CEC450
Real-Time Systems

Lecture 15 – Block Diagram Design Examples

November 10, 2020

Design Elements for Proof-of-Concept

- Top N Capability (Functional) Oriented Requirements
  - State and Explain what your solution “must” do or “shall” do
  - Hold Q&A and Ask for Reviewer Input on Completeness, Errors and Omissions
- Top N Real-Time Requirements [C_i, T_i, D_i or each S_i]
  - State and Explain Service request frequency drivers and relative deadlines
  - How did you estimate or measure C_i WCET
- Single Page High Level Block Diagram of Software System
  - Show End-to-End Elements and Dataflow
  - Source to Sink (Top Left Corner to Bottom Right)
- CFD/DFD, Flow Charts, State Machines or Other Design Models
- Proof-of-Concept Time-Stamp Tracing Analysis

Top Level Design Examples

STS-85 Payload

(Flown 1997, U. of Colorado)

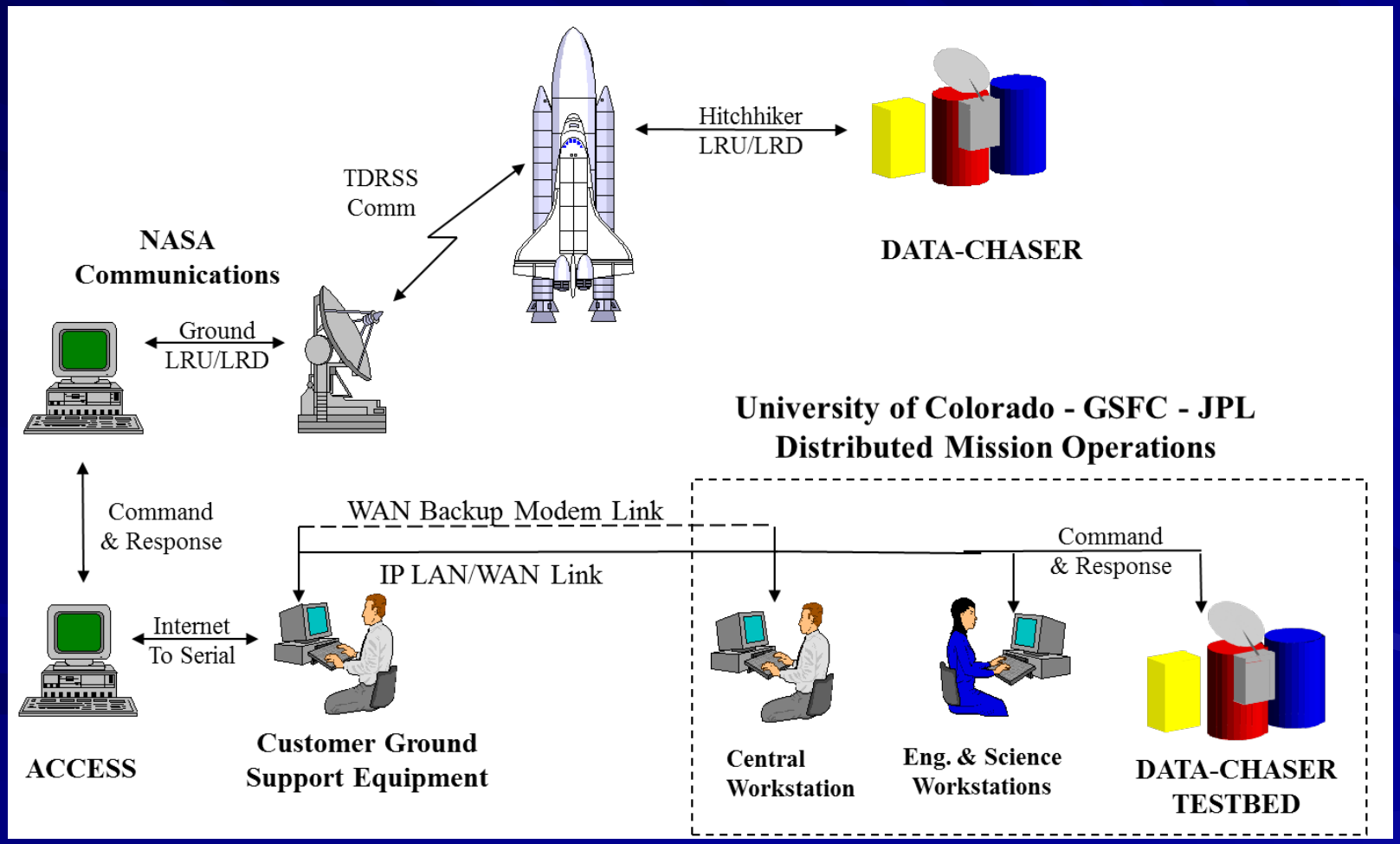
Payload Operations Requirements

1. The Embedded System **shall** Operate 3 Instruments (LASIT, SXEE, FARUS) According to a Scheduled Observing Plan of the Sun within STS Imposed Viewing and Operation Constraints
2. The Health & Status of Each Instrument **shall** be Reported to the Ground Continuously at no less than 1 Hz
3. Science Data Collected by Each Instrument **shall** be Streamed to the Ground While an Instrument is Observing
4. Observing Plan Updates **must** be Uplinked from the Ground Systems as Command(s) with Response
5. Commands to Operate Instruments Interactively **must** be Uplinked from the Ground and Status Indication Response Will be Provided
6. The Embedded System **must** Interface to Low-Rate Uplink and Downlink interfaces on STS for Command/Response, and H&S Telemetry Streaming
7. The Ground Software at GSFC **must** Interface to the ACCESS LRDU
8. Telemetry **must** be Stored in a Time-stamped Database
9. A HMI GUI **must** Display H&S Telemetry at GSFC and Provide a Command/Response Interface
10. GSFC Ground Systems **must** Host a Planning and Operations Rules and Constraints Database and Engine
11. GSFC Ground Systems **must** Host H&S Telemetry Monitoring to Detect Anomalous Behavior to Generate Alerts for the HMI/GUI
12. A Data Bridge Between GSFC Ground Systems and CU Boulder **must** Provide a Command/Response and H&S Telemetry Network Interface
13. CU Boulder Ground Systems **must** Interface an Automated Planning and Scheduling Software Application and Allow it to Generate Uplink Commands to Modify or Replace the Current Embedded System Observing Plan
14. The CU Boulder Ground Systems **must** Provide and HMI/GUI for H&S Telemetry, Command/Response and Automated Planning and Scheduling
15. A CU Boulder to NASA JPL Data Bridge **must** Provide H&S Telemetry for Beacon Monitoring to NASA JPL for Display on a High Level Status HMI/GUI

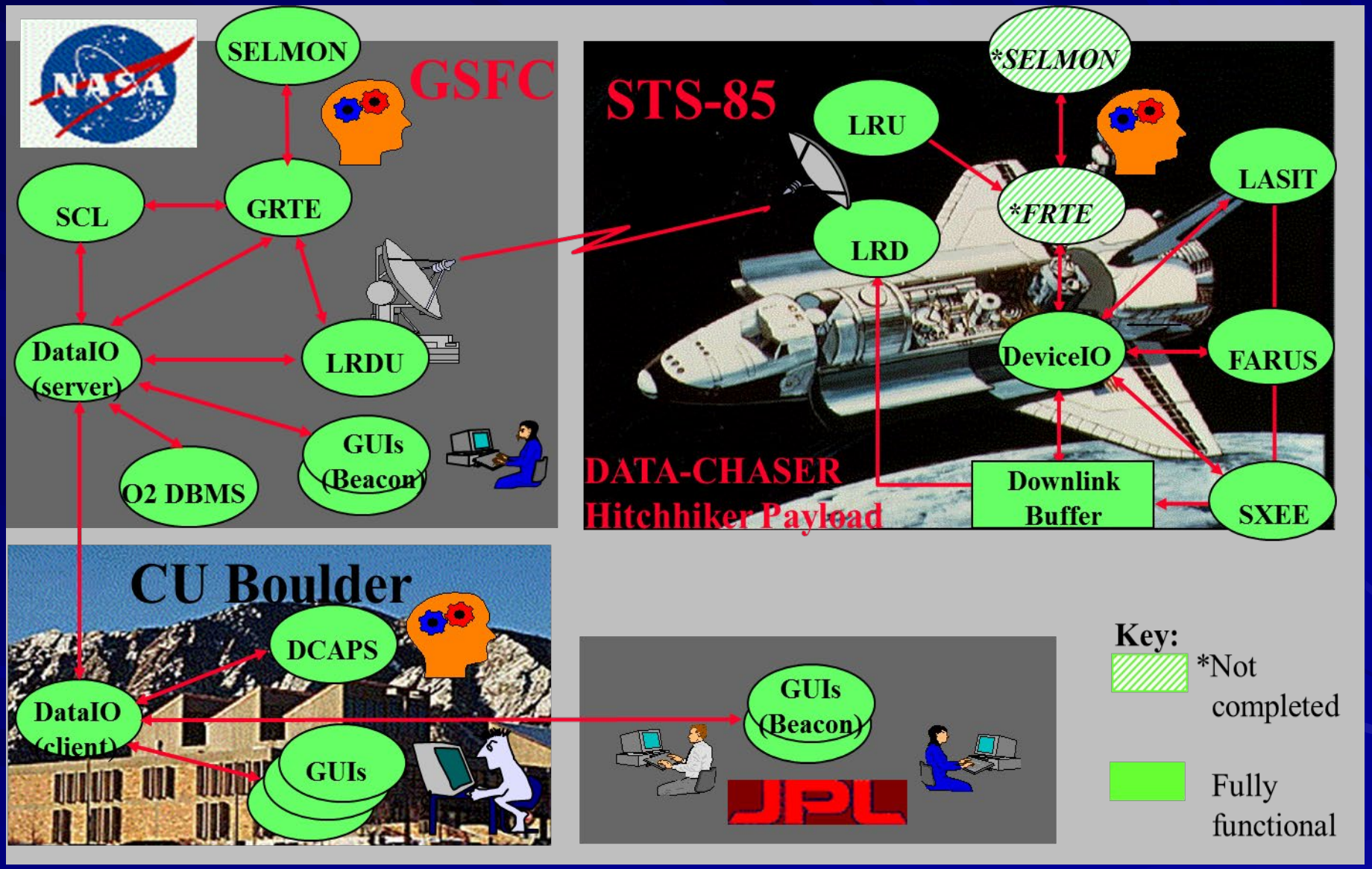
Constraint related to requirement

System Block Diagram

- Simple Interfacing between Major Hardware and Software Elements (Components or Subsystems) with User Interaction Shown
- E.g. CU Boulder Space Grant DATA-CHASER Mission (STS-85)

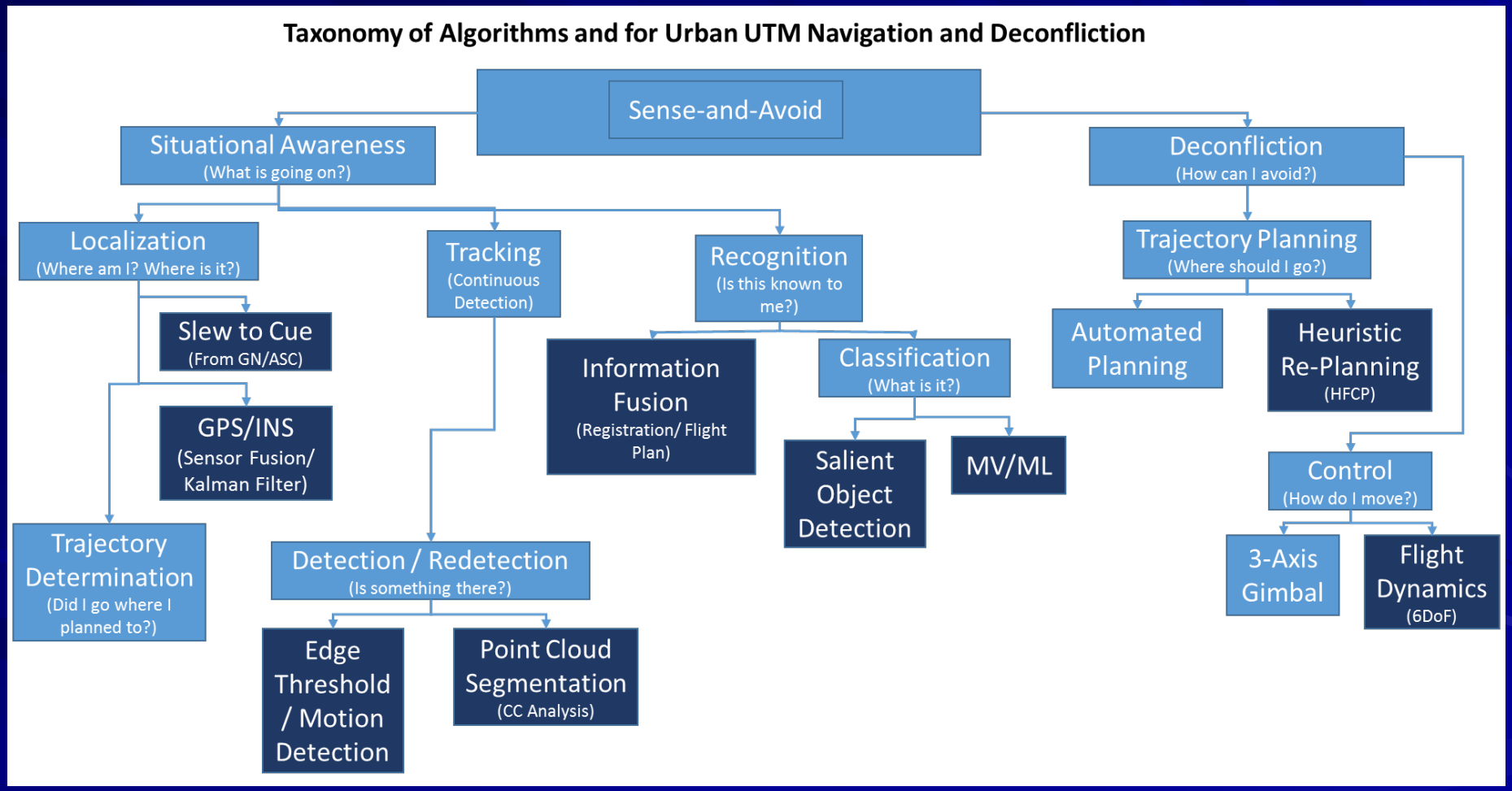


Software End-to-End System



System of Systems Block Diagram

- Complex Systems that are Systems of Systems or Integration of Subsystems that can also stand alone (E.g. Drone Net)
- E.g. IEEE SOSE (Drone Net IEEE Aerospace - presentation, paper)



Application Block Diagram

- Hardware shows standard platform(s), Software, and User Interaction
- Label Interface Dataflow and Protocols
- E.g. Contacts App on AOS