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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

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

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?