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Analogies and Comparisons for STM Data Bodies

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Space Traffic Management

UT Austin

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Data Background for STM

ExoAnalytic Global Telescope Network (EGTN) map

ExoAnalytic GEO SSA Data Ingestion

- 450,000 images
- ~11 TB per diem
- 600,000 obs
- ~62 MB per diem

Space Traffic Scale

- SSN tracks ~19,000 RSOs (July 2018)
  - 1232 active LEO / 16,000 total (7.7% active)
  - 558 active GEO / 3000 total (18.6% active)
- Superconstellations
  - Additional ~15,000 in LEO

Regime	Data demand per diem (bits)
	Representative
Global Imagery	3.65e19
Human Performance	1.13e19
IT Net	1.30e19
STM	6.6e15

1.4e19 bit/diem =20 TB/s

Takeaways

Data sources (RSOs) may double

Data need will rise

Global Imagery: 1-m img of pop. globe, 0.1 Hz

Full-Body Data: Human cell/organelle, 680 Hz

IT Network: Every device at 2 packets/second

STM: RSOs/debris at 1 Hz, with image chip

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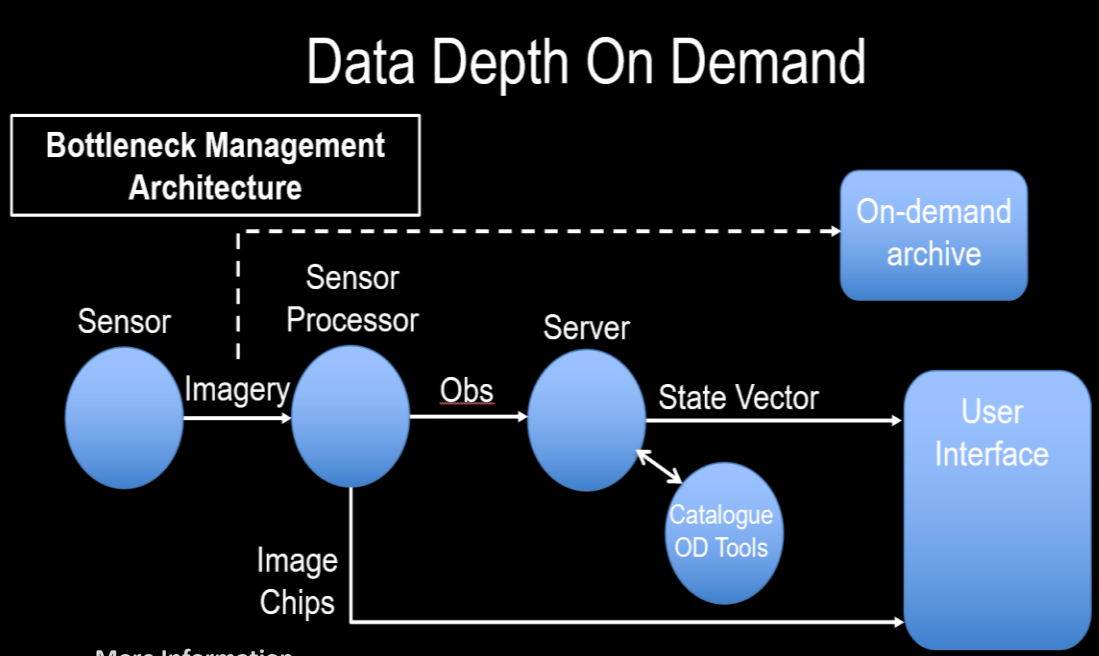
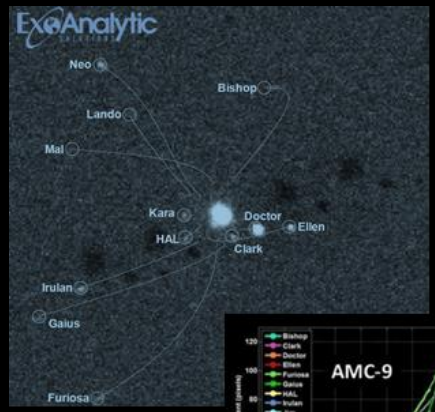
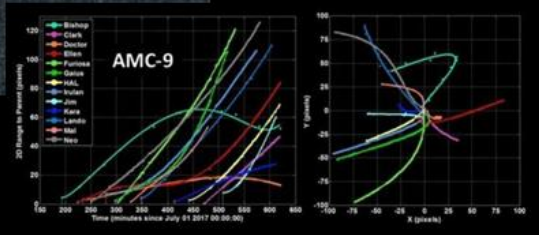
Data Overwhelming

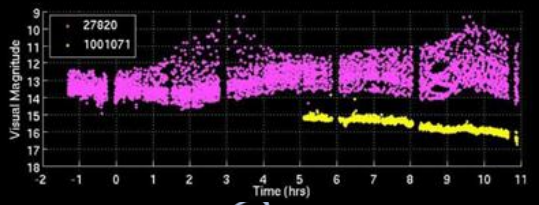
Perspective on data amounts

- Shipping 5’ cube of 30-TB hard drives overnight: data transfer at ~2.7 TB/sec
- Handling this data volume is a serious infrastructural challenge
  - STM is in infancy; can still manage data volume thoughtfully
  - Builds infrastructure for future needs without engendering massive future strain
- De facto management method: data depth on demand









More Information

- AMOS 2017 https://amostech.com/TechnicalPapers/2017/Poster/Cunio.pdf
- STM 2018 https://commons.erau.edu/stm/2018/tuesday/2/

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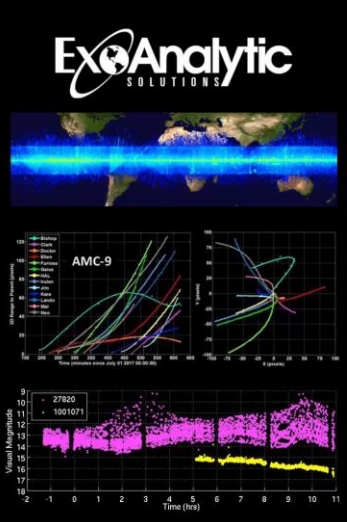
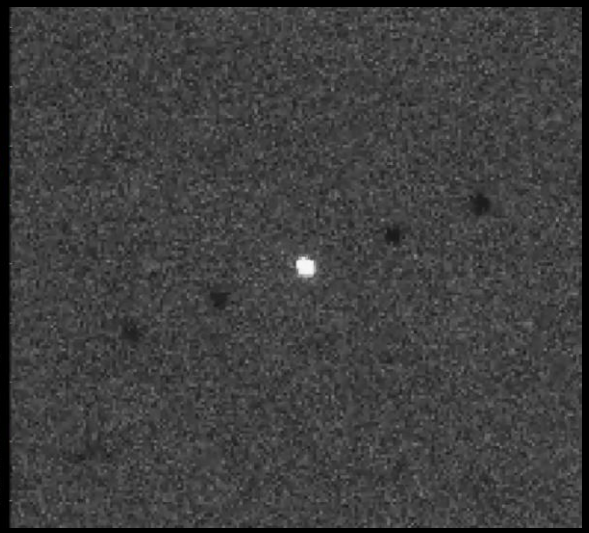
Traffic Density and Persistence - GEO vs. LEO

- LEO
  - 16,000 objects, 1.26e-08 obj/km^3
  - Up to 30,000 obj, 2.36e-08 obj/km^3
- GEO
  - 3000 objects, 4.72E-08 obj/km^3





GEO is denser - 18% of objects active and maneuverable
LEO has <8% active, <1% maneuverable today
LEO Super Constellations **~50% active and maneuverable**

- GEO can be observed every 5 seconds; rapid convergence to spacecraft state
- Persistence enables:
  - Recovery/forensics on unexpected events
  - Responsive support to operators
- LEO STM at density of GEO challenges human in the loop

- LEO is a very different traffic situation
  - Supported by fewer sensors
  - Less time for post-maneuver evaluation
  - Models assume ballistic behavior
  - **Critically significant challenges** in sensor support strategies if frequency of non-coordinated maneuvering increases
- More traffic, less time between events
  - More complex conjunctions; less C2 time
  - Suggests move to **fully-automated real-time process**

Key questions for future STM

- Will new members of the LEO population be required to carry propulsion?
  - LEO density is increasing at an alarming rate; this increases collision risk
  - Increasing maneuverable members of the LEO population will break assumptions assuming long ballistic periods
  - Either a significant increase in coordination, an increase in sensor support, or real-time connectivity and automation will be required as these trends continue (probably all)
- Are our sensing strategies sufficient for expected increases in maneuvering space traffic?
- As these challenges associated with complexity, speed, density increase the STM sensor footprint, are we appropriately considering the big data paradigm that will be necessary?