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Analogies and Comparisons for STM Data Bodies

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Analogies and Comparisons for STM Data Bodies

Brien Flewelling and Phillip M. Cunio

Space Traffic Management
UT Austin

26 February 2019
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

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

<table>
<thead>
<tr>
<th>Regime</th>
<th>Data demand per diem (bits)</th>
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<tbody>
<tr>
<td>Global Imagery</td>
<td>3.65e19</td>
</tr>
<tr>
<td>Human Performance</td>
<td>1.13e19</td>
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<tr>
<td>IT Net</td>
<td>1.30e19</td>
</tr>
<tr>
<td>STM</td>
<td>6.6e15</td>
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</tbody>
</table>

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
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

Bottleneck Management Architecture

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.

- 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

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