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Analogies and Comparisons for STM Data Bodies

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Space Traffic Management
UT Austin

26 February 2019
ExoAnalytic Global Telescope Network (EGTN) map

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
--- | --- | ---
SSN/RSO | 3.65e19 | 1.13e26
Human Performance | 1.13e19 | 3.65e19
IT Net | 1.30e19 | 3.65e19
STM | 6.6e15 | 1.13e26

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

Takeaways
Data sources (RSOs) may double
Data need will rise
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

Data Depth On Demand

More Information
• STM 2018 [https://commons.erau.edu/stm/2018/tuesday/2/]
Traffic Density and Persistence - GEO vs. LEO

- **LEO**
  - 16,000 objects, 1.26e-08 obj/km³
  - Up to 30,000 obj, 2.36e-08 obj/km³

- **GEO**
  - 3000 objects, 4.72E-08 obj/km³
  - 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

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

- 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?