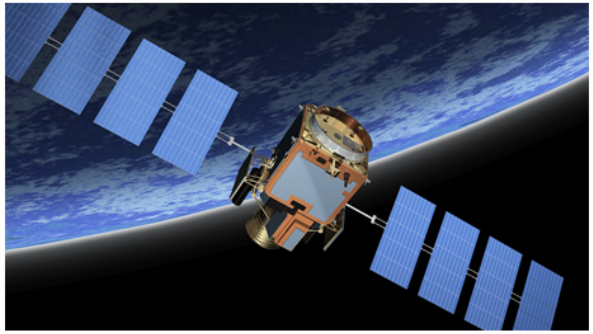
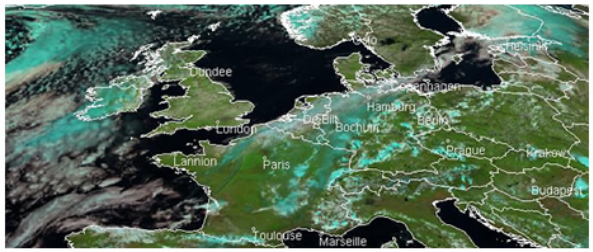
SOIS Electronic Data Sheets for Onboard Devices

Current Status

Stuart Fowell

22nd October 2013





Overview

- Why SOIS EDS are useful
- How will SOIS EDS be applied
- Current Status of Prototyping
- Specification by CCSDS

SCISYS

Why SOIS EDS are useful

SCISYS

Electronic Data Sheets replacing Device ICDs

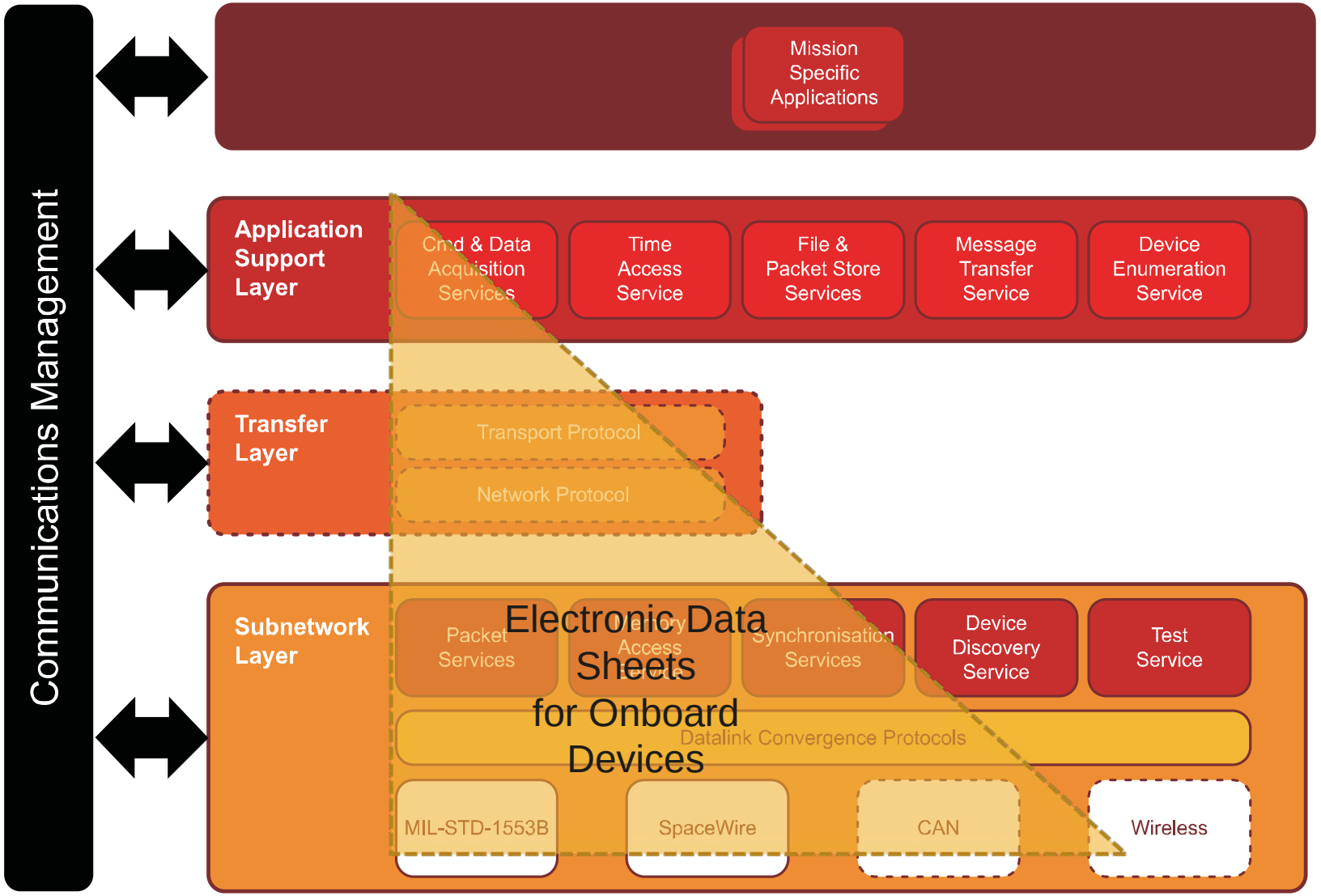
- Function Interface information for a device is today typically provided within an ICD
  - Paper document
    - Different formats from different organisations
    - With potentially different levels of information provided
  - Requires extensive testing for inconsistencies with implemented device
  - Requires manual translation to:
    - OBSW development
    - Spacecraft databases
    - Simulators
    - Mission Control System databases
    - Others?

- Define Electronic Data Sheets to replace ICDs
  - Capture electronically all information
  - Include associated semantic meaning
  - Allows for checking that information is consistent and complete
  - Allows for automatic transformation into OBSW, test harnesses, databases, ICDs, etc.

How will SOIS EDS be applied

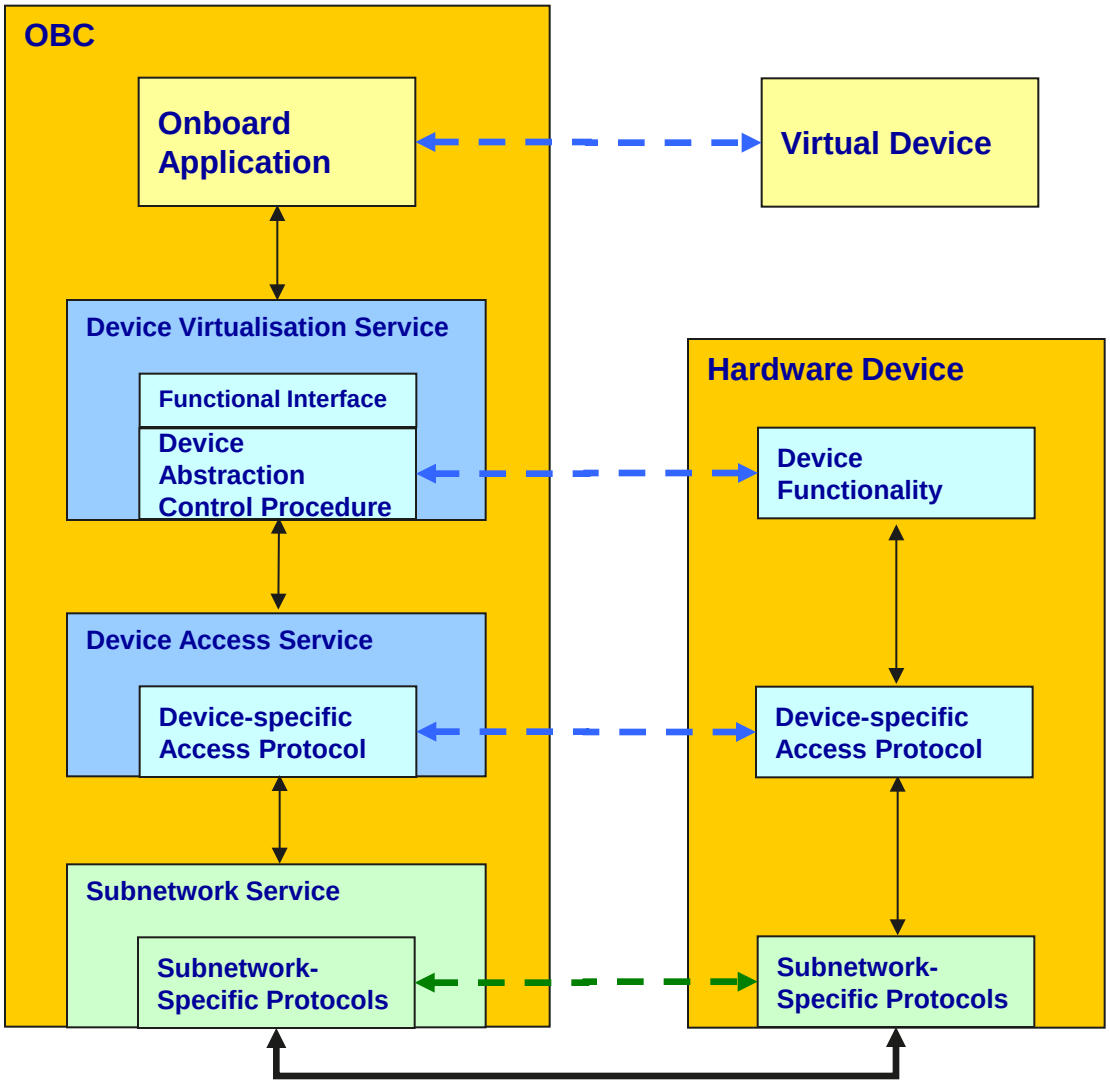
SCISYS

CCSDS SOIS Reference Communications Architecture



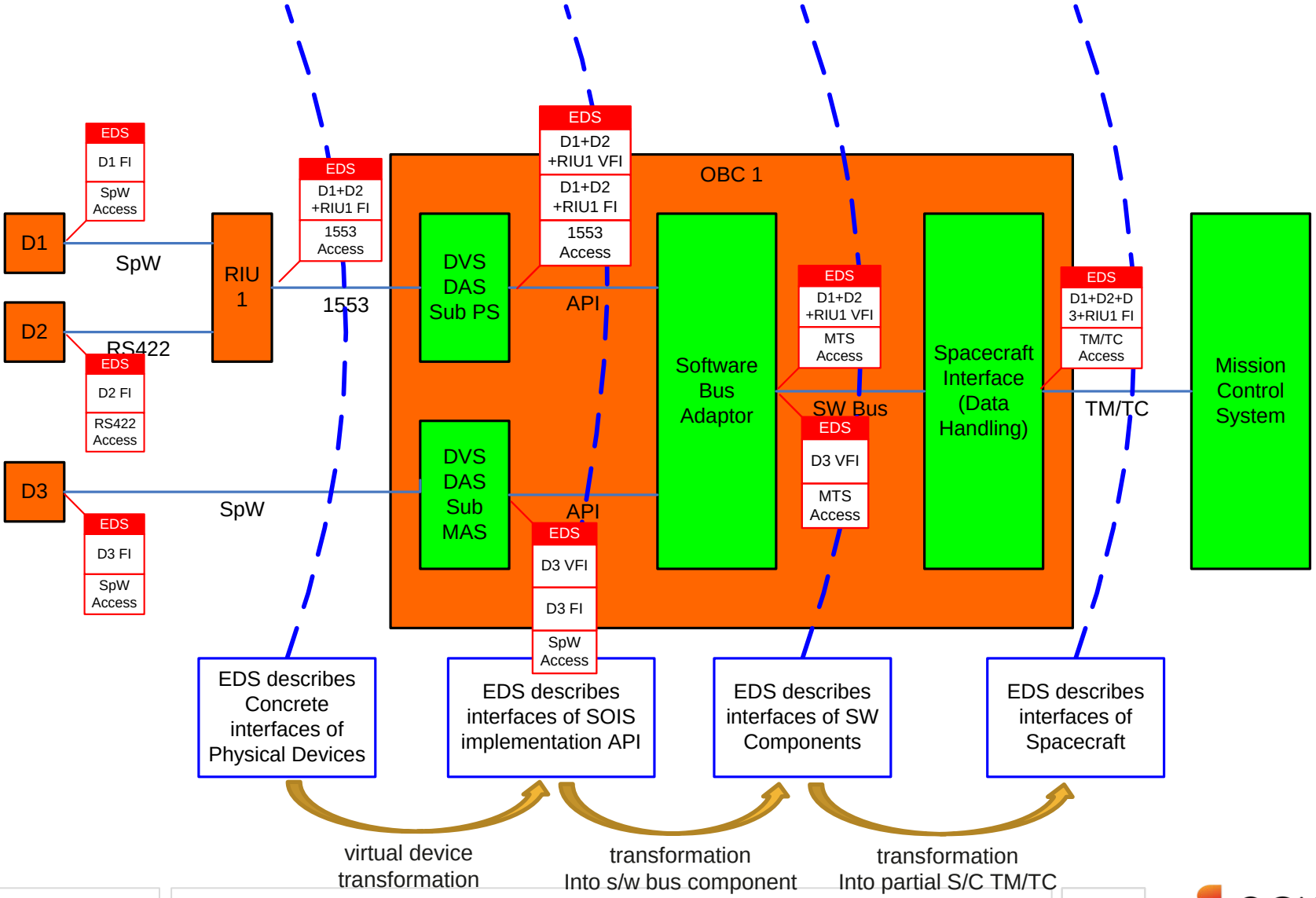
SCISYS

SOIS Command and Data Handling Services



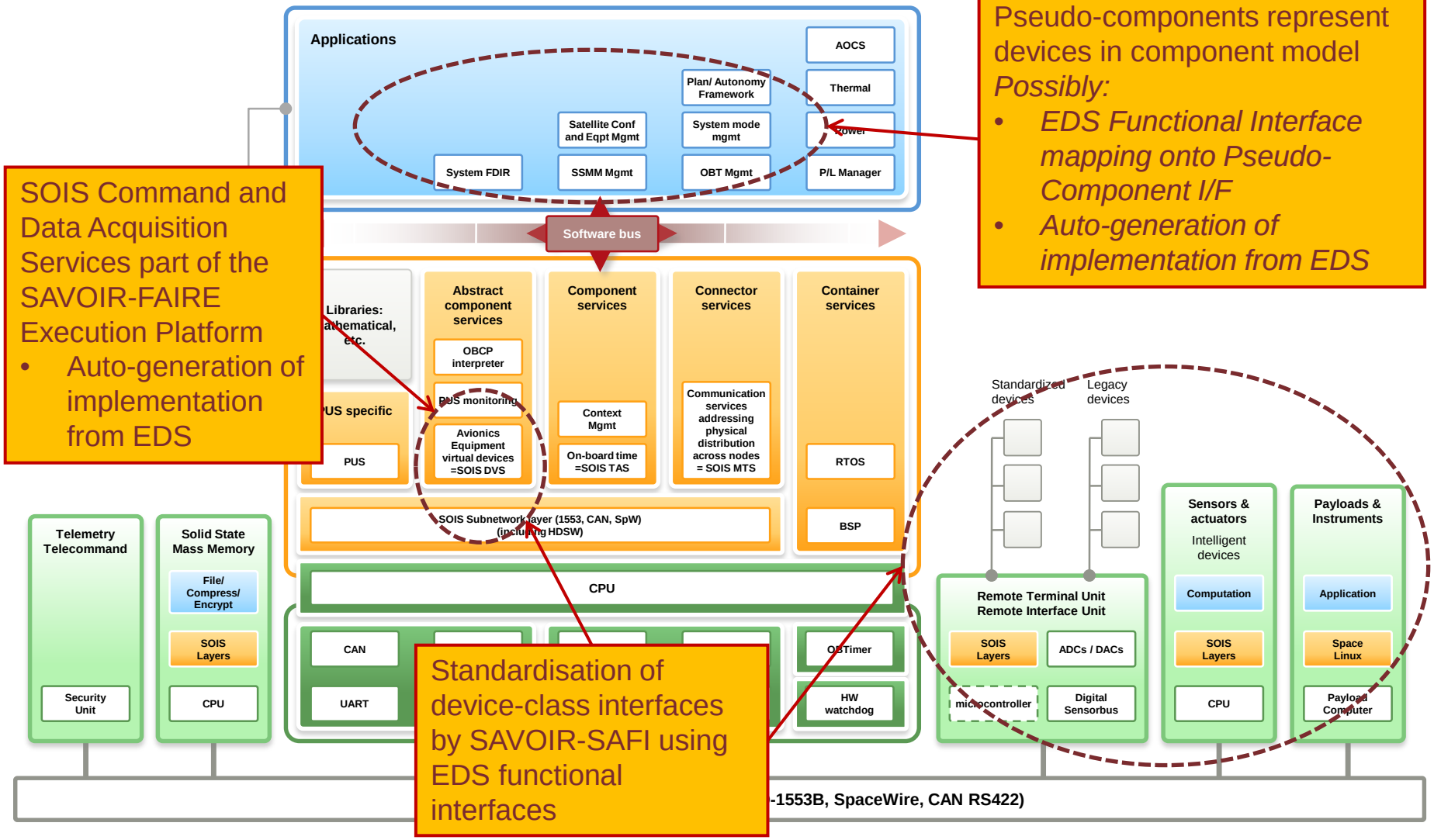
- Generic Functional Interface
  - » Functionality common to a device type
- Device Abstraction Control Procedure
  - » How the Functional Interface is mapped onto the device-specific access protocols
  - » Type conversions, operations, state-machine
- Device-specific Access Protocol
  - » How to command and acquire raw data for specific devices using subnetwork-specific protocols, e.g. packet structures
  - » State machine
- Subnetwork-specific Protocol
  - » How to transfer data to/from device across subnetwork
  - » QoS: ack, retransmit, priority etc.

Where can EDS be used: The Onion Diagram



SCISYS

Planned Usage in SAVOIR (ESA)



SOIS Command and Data Acquisition Services part of the SAVOIR-FAIRE Execution Platform

- Auto-generation of implementation from EDS

Pseudo-components represent devices in component model

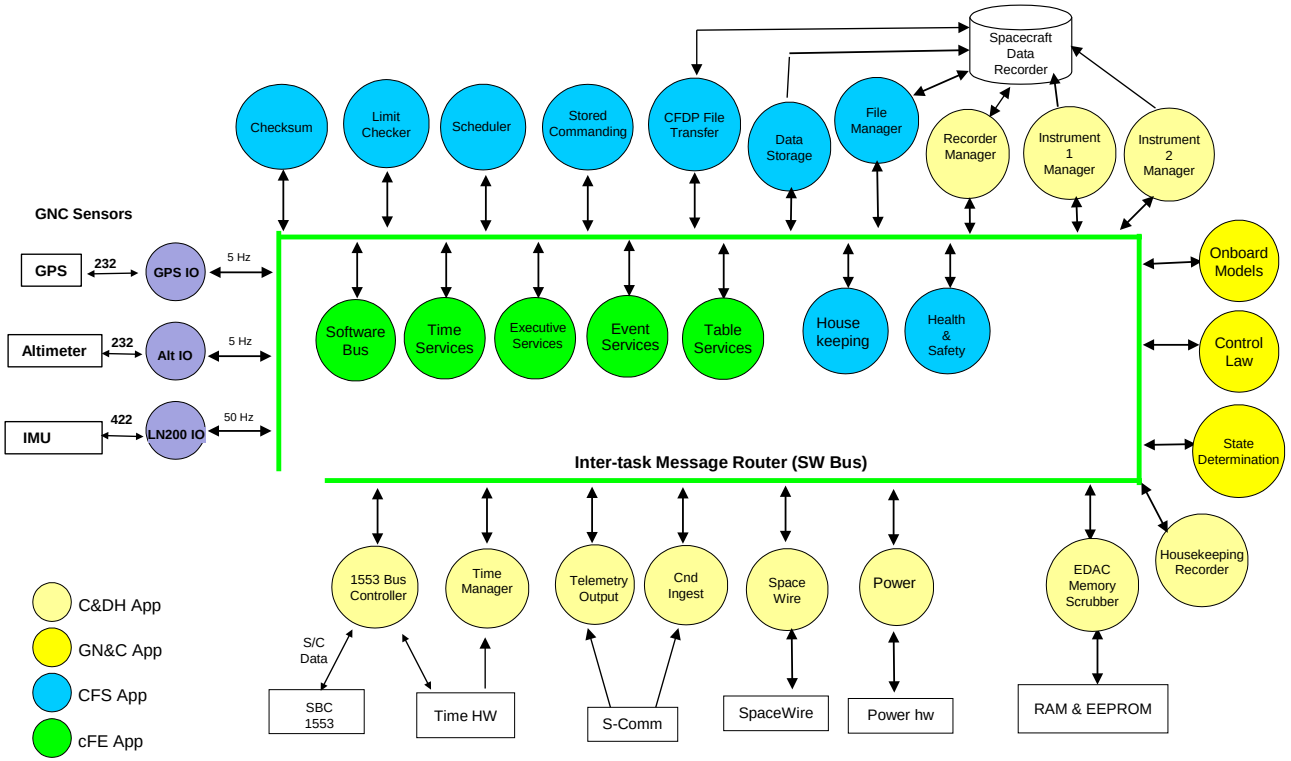
Possibly:

- *EDS Functional Interface mapping onto Pseudo-Component I/F*
- *Auto-generation of implementation from EDS*

Standardisation of device-class interfaces by SAVOIR-SAFI using EDS functional interfaces

SCISYS

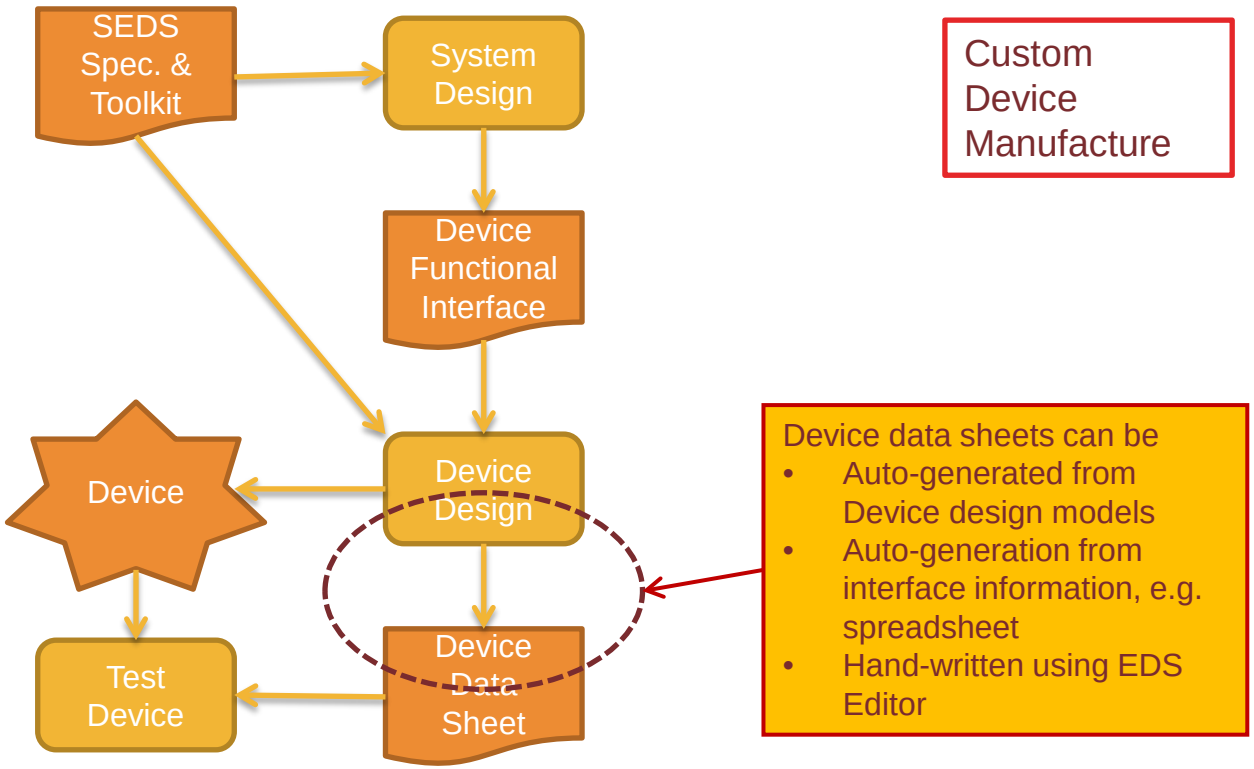
Planned Usage in cFE (NASA/GSFC)



- Core Flight Executive (cFE): a Software bus & adaptors
  - » EDS identifies parameters that can be subscribed to & S/W bus message structures
    - › These could be auto-generated from parameter definitions using rules but currently done by hand
  - » Not interested in physical interface or auto-generation of software adaptor implementation
    - › Written once, re-used between missions
  - » EDS will be used to auto-generate subscriber interfaces, published data structures and mission control system databases

How and When are EDS Used (1/2)

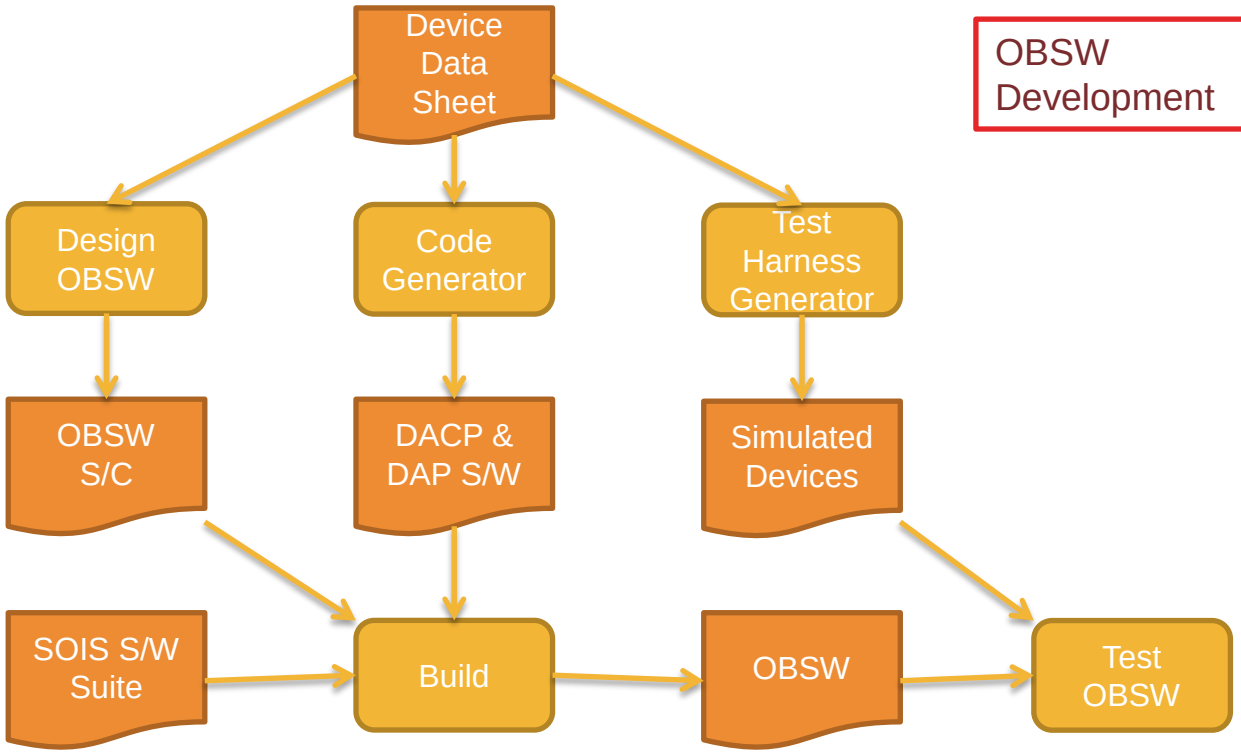
- *Device Manufacture*
- OBSW Development
- Spacecraft databases
- Simulators
- MCS databases
- Others?



- Device Manufacture
  - » Off-the-shelf device, e.g. most platform devices
  - » Custom device, e.g. most payload devices
  - » Implementation of formally or informally agreed standardised device type
  - » Aggregate Device assembled from lower-level components, i.e. RTU
  - » Can be used by test tools to validate that the manufactured device and the device data sheet agree upon the behaviour of the device as exposed on the subnetwork interface

How and When are EDS Used (2/2)

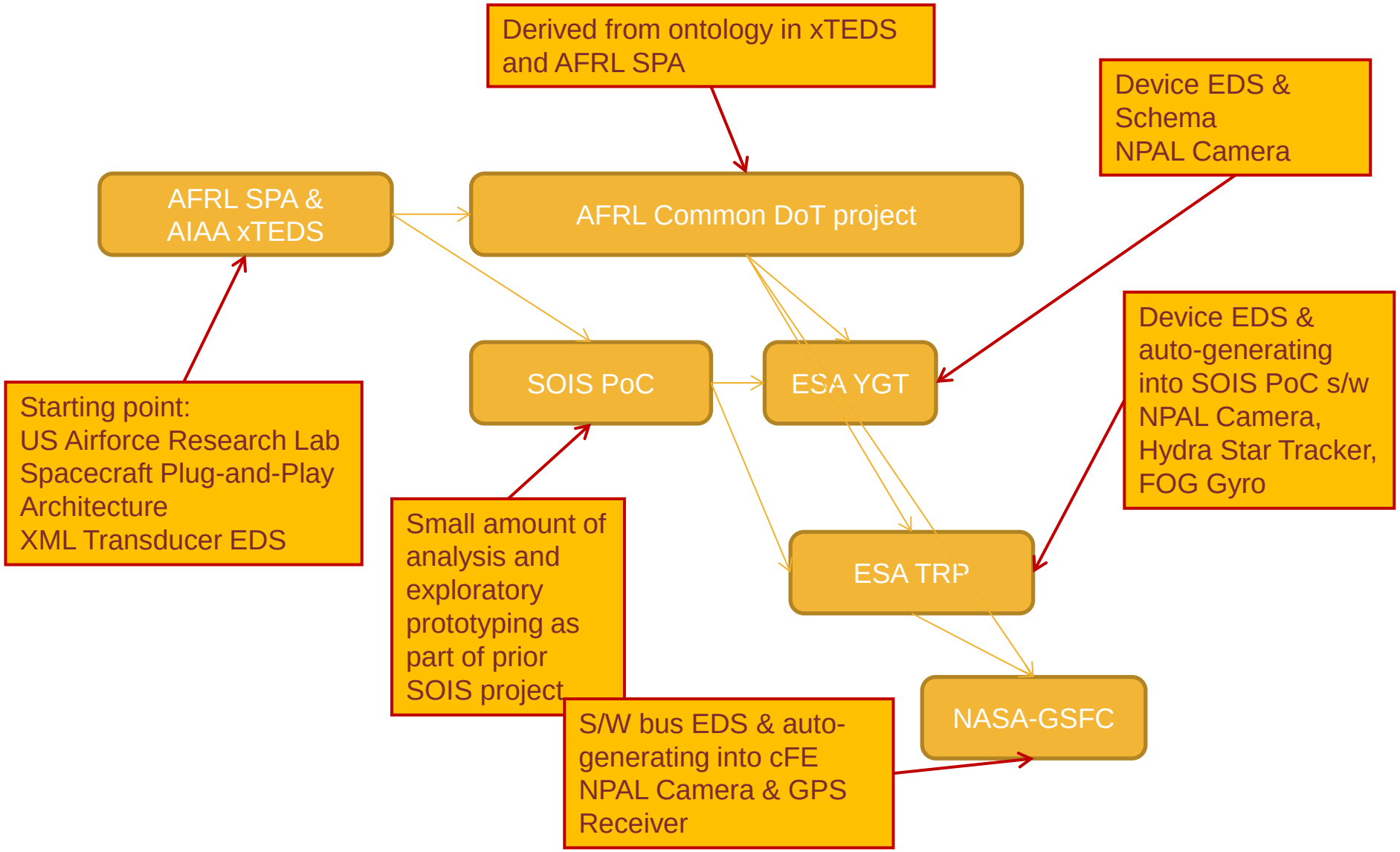
- Device Manufacture
- *OBSW Development*
- Spacecraft databases
- Simulators
- MCS databases
- Others?



- OBSW Development
  - » Eliminates the interpretation of behaviour
  - » OBSW automatic generation is dependent upon software architecture used for OBSW
  - » Clearly it will only generate a fragment of the OBSW
  - » Other system issues need to be addressed, e.g. determining a MIL-STD-1553B schedule
    - › Of course, this can make use of a device data sheet too as this encodes the communication patterns
  - » Also test harnesses can be generated

Current Status of Prototyping

Prototyping Projects

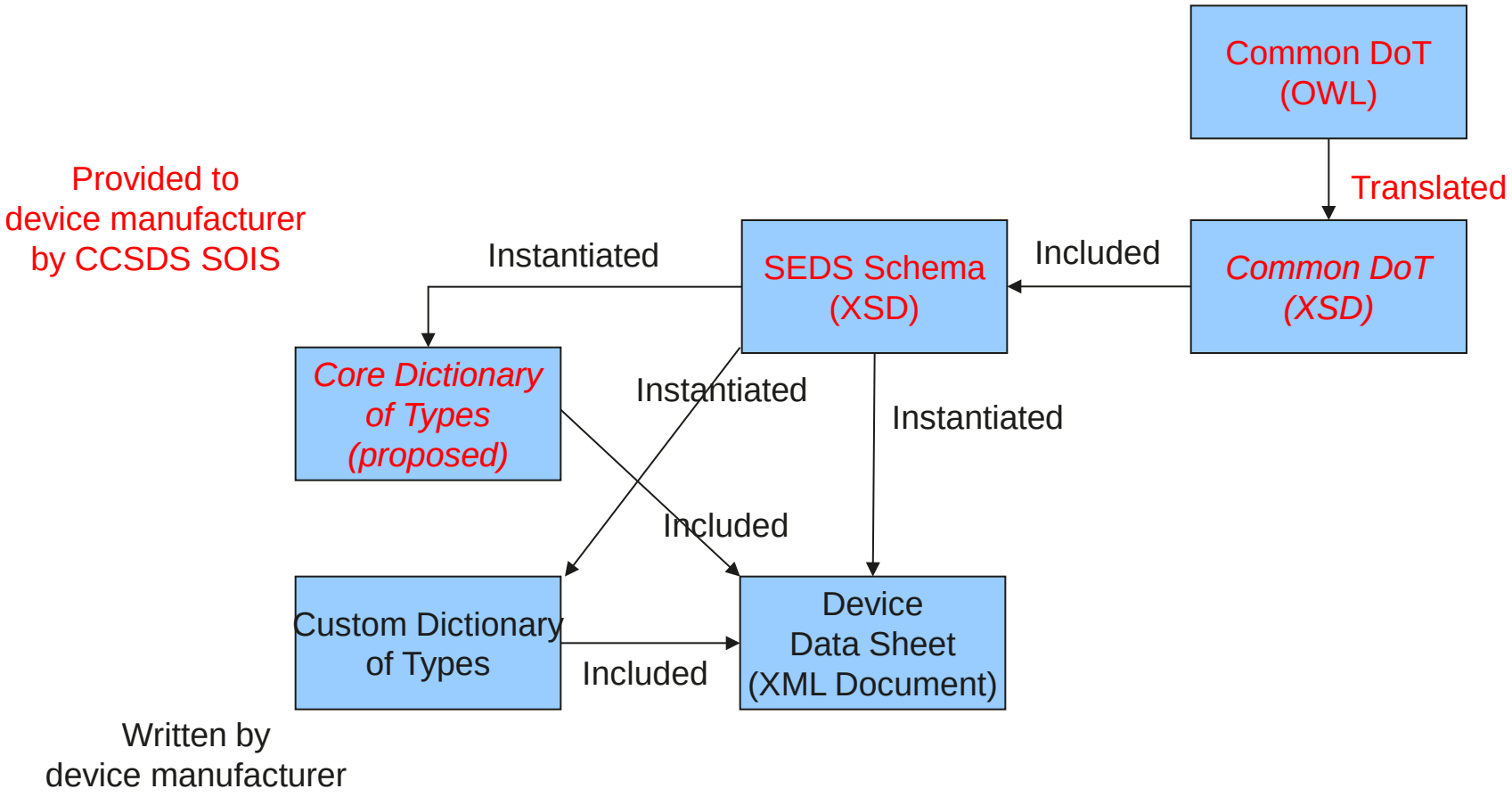


SCISYS

ESA TRP Project

- Project
  - Follow-on from SOIS Proof of Concept TRP study
  - SCISYS supported by Astrium (F) and TAS-F
  - 15 month TRP study, kicked on September 2012
- Objectives
  - EDS Use Cases Capture and resulting Requirements
  - Definition of EDS XML Schema and Specification
  - Test with defining EDS from real-world ICDs
  - Proof of Concept demonstration of code generation from EDS
- Outputs
  - EDS XML Schema & draft CCSDS SOIS standard
    - In cooperation with CCSDS SOIS WG and SAVOIR-SAFI WG
  - Example Functional Interfaces and EDS for selected real-world devices
    - Hydra Star Tracker, FOG Gyro, NPAL Camera
    - Use of draft Common Dictionary of Terms from AFRL
    - Using SAVOIR-SAFI generic Functional Interfaces, where possible
  - Proof of Concept Demonstration on RASTA
    - EDS-generation toolkit
    - SOIS and ICD documentation auto-generation
    - Demonstration of OBSW using auto-generated SOIS to interface to simulated devices
      - Based on SOIS Proof of Concept software

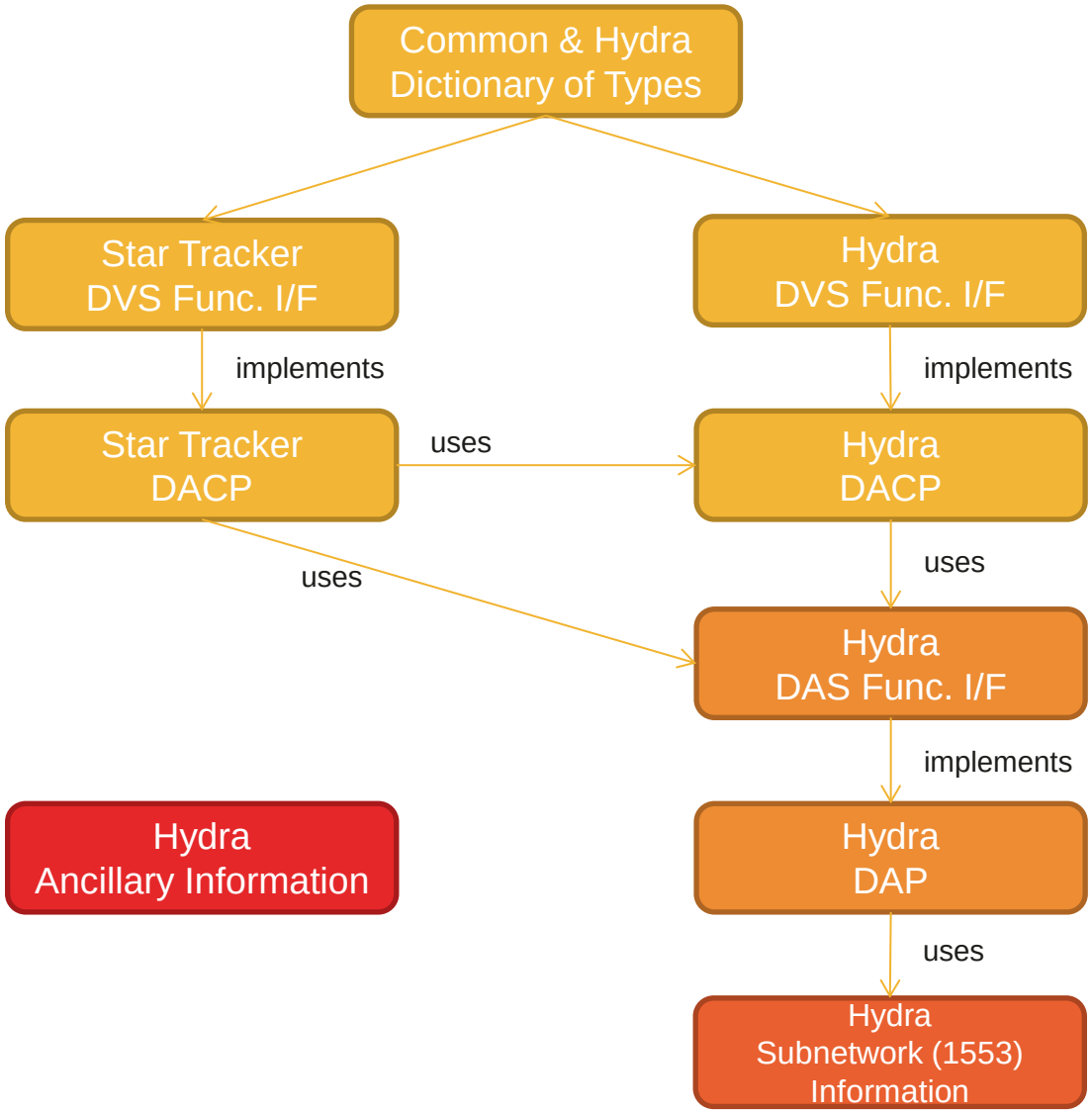
Standards, ontologies, schemas and data sheets



Normative elements indicated in red

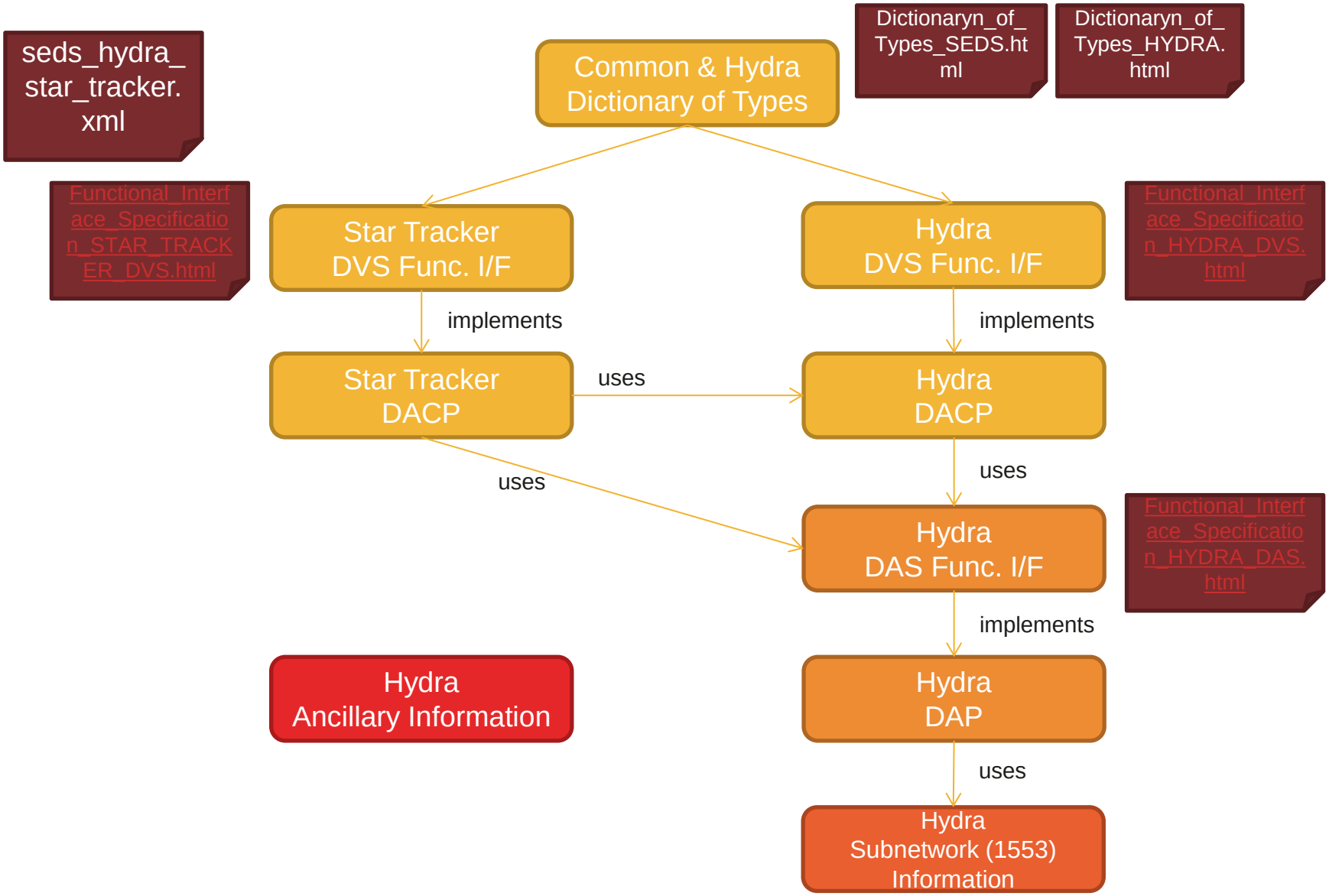
Contents of a device data sheet: Hydra Star Tracker

seds_hydra_star_tracker.xml



SCISYS

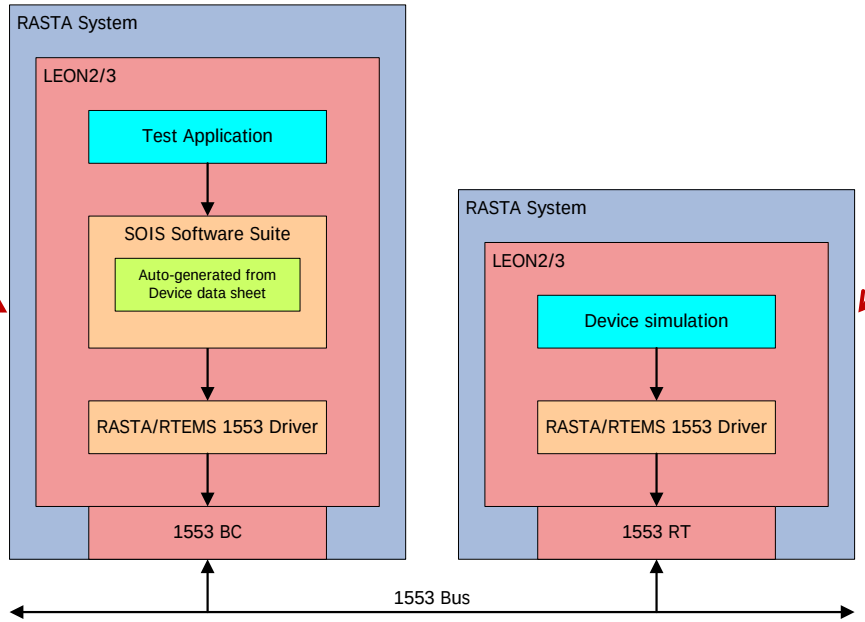
Auto-generated Documentation: Hydra Star Tracker



SCISYS

Auto-generated OBSW: Hydra Star Tracker

RASTA representing OBC
SOIS Software Suite from SOIS PoC project containing *auto-generated code from device data sheets*
E.g.
- Interfaces
- State machines



RASTA representing simulated Hydra Star Tracker
Hand-coded from paper ICD

- Demonstrate that device data sheets can be used to automatically generate OBSW
- Proof of concept code generator toolset for SOIS Software Suite framework from SOIS Proof of Concept project
- Test Applications call DVS or DAS to command and acquire data from e.g. simulated Hydra Star Tracker
- Successful demonstration
  - » Now into refinement & improvement of how data is captured in data sheets

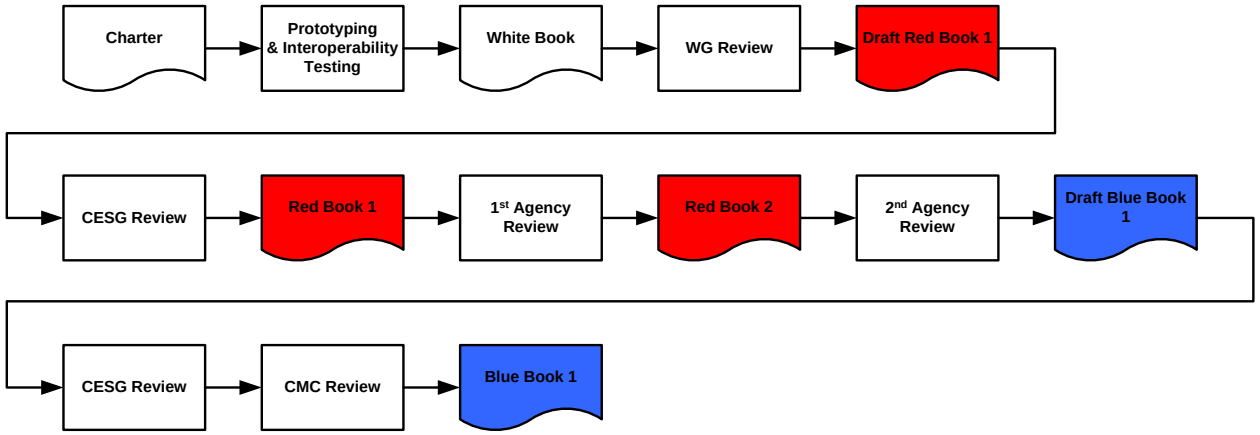
Technical and Process Issues Identified

- Balance readability of data sheets with sufficient complexity to capture all sensible patterns
  - » XML is unreadable in all but most simple cases
  - » Most simple cases are too simple to test schema is sufficiently rich enough
  - » Viewer, editor support tools required (beyond standard XML)
- Need to explore multiple use cases to iron out issues
  - » Coverage of all device classes and sufficient examples
  - » Test interfacing to real rather than simulated devices
  - » Different uses, different processes
- Handling access to legacy devices
  - » Little or no implementation of ECSS 1553 services
  - » NPAL camera doesn’t use SpW protocol IDs
- Not enough standardisation of SpW protocols yet
  - » Need e.g. SpW-D & defined protocol stack

Specification by CCSDS

Specification by CCSDS

Supported by
- ESA
- UKSA
- NASA:
  - GSFC, JSC, SUMO, AIAA



- CCSDS Standards
  - » CCSDS 876.0 XML Specification for Electronic Data Sheets for Onboard Devices
    - › Blue Book, EDS XML schema
  - » CCSDS 876.1 Common Dictionaries of Terms & Types for Onboard Devices
    - › Blue Book, OWL ontology, Common Dictionary of Terms XML schema, Common Dictionary of Types XML document
  - » Items in Red managed and online access provided by CCSDS SANA
- Electronic Data Sheets informational report (Green Book)
  - » Overview of structure and expected usage of Electronic Data Sheets
    - › More detailed that forthcoming general SOIS Informational Report Issue 2
- Standardisation of device class-specific generic Functional Interfaces
  - » In EDS format
  - » Extensible set of device classes, perhaps derived from SAVOIR-SAFI work
  - » *Which standards organisation should own this?*

Thank you

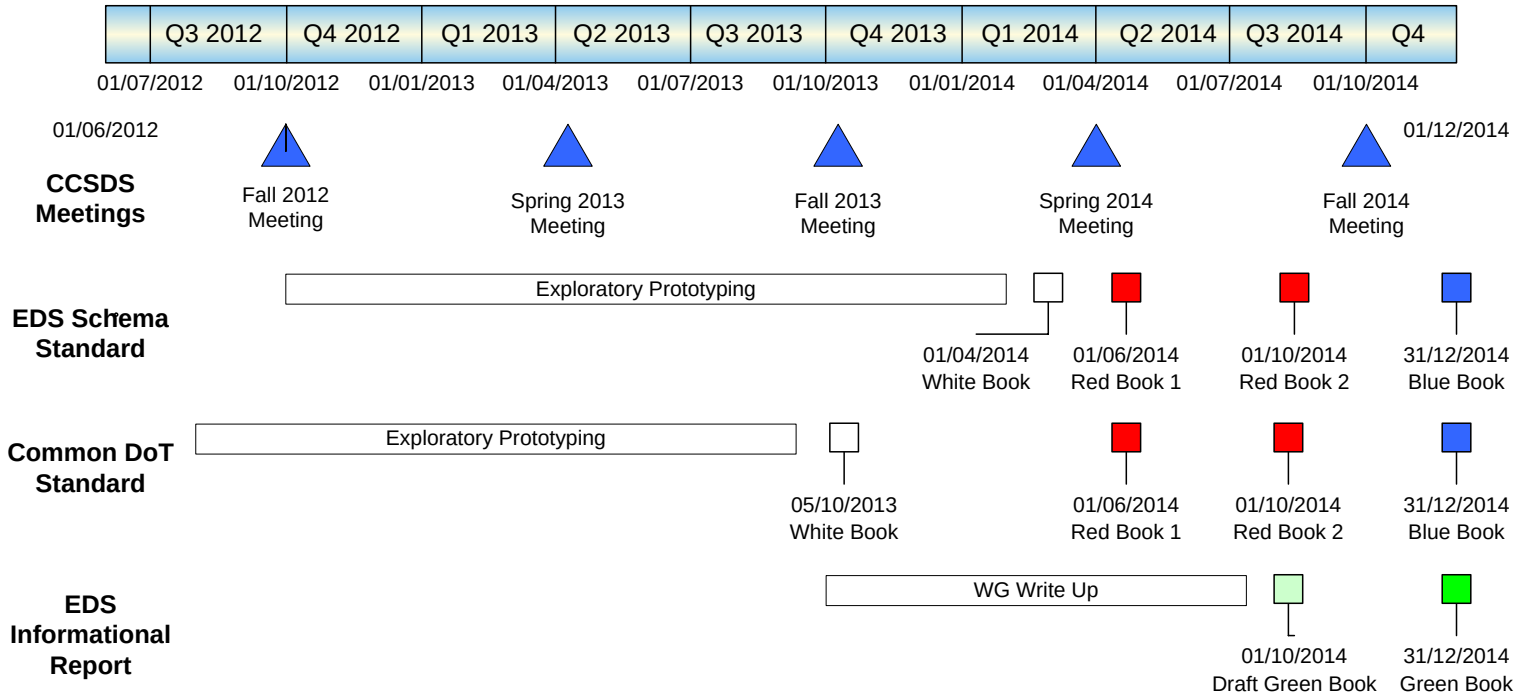
Any questions?

SCISYS

Backup Slides

Planned Roadmap to CCSDS Standardisation

Planned Roadmap to CCSDS Standardisation



- Items to address at Fall 2013 meeting
  - Consider feedback from exploratory prototyping
  - Further experimentation with different devices
    - Different communication patterns, types, terms?
  - Other uses, e.g. ancillary information, use in SCDB
  - Merge different schemas, respecting different usages
    - Common types & functional interfaces, but different protocols?
  - Identifying what else should be provided:
    - Interoperability Testing
    - Reference toolset and worked examples to supplement standards