

Storage solutions from the data center to the International Space Station



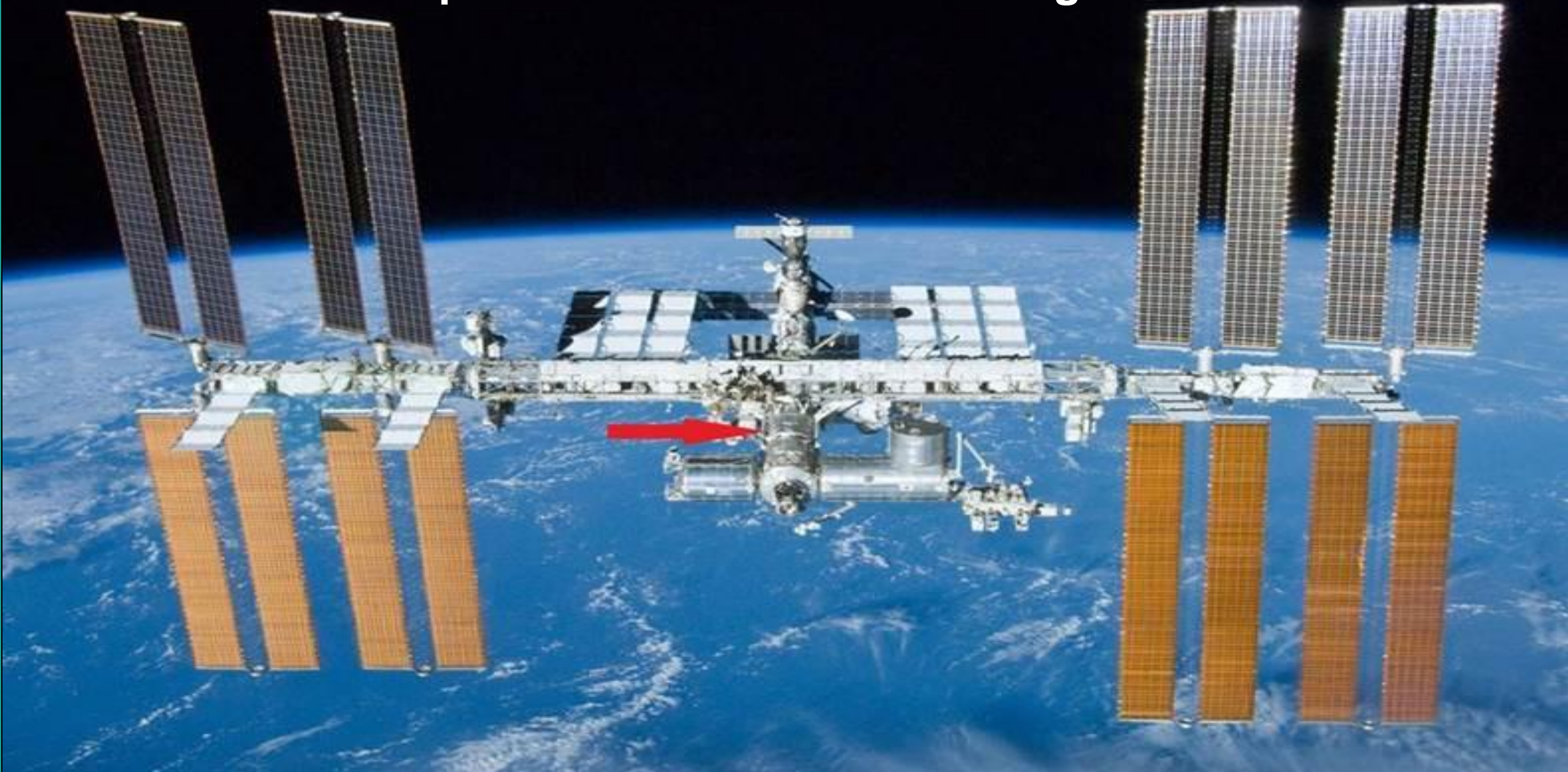
Mark R. Fernandez, Ph.D.

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Chief Scientist, Space Technologies and Solutions
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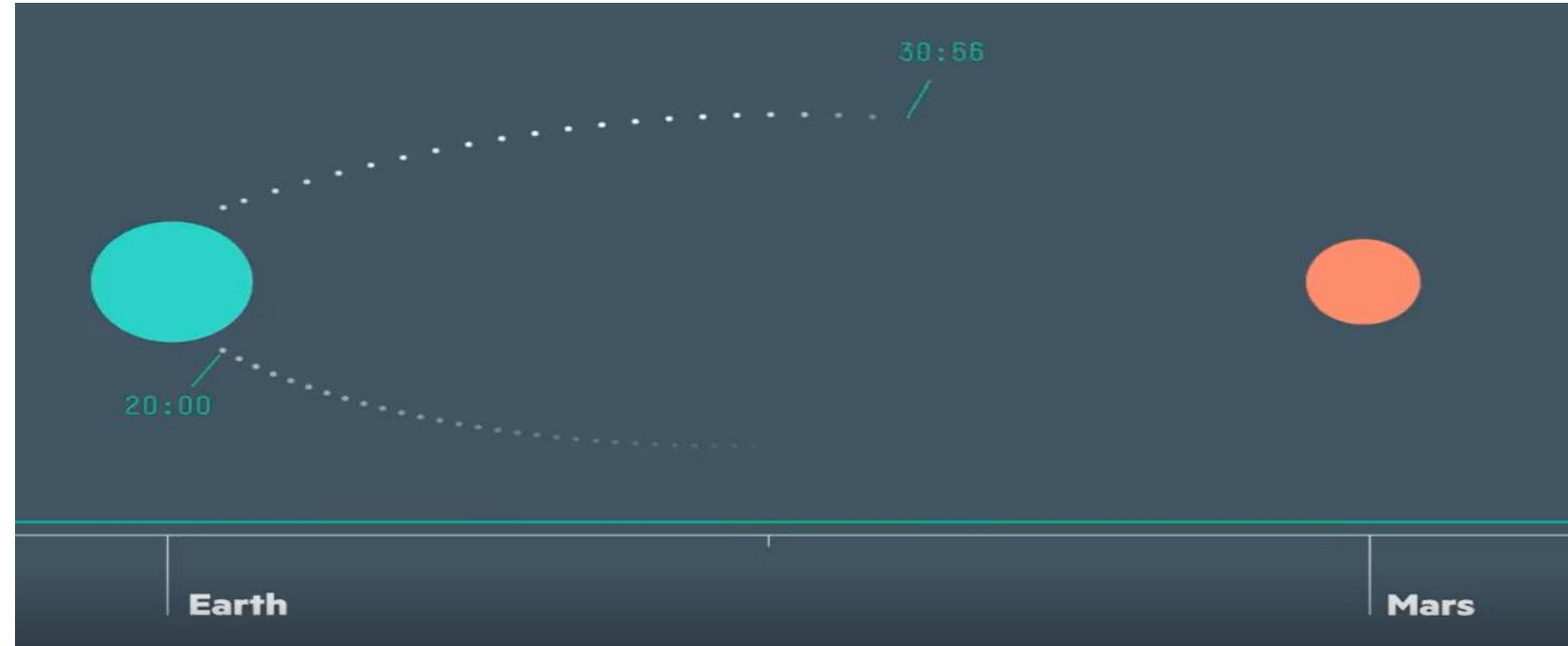
Spaceborne Computer: An “Out of this World” Data Center ... complete with KIOXIA SSD Storage



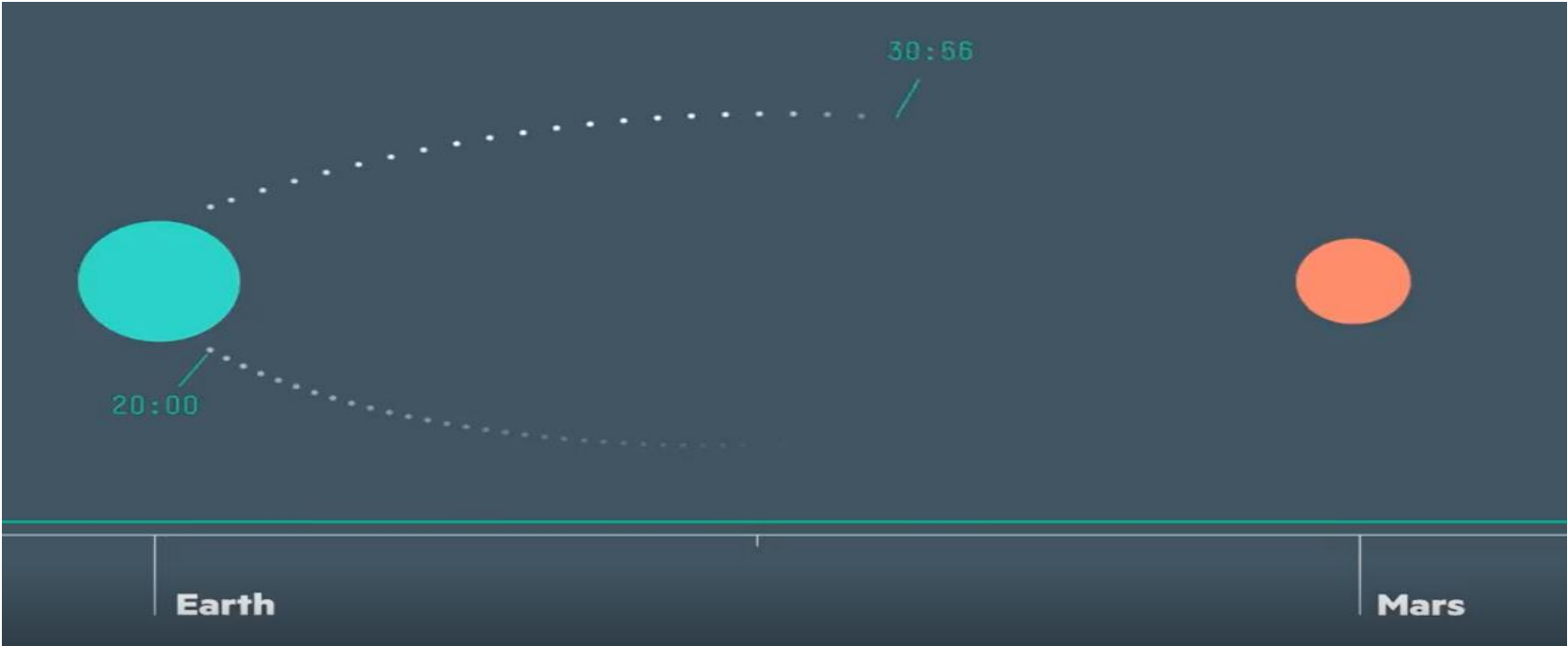
Flash Memory Summit



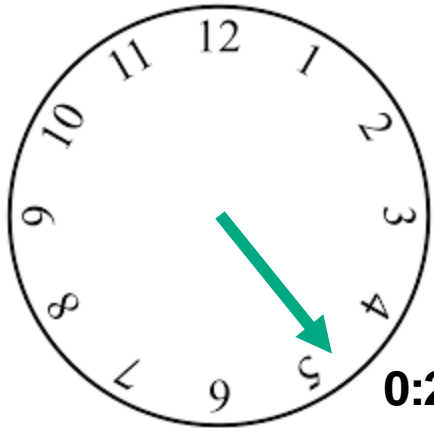
Spaceborne Computer: Objective / Mission: Why?



Spaceborne Computer: Objective / Mission: Why?

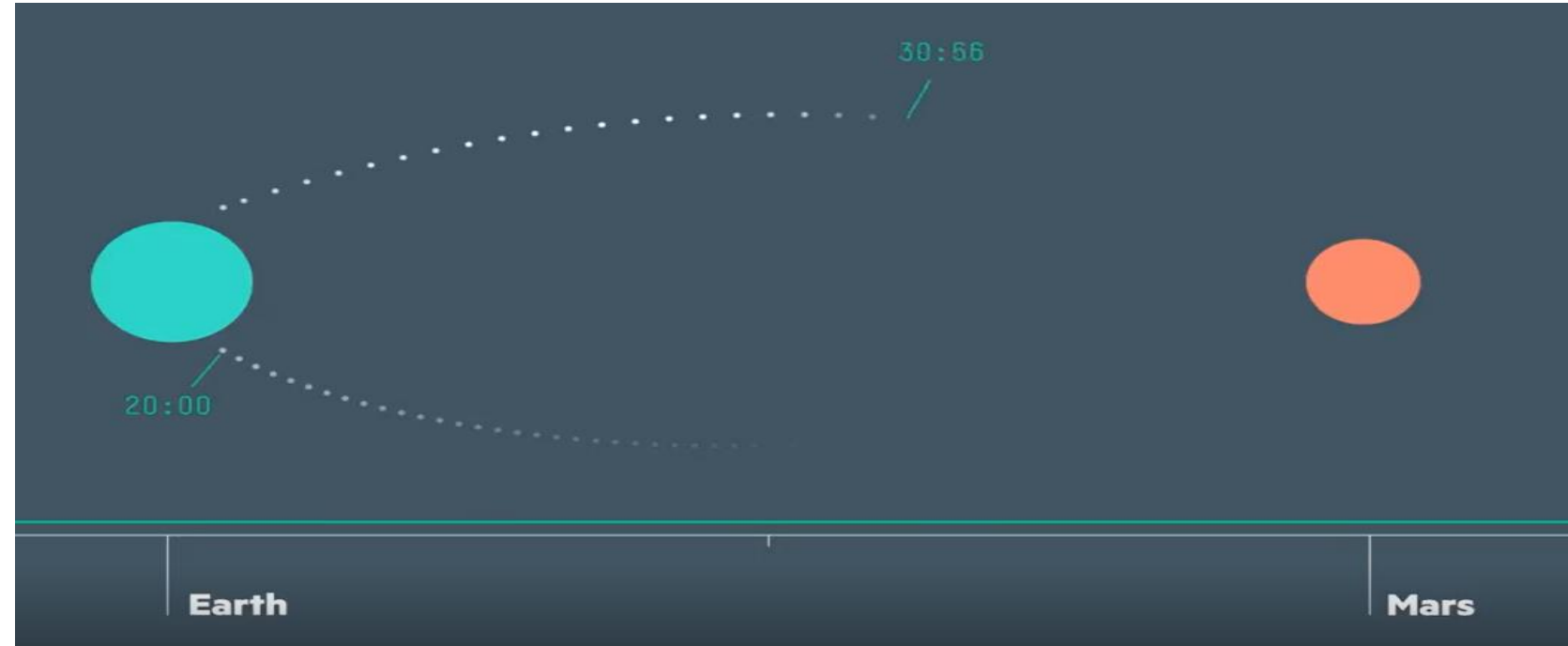


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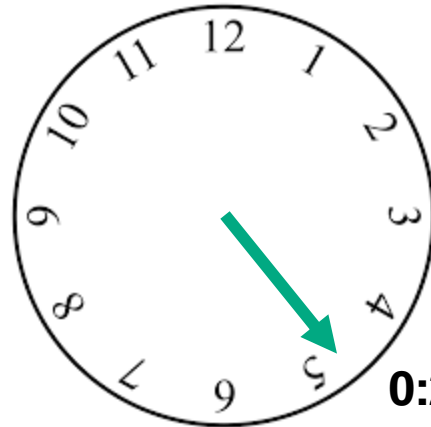


0:24:

Spaceborne Computer: Objective / Mission: Why?

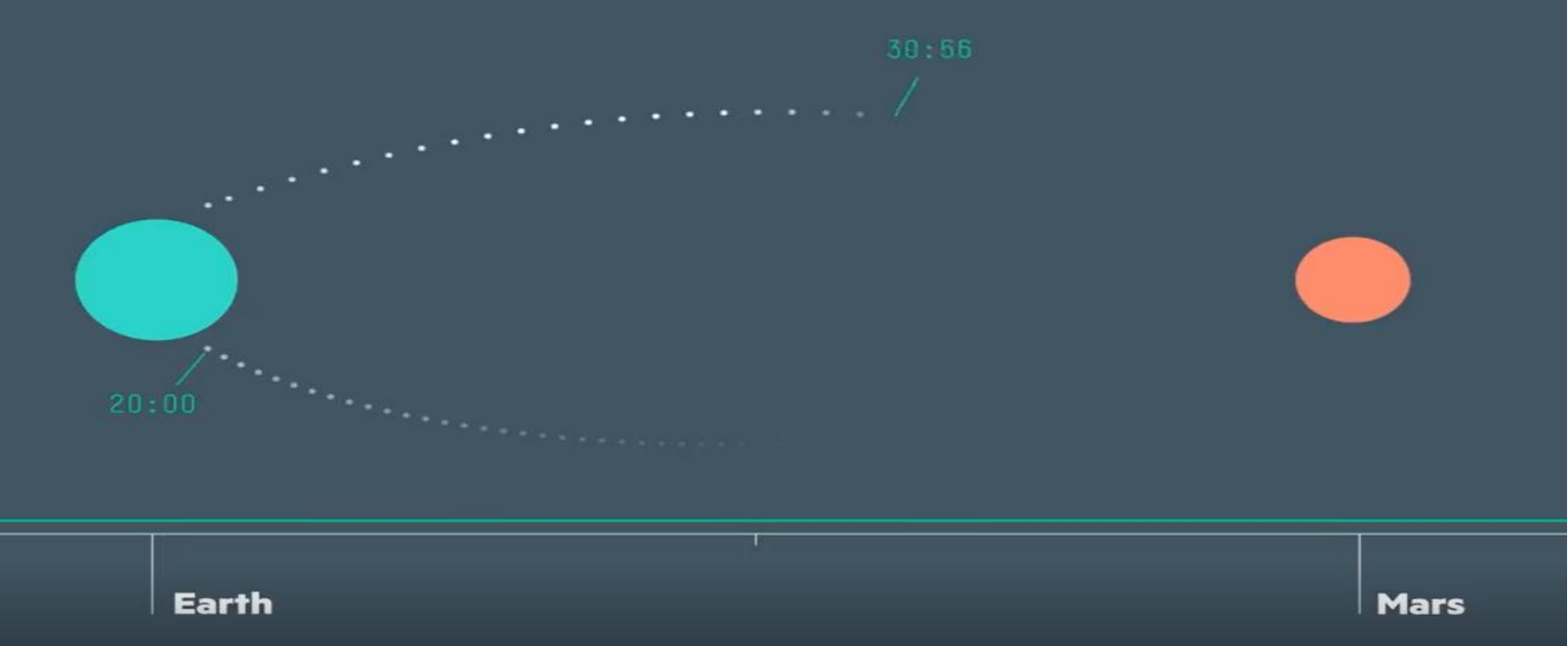


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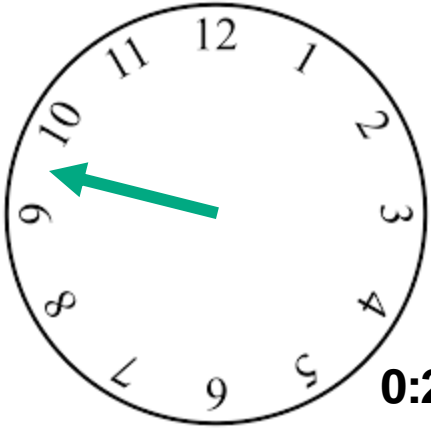


0:24: “Okay, Houston,
we’ve had a problem
here.”

Spaceborne Computer: Objective / Mission: Why?

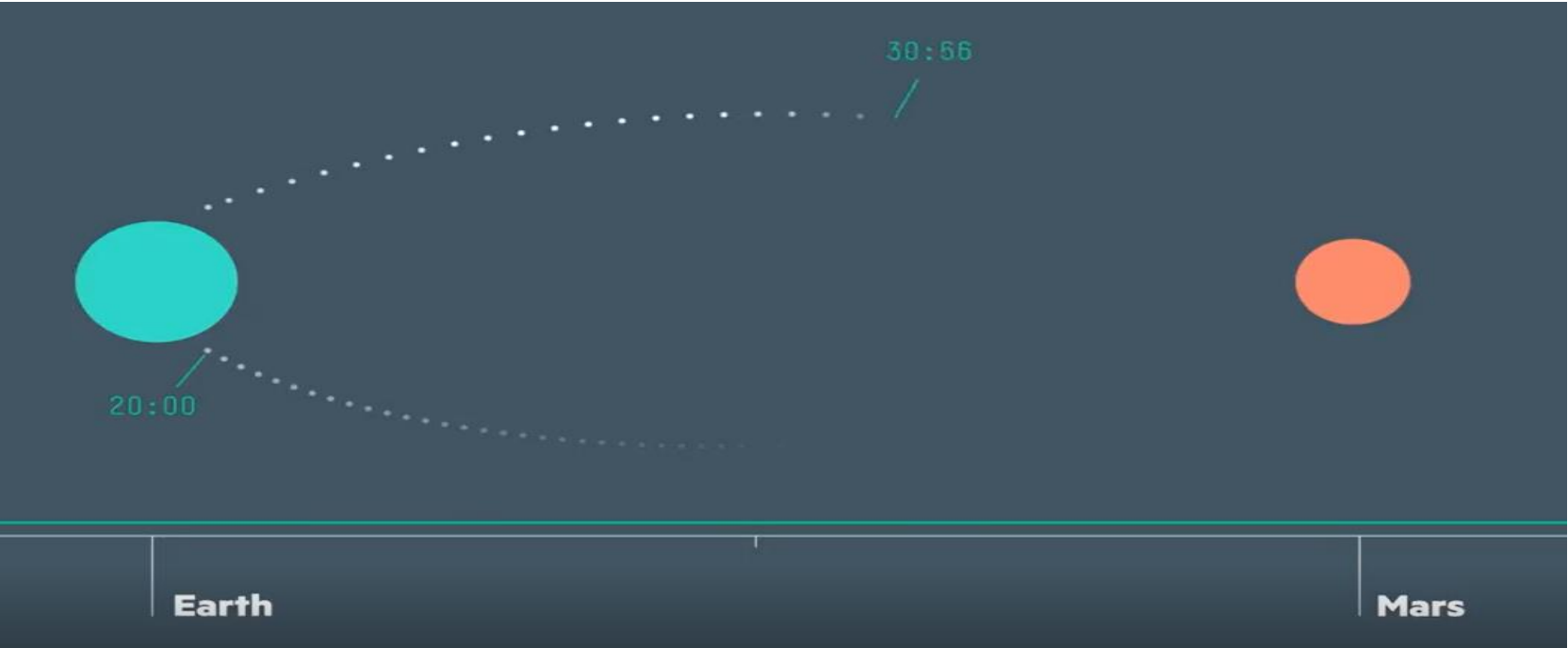


0:48:

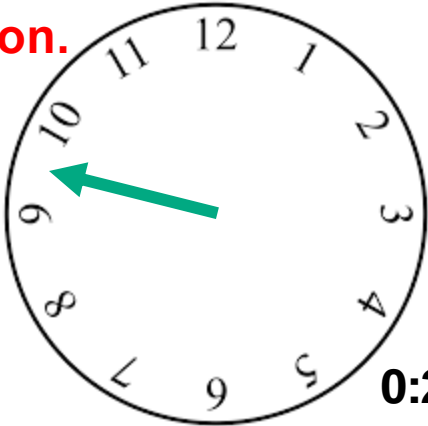


0:24: “Okay, Houston, we’ve had a problem here.”

Spaceborne Computer: Objective / Mission: Why?



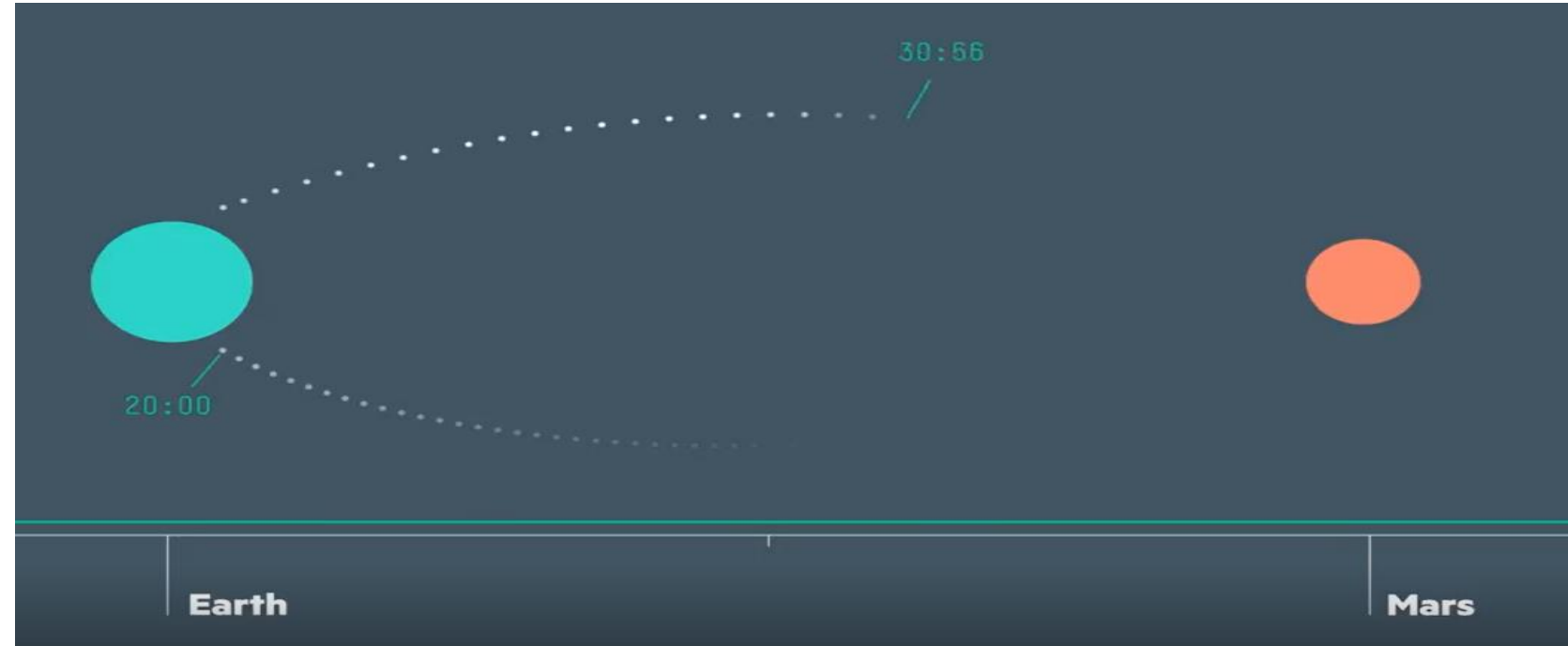
0:48: “This is Houston.
Say again, please.”



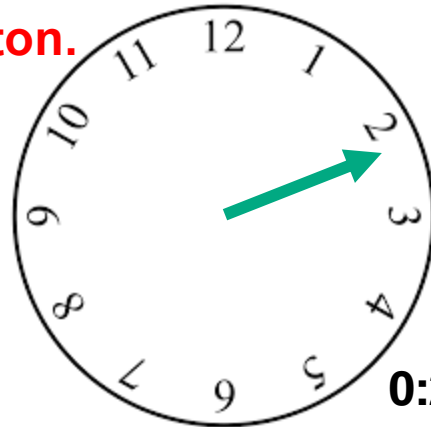
0:24: “Okay, Houston,
we’ve had a problem
here.”



Spaceborne Computer: Objective / Mission: Why?



0:48: **"This is Houston.
Say again, please."**



1:12: **"Houston,
we've had a problem."**

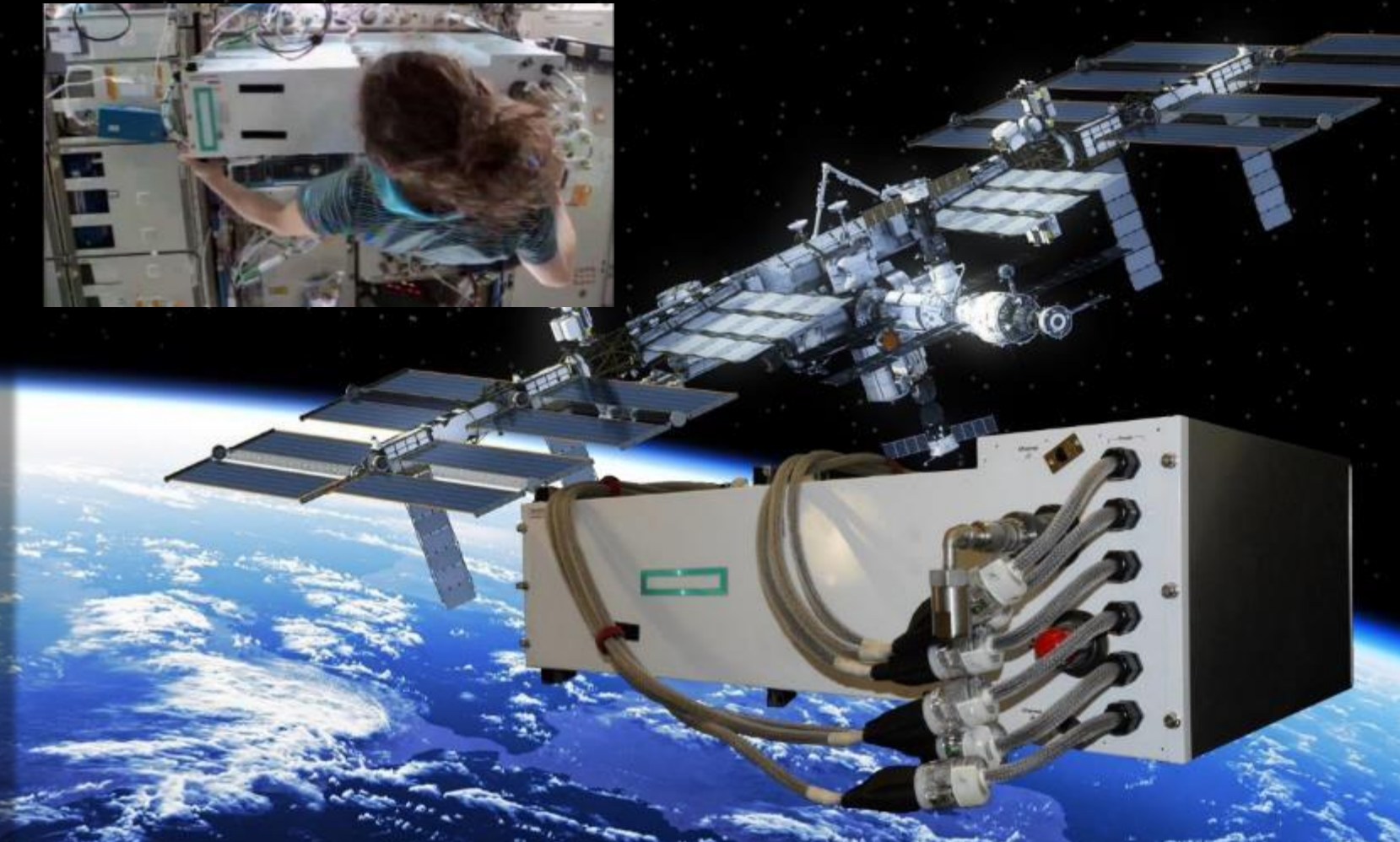
0:24: **"Okay, Houston,
we've had a problem
here."**



Spaceborne Computer: The Dawn of HPC And AI Above the Clouds

SBC-1: Launched on SpaceX CRS-12 on 08/14/2017 -- Flown for 1.8 years
9,562 orbits -- 6,879 SAA Passes -- 53,936 Experiments Completed -- All Successful

First COTS HPC System in Space (1.1TF HPL)



Next Mission: Spaceborne Computer-2

Launched: 20-Feb-2021, Northrop Grumman Resupply Mission to the ISS (NG-15)



Spaceborne Computer-2

Installed: 29-Apr-2021 (in the “overhead” of the Columbus Module)

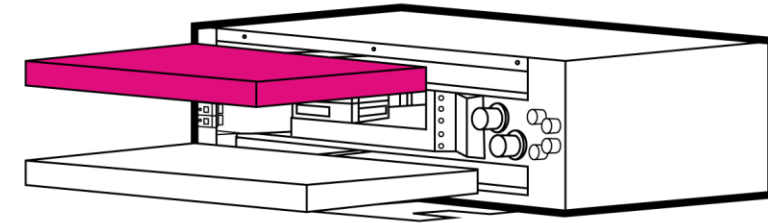


Spaceborne Computer-2: Hardware & Software



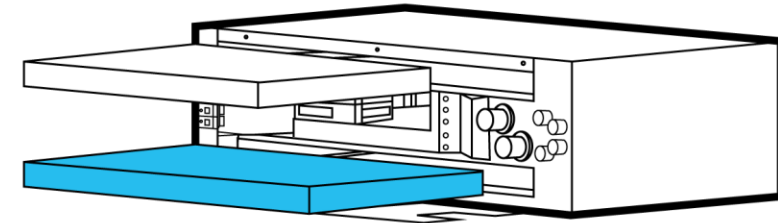
Hardware: HPE Edgeline EL4000
(edge-focused single socket with a single GPU)

- 1 x low wattage x86
- 1 x low wattage GPU
- 64 GB of memory total
- ➡ • **4 x 240GB solid state drives**
- 1 x 10GbE Ethernet adapter



Hardware: HPE DL360 Gen10 server
(traditional 2-socket HPC compute node)

- 2 x low wattage x86 processors
- 192 GB of memory total
- ➡ • **8 x 240GB solid state drives**
- 1 x 10Gb Ethernet Adapter



* Software: Red Hat 7.8 Operating System
NASA TReK 5.3.1

* Powered from 28Vdc
* Cooled by AAA & MTL

Spaceborne: Demonstrating the Value of Edge Storage & Computing

SBC-2 ISS Projects		Traditional Collect & Forward		SBC-2 Edge Storage & Computing		
Vertical	Edge Technologies	Raw Data Size	Original Download Time	SBC-2 Download Time	Output / "Insight" Size	Download Size Improvement
Life Sciences	GPU-enabled	2.8 GB 2,816,431 KB	"about 18 hours"	~2 secs	92 KB	30,000X
Life Sciences	Hybrid CPU-GPU multistep workflow	22 GB 22,702,059 KB	"days to weeks"	~11 secs	235 KB	93,000X
Image Processing QA/QC	GPU-enabled AI/ML model	899 MB 898,896 KB	"about a day"	<1 sec	5 KB	179,000X
Image Processing Feature Extraction	AI/ML model	299 Photos 5.5GB of .NEF	"about 6 hours"	~7 minutes	100 MB	98% Reduction
Feature Extraction	Docker Containers (updates)	5GB image (tar.gz)	383 min. (over 6 hours)	~2 secs (upload)	50 KB "patch" (upload)	99% Reduction (upload)

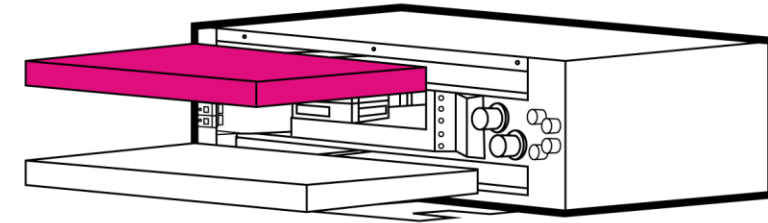
Proven in Space – Available on Earth™

Spaceborne Computer-2: Hardware & Software Refresh



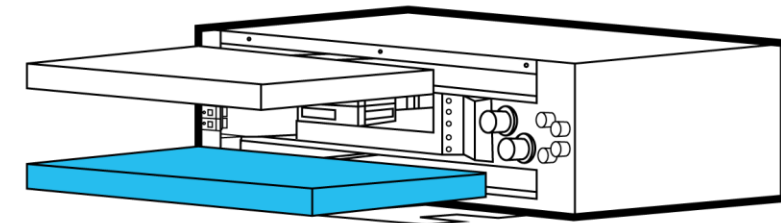
Hardware: HPE Edgeline EL4000
(edge-focused single socket with a single GPU)

- 1 x low wattage x86
- 1 x low wattage GPU
- 64 GB of memory total
- ➔ • **4 x 1024 GB KIOXIA XG6 M.2 SSDs**
- 1 x 10GbE Ethernet adapter



Hardware: HPE DL360 Gen10 server
(traditional 2-socket HPC compute node)

- 2 x low wattage x86 processors
- 192 GB of memory total
- ➔ • **8 x 960 GB KIOXIA RM6 2.5" SSDs**
- 1 x 10Gb Ethernet Adapter



* Software: Red Hat 7.8 Operating System
NASA TReK 5.3.1

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Spaceborne: Demonstrating the Value of Edge Storage & Computing ... requires Data Generated at the Edge to be Stored at the Edge

KIOXIA

Storage Solutions from
the Edge to the Cloud

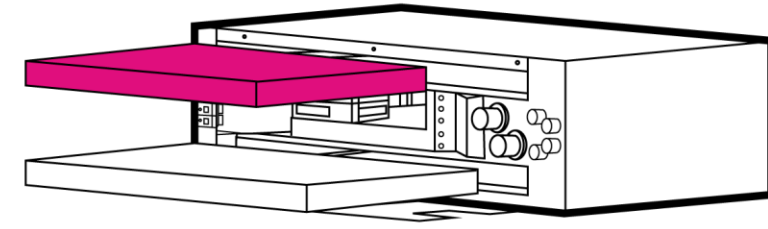
- ✓ Completed FA on SBC-1 SSDs
- ✓ Design Assistance for Future Missions
- ✓ New SSDs in SBC-2 Locker-1!!!

Spaceborne Computer-2: **Hardware & Software Refresh !**



Hardware: HPE Edgeline EL4000
(edge-focused single socket with a single GPU)

- 1 x low wattage x86
- 1 x low wattage GPU
- 64 GB of memory total
- ➔ • **4 x 1024 GB KIOXIA XG6 M.2 SSDs**
- 1 x 10GbE Ethernet adapter

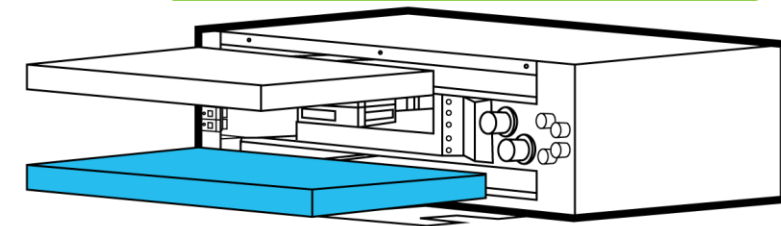


Upgraded with:

- **4 x KIOXIA PM6
30.72 TB SSDs**
- **> 120TB storage**

Hardware: HPE DL360 Gen10 server
(traditional 2-socket HPC compute node)

- 2 x low wattage x86 processors
- 192 GB of memory total
- ➔ • **4 x 960 GB KIOXIA RM6 2.5" SSDs**
- ➔ • **4 x 30.72 TB KIOXIA PM6 2.5" SSDs**
- 1 x 10Gb Ethernet Adapter



* Software: Red Hat 7.8 Operating System
NASA TReK 5.3.1

* Powered from 28Vdc
* Cooled by AAA & MTL



**Hewlett Packard
Enterprise**

KIOXIA

Thank you!

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Thanks and Acknowledgments



NASA ISS-NL CASIS

HPE SBC-2 TeamOfSeven++

1. Dave Petersen, PD for Hardware
2. John Kichury, Chief Software Developer
3. Mike Scott, Mechanical Design
4. Robert Behringer, Safety Engineer
5. Calandra Szulgit, Technical Writer
6. Carrie Knox, Systems Administrator
7. Mark Fernandez, PI & Software PD

8. Ben Bennett, Business Development
9. Norm Follett, Marketing
10. Nahren Khizeran, Communications
11. Eng Lim Goh, PI SBC