Using CCSDS Standards to Reduce Mission Costs

SSC17-XII-02

Jonathan Wilmot

NASA/GSFC

cFS Lead Architect

CCSDS SOIS Area Director

08/10/2017

Agenda

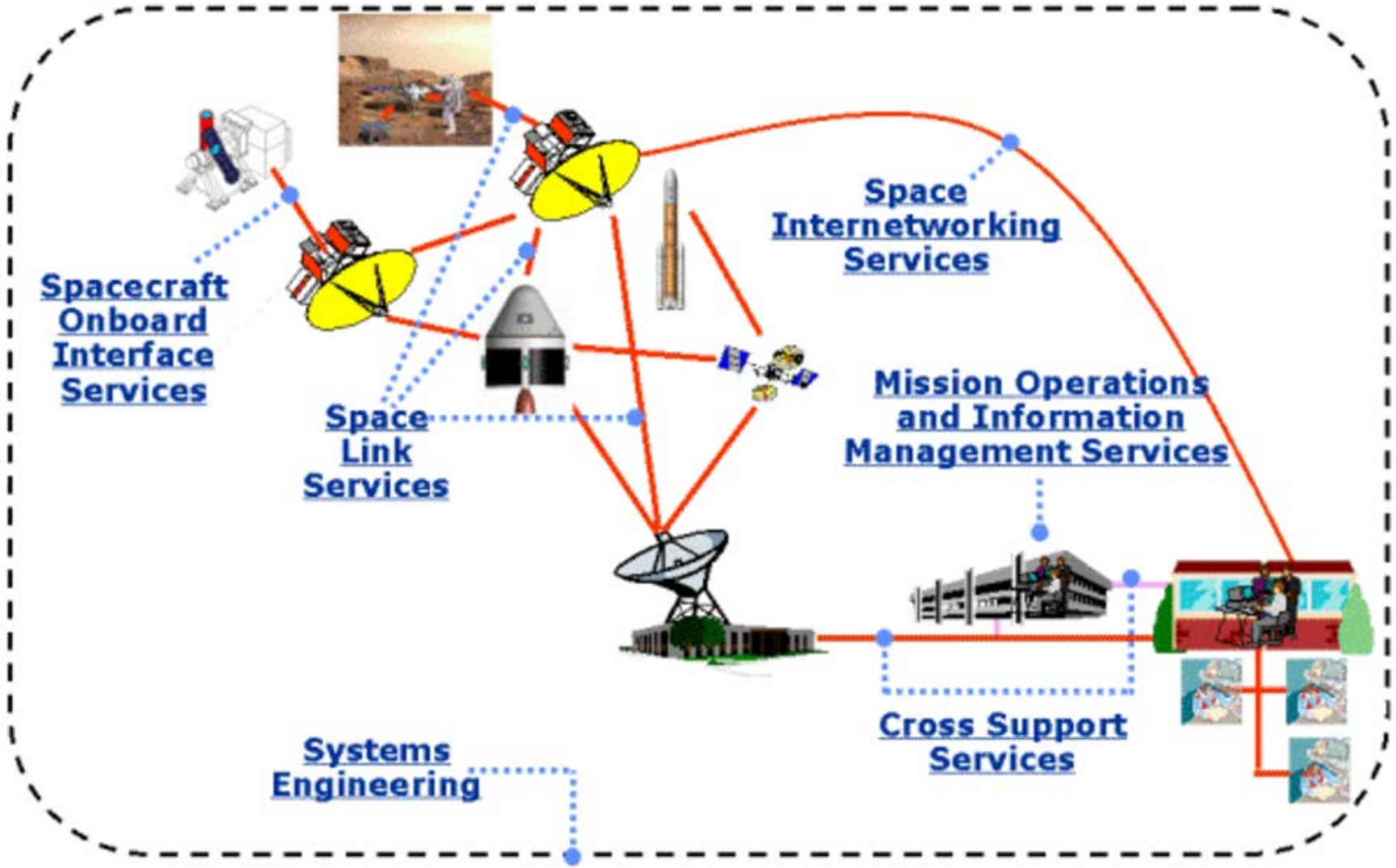
- Introduction to Consultative Committee for Space Data Systems (CCSDS) Standards
- Applying the upcoming CCSDS Electronic Data Sheets (EDS) standards
- EDS use with NASA's Core Flight System (cFS)
- Quick introduction to Delay/Disruption Tolerant Networking (DTN)

Introduction to Consultative Committee for Space Data Systems (CCSDS)

If you use agency communications infrastructure, you probably use a few CCSDS standards

Over 718 major space missions have!

CCSDS Scope



https://public.ccsds.org

Consultative Committee for Space Data Systems Mission

- **CCSDS develops and maintains recommendations and standards to:**
  - To promote interoperability and cross support among cooperating space agencies supporting spaceflight collaboration and cost sharing
- **Recommendation and standards include:**
  - Uplink/downlink packet and data link framing protocols
  - Compression, File transfer, messaging, security
  - Cross support between agency infrastructure
  - Radio and Optical encoding and error correction
  - Mission operations and information management services
  - Space networking (Delay/Disruption Tolerant Networking), encapsulation
  - Onboard subnetwork and service interfaces
  - Data exchange format specifications

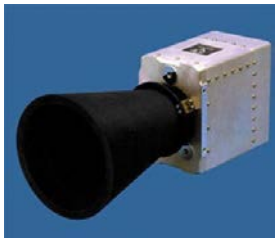
Introduction CCSDS Spacecraft Onboard Interface Services Electronics Data Sheets

CCSDS Electronic Data Sheet Definition

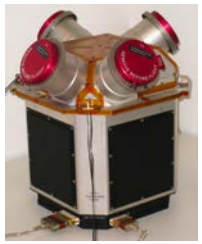
- **An Electronic Data Sheet (EDS) is a formal specification of a device, system, or software interface in a machine readable format**
  - Unambiguous and machine verifiable specification
  - Delivered with the device, system, or software
  - It is not an Interface Control Document (ICD) in that it does not specify how a system or mission will use the device or software
- **EDS specifies black box view of interfaces**
  - Data formats, conversions, limits, exchange protocols, and state machines, …
- **A CCSDS Spacecraft Onboard Interface Services (SOIS) EDS (SEDS) is an EDS defined using the SOIS Dictionary of Terms and the SOIS EDS XML schema**
  - Electronic Data Sheets and Common Dictionary of Terms - Overview and Rationale (Green 870.1)
  - XML Specification for Electronic Data Sheets for Onboard Devices and Software Components (Magenta 876.0)
  - Specification for Dictionary of Terms for Electronic Data Sheets for Onboard Components (Blue 876.1)
  - SEDS schema and dictionary of terms are keep in SPACE ASSIGNED NUMBER AUTHORITY(SANA) REGISTRY http://sanaregistry.org/r/sois/sois.html

Provides a standard to exchange system, device and software interface definitions between organizations and agencies

Device and Software Component EDS



Star trackers



Thrusters

Sun sensors

Software Component

Software Component

Software Component

EDS

EDS

EDS

EDS

EDS

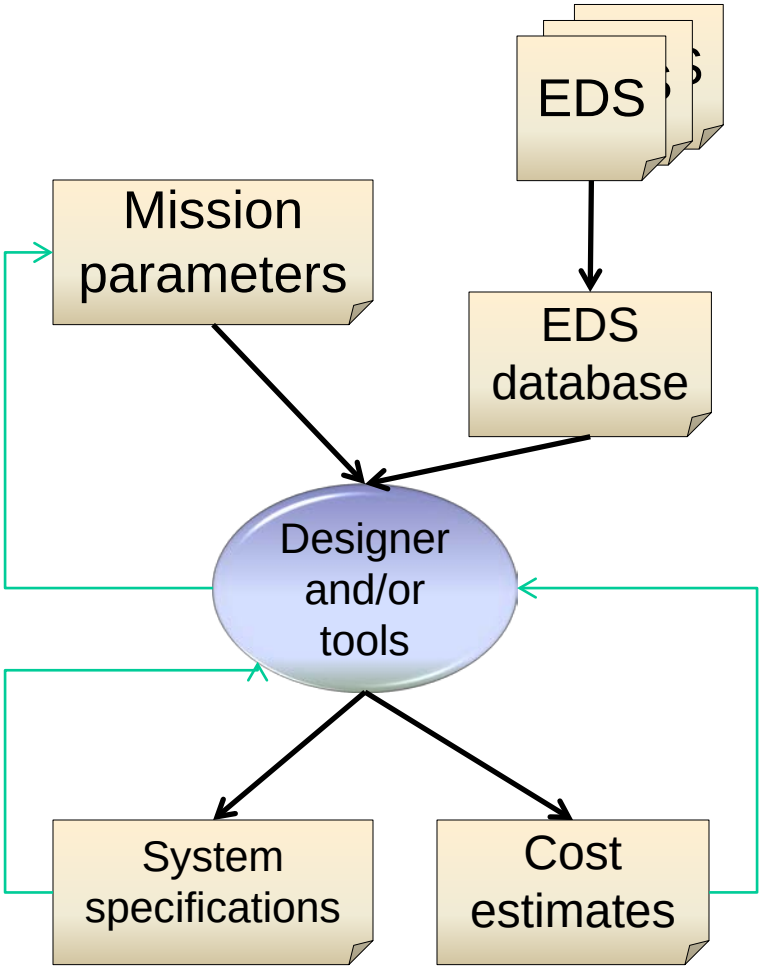
EDS

Software tools

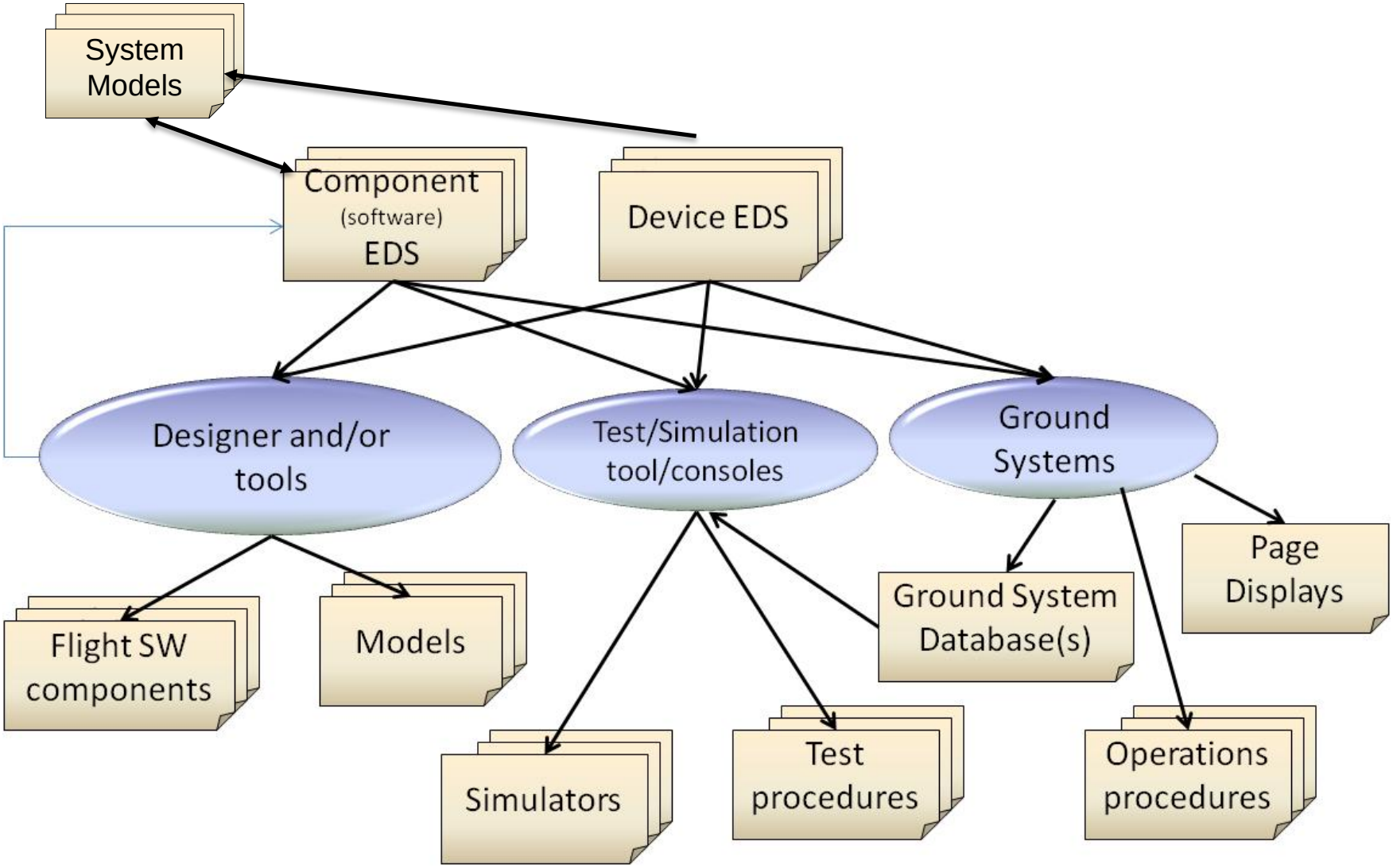
Vision: device manufactures provide an EDS with each component

Use in Early Mission Design

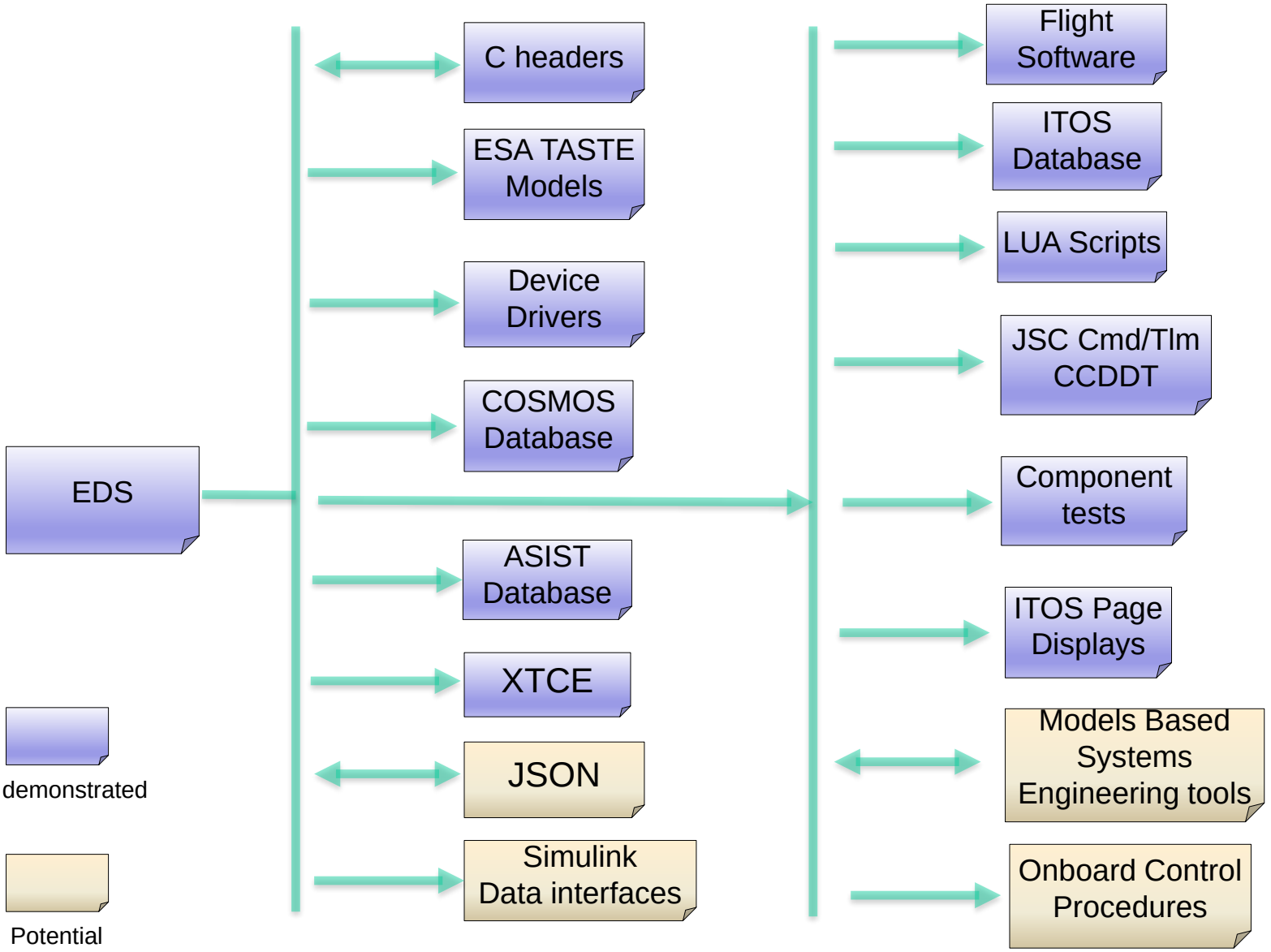
- **Automated tools used for device selection based on mission parameters**
  - Orbit, lifetime, performance…
- **Automated tools can generate system specs and cost estimates**
- **Mission designers review specs and cost estimates and adjusts mission parameters**
- **US Air Force Research Lab (AFRL) created prototype tools for this use case, Spacecraft Plug and Play (SPA)**



Development and Operations Use Cases



Existing and Upcoming/potential Tools

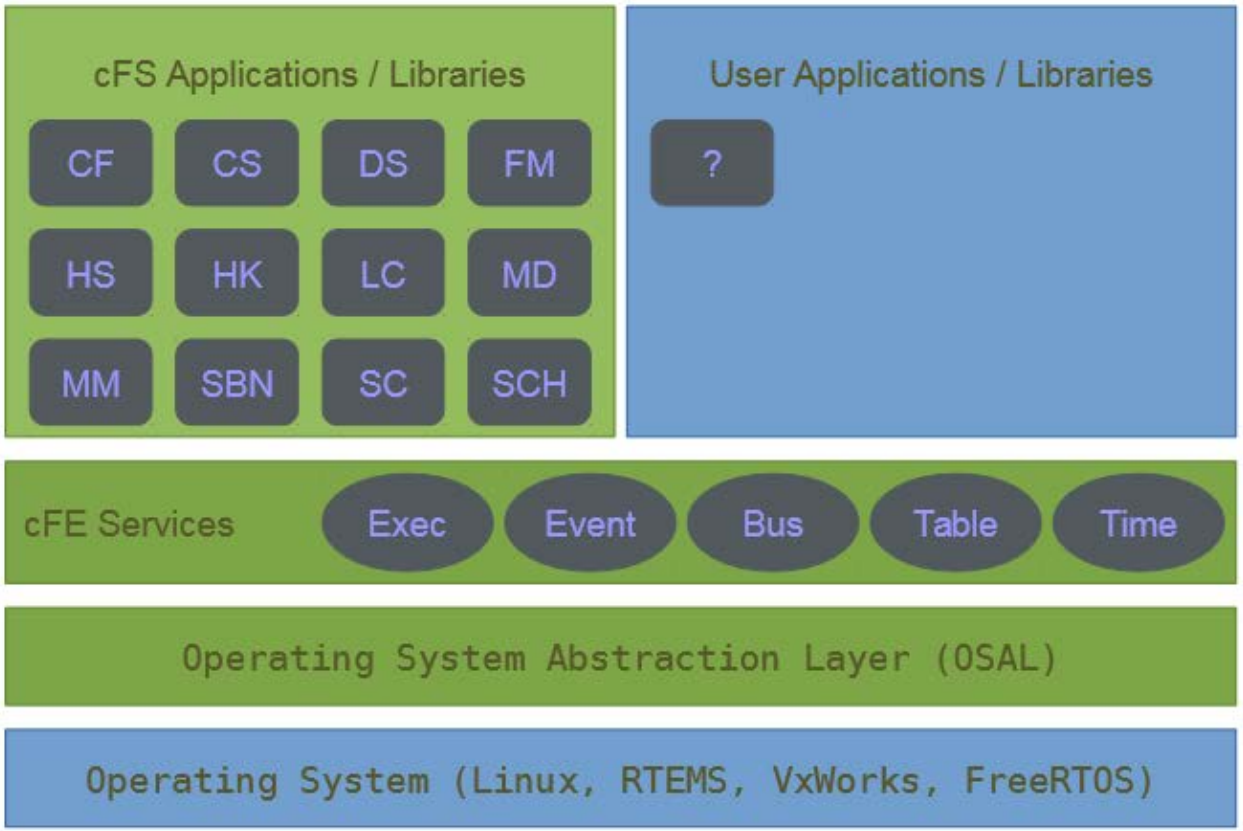


Introduction to NASA's core Flight System (cFS) software

Free, open source, reliable flight software

cFS Overview

- **Layered Architecture**
- **Pub/Sub Messaging**
- **Common Services**
  - **Executive**
  - **Time**
  - **Message Bus**
  - **Events**
  - **Tables**
  - **Files**
- **Distributed systems**
- **Time/Space Partitions**

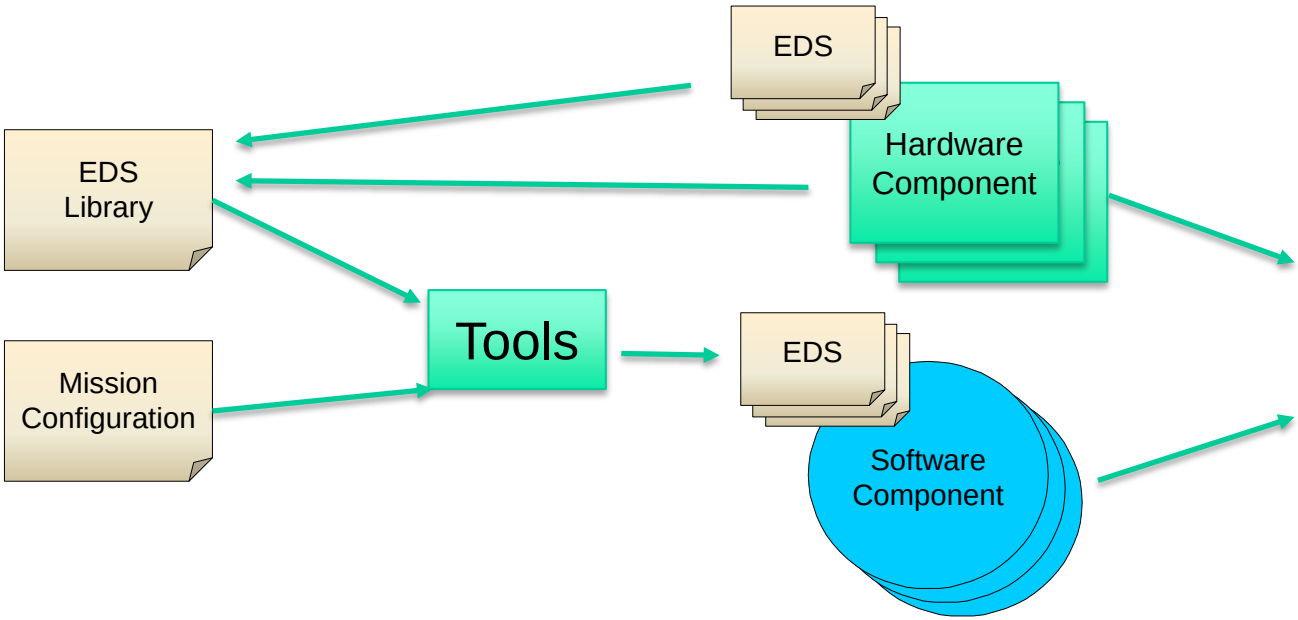


Applications and libraries can be stopped, restarted, removed, and reloaded dynamically at run-time

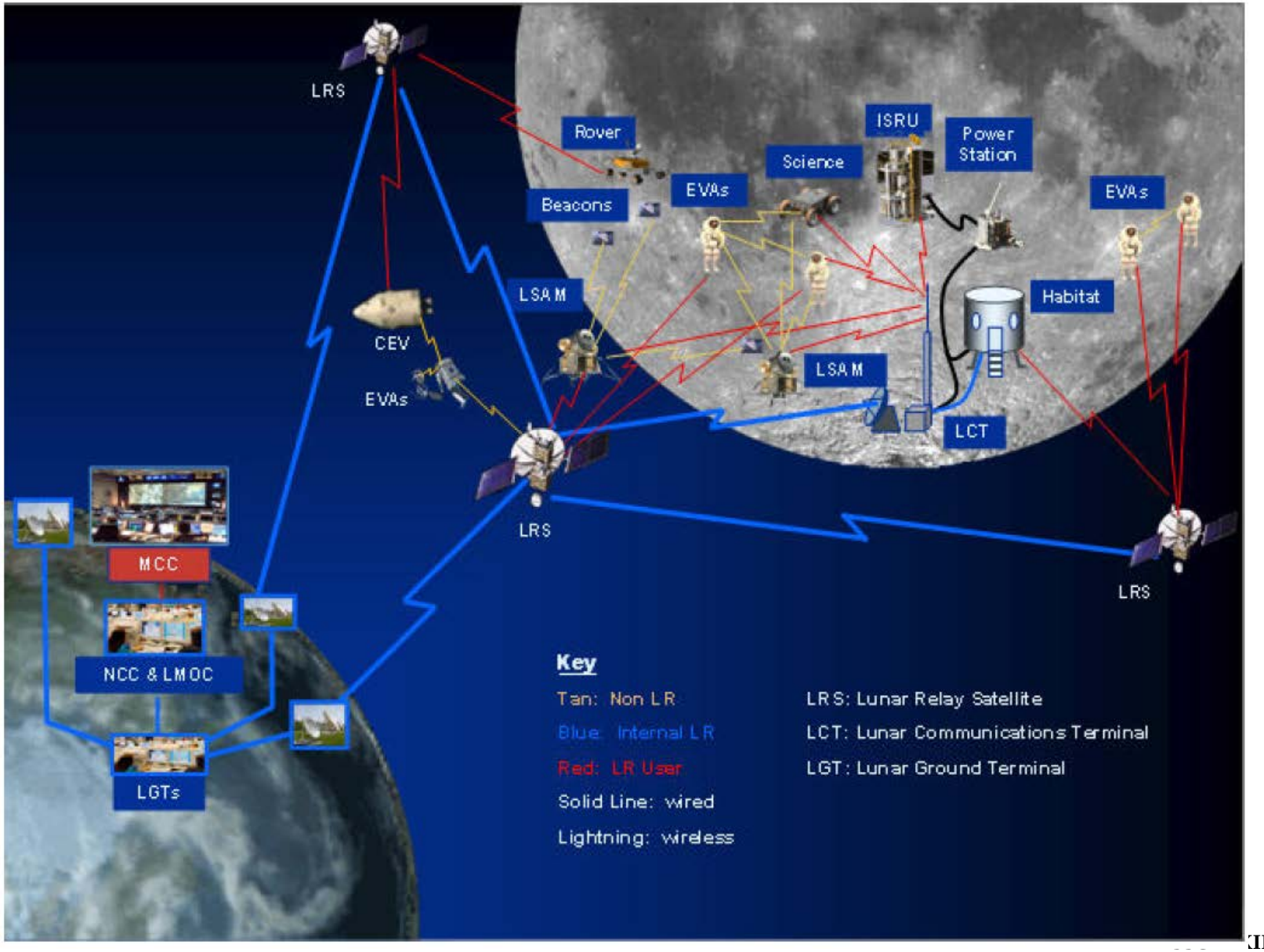
Go get it at https://cfs.gsfc.nasa.gov/

Components and Build Time Parameters

- **Each device and software component includes an associated SEDS**
- **SEDS specifies the data formats, conversions, limits, commands, telemetry, and exchange protocols in terms of the message bus and/or hardware interface**
- **Some parameter values in the message packet EDS are determined at build time**
  - The original component EDS author does not know these values
  - Values are defined in mission deployment files
  - The values will be set by a tool that reads the mission files and creates a software component header file at build time
  - The EDS Schema has mechanisms for this



CCSDS SOIS EDS provides a standard mechanism to exchange interface & data definitions and automate many aspects of system development



Delay/Disruption Tolerant Networking (DTN)

https://www.nasa.gov/content/dtn

- **Designed to handle the delay and intermittent connectivity of spacecraft, rovers, …**
  - Scheduling, routing, security, QoS. network management, …
  - A suite of standards developed by Internet Engineering Task Force (IETF) and CCSDS
- **Open source Interplanetary Overlay Network (ION) code available now**
- **cFS components available late Spring 2018**