FUTURE COMPUTING ARCHITECTURES FOR SIGNAL PROCESSING, AI, AND AUTONOMY FOR SPACE VEHICLES

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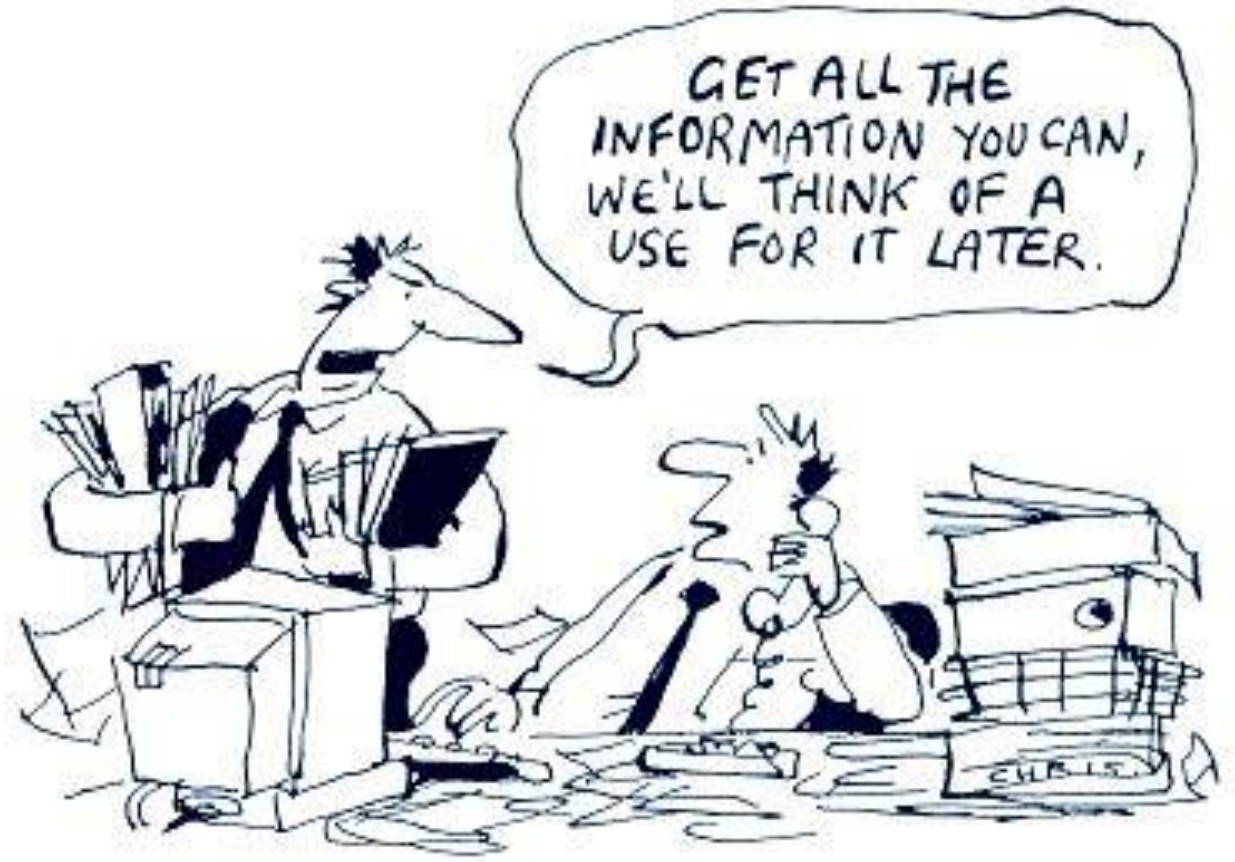
Senior Solutions Architect – NVIDIA Federal Team

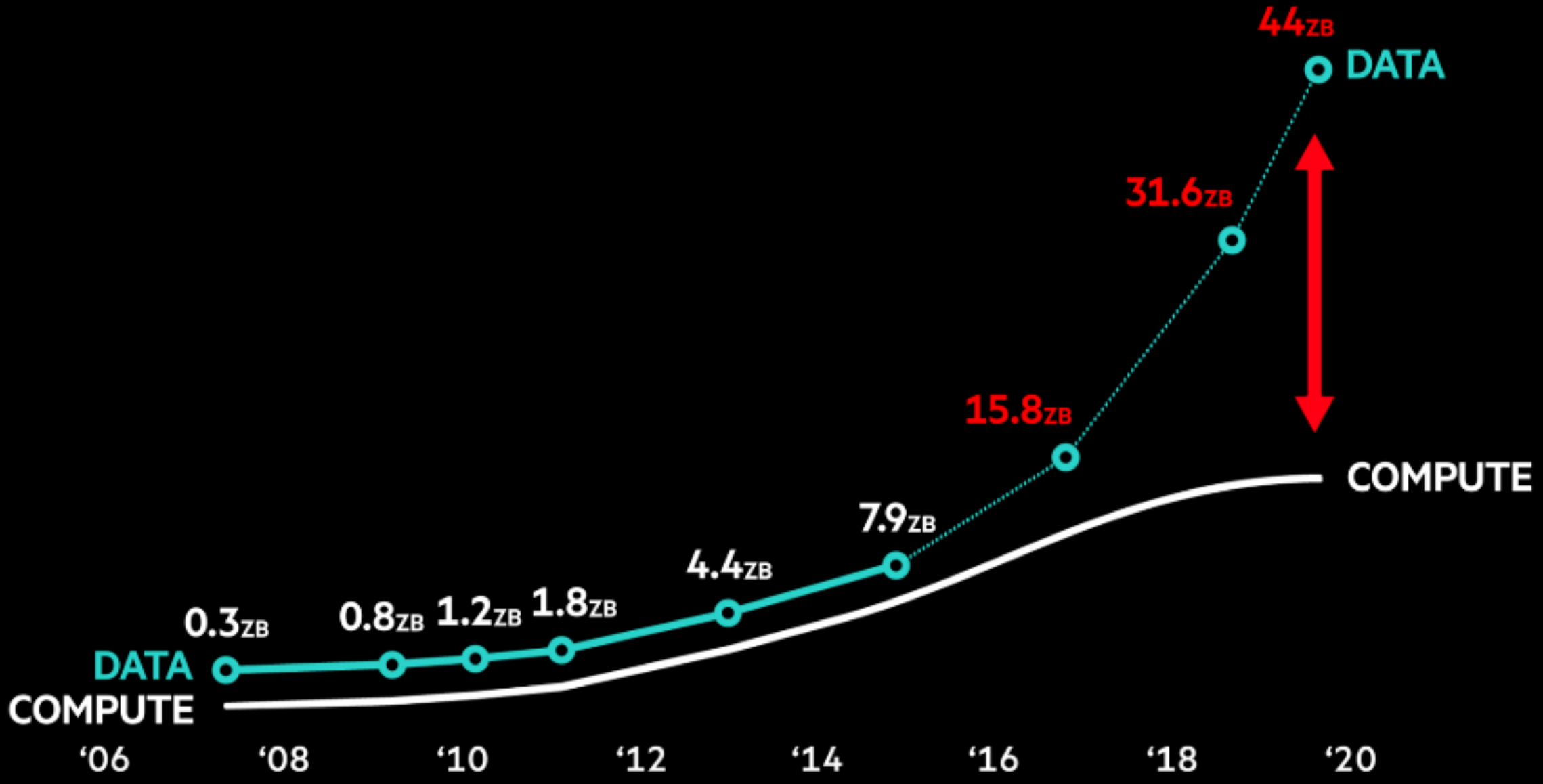
Nebulae: Deep-Space Computing Clouds



Research from the International Data Corporation estimates a compound annual growth rate of 65% for digital data

It is expected that in the year 2025 that data will be generated at the rate of 1.75 megabytes per person per second.

Patrizio, A. (2019). IDC: Expect 175 zettabytes of data worldwide by 2025. [online] Network World. Available at: https://www.networkworld.com/article/3325397/idc-expect-175-zettabytes-of-data-worldwide-by-2025.html [Accessed 23 Aug. 2019].


44ZB
DATA
31.6ZB
15.8ZB
COMPUTE
7.9ZB
4.4ZB
0.3ZB
0.8ZB
1.2ZB
1.8ZB
DATA
COMPUTE
‘06
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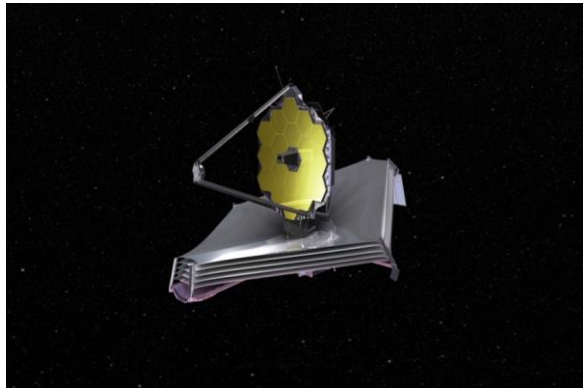
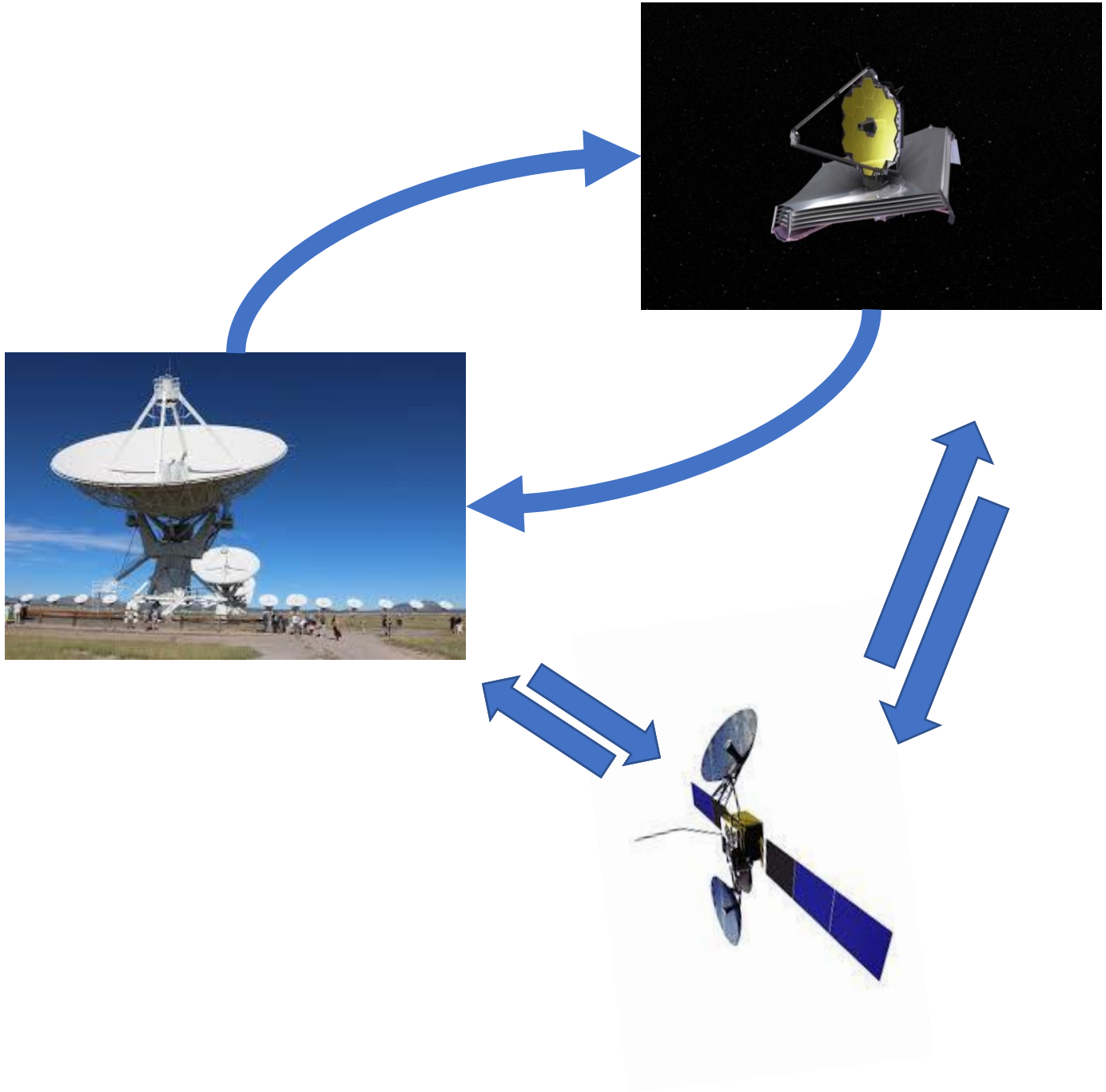
‘20

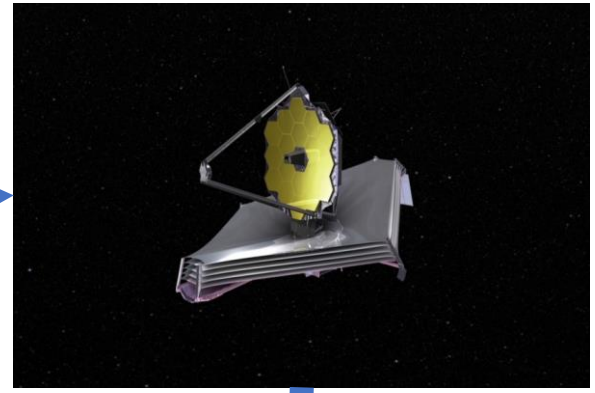
*"For NASA EO data, a commercial public cloud offers advantages to data users. For one, a commercial system **allows non-NASA users to access NASA-managed archives without the need to download data**—an important consideration for enabling research using the tremendous EOSDIS archive."*

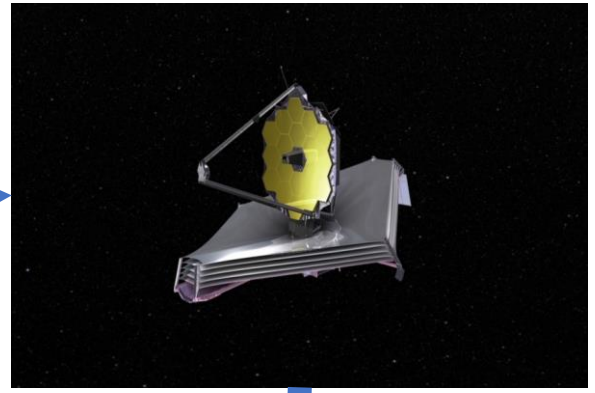
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cumulative Archive Size (PB)	15.0	17.7	21.6	26.8	32.0	37.2	55.6	103.4	151.1	198.9	246.6
Archive Growth Rate (PB)	2.6	2.8	3.9	5.2	5.2	5.2	18.4	47.7	47.7	47.7	47.7

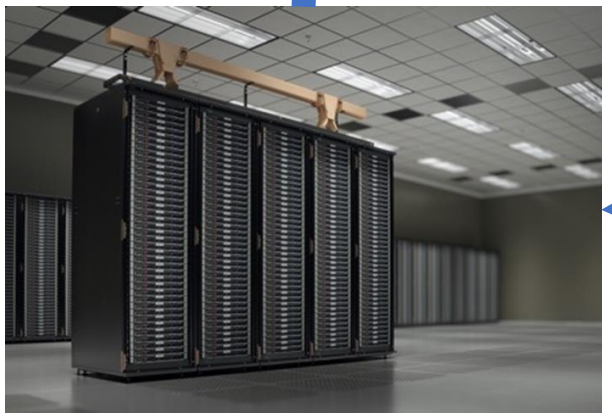
Earthdata.nasa.gov. (2019). *EOSDIS Cloud Evolution | Earthdata*. [online] Available at: https://earthdata.nasa.gov/eosdis/cloud-evolution [Accessed 25 Aug. 2019].





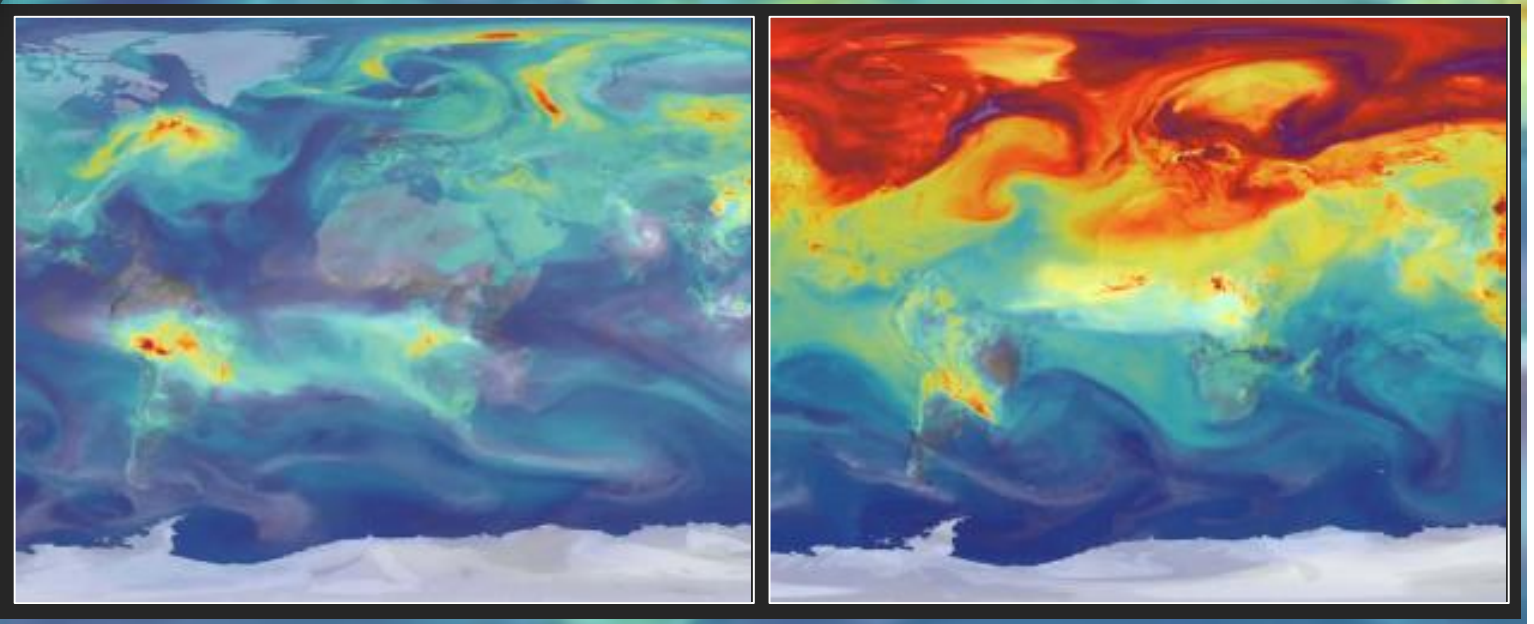






AN AI MONITOR OF EARTH'S VITALS

NASA Ames uses satellite imagery to measure the effects of carbon and greenhouse gas emissions on the planet. They developed DeepSat—a deep learning framework for satellite image classification trained on a GPU-powered supercomputer. The enhanced satellite imagery will help scientists plan how to protect ecosystems and improve crop production.



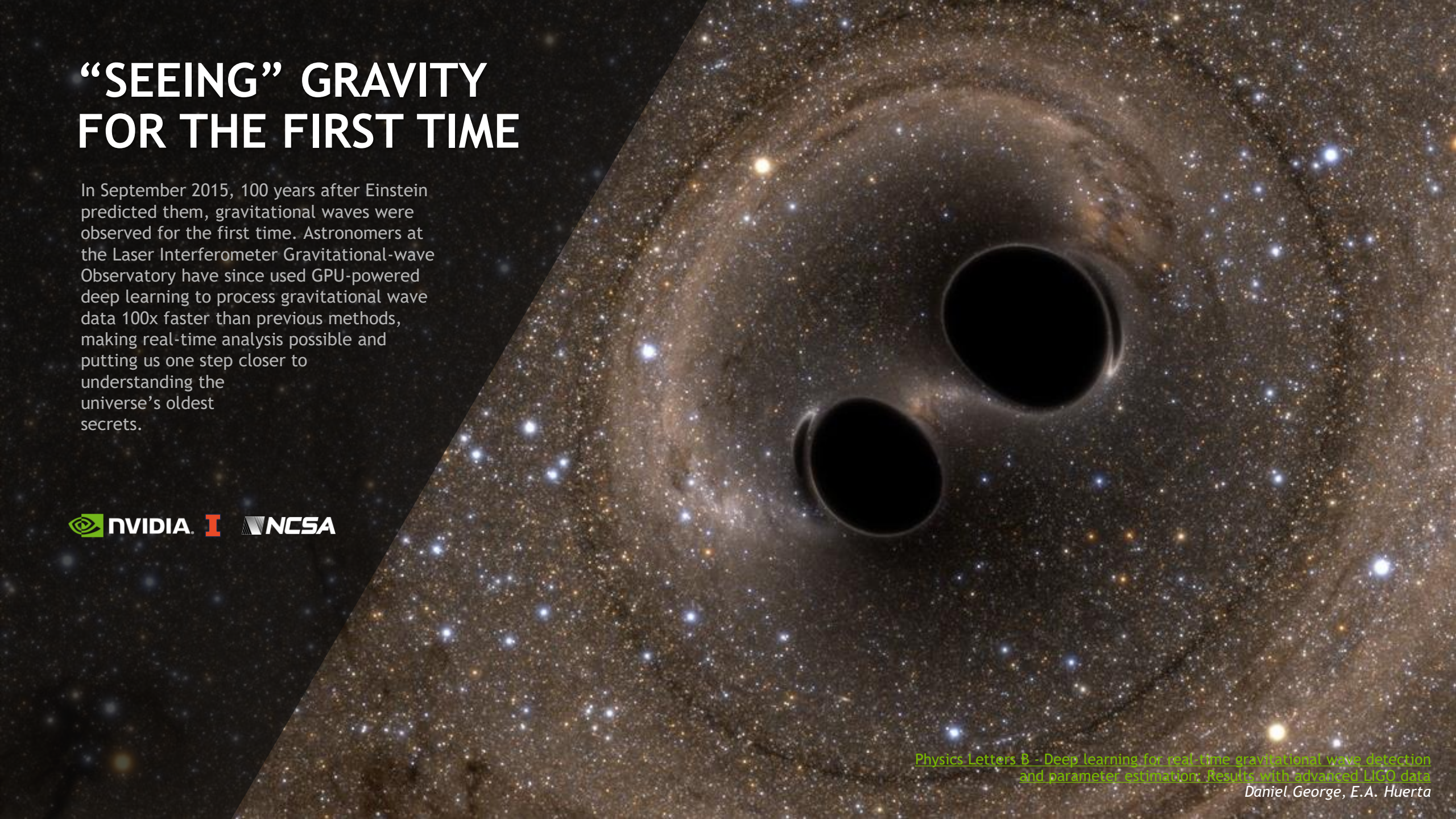
NASA: Late summer 2016, forest fires in Africa produce plumes of CO_2
Left: CO_2 - 10/14/2016 / Right: CO_2 - 12/24/2016

Source: https://climate.nasa.gov/climate_resources/142/

“SEEING” GRAVITY FOR THE FIRST TIME

In September 2015, 100 years after Einstein predicted them, gravitational waves were observed for the first time. Astronomers at the Laser Interferometer Gravitational-wave Observatory have since used GPU-powered deep learning to process gravitational wave data 100x faster than previous methods, making real-time analysis possible and putting us one step closer to understanding the universe’s oldest secrets.

NVIDIA. I NCSA



Physics Letters B - Deep learning for real-time gravitational wave detection and parameter estimation: Results with advanced LIGO data

Daniel George, E.A. Huerta

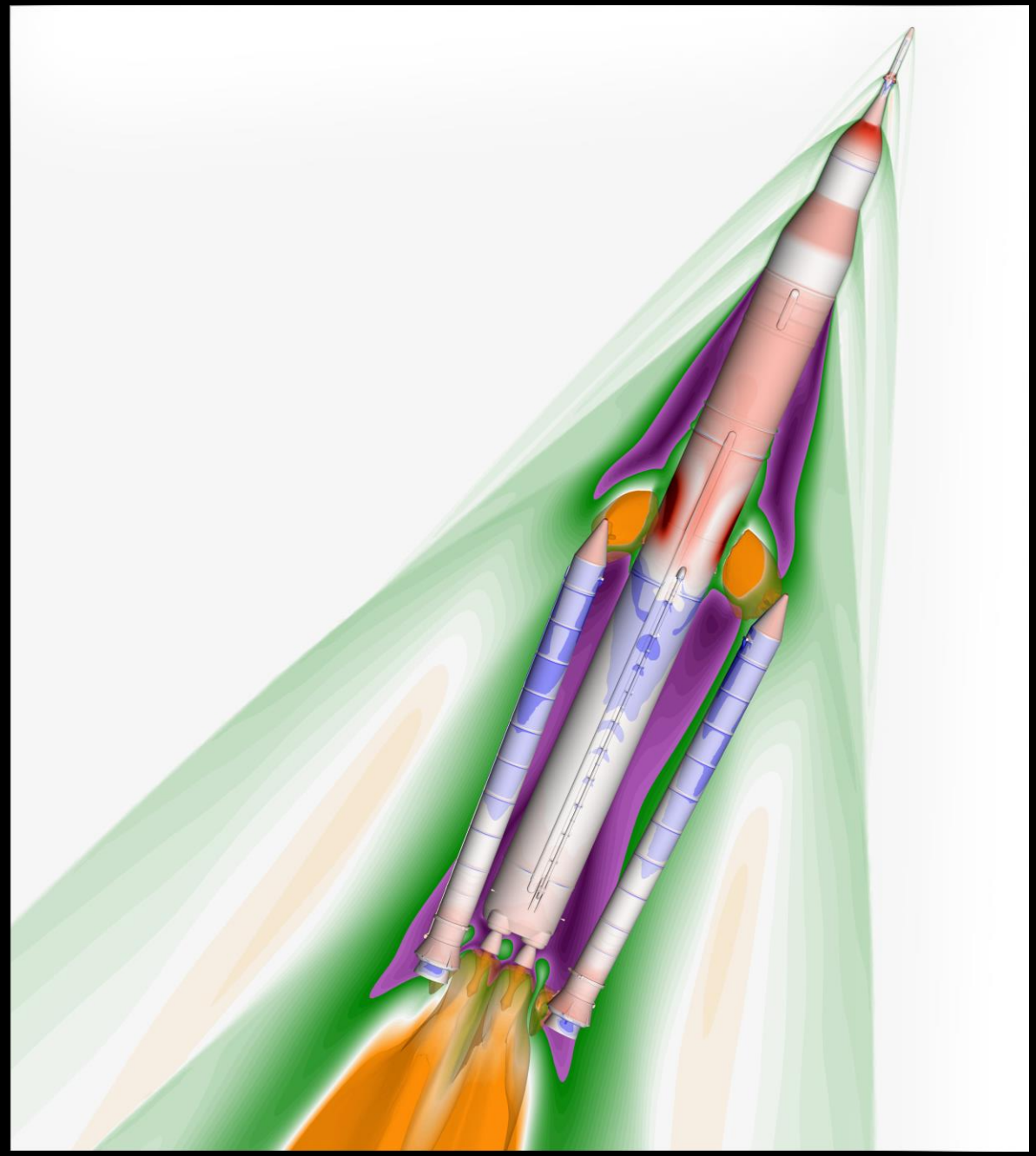
DESIGNING SPACECRAFTS WITH GPU ACCELERATED SIMULATIONS

Large scale aerodynamic simulations are necessary to help define the shape and performance of aircraft, spacecrafts, automotive vehicles and others. NASA Langley Research Center develops FUN3D computational fluid dynamics software to simulate fluid flow for a broad range of aerodynamics applications. This single application consumes more cycles at NASA's supercomputers than any other application. GPU acceleration enables over 23X higher performance than CPU servers while running these simulations.

The performance on GPUs scales very well to enable efficient computation of the largest and the most complex simulations. NASA has shown that a thousand GPU servers on Summit supercomputer can do the work of over a million CPU cores for a fraction of the energy costs.

NVIDIA

NASA



Images: SLS)Block 1B booster separation flowfield simulated using NASA's FUN3D code. . Credit: Jamie Meeroff, Henry Lee, NASA/Ames

INTERSECTION OF HPC & AI TRANSFORMING SCIENCE

HPC

> Algorithms based on first principles theory

> Proven models for accurate results

AI

> Neural networks that learn patterns from large data sets

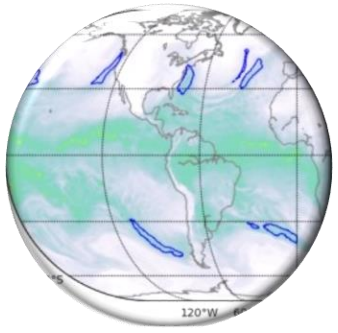
> Improve predictive accuracy and faster response time

SPEEDING PATH TO FUSION ENERGY

PRINCETON UNIVERSITY

90% Prediction Accuracy
Publish in Nature April 2019

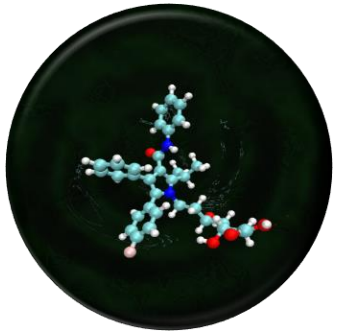
EXASCALE WEATHER MODELING



BERKELEY LAB

Tensor Cores Achieved 1.13 EF
2018 Gordon Bell Winner

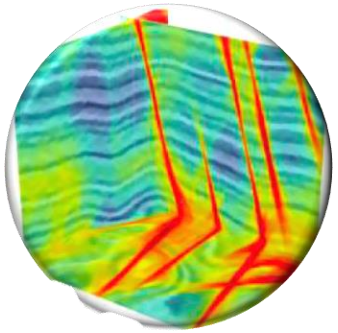
INDENTIFYING CHEMICAL COMPOUNDS



DOW

Orders Of Magnitude Speedup
3M New Compounds In 1 Day

O&G FAULT INTERPRETATION



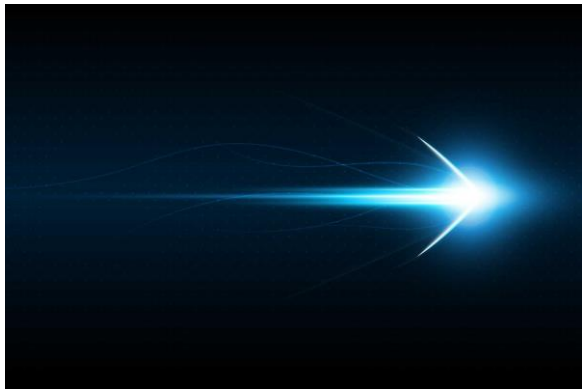
BUREAU OF ECONOMIC GEOLOGY

Time-to-solution Reduced From Weeks To 2 Hours

WHY PROCESSING AT THE EDGE MATTERS

Bandwidth

- The data rate between Earth and the Mars Reconnaissance Orbiter is somewhere between 500 and 32000 bits-per-second
- It took 469 days to download the last bits of data from the New Horizons Probe after the Pluto flyby.



Latency

- At 1,079,000,000 km/hour, light is quick; you could get around the Earth in 133 milliseconds, to the moon in about 1.3 seconds, closest possible Mars approach…. 3 minutes

Availability

- DSN operates 3 facilities each using 5+ dishes of varying size
- There are currently over 2000+ operational satelites in service today.

"Mars traffic jams could overwhelm NASA's Deep Space Network"

-- SpaceNews.com

David, L. (2019). Mars traffic jams could overwhelm NASA's Deep Space Network - SpaceNews.com. [online] SpaceNews.com. Available at: https://spacenews.com/mars-looming-traffic-jam/ [Accessed 23 Aug. 2019].