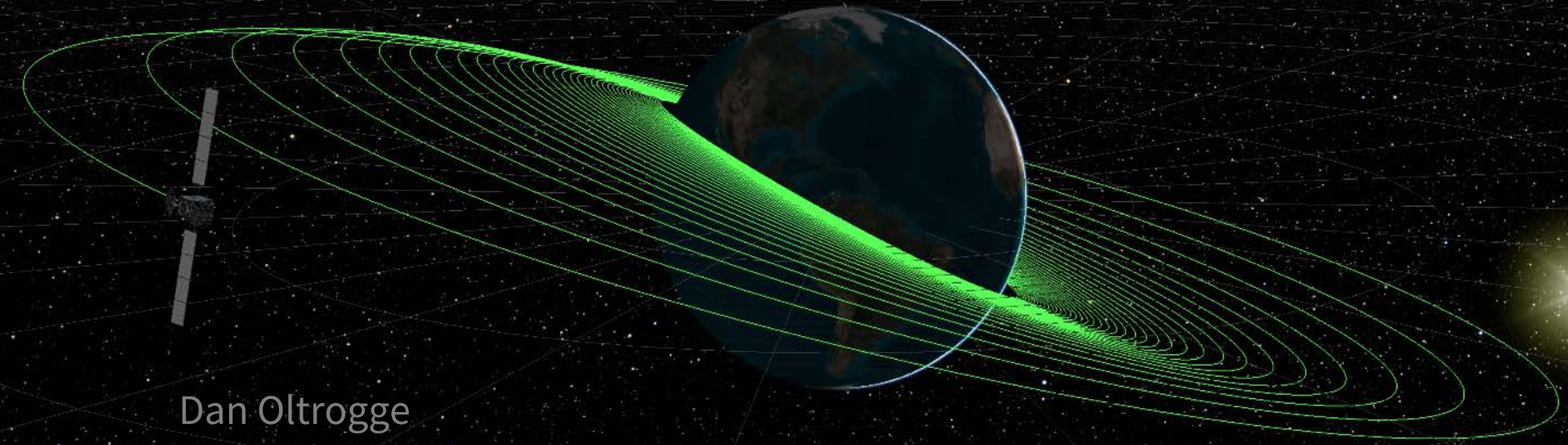
Data integrity aspects of flight safety



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COMSPOC

Data security + data quality = data integrity

- Ensuring data integrity between and within space systems includes:
  - Data creation, data interpretation, exportation, transmittal, ingestion, interpretation, normalization, curation, comparison, analysis/fusion, and storage.

Sender

Data

Terminology

Interpretation

Analytical tools/ foundation

Mapping into a Data Message Standard

Assured transmission?
Man-in-middle?
Intentional or accidental data corruption/dropouts?

Terminology

Analytical tools/ foundation

Reading from a Data Message Standard

Ensemble comparisons

Fusion

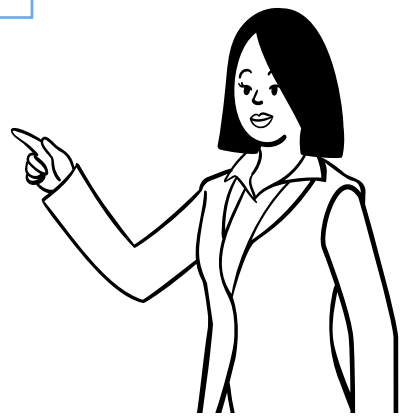
Information

Normalization

Curation

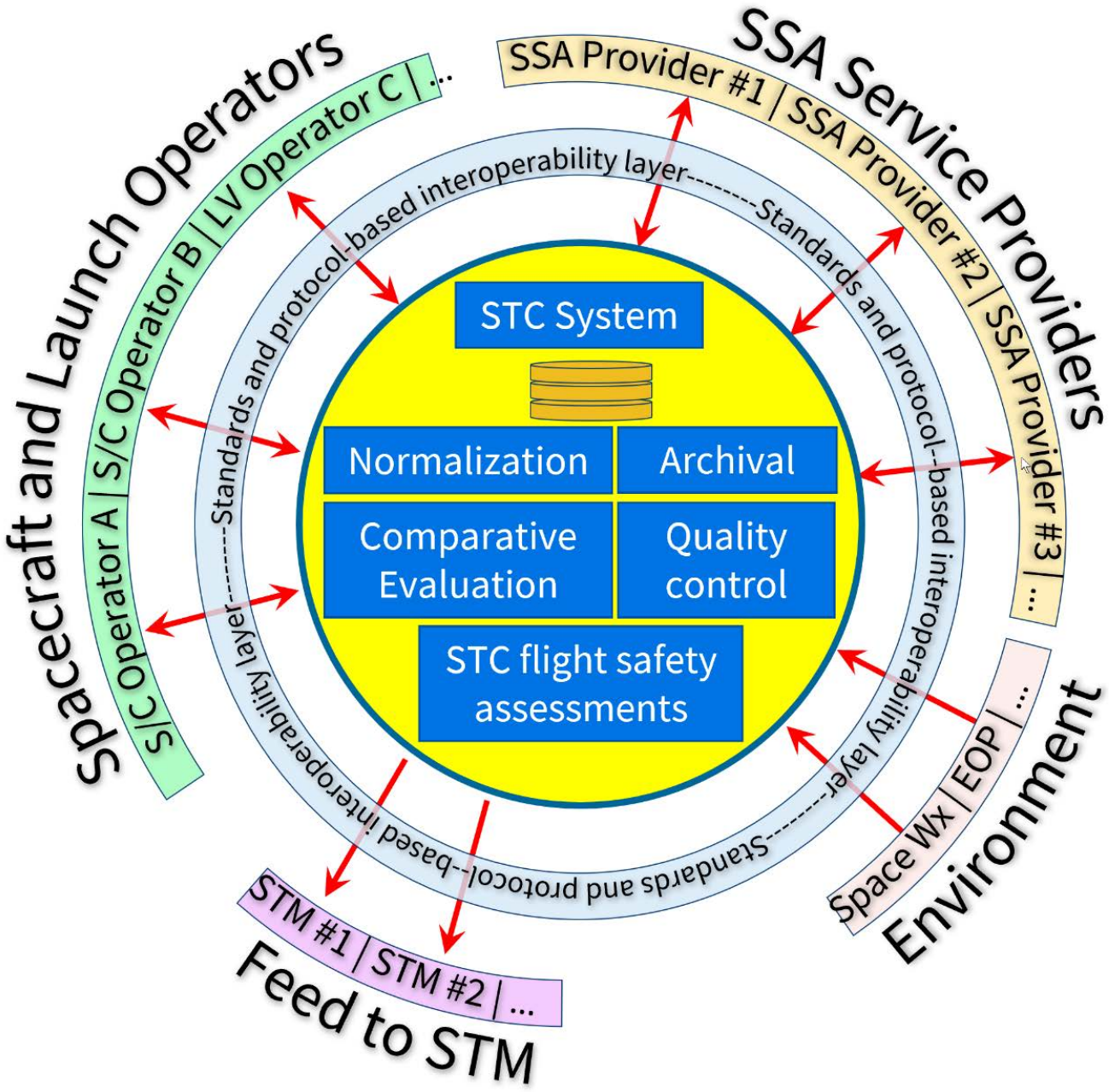
Storage

Interpretation



Recipient(s)

The basic framework for Space Traffic Coordination and Management



Space object information*

- Analogous to Earth Observation data catalogs (e.g., EOSDIS, ESA EO PDGS, COPERNICUS), “Space Data” can be thought of in terms of Data Processing Levels (https://science.nasa.gov/earth-science/earth-science-data/data-processing-levels-for-eosdis-data-products)
  - **Level 0**: Anything that you know a priori, or is constant, or can be measured directly. Sources of this information are (1) application authorities; (2) spacecraft designers; (3) spacecraft operators.
  - **Level 1**: Provided by operator or other authoritative source, deduced from Level 0 data
  - **Level 2**: Inferred by observation
  - **Level 3**: Estimated or derived based upon Level 0-Level 2 info

CA-relevant space object data and metadata: Levels and use cases

Level	Use cases	SSA, risk assessment, conjunction assessment	Compliance assessments (e.g., 25-yr rule)
0	Uncalibrated astrometric observational data		…
0	Dimensions & shape		
0	Thrust Capabilities		
0	Owner/operator		
0	Manufacturer		
0	Spacecraft dry mass		
1	Activity status provided by the operator		
1	Planned maneuver(s)		
1	Attitude stabilization method(s)		
2	Activity status obtained by patterns of life		
2	Past orbit (state vector, ephemeris, etc.)		
2	Predicted orbit (state vector, ephemeris, etc.)		
2	Attitude (quaternion, rates)		
2	Spacecraft wet mass		
3	Orbit lifetime		
3	Maneuver system status (full/partial/failed)		

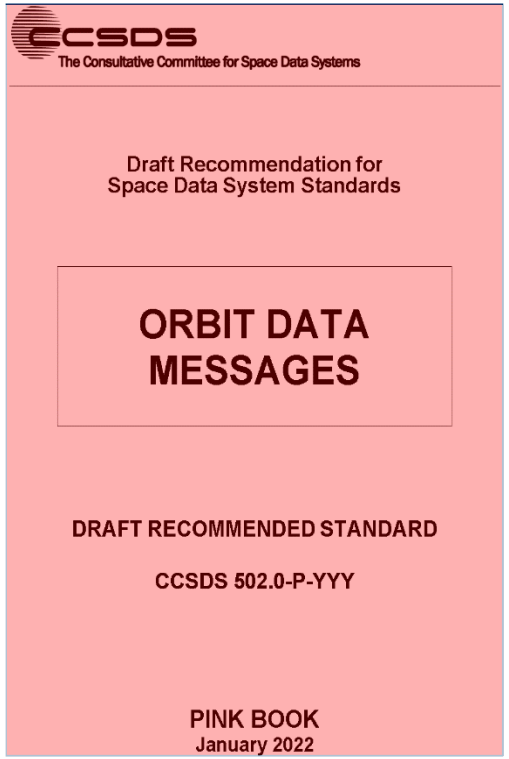
SAMPLE; WORK IN PROGRESS

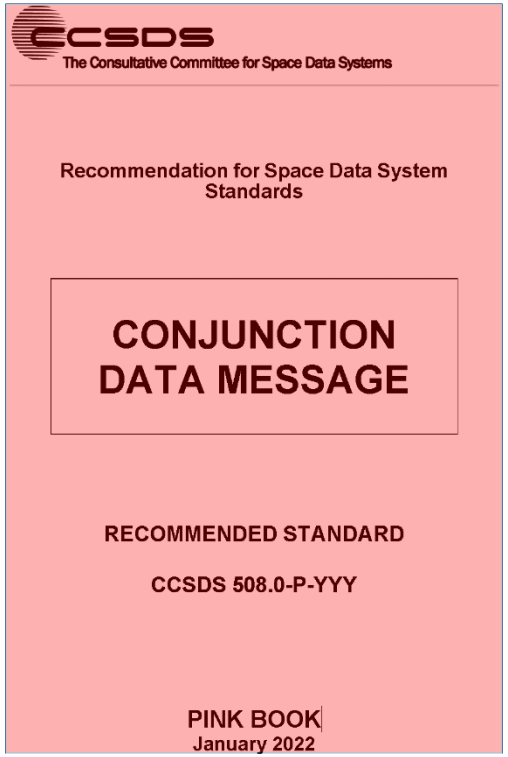
CCSDS standards relevant to Space Traffic Coordination

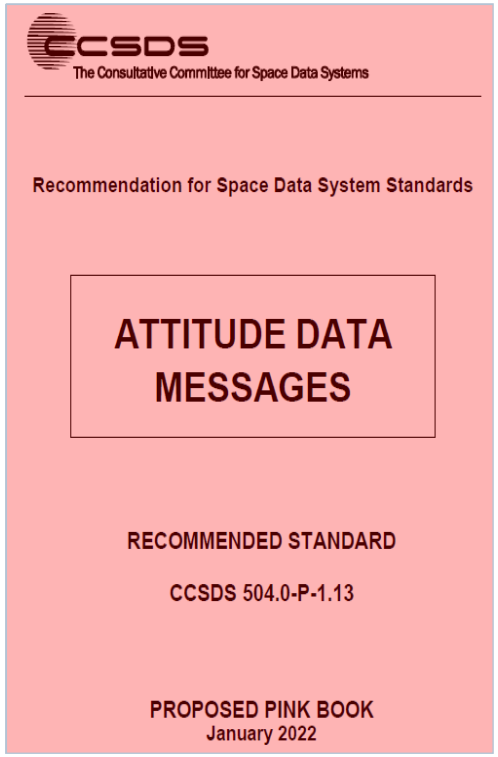
Table 1 STC-relevant data conveyance needs and standards

	Existing CCSDS messages and related standards										
	Attitude Data Message	Conjunction Data Message	Digital Motion Imagery	Events Message*	Orbit Data Message	Pointing Request Message	Radio Freq & Mod. Systems	Re-entry Data Message	Space Data Link Security Stds	Time Code Formats	Tracking Data Message
Attitude	•				•	•				•	
Conjunctions	•	•			•					•	
Maneuvers					•					•	
Orbit & errors					•					•	
"Phonebook"					•						
Reentry								•			
RF, RFI, Geoloc							•				
RPO/OOS			•		•		•		•		•
Space catalog					•	•				•	•
Space events	•	•		•	•			•		•	•
S/C chars, SoH					•					•	
Sensor trk, obs						•				•	•
STC system									•		

Latest developments in STC-relevant ISO/CCSDS space safety standards







As good as these standards are (or will soon be), they have no “check sums” or error correction or security features.

These standards assume that the “cybersecurity infrastructure” just works.

Thank you !

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