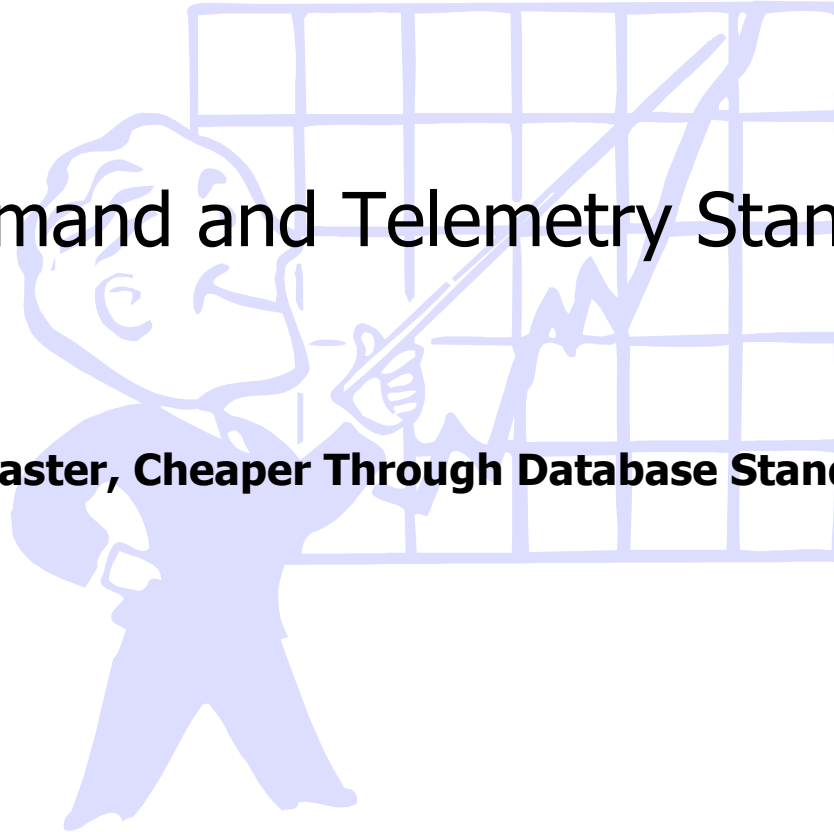




XML Command and Telemetry Standardization

Better, Faster, Cheaper Through Database Standardization



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Who We Are

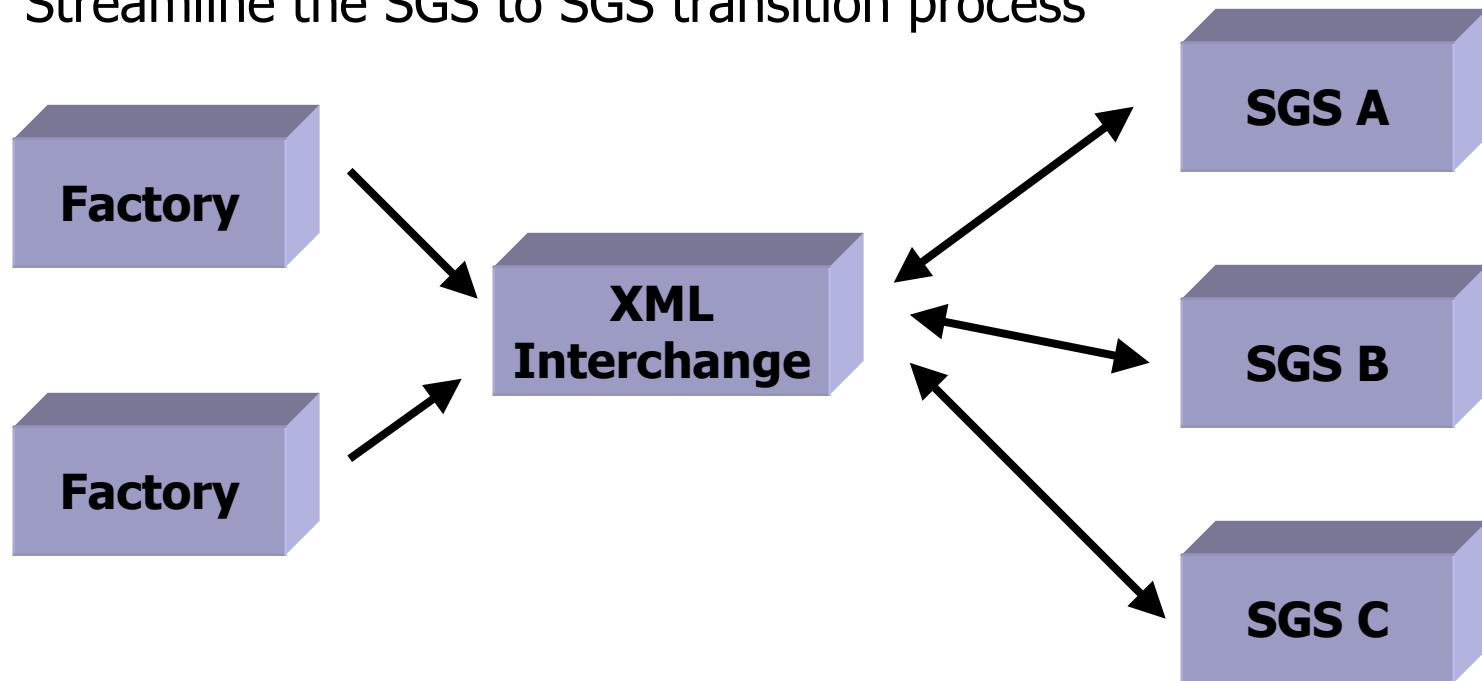
SMC Det 12 Vehicle Operations

- RDT&E Support Complex (RSC)
 - Mission Readiness, Operations and Experiment Support for:
 - Argos / Mightysat II.1 / TSX-5 / XSS-10 / MSTRS / Coriolis / C/NOFS ...
 - Ground Systems Engineering
- CEnter for REsearch Support (CERES)
 - Maintain post-operational assets for test application
 - DSCS II / DSP-12/13 / DSCS III / TSX-5
 - Host and Conduct Ground System Experiments
 - CANE / DTB / QRD / DCC / LADO / CCS-C / Internal Projects



Motivation for Common S/C Database

- Streamline the spacecraft factory to ground system (SGS) transition process
- Streamline the SGS to SGS transition process





Scope of This Standardization Effort

- Parameters (name, description, bit/byte order, type, calibration etc.)
- Command Definitions (name, description, opcode, arguments, etc.)
- Packaging (TDM frame definition, packet, block coding)
- PCM Streams (CCSDS, stream coding)
- Special Algorithms (inputs, outputs, triggers)
- Administrative (version, history, source, classification, etc.)
- Does not include orbit data, physical properties, display properties, mission planning data, or RF characteristics



Benefits to Standardization

- Lower the costs associated with database conversions (*cheaper*)
- Decrease the time required for mission readiness (*faster*)
- Decrease program risk due to improper or incomplete exchanges (*better*)
- Foundation for increased spacecraft complexity (*better*)
- Encourages minimal capabilities in T&C systems (*better*)



Introduction to XML

- Developed by the World Wide Web Consortium (W3C) as a recognized need for a data content language
- Self describing data format markup language `<tag></tag>`
- XML documents can be validated against one of several data content specifications - schemas



Why XML for Data Exchange

- Provides for hierarchical structure of data validated against a user specified format definition
- Robust data format (object-oriented, hierarchical, extendible, comments, etc.)
- Tremendous software support (parsers, editors, browsers, database, etc.)
- **Enthusiastic** IT support
- "ASCII of the future"
- Being adapted by many industries for data transfer (electronic business, chemical, aviation, utilities, real estate)



XML Example

```
<?xml version="1.0" encoding="UTF-8" ?>
<!DOCTYPE EISet (View Source for full doctype...)>
- <EISet>
  <Identifier>
    <SatelliteNumber Classification="Unclass">23456</SatelliteNumber>
    <LaunchData LaunchYear="1990" LaunchPieceNumber="1"
      LaunchNumber="12" />
  </Identifier>
  - <OrbitElements ElementNumber="262" EphemerisType="0">
    <BSTAR>1.0191E-3</BSTAR>
    <Inclination>99.0090</Inclination>
    <RAAN>272.6745</RAAN>
    <Eccentricity>0.0008546</Eccentricity>
    <ArgumentOfPerigee>223.1686</ArgumentOfPerigee>
    <MeanAnomaly>136.8816</MeanAnomaly>
    <MeanMotion>14.11711747</MeanMotion>
    <MeanMotionDot>0.00000140</MeanMotionDot>
    <MeanMotionDotDot>0.0</MeanMotionDotDot>
    <EpochYear>1997</EpochYear>
    <EpochDay>320.90946019</EpochDay>
    <EpochRevolutionNumber>14849</EpochRevolutionNumber>
    <!-- this is a comment -->
  </OrbitElements>
</EISet>
```



Phase 1 Timeline

- Dec 1999 – Project start at CERES
- Feb 2000 – GSAW
- Dec 2000 – OMG space day
- Apr 2001 – DTD based implementation complete



Object Management Group (OMG)

- Founded 1989, 800 member companies
- Major accomplishments
 - CORBA (platform and language independent middleware)
 - IIOP (internet communications protocol)
 - UML (analysis and design modeling language)
- Domain task forces established to provide standards development within vertical industries
- Space DTF mission
 - ... Cost effective, timely, commercially available and interoperable space, satellite and ground system domain software components ...*



OMG Space Domain Task Force Products

- Request For Information (RFIs)
 - Space, Satellite, Ground Systems Working Group RFI
 - CORBA-based Space Communications
 - Reference Architecture
- Request For Proposals (RFPs)
 - Telemetric and Command Data Specification 😊
 - Telemetry & Command Data Access Service

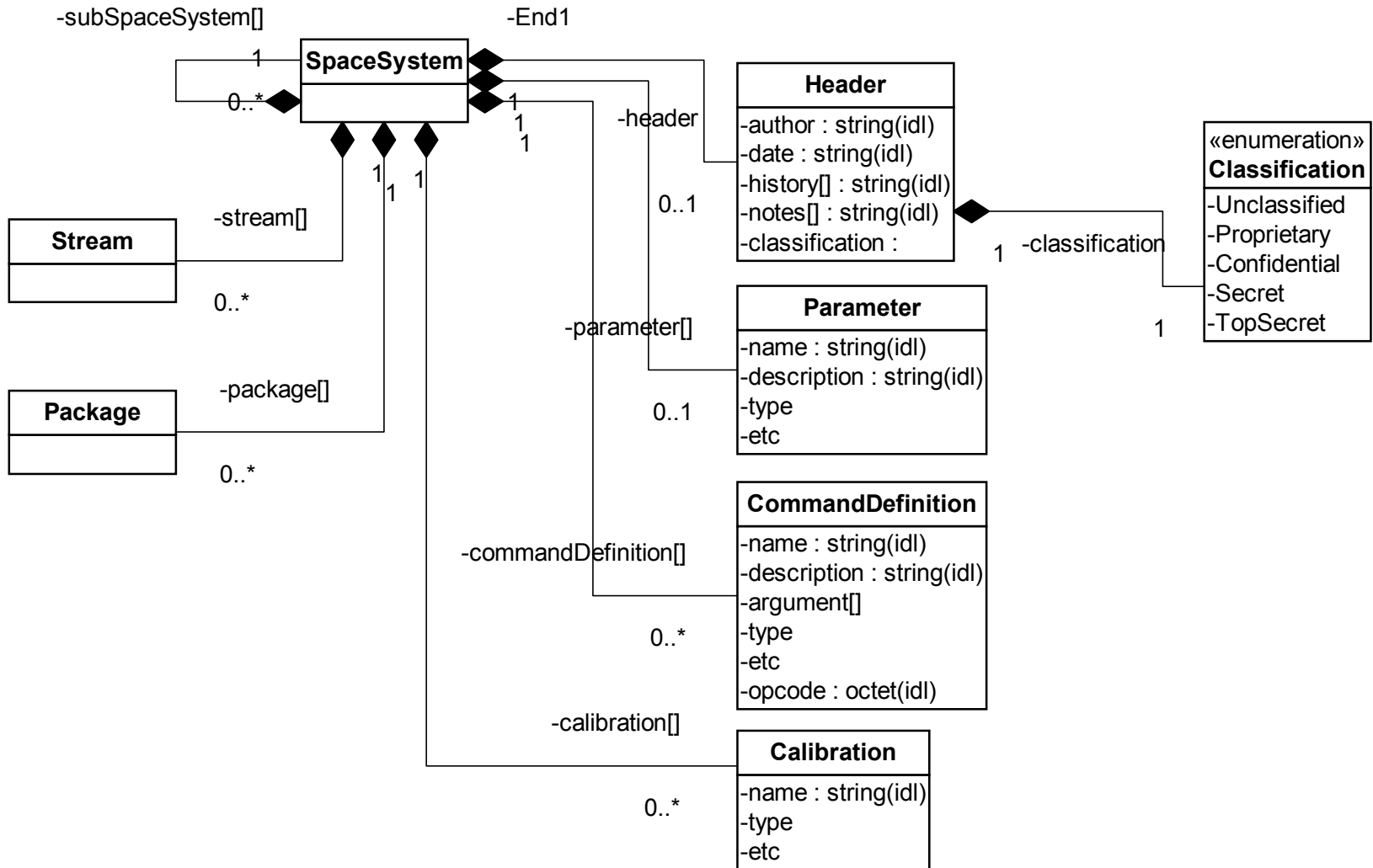


Phase 2 & OMG Timeline

- Apr 2001 – Schema based implementation begins
- Apr 2001 – OMG releases RFP-1
- Oct 2001 – LM, Boeing, and ESA submit to RFP-1
- Jan 2002 – All submitters agree to provide a revised joint submission by June 2002
- Jun 2002 – Revised submissions due



The Consolidated OMG Submission – UML





The Consolidated OMG Submission – Schema

```
<element name="SpaceSystem">
  <complexType>
    <choice minOccurs="0" maxOccurs="unbounded">
      <element ref="tc:Parameter"/>
      <element ref="tc:Algorithm"/>
      <element ref="tc:CommandDefinition"/>
      <element ref="tc:Calibrator"/>
      <element ref="tc:Stream"/>
      <element ref="tc:Package"/>
      <element ref="tc:SpaceSystem"/>
    </choice>
    <attribute name="name" type="string" use="required"/>
  </complexType>
</element>
```



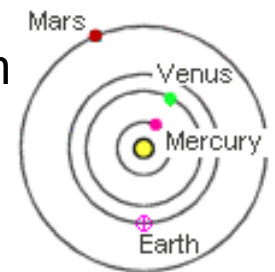
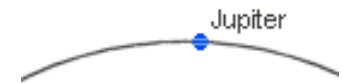
The Consolidated OMG Submission - XML

```
<?xml version="1.0" encoding="UTF-8" ?>
<!-- Sample XML file for a simple satellite -->
- <SpaceSystem xmlns="http://www.omg.org/space/tcspec"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.omg.org/space/tcspec
  SpaceSystem.xsd" name="simpleSat">
<SpaceSystem name="EPS">
-   <SpaceSystem name="Battery1">
      + <Parameter name="Voltage" type="Float32" units="volts">
      ± <Parameter name="Current" type="Float32" units="Amps">
-   </SpaceSystem>
</SpaceSystem>
```



Summary

- Confluence of
 - CERES/RSC (and all other space operators) need for database interoperability
 - Increasing spacecraft complexity
 - Emergence of COTS Command and Control software
 - W3C XML Schema
 - Space standardization efforts within the OMG
 - W3C XML rapid emergence as **THE** data exchange medium
- Create a unique window of opportunity for:
 - spacecraft database standardization
 - using XML
 - sanctioned by the OMG





Look Ahead

Factory and vendor support of T&C database standard will bring

- Better
 - SGS interoperability
 - Database maintenance tools
- Faster
 - Mission readiness
 - SGS upgrades
- Cheaper
 - Mission readiness
 - Sustainment for operations
 - SGS upgrades

