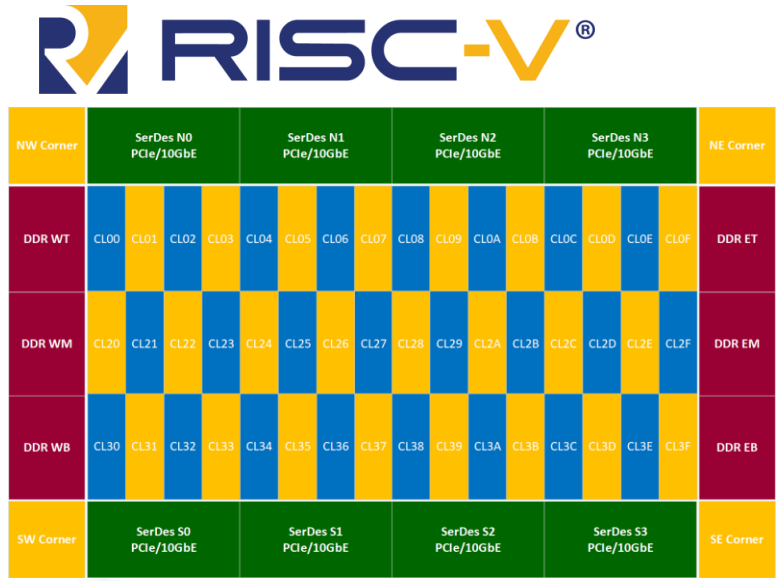
Thunderbird Accelerated Computing Solution

- ***Ultra-Efficient, Ultra-compact custom CPU cores***
  - Based on modern open-standard RISC-V architecture (unlike ARM)
  - InspireSemi designed high-perf superscalar, out-of-order CPUs
- ***A supercomputer cluster-on-a-chip***
  - 1,536 high-perf 64-bit CPU cores per chip (>6,000 per PCIe card)
  - Comparable to GPU shader count but are independent CPUs
- ***Innovative low latency interconnect fabric***
  - Key to efficient utilization of so many cores
  - Seamlessly spans multiple-chip arrays up to 256 chips!
- ***Energy efficiency: 30-60% power reduction***
  - Focus on performance/watt
  - Higher energy efficiency, fits in current datacenters
- ***Supporting existing open RISC-V software ecosystem***
  - Enables customers to easily adapt their software programs
  - Fast – no big investment or training required
- ***Recognized global partners to deliver turnkey solutions***
  - High-volume across multiple markets and geographies



Lenovo
PENGUIN COMPUTING
A subsidiary of SMART Global Holdings, Inc.
World Wide Technology
POWERED BY DELL Technologies
SUPERMICRO
E4 COMPUTER ENGINEERING

Thunderbird Datacenter Impact:

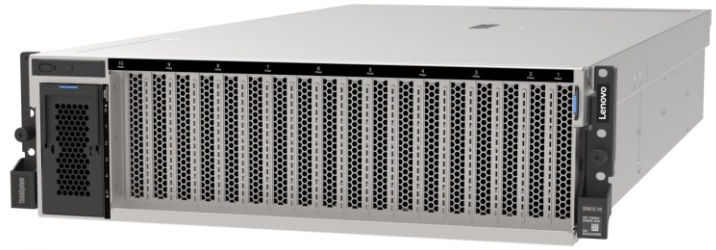
Significant datacenter TCO savings and carbon footprint reduction

One Thunderbird board has more CPU cores than an ***entire rack of standard Intel or AMD severs!***

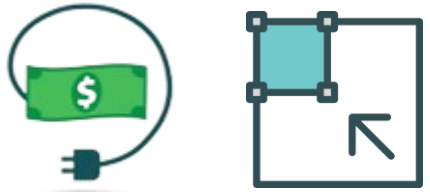
- Less cost: real estate, servers, networking, power, cooling
- Less complexity, interconnects, points of failure

Thunderbird has **>20X** CPU cores vs. Intel or AMD server chips

- Intel and AMD CPUs: Up to 256 general purpose x86 cores per server board
- Thunderbird: 6,144 high-performance/low-power RISC-V cores per add-in board (all 64-bit)



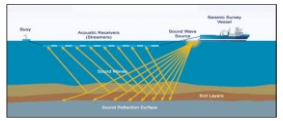
3U Server with 8 Thunderbird cards



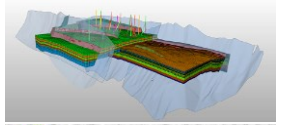
Addressing the Need to Accelerate All HPC & AI Software

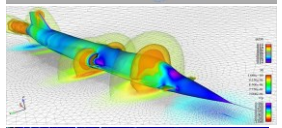
What customers always wanted…not "yet another GPU"


Financial simulations

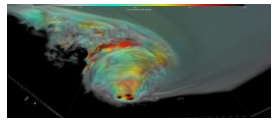

Geology: Seismic


Financial Trading & Graph Analytics

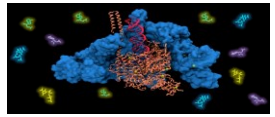

Energy: Reservoir Modeling & Sim


CAE/Computational Fluid Dynamics

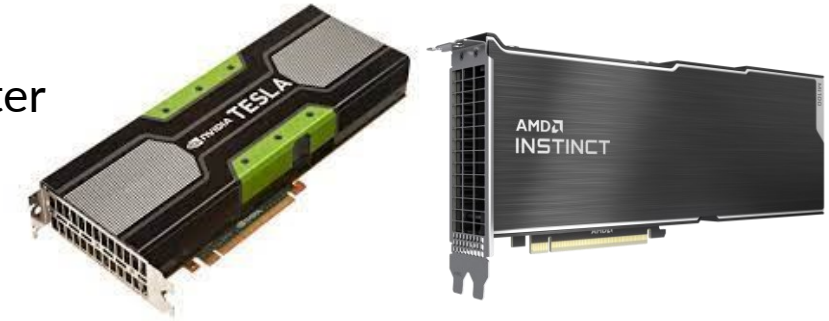

Government Lab Simulations


Climate & Weather Modeling


Cybersecurity & Cryptography


Genomics, Pharma, Life Sciences

Datacenter GPUs



Datacenter GPUs do it all, right?

InspireSemi Thunderbird

Highly differentiated "supercomputer-cluster-on-a-chip"

- Versatile platform delivers unprecedented capability
- 4 chip PCIe card delivers >6,000 64-bit CPU cores (FP64)
- Innovative high bandwidth, low-latency on-chip network
- Best-in-class for both Performance/$ and Watt
- Large scale computing power with much lower TCO - can replace many racks of servers and expensive high-speed networking

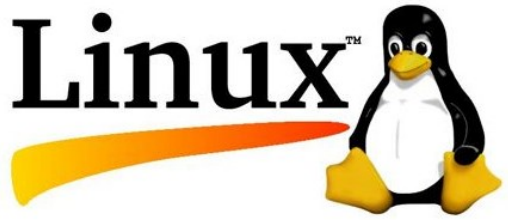
InspireSemi™

Open Software Ecosystem Solves Customer Porting Challenges

- Supports standard operating systems (unlike competing compute accelerators)
  - **Linux!** provides access to existing HPC/AI software ecosystem
  - Plus Zephyr and FreeRTOS (Real-Time Operating Systems)
  - Eliminates need to learn and use proprietary software stacks
  - Eliminates vendor lock-in
- Uses standard CPU-style programming models
  - No need for CUDA, ROCM, etc. that GPUs require
  - No need for disruptive software algorithm rewrites
  - Standard compiler, OpenMP, MPI, etc. approaches
- Leverages key RISC-V software ecosystem
  - Address-accurate QEMU model
  - Standard compilers, e.g.- GCC, Gfortran, GDB toolchains
  - Standard HPC libraries, e.g. – BLAS, LAPACK, FFTW

Linux on Thunderbird - Customer Benefits

- No competing compute accelerator runs Linux (or any other standard operating system)
- The HPC-AI industry loves Linux and open source software
- Provides access to the entire existing HPC-AI software ecosystem
- Customers and software companies can utilize the Linux software stack we provide and immediately begin developing or tuning their custom applications



RISC-V

- **What do you think this the greatest achievement of RISC-V in HPC to date?**
  - Enabling kilocore CPU's, e.g.- InspireSemi Thunderbird, Esperanto, Tenstorrent
  - Both by removing licensing barriers and being amenable to area- and power-efficient implementations

- **What is the biggest limiting factor for RISC-V in HPC at the moment?**
  - Complexity of some extensions (V, and to a lesser extent F,D, and even I) compromises that efficiency without proportionate benefits, and tempts partial/noncompliant implementations that may fragment the ecosystem