

Exchanging Databases with Dissimilar Systems Using CCSDS XTCE

CCSDS Spacecraft Monitoring & Control WG

and

OMG Space Domain Task Force

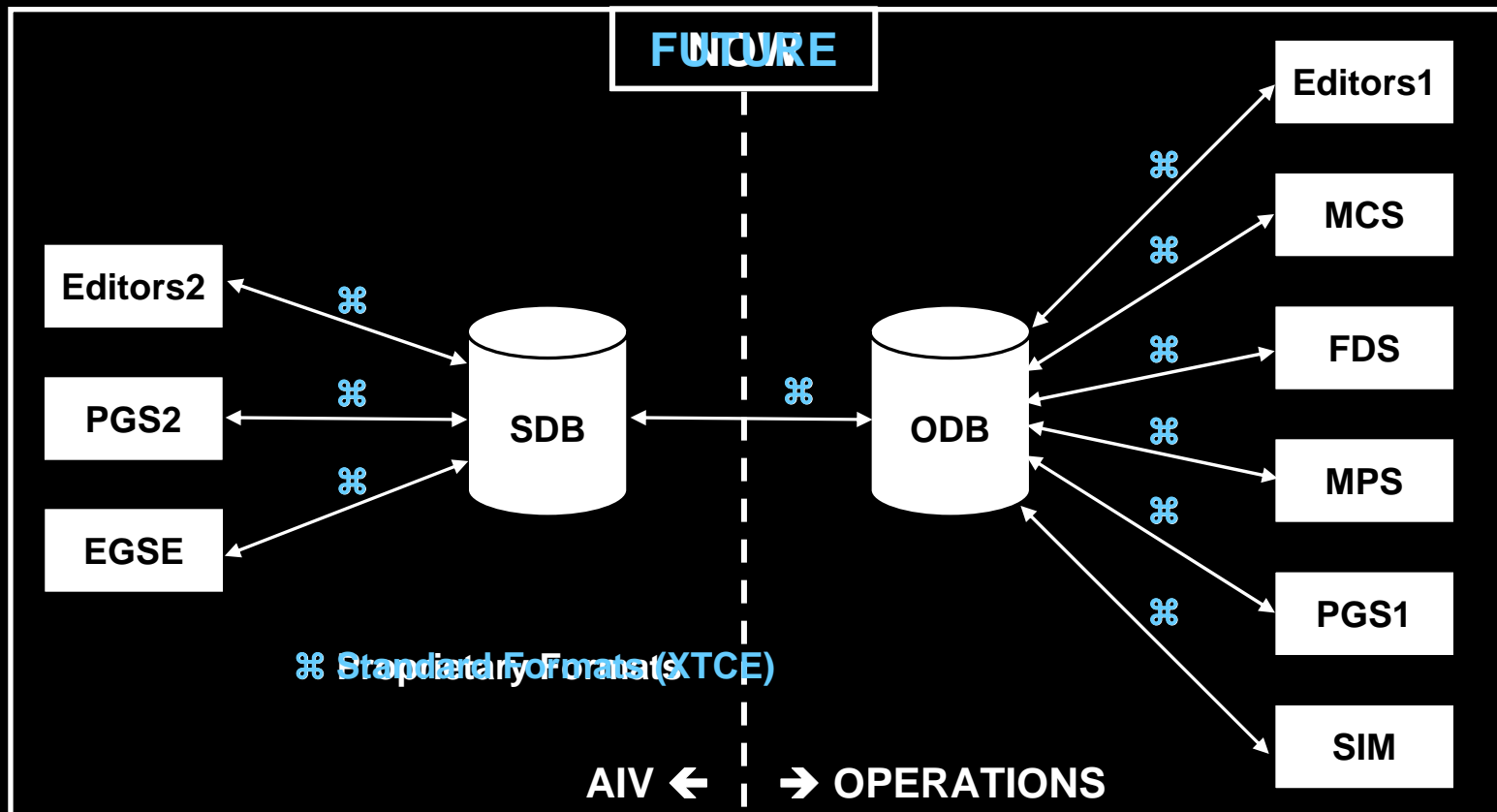
Presented by Mario Merri, ESA

Outline

XTCE = XML Telemetric and Command Exchange

- What is XTCE and where does it come from?
- Its goals and benefits
- How does it work?
- Usage so far
- XTCE Status
- Conclusions

XTCE Vision



AIV: Assembly, Integration Verification
 DB: Database
 EGSE: Electrical Ground System Equipment
 FDS: Flight Dynamics System
 MCS: Mission Control System

MPS: Mission Planning System
 ODB: Operational Database
 PGS: Procedure Generation System
 SDB: Source Database
 SIM: Spacecraft Simulator

XTCE History

- Object Management Group (OMG) standard originally developed by
 - European Space Agency
 - US Air force/Mission Operations (Lockheed Martin)
 - Boeing Communications & Satellites
 - with the support of NASA & JPL
- Being adopted by CCSDS via Agency Review under responsibility of the Spacecraft Monitoring & Control Working Group (SM&C WG)

CCSDS SM&C and XTCE



- ESA
 - [M Merri](#) (chairman), M Schmidt, A Ercolani, [J Muller](#), I Dankiewicz, S Cooper



- BNSC
 - R Thompson (deputy chairman), B Harnett



- CNES
 - B Béhal, E Poupart, R Soumagne



- CSA
 - P Melanson



- DLR
 - H Hofmann



- INPE
 - PG Milani, AM Ambrosio



- JAXA
 - T Yamada



- NASA/GSFC
 - DC Lokerson, F Johnson, [JK Marquart](#), [JS Gal-Edd](#), [C Fatig](#), [R Jones](#), [K Rice](#)



- NASA/JPL
 - [A Oyake](#), P Shames, [J Moholt](#)



- ASI
 - C Labonia



- OMG
 - [G Simon](#) (Lockheed Martin), [B Kizzort](#) (Harris Corp.)



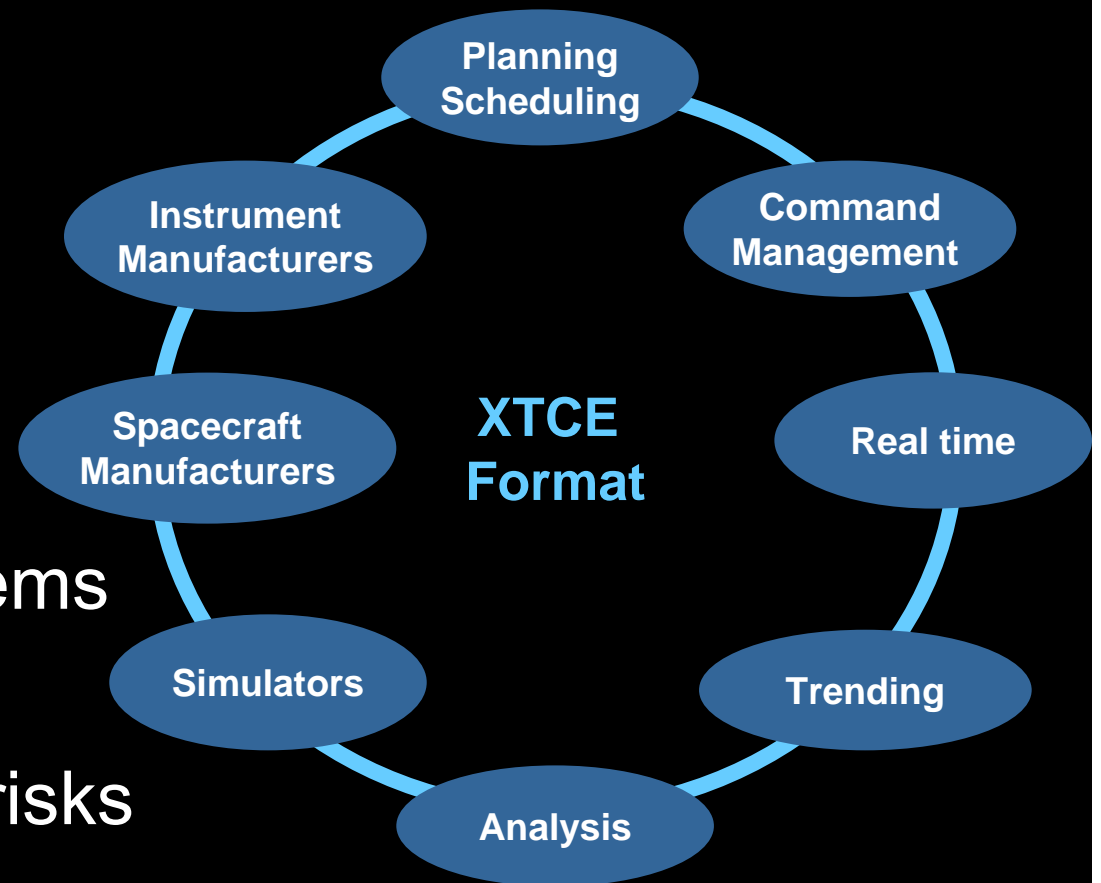
XTCE Splinter Group

XTCE Goal

- *Non-proprietary* standard format to exchange TM & TC data definitions that will reduce
 - human errors
 - ambiguities, confusion, and
 - lost time and money in difficult, sometimes lousy (painful) conversions between dissimilar systems

Application Field

- Exchange between
 - working teams
 - systems
 - missions
 - agencies
- ▶ Reuse legacy systems
- ▶ Adapt only I/O
- ▶ Reduce costs and risks



XTCE Benefits

- Allows better interoperability
 - Across organisations (e.g. JWST)
 - Within a mission (e.g. S/C Prime -> operations)
- Lets different technologies collaborate in one data model
 - Packet telemetry/telecommand and TDM frames
- Separates “pure” telemetry and telecommand data from dedicated/proprietary processing data
 - Extra processing, required by external software is separated from the telemetry/telecommand data
- Is extensible

XTCE Scope

- TM & TC definitions are very similar between space systems ...
- XTCE defines standard exchange formats for:
 - TM & TC parameter properties
 - Telemetry
 - Telecommand
 - Data transmission and packaging
- Uses XML Schema technology
- Covers only exchange of operational TM & TC information
 - e.g. no displays, no operational procedures

XTCE Hierarchy

- The “SpaceSystem” is the basic building block
- “SpaceSystems” produce/consume TM/TC
- “SpaceSystems” associate hierarchically one another
 - Their granularity is left to the user
- The hierarchy allows integration of multiple data description into one overall data description
 - e.g. multi-satellite missions, multi-instrument satellite

Example: XTCE for a single spacecraft

Spacecraft level

Space System

Instrument level

Space System

Space System

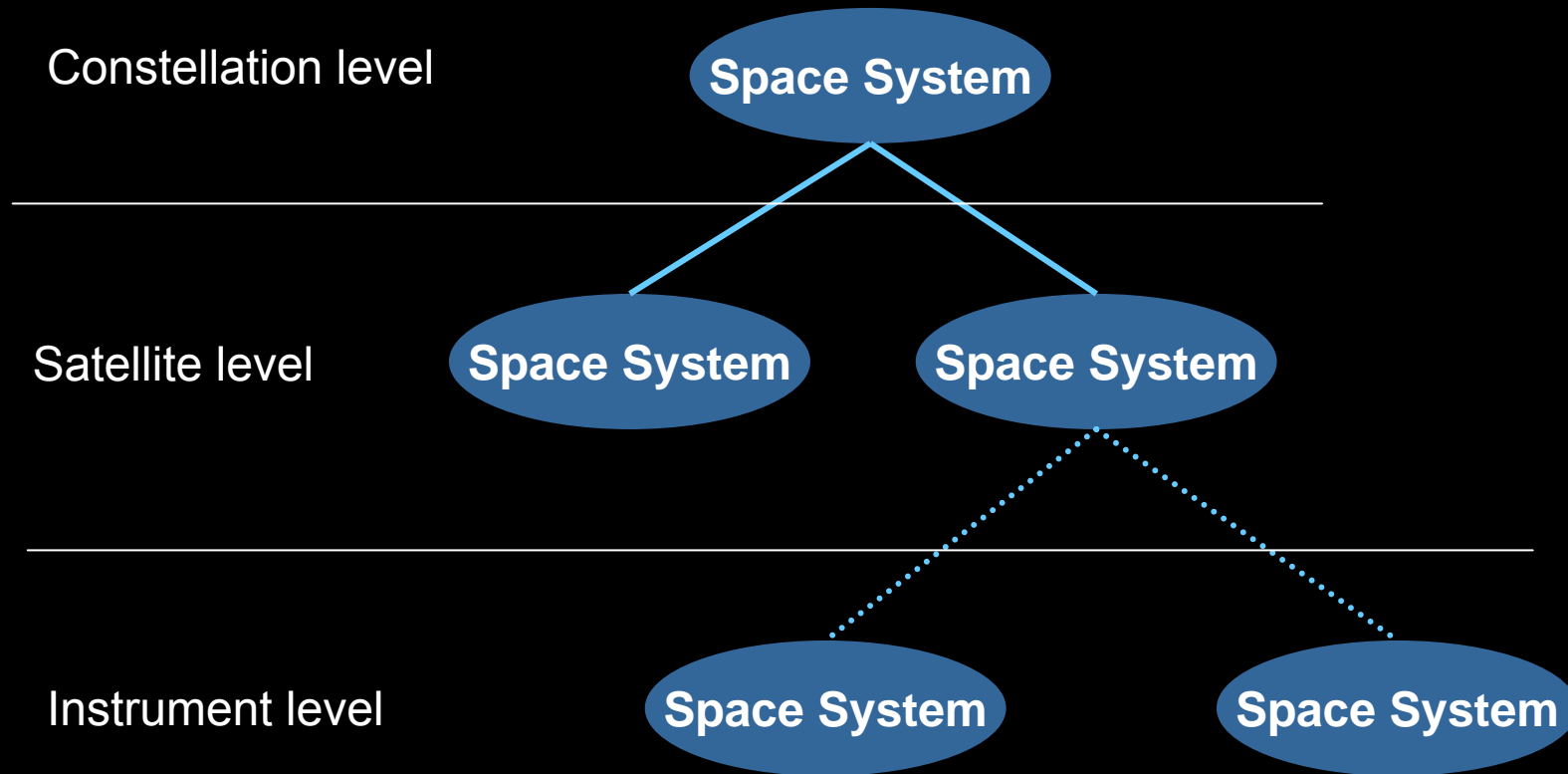
Device level

Space System

Space System

CCSDS
XTCE
BDS

Example: XTCE for a constellation



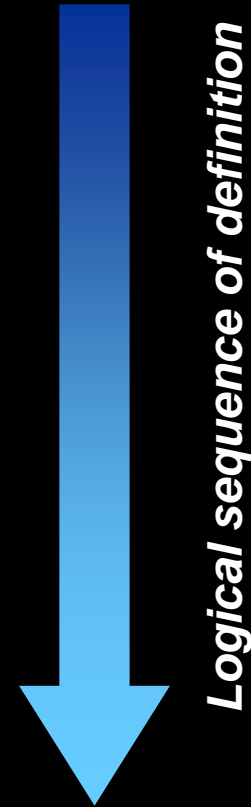
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XTCE SpaceSystem Basics

- A SpaceSystem describes:
 - Telemetry parameters and their packaging
 - Telecommand arguments and their packaging
 - Streams (up and down, with coding information)
 - Some configuration control information
 - Conversion information (i.e. calibration)
 - Limits and pre/post command checks

XTCE Telemetry Data

- Telemetry data consists of:
 - Parameter types
 - Encoding
 - Limit checking information
 - Calibrations
 - Unit (mnemonic)
 - Parameters
 - Validity conditions
 - Containers
 - e.g. CCSDS frames or packets
 - Streams
 - Encoding, decoding of frames
 - e.g. sequences of frames on a VC
 - Algorithms
 - e.g. derived parameters



XTCE Parameter sample

```

<xtce:IntegerParameterType name="AST50068" signed="true" sizeInBits="32">
  <xtce:UnitSet>
    parameterTypeRef="Type AST50068"
    <xtce:Unit>DegC</xtce:Unit>
  </xtce:UnitSet>
  shortDescription="Temperature of Thermistor A">
  <xtce:AliasSet>
    <xtce:DefaultCalibrator name="3023" shortDescription="Thermistor A">
      <xtce:Alias name="503758864" namespace="OnBoardID"/>
    </xtce:AliasSet>
    <xtce:SplinePoint calibrated="160.0" raw="65535"/>
    <xtce:SplinePoint calibrated="124.2" raw="5000"/>
    <xtce:ParameterProperties dataSource="telemetered">
      <xtce:SplinePoint calibrated="-165" raw="430"/>
      <xtce:SystemName>1</xtce:SystemName>
      <xtce:SplinePoint calibrated="160.0" raw="33180"/>
      <xtce:ValidityCondition>"125.2" raw="30000"/>
      <xtce:Comparison comparisonOperator="==">
        <xtce:SplinePoint calibrated="71.8" raw="25000"/>
        <xtce:SplinePoint calibrated="20.2" raw="20000"/>
        parameterRef="ASD000001" value="1"/>
      </xtce:Comparison>
      <xtce:SplinePoint calibrated="-29.7" raw="15000"/>
      <xtce:ValidityCondition>
        <xtce:SplinePoint calibrated="-77.8" raw="10000"/>
      </xtce:ValidityCondition>
    </xtce:ParameterProperties>
    <xtce:SplinePoint calibrated="-169" raw="0"/>
  </xtce:ParameterProperties>
</xtce:ParameterType>
</xtce:IntegerParameterType>
  </xtce:DefaultCalibrator>
</xtce:ParameterType>
</xtce:IntegerParameterType>

```

XTCE Container and Stream



Container: Packet header



Container: Packet



Container: Frame

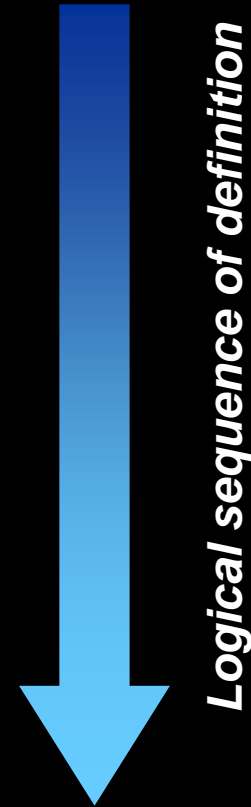
Sequence of those frames

Stream



XTCE Telecommand Data

- Telecommand data consists of:
 - Argument types
 - Same definition as Parameter types
 - Containers
 - e.g. Frames and packets
 - Metacommands (i.e. command definitions)
 - Arguments
 - Command container (data field of a TC packet)
 - Transmission constraints
 - Interlock
 - Verifiers (execution, transmission, reception)
 - Streams
 - Telecommand link, sequences of frames
 - Algorithms
 - Additional processing tasks, external scripts



XTCE Applications so far

- **NASA:** James Webb Space Telescope XML Schema converted:
 - Future work includes exchanging database with other archive systems and control centre real-time systems
- **ESA:** two conversion tools created:
 - Rosetta database converted
 - Cryosat database converted
 - MetOp-1 database converted
 - Herschel-Planck database to be converted
- **Industry:**
 - EADS: scalable monitoring & control system uses XTCE
 - Harris Corp: OS/COMET XTCE ingest tool
 - Hardware vendors deliver the database information in XTCE format to the spacecraft integrator on some US programs

CCSDS Documentation

- CCSDS **Red book** released
 - Adopting OMG XTCE 1.1
 - Under agency review until 20th March 2006
- Draft CCSDS **Green book**
 - Tutorial
 - Pending publication
- Draft CCSDS **Magenta book**
 - Best practices report, developer guide for CCSDS missions
 - Released for internal CCSDS review
 - Validation by prototype at ESA and NASA ongoing

Conclusions

- XTCE powerful concepts are ideal for exchanging TM & TC data descriptions across systems and teams
 - Standard and auxiliary information will be shortly available
- Legacy systems can still be used
 - Adaptors may be needed
- Mission databases have been mapped to XTCE
 - Very good initial results
 - Main issues:
 - Command sequences
 - Type definition
- XTCE is an XML Schema
 - XML self-describing nature reduces learning curve and errors
 - XML is easy to work with, due to the amount of libraries, tools, and broad industry acceptance

Questions and Answers

?

XTCE and other related CCSDS standards

- XTCE is an exchange format and covers several CCSDS standards

How

XTCE

Telemetry Channel Coding

Packet Telemetry

Telecommand Part 2

Telecommand Part 3

What

XTCE SpaceSystem Decomposition

- Header for configuration data
- Telemetry for core data
- Telecommand for core data
- Services for packet identification

