Study of Tools for Command and Telemetry Dictionaries

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Spacecraft and Ground FSW needs

- **Spacecraft Defined by data**
  - Commands - Formatted to the Spacecraft
  - Telemetry – From the Spacecraft
  - Ground Software
  - Subsystem Teams
    - Command and Data Handling (C&DH)
    - Electrical Power System (EPS)
    - Guidance, Navigation and Control (GN&C)
  - Third Party Vendors
  - Science Payloads…….....

- **Flight Software needs to figure out how to talk to all of it.**
  - And not do it multiple times for each use (Simulink, C Code, ITOS, …)

Our early approach – C&T Database

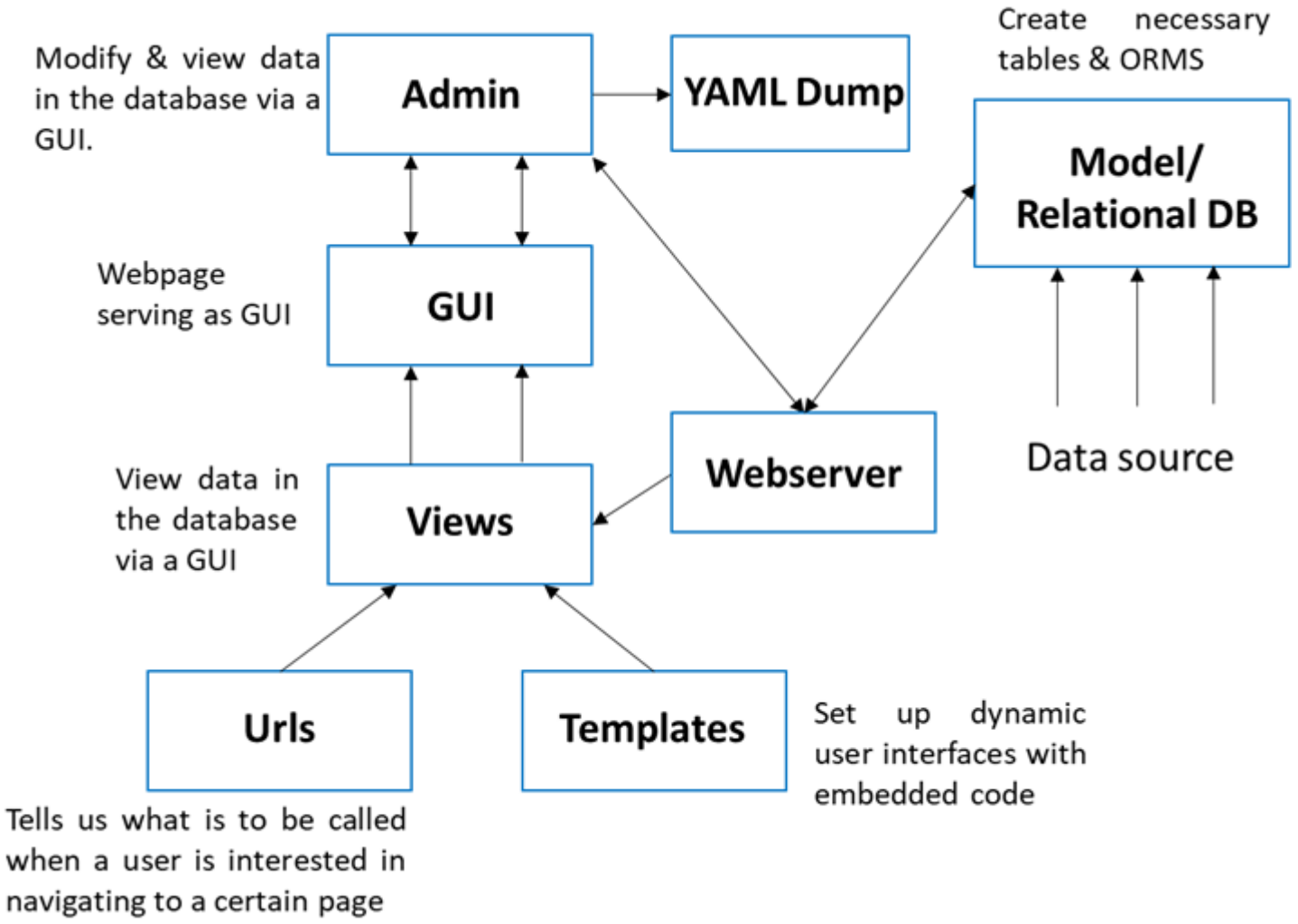
- **LADEE – Integrated Command and Telemetry Database (Mostly…)**
  - Shared between C&DH Flight Software, Simulink Models and ITOS
  - Other data analysis tools leveraged

- **Not for all data uses:**
  - Legacy source code. (cFS was hand inserted into C&T DB)
  - Created “Pass-Thru” Commands
  - Mostly just Commands and Telemetry (Packets)
  - Other systems for: Parameter Tables, Temperature Calibration Curves
    - **Monstrous Excel Spreadsheets**
    - **Spreadsheet difficult to maintain**

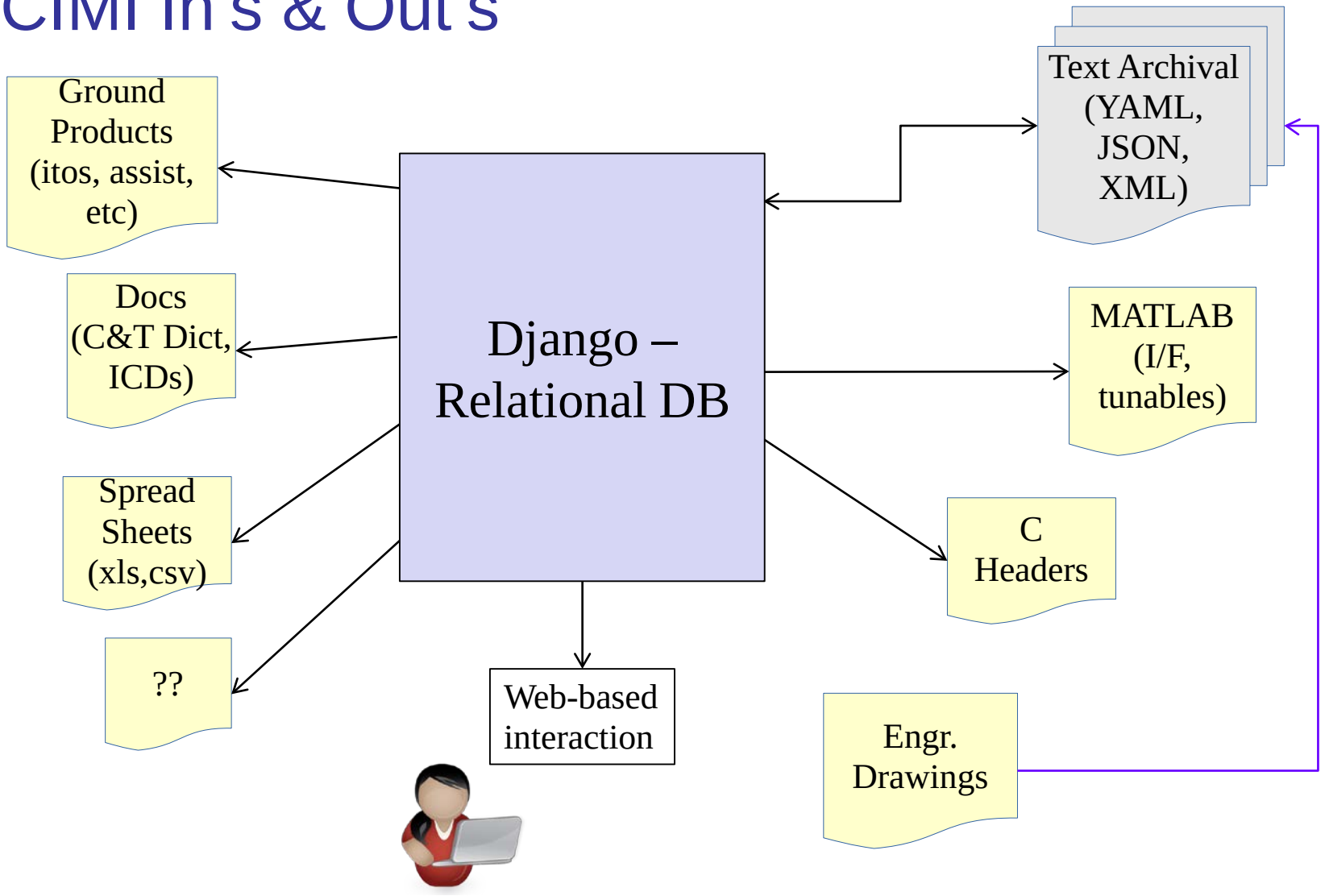
Next Step - SCIMI

- **SCIMI – System Configuration Information & Mission Interfaces**
- **Relational Database based off of Django**
- **Address limitations of previous “LADEE” approach**
  - Full Command & Telemetry plus…
  - Produces Simulink tables products
  - Handle other cFS tables
  - Calibration Curves
  - Consumes YAML and uses Python for product generation
  - Infrastructure entirely Python
  - Built-in Embedded web GUI and command-line interfaces
  - *Light on* documentation
  - Extremely customizable per mission (almost too much, meaning not out-of-the-box)

SCIMI Logical Flow



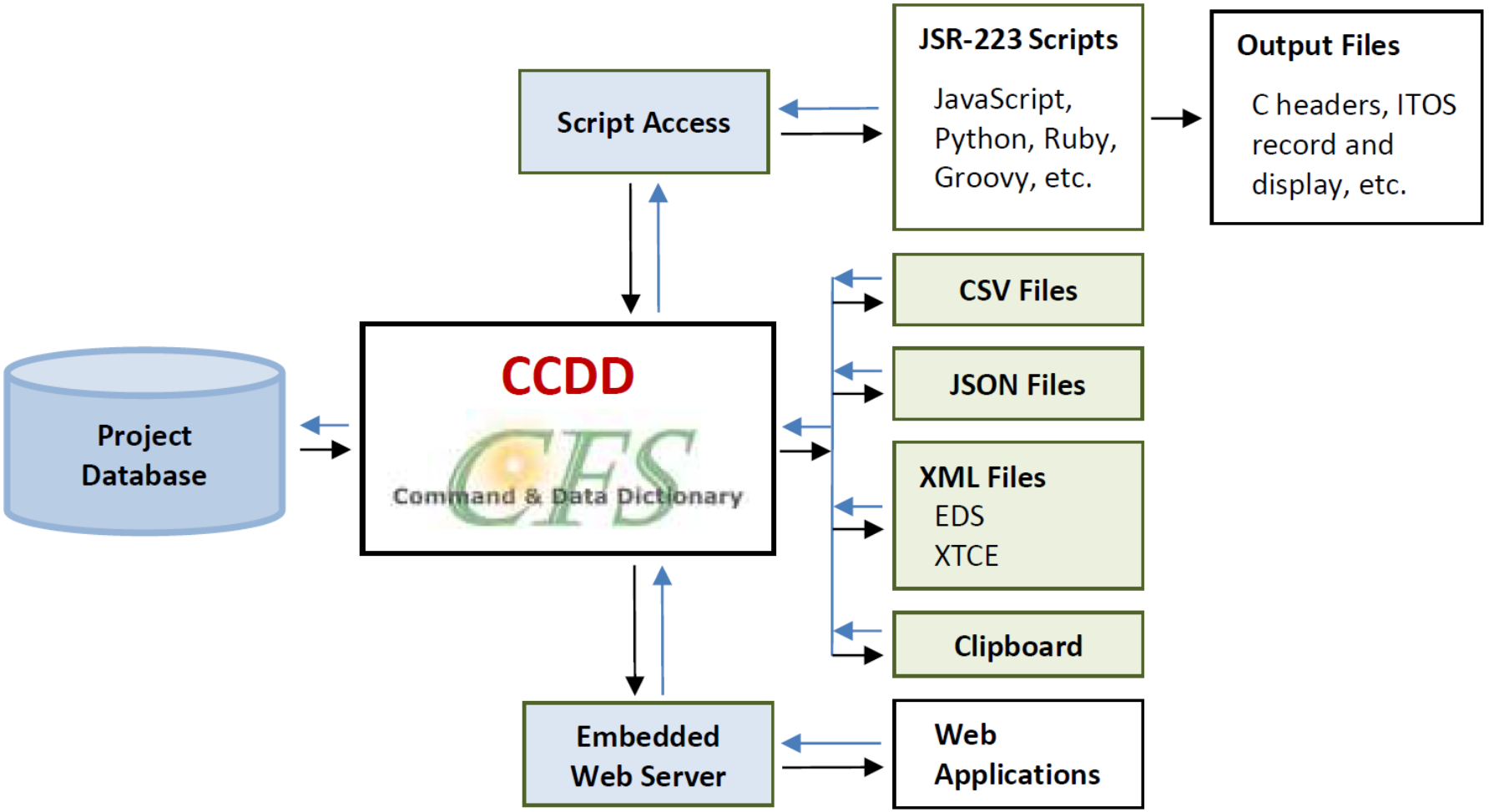
SCIMI In's & Out's



New Development - CCDD

- **CCDD – Core Flight System (cFS) Command and Data Dictionary**
- **JSC Developed, officially NASA Open-Sourced**
  - These are two tools similar GIT vs Subversion
- **Central SQL Database - (PosgreSQL)**
- **Infrastructure implemented in Java**
- **Multiple sources and products**
  - Consumes CSV, JSON, EDS, and XTCE and uses JavaScript, Python, Ruby, Groovy, etc… for product generation
  - Highly customizable due to variety of input and output formats
- **Embedded web GUI and command-line interfaces**
- **Extremely well documented**

CCDD Logical



What to Do? (SCIMI vs CCDD)

- **Struggled to keep consistency with tools**
- **Problems with “Clone and Own”**
- **Looking hard at transitioning to CCDD – Test Implementation**
- **Creating needed CCDD Additions for us.**
  - Simulink
    - **Strength of DB tools is – adapter/translator**
- **Todo for Us**
  - Interfaces to additional data analysis tools
  - Data Marshalling - Translation
  - Possible – Database flexibility

What did we need to do to implement CCDD test for RP?

- **Every mission has slightly different approach**
  - Command and Data Dictionary tools need flexibility
  - CCDD provides such flexibility through table customization
  - In addition, provides full API for interaction with database

- **Slight modifications to infrastructure**
  - Facilitated by tool creators
  - Particularly relevant for Model Based Design code auto-generation
  - Not too much needed because of high customizability of tables
    - **Namely the ability to add “data fields” to tables that uniquely identify information contained therein**
    - **For example, “Produce REC” and “Simulink App” boolean data fields for structures**

- **Most modification done to scripts that generate products**
  - Again, primarily to facilitate specific products for MBD auto-generation

Summary

- **Space Missions are defined by data**
- **Tools for Managing make it much simpler and reduce errors**
- **CCDD and SCIMI are two tools for managing that data**
  - Both have strengths and weaknesses
  - Tools themselves need support
- **Evaluation of tools based on project/mission needs**

Backup

Implementation Details

Common issues for all tools

- **Maintenance of the tools**
- **Which group "Owns" the Database through the Project?**
  - Start with FSW
  - Transition to Mission Operations
  - Science Operation Requirements?
- **What Tools?**
  - FSW Development.
  - Integration and Test
  - Mission Operations
  - Science Operations
- **Procedures for modification?**
- **Backup and CM issues?**

SCIMI vs CCDD

- **SCIMI**
  - Pros:
    - **Django**
      - Powerful/Flexible Database Tool
      - Database agnostic
    - **Met mission needs**
  - Cons:
    - **Need for internal mission support**
    - **Lack of documentation**
    - **Mission specific implementation**
- **CCDD**
  - Pros:
    - **Complete implementation – with API**
    - **Mission/project agnostic**
    - **Well documented**
  - Cons:
    - **Customization needed for missions**
    - **Needed script development (Simulink)**