New ASC Magma System Overview and CTS-2 Update

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November 14th, 2019

LLNL-PRES-798672

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

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Outline

- ASC Magma “CTS-1+” Cluster
  - Technologies considered for Magma
  - Magma System Architecture & Timeline
  - Comparison to ASC Jade CTS-1
  - Performance Estimates

- CTS-2 Update
  - Current status & Timeline
  - Potential Architectures and Cost Trade-offs (Complex Landscape)
  - Current and Future ASC Workloads
  - Mapping workloads to Architectures (More challenging than past CTS)

Why Magma?

- Growing demand for capacity cycles across the ASC Program

- Decision Factors for Magma
  - Cost/performance & schedule
  - Compatibility with CTS-1 architecture (ease user transition)
  - Cluster integration/admin concerns
  - Liquid cooling solutions

- What technologies are viable for late 2019?
  - Intel Broadwell CPUs + Omni-Path Interconnect (End of Life)
  - Intel Skylake CPU’s + Omni-Path Interconnect
  - Marvell ARM64 ThunderX2 + Mellanox HDR
  - AMD Rome CPU’s + Mellanox HDR Interconnect
  - Intel Cascade Lake-SP + Omni-Path Interconnect
  - Intel Cascade Lake-AP + Omni-Path Interconnect

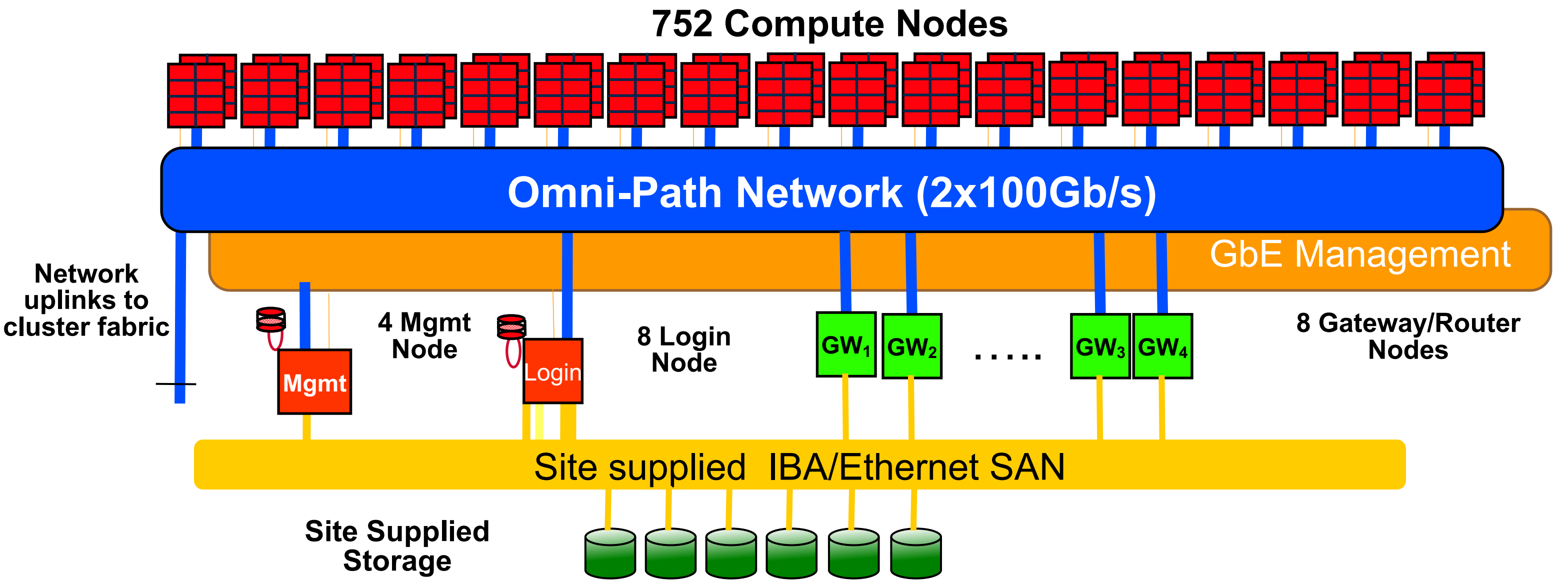
- Selected Intel Cascade Lake AP (CLX-AP) + Dual Omni-Path Interconnect

Magma is a Next-Generation CTS-1 System for the LLNL ASC Program

- 4 Scalable Units
- Intel Cascade Lake AP based nodes
- Intel Servers (4 node in 2U)
- CoolIT direct liquid cooling to CPUs and DIMMs – certified by Intel
- Dual-Rail Omni-Path Interconnect
- TOSS 3.5-x (same version as Jade)
- Delivered Nov 2019
- Operational Jan 2020

Magma 1st racks @ Penguin

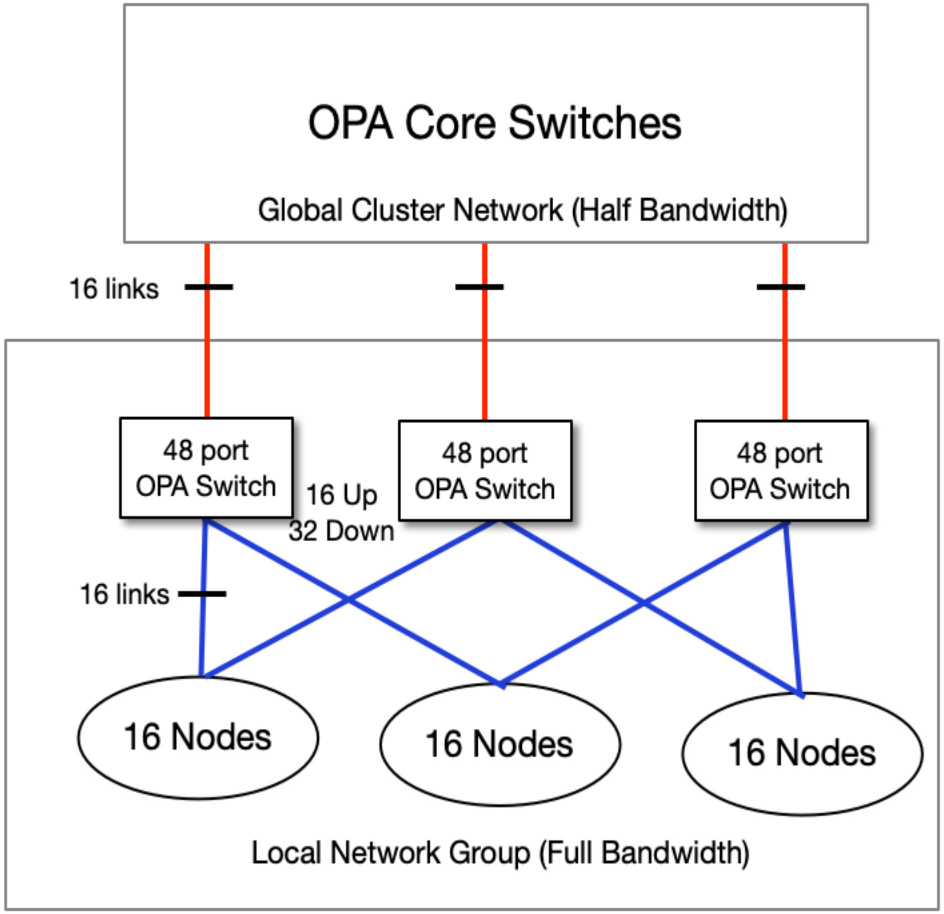
Magma Cluster Design



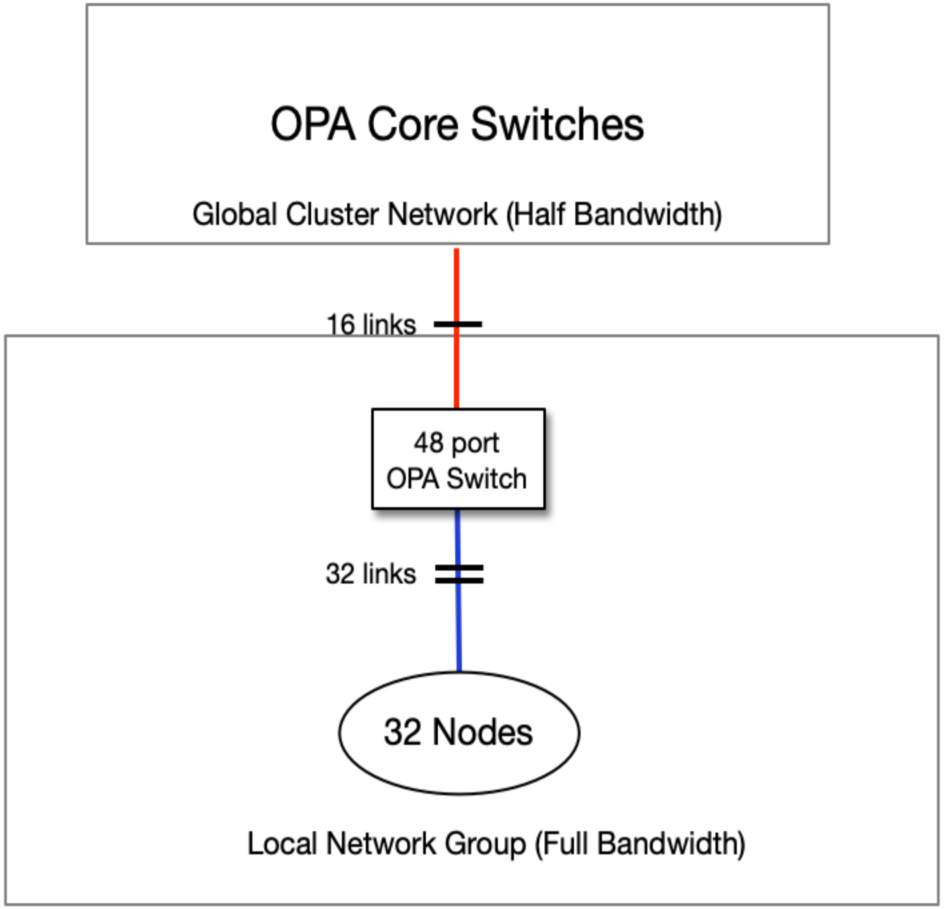
Magma Parameters (772 total nodes; 752 compute; 8 GW; 8 Login; 4 Mgmt)

- CLX-AP compute and login nodes
- CLX-SP gateway and management nodes
- Dual socket nodes; Total memory capacity 294 TB; 431 TB/s memory bandwidth
- 4 GB memory capacity per CPU core
- 5.6 PF/s theoretical peak FP64
- Over 73K cores

Magma Dual Rail Network Enables Large Local Groups



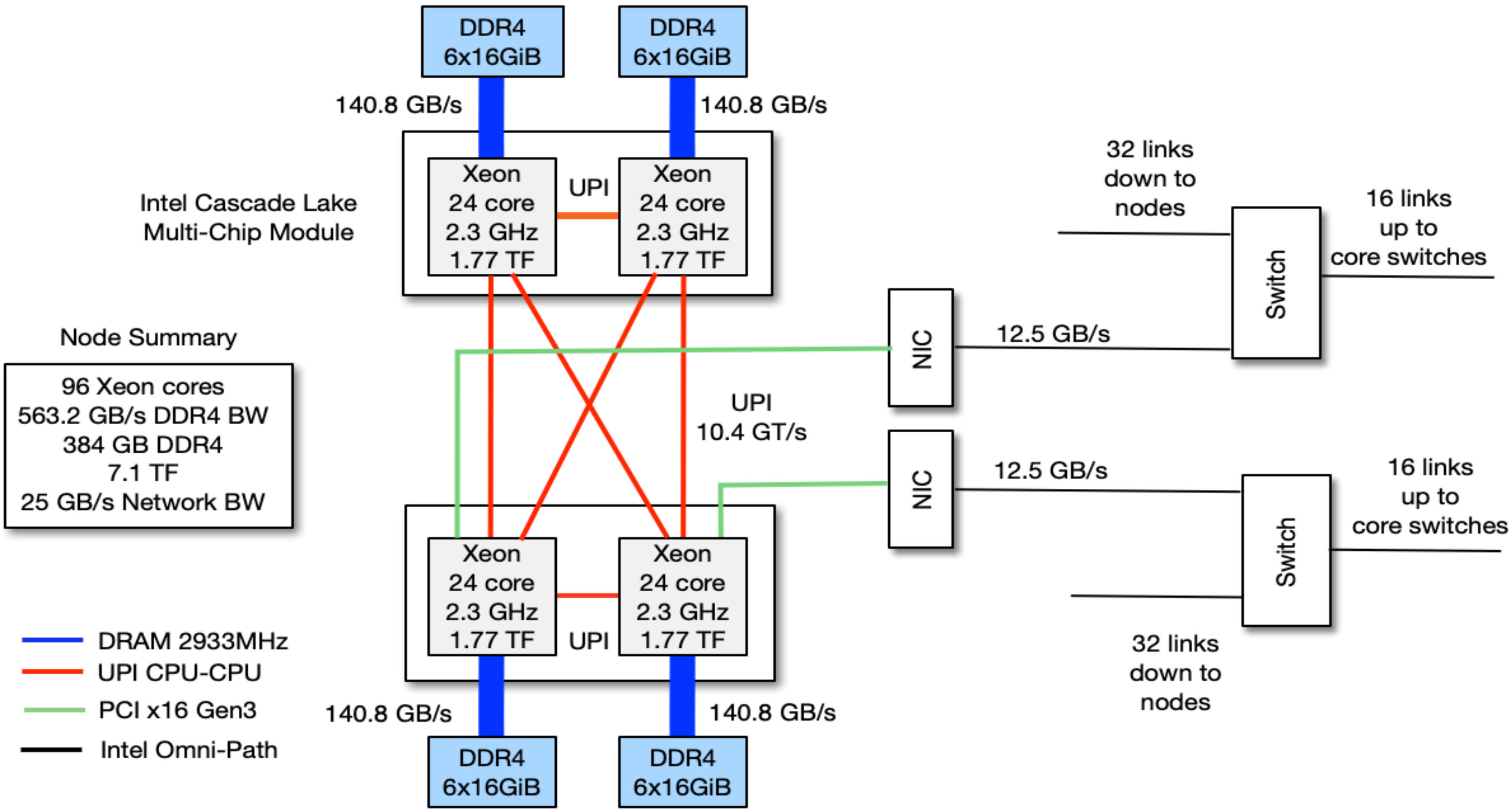
Magma Local Group:
48 nodes; 354 TF/s; 27 TB/s; 18.4 TB


OPA Core Switches
Global Cluster Network (Half Bandwidth)
16 links
48 port OPA Switch
32 links
32 Nodes
Local Network Group (Full Bandwidth)

CTS-1 Local Group:
32 nodes; 39 TF/s; 4.9 TB/s; 4 TB

Magma Node Level Architecture

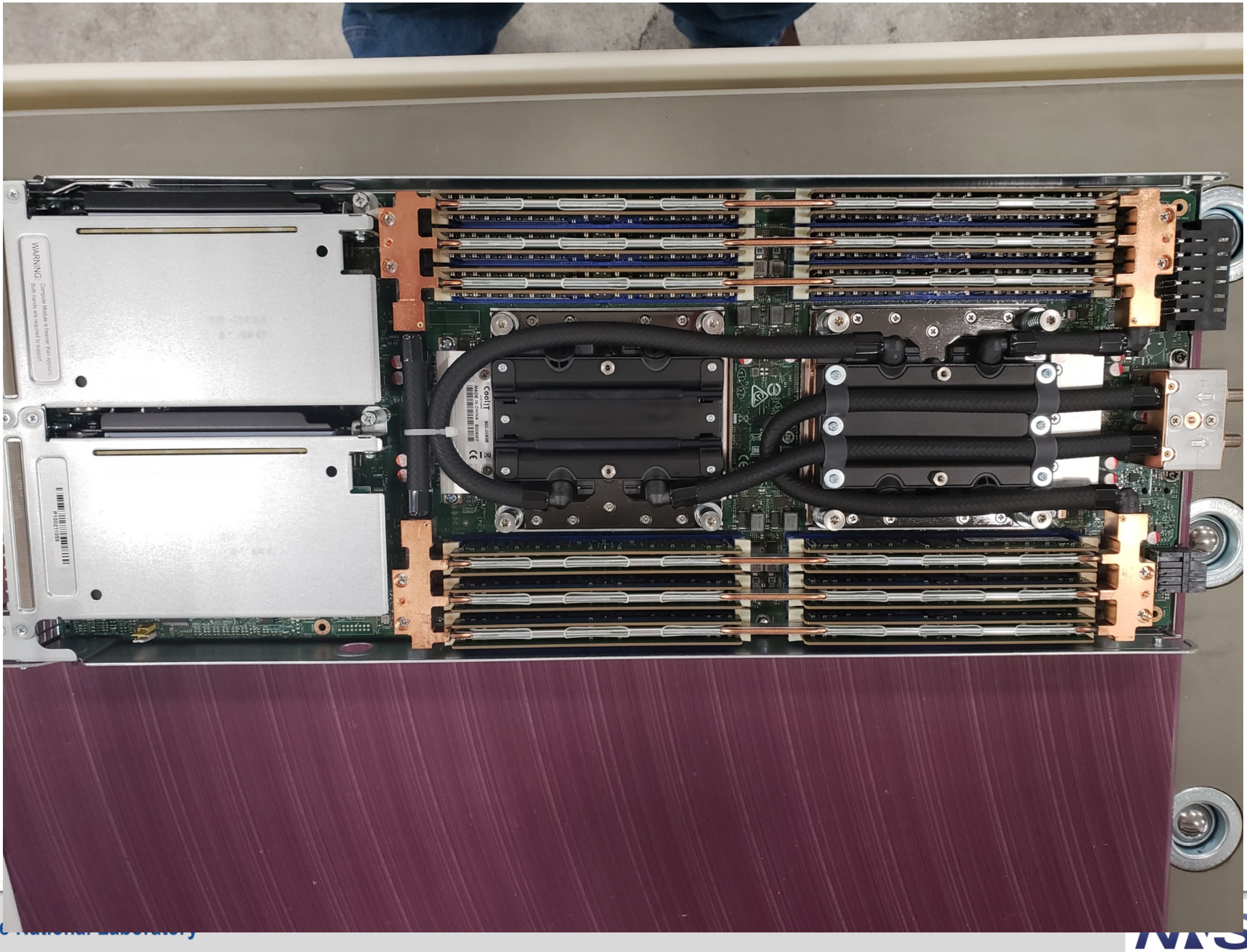
Magma Compute and Login Nodes:
Intel Xeon Cascade Lake Advanced Processor (CLX-AP)



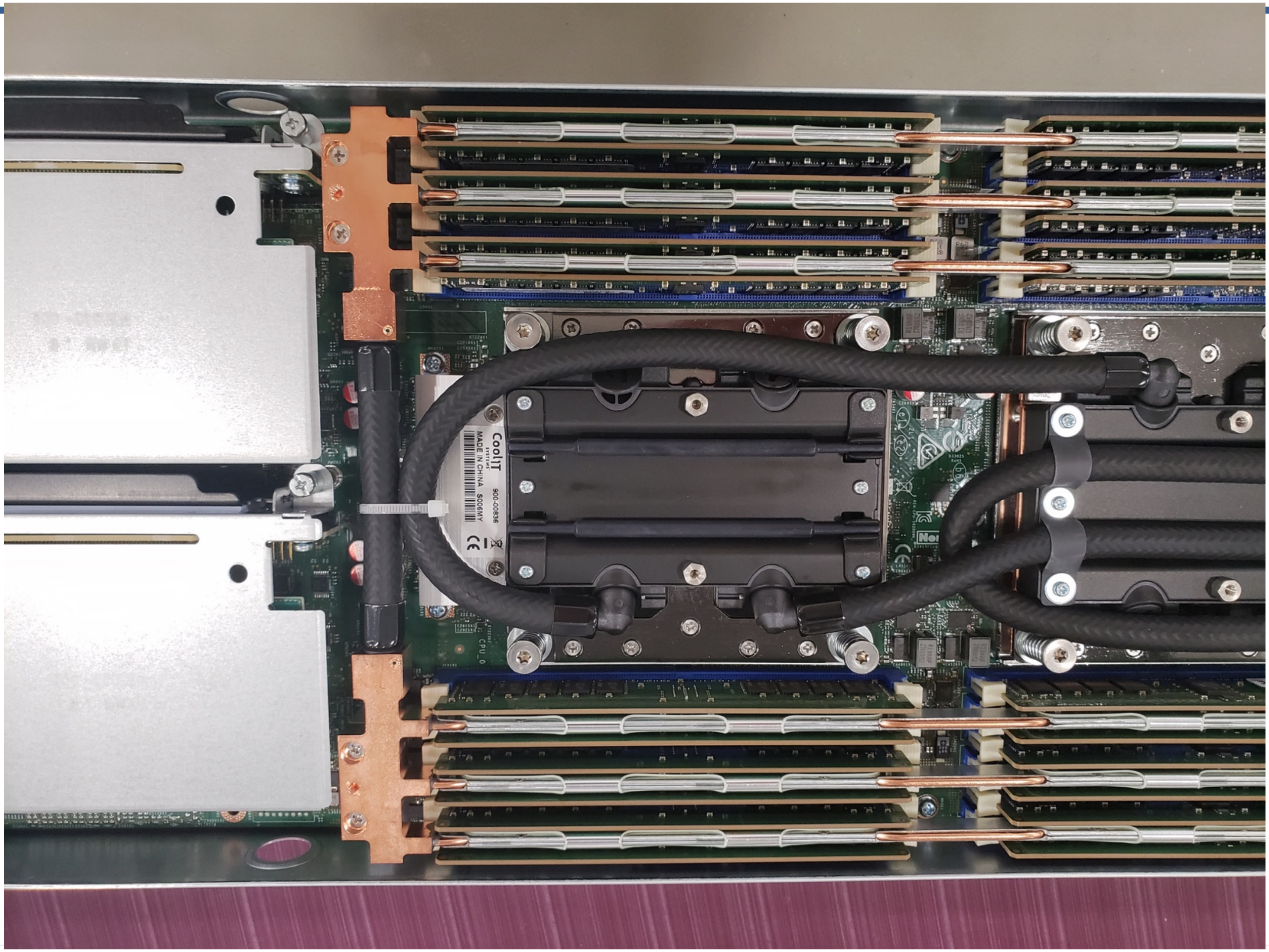
Node Summary

96 Xeon cores
563.2 GB/s DDR4 BW
384 GB DDR4
7.1 TF
25 GB/s Network BW

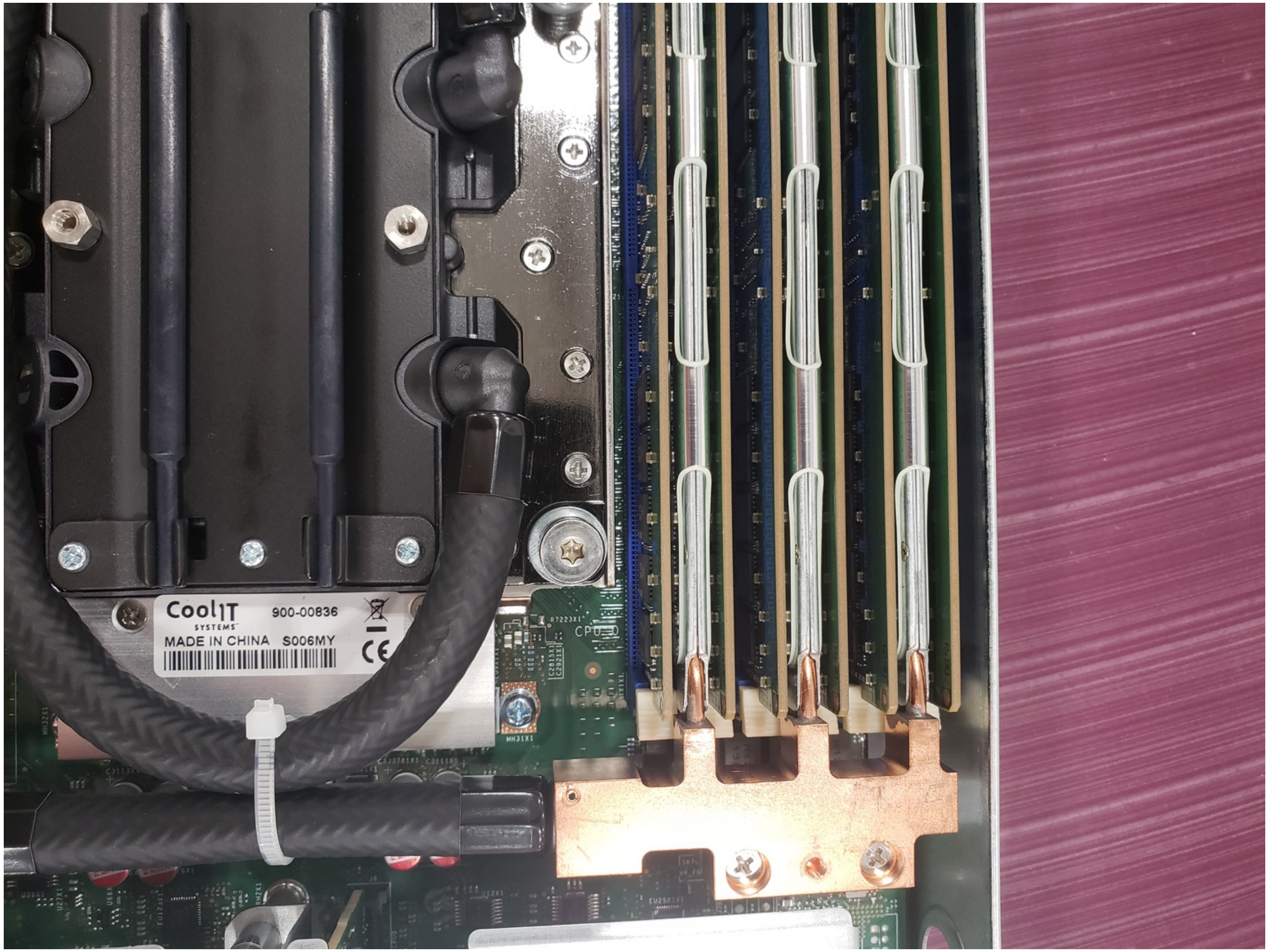
Magma Node Blade


WARNING
Compute Module is heavier than appears.
Both hands are required to support.
CoolIT

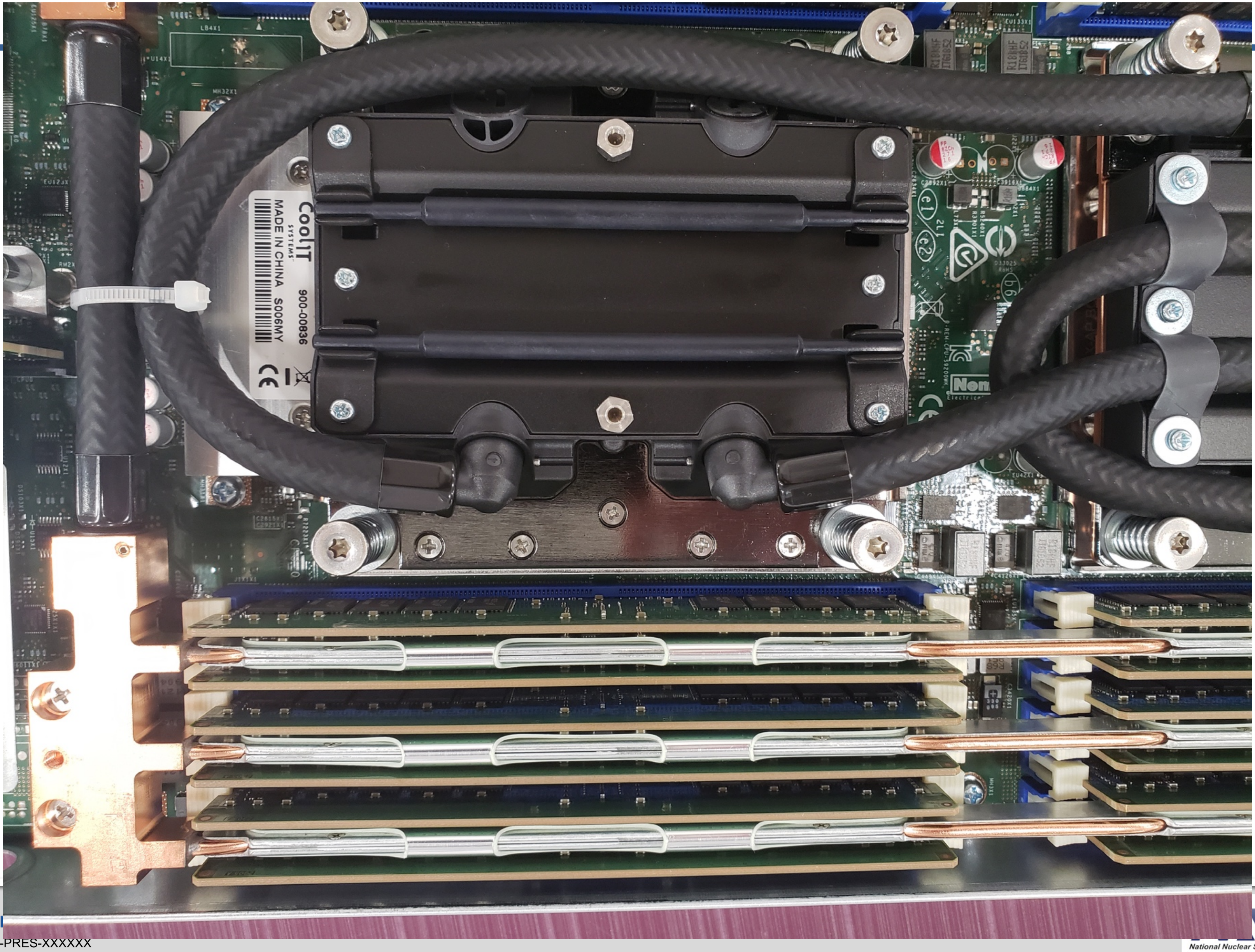
Magma Node Blade



Magma Node Blade



Magma Node Blade



Magma is a Significant Increase in ASC Capacity Computing

System	#Nodes	# Cores	Clock Rate (GHz)	PF/s
Magma	772	73.5K	2.3	5.3
Jade	2,688	96.8K	2.1	3.3

System	Memory Capacity (TB)	Memory Bandwidth (TB/s)	Network Injection BW (GB/s)	Network Bisection BW (TB/s)
Magma	294	431	25	9.6
Jade	344	413	12.5	16.8

Magma is nearly equivalent to another Jade system!

Questions on Magma?

Update on Commodity Technology Systems (CTS-2) Procurement

Ian Karlin and Matt Leininger

October 23, 2019

LLNL-PRES-798672

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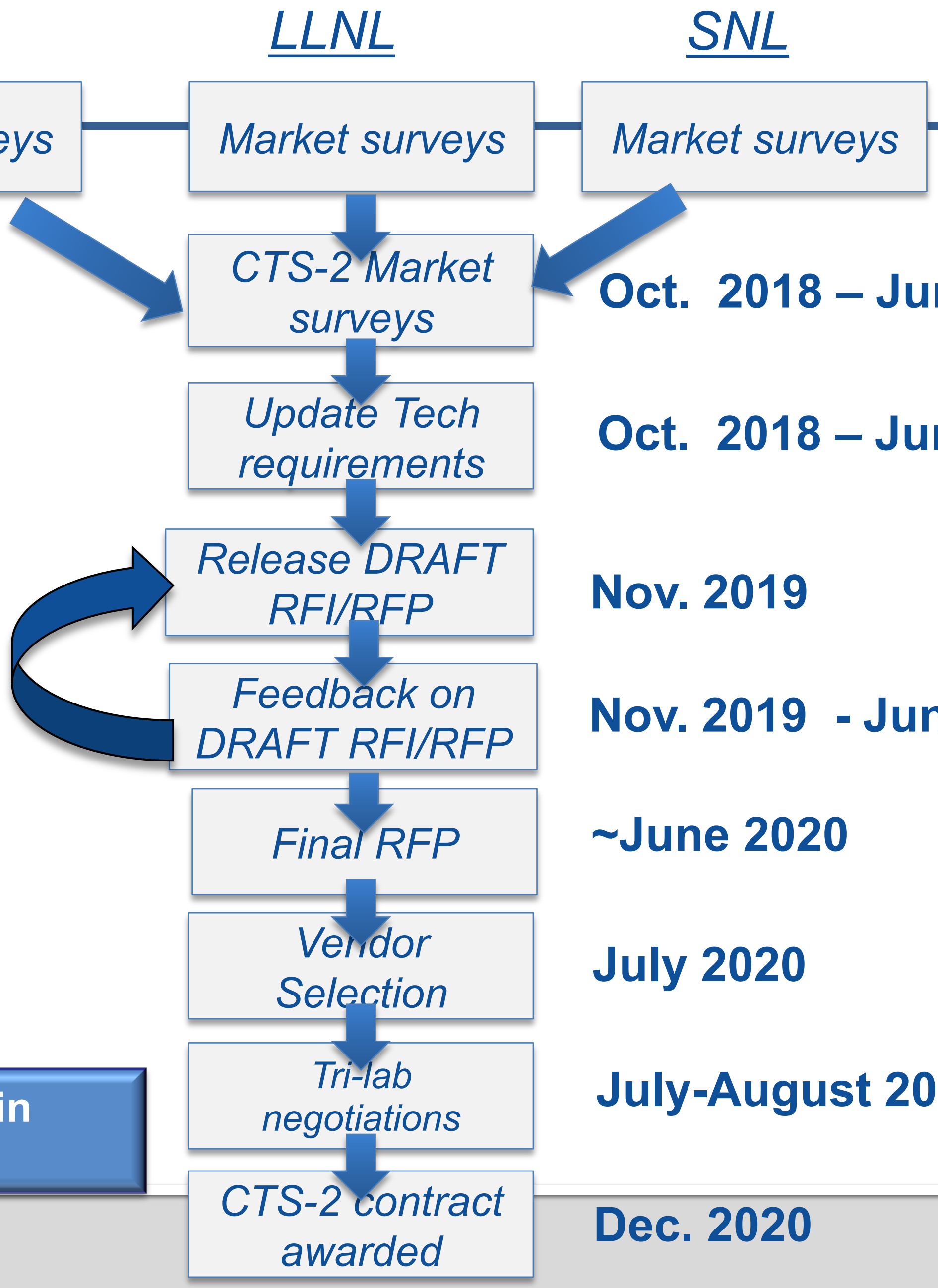
CTS-2 Activities Leading to RFP and Contract



LANL — *Market surveys*

LLNL — *Market surveys*

SNL — *Market surveys*

2018-2020

CTS-2 Market surveys — **Oct. 2018 – June 2020**

Update Tech requirements — **Oct. 2018 – June 2020**

Release DRAFT RFI/RFP — **Nov. 2019**

Feedback on DRAFT RFI/RFP — **Nov. 2019 - June 2020**

Final RFP — **~June 2020**

Vendor Selection — **July 2020**

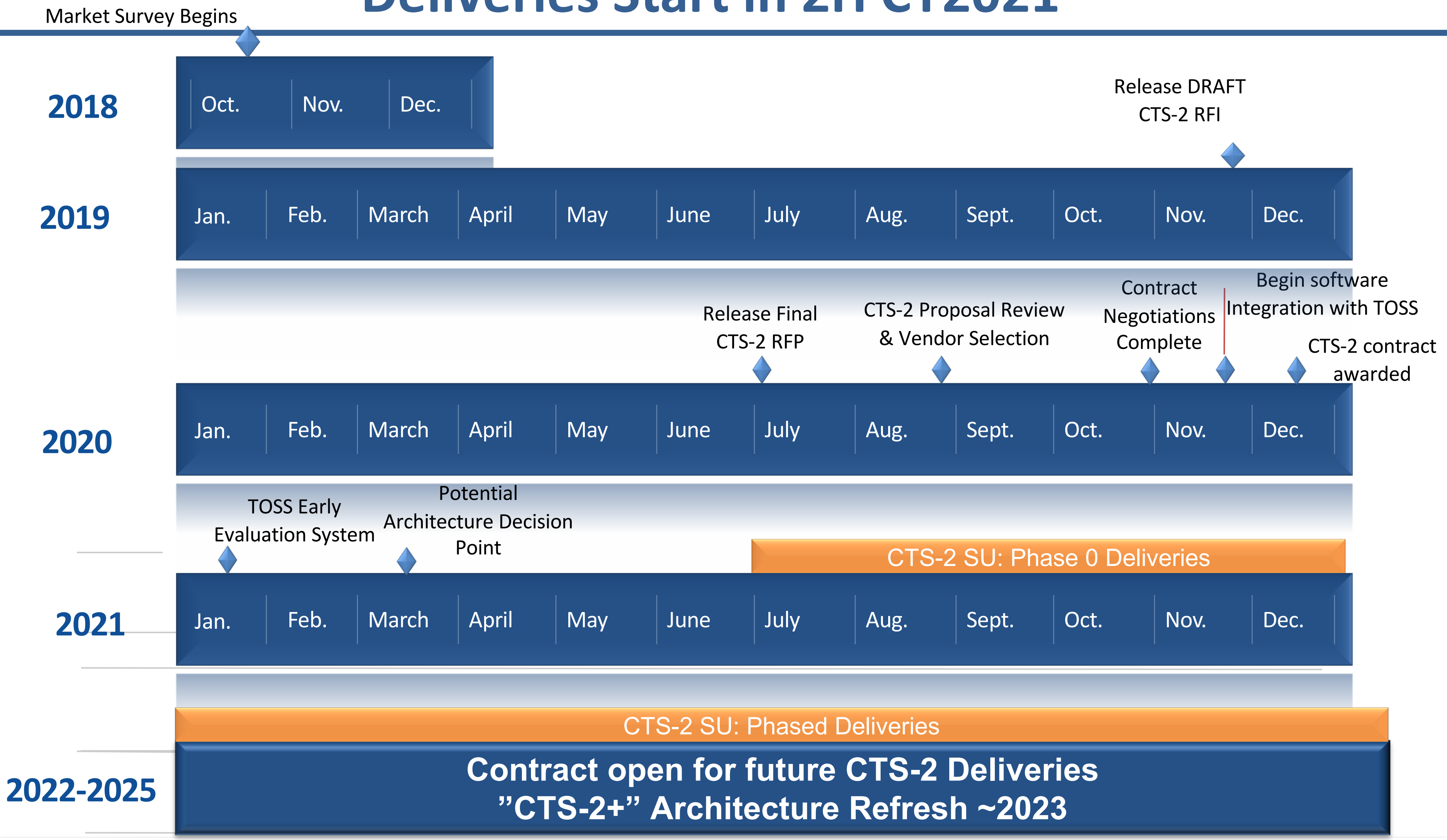
Tri-lab negotiations — **July-August 2020**

CTS-2 contract awarded — **Dec. 2020**

CTS-2 and TOSS teams continue to work together during CTS-2 deployment & lifetime support

Initial system deliveries in 2H CY2021

CTS-2 Procurement Timeline: Deliveries Start in 2H CY2021



Market Survey Begins

2018

Oct. Nov. Dec.

Release DRAFT CTS-2 RFI

2019

Jan. Feb. March April May June July Aug. Sept. Oct. Nov. Dec.

Release Final CTS-2 RFP

CTS-2 Proposal Review & Vendor Selection

Contract Negotiations Complete

Begin software Integration with TOSS

CTS-2 contract awarded

2020

Jan. Feb. March April May June July Aug. Sept. Oct. Nov. Dec.

TOSS Early Evaluation System

Potential Architecture Decision Point

CTS-2 SU: Phase 0 Deliveries

2021

Jan. Feb. March April May June July Aug. Sept. Oct. Nov. Dec.

CTS-2 SU: Phased Deliveries

2022-2025

Contract open for future CTS-2 Deliveries
”CTS-2+” Architecture Refresh ~2023

Multiple CPU Architectures are Viable for CTS-2

- Intel Xeon CPUs
  - Direct evolution of TLCC2 and CTS-1 CPUs
  - Mature software solutions and ecosystem
- AMD Epyc CPUs
  - Emerging as strong competitor to Intel Xeon
  - Many x86_64 tools already work
  - Compilers are still maturing with respect to performance
- Marvell ThunderX or Fujitsu (ARM64)
  - Also emerging as a strong competitor
  - Tools, compilers, and other software is still maturing
  - Learn from SNL Astra and LLNL ARM testbed experiences
- Power10
  - Typically supports very large memory per core!

Processor architecture & software readiness will be one key aspect of any CTS-2 selection

Data that will help us spend our money more effectively.

- What fraction of the workload today is 2D vs. 3D?
  - This is not number of jobs, but rather cycles used
  - Are there node counts below, which all jobs are 2D and above which all are 3D?
- Where do you think you are going in the future?
  - Past data shows job sizes are using about 2x the compute 4 years later. Is this 2x larger jobs or more strong scaled workloads?
- Are you more concerned about improving time to solution, total throughput, or something else?
  - Different designs will have different tradeoffs for each, some of which is workload dependent.
- Do you have a good understanding of typical zone counts or other parameters that would help us out?

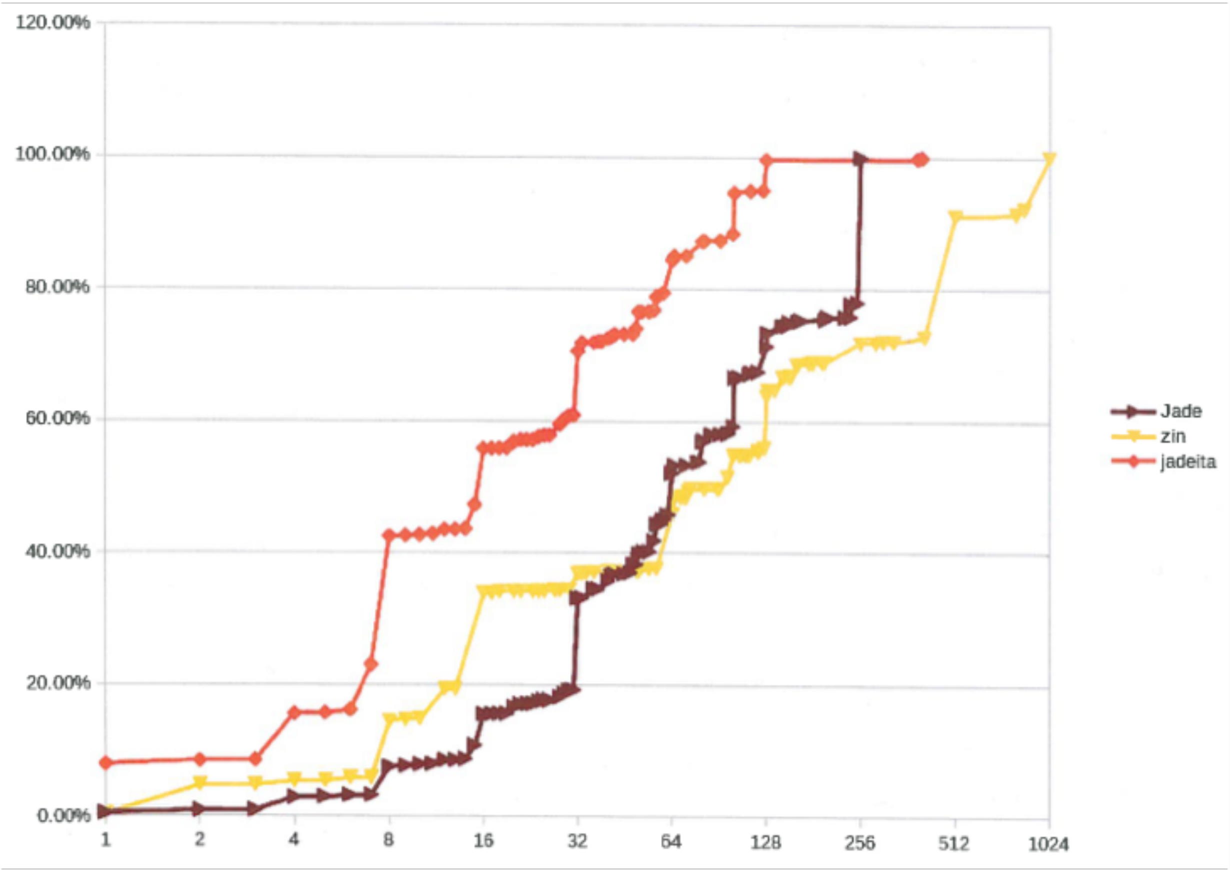
Next Steps

- Our goal is to provide the ASC program with sufficient data to make an informed decision on CTS-2 architectures
- Looking for your feedback
- Willing to meet with smaller groups/code teams/users
- We need to begin collecting data soon
- We can leverage LC data on job sizes, but need more
- Matt Leininger (matt@llnl.gov)
- Ian Karlin (karlin1@llnl.gov)

What are your biggest concerns for CTS-2?

Backup Slides

Machines are used differently are the workloads different?



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