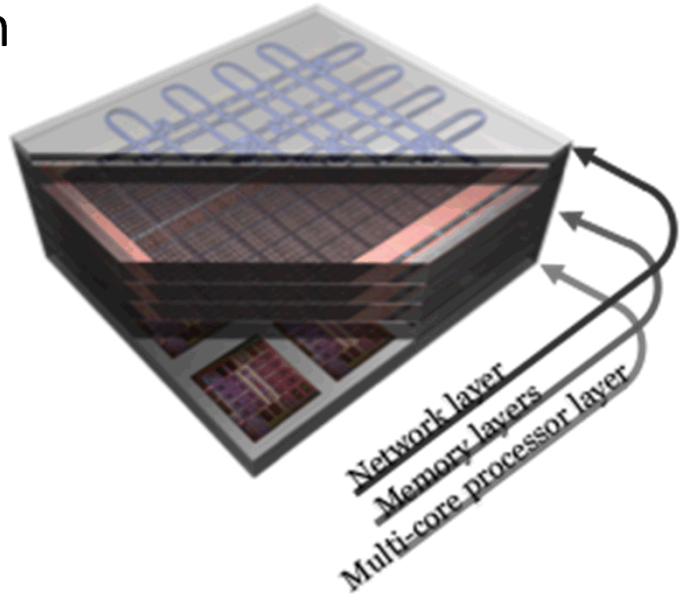
- We proceed with the *status quo* – integrate commodity computing components into large scale MPPs
- ASC's Advanced Technology Development and Mitigation (ATDM) effort supports reactive co-design – Apps and Sys SW
- Examples of technology we are reacting to:
  - Multi and Many Core Processors
  - Heterogeneous Processors
  - Multi-tiered Memory
  - Commodity Interconnects



AMD Two Level Memory Concept

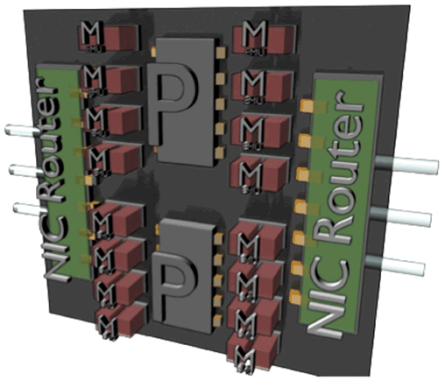
Proactive Co-Design

- If the DOE Exascale Initiative materializes, resources and collaborations can directly influence the design of *future commodity* computing components and technology
- Co-designed COTS components can be integrated to address other application areas such as graph analytics that are also not met with *status quo* COTS components
- Current and planned FF & DF projects establish a runway for future COTS

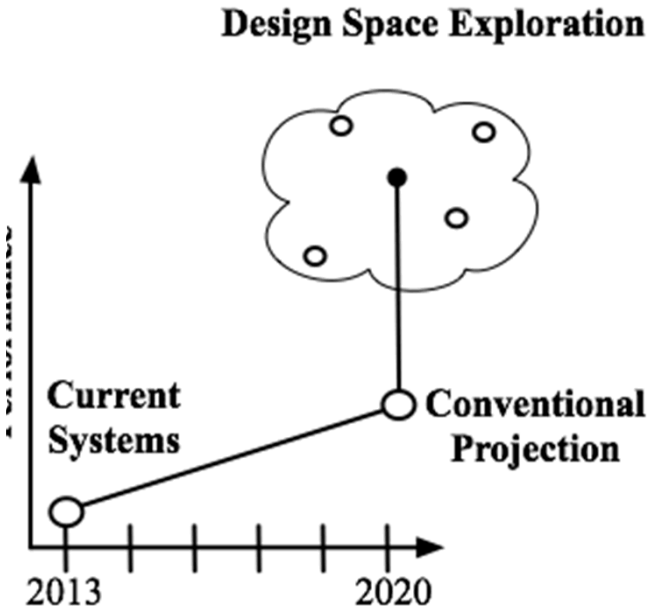


Holistic Co-Design

- The DOE Exascale initiative can also directly influence the design of *future special purpose* HPC computing components
- Leverage the System on Chip (SoC) Ecosystem to develop computing technology designs that are unconstrained by product roadmaps
- Develop *prototype* testbeds
  - Can lead directly to SoC products
  - Or be adopted by the COTS computing ecosystem



Sandia's Xcaliber Node Concept

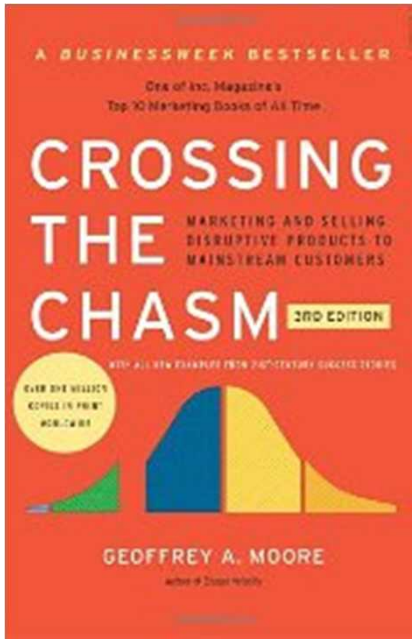


Sandia's XGC Point Design/ Design Space Exploration

Proactive versus Holistic Co-Design?

- We understand it is challenging for technology to transition from R&D into Product
  - Product Roadmaps have a lot of inertia
  - Given the difficulty in adopting new technology from within, how much *influence* can DOE have?

- Holistic Co-Design and a DOE SoC strategy can help *Bridge the Chasm*
  - Co-Design Analysis Tools
  - Proof of concept technology demonstrators
  - Lower the risk of adoption by COTS computing component manufacturers



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