CEC450
Real-Time Systems

Lecture 15 – Block Diagram Design Examples

Design Elements for Proof-of-Concept

- Top N Capability Oriented Requirements
  - State and Explain
  - 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

Design Example

STS-85 Payload

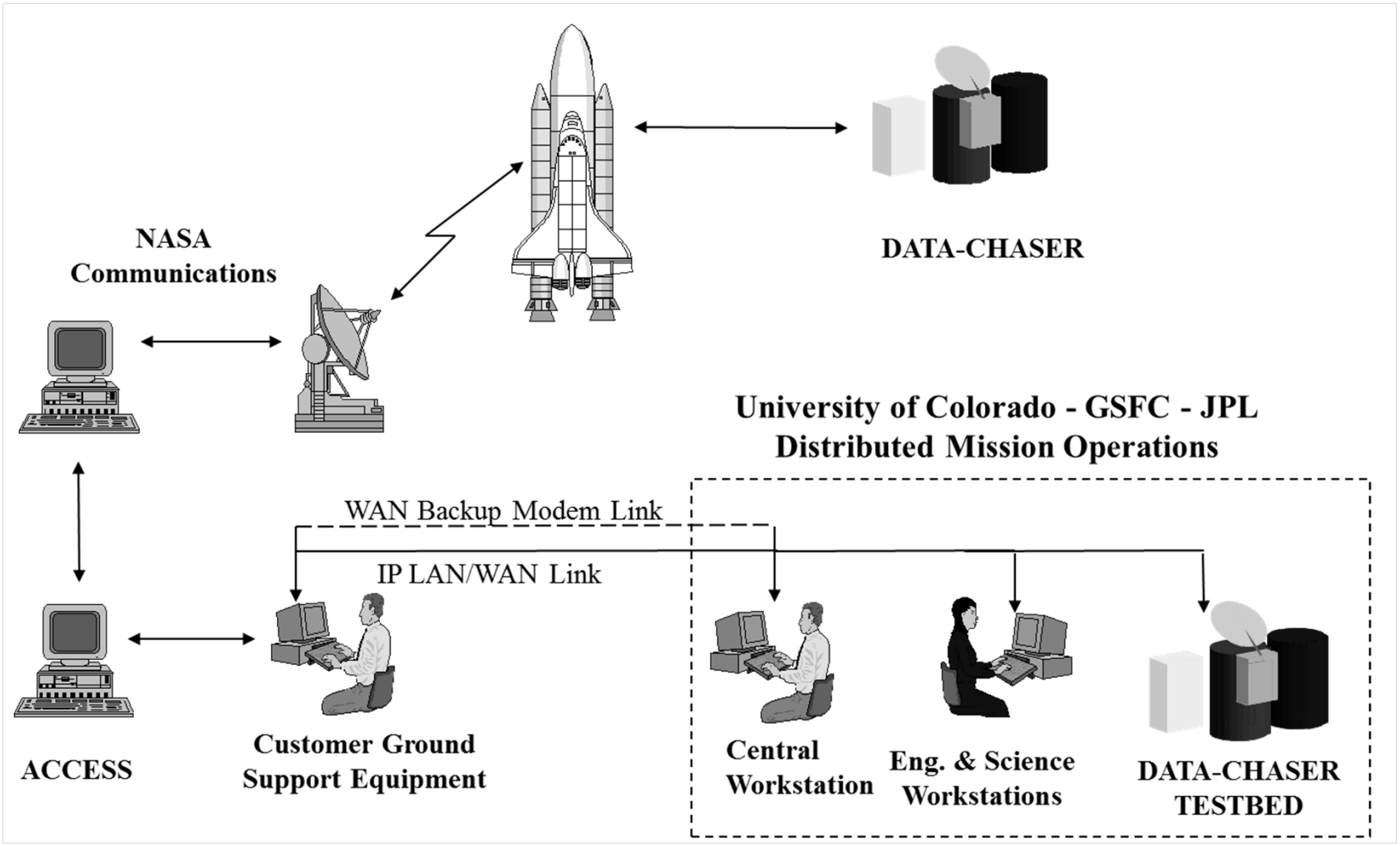
(Flown 1997, U. of Colorado)

Payload Operations

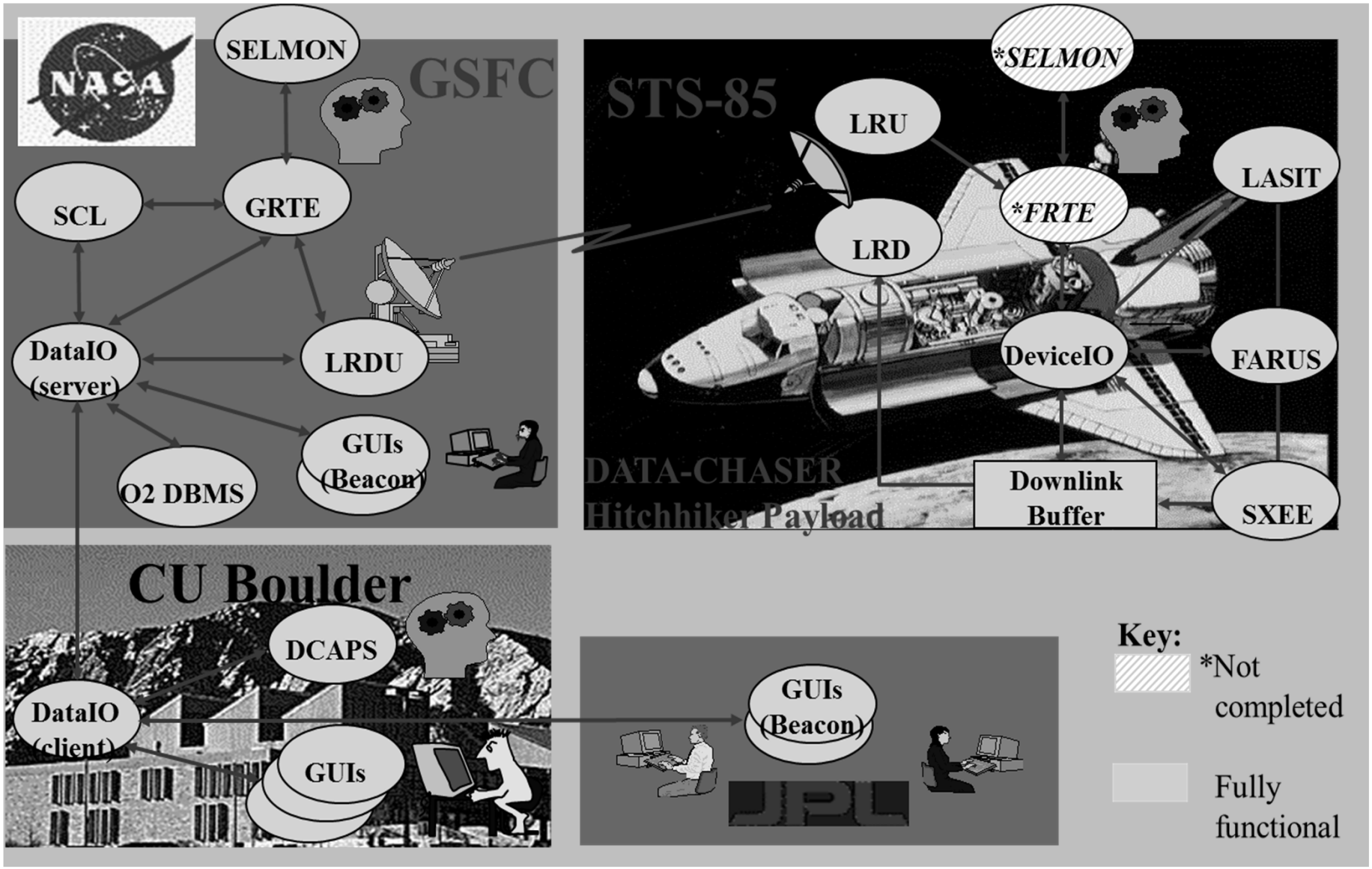
1. The Embedded System Shall Operate 3 Instruments (LASIT, SXEE, FARUS) According to a Scheduled Observing Plan of the Sun within STS Imposed Constraints
2. The Health & Status of Each Instrument Shall be Reported to the Ground Continuously
3. Science Data Collected by Each Instrument Shall be Streamed to the Ground While an Instrument is Observing
4. Observing Plan Updates Can be Uplinked from the Ground Systems as Command(s) with Response
5. Commands to Operate Instruments Interactively Can 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, 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

Hardware End-to-End System

- DATA Hitchhiker Payload, flown STS-85, Summer 1997
- Designed, Built and Operated by U. of Colorado Students



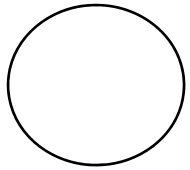
Software End-to-End System



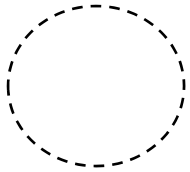
SE300 RT Design Models

Examples from SE300
(Specific to Real-Time Design)

Real Time Systems Design



transformational processes, representing computations or information processing activities



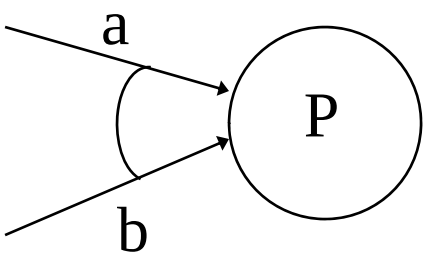
control processes, representing system's state dependent behavior, which is modeled by a Mealy type state machine

continuous data flow, which must be processed in real time

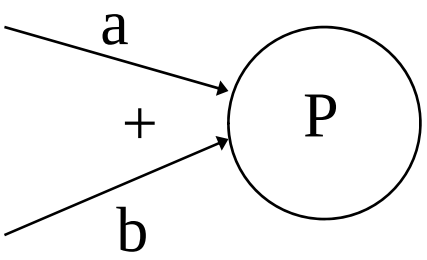
ordinary or discrete data flow

event flow or control flow that triggers a transition of the state machine of a control process, or a command from a control process to a transformational process

Real Time Systems Design



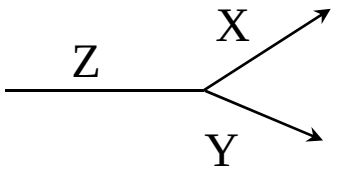
indicates that both data flow a and data flow b are required to begin executing process P



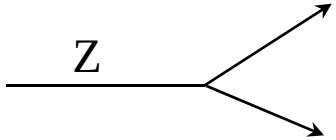
indicates that either data flow a or data flow b is required to begin executing process P

These logical connector can be applied to both data flow and control flow and transformation process and control process.

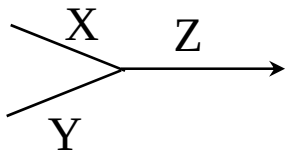
Real Time Systems Design



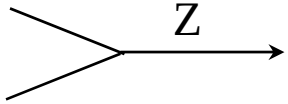
Two subsets of Z are used by two different successor processes.



All of Z is used by two different successor processes.

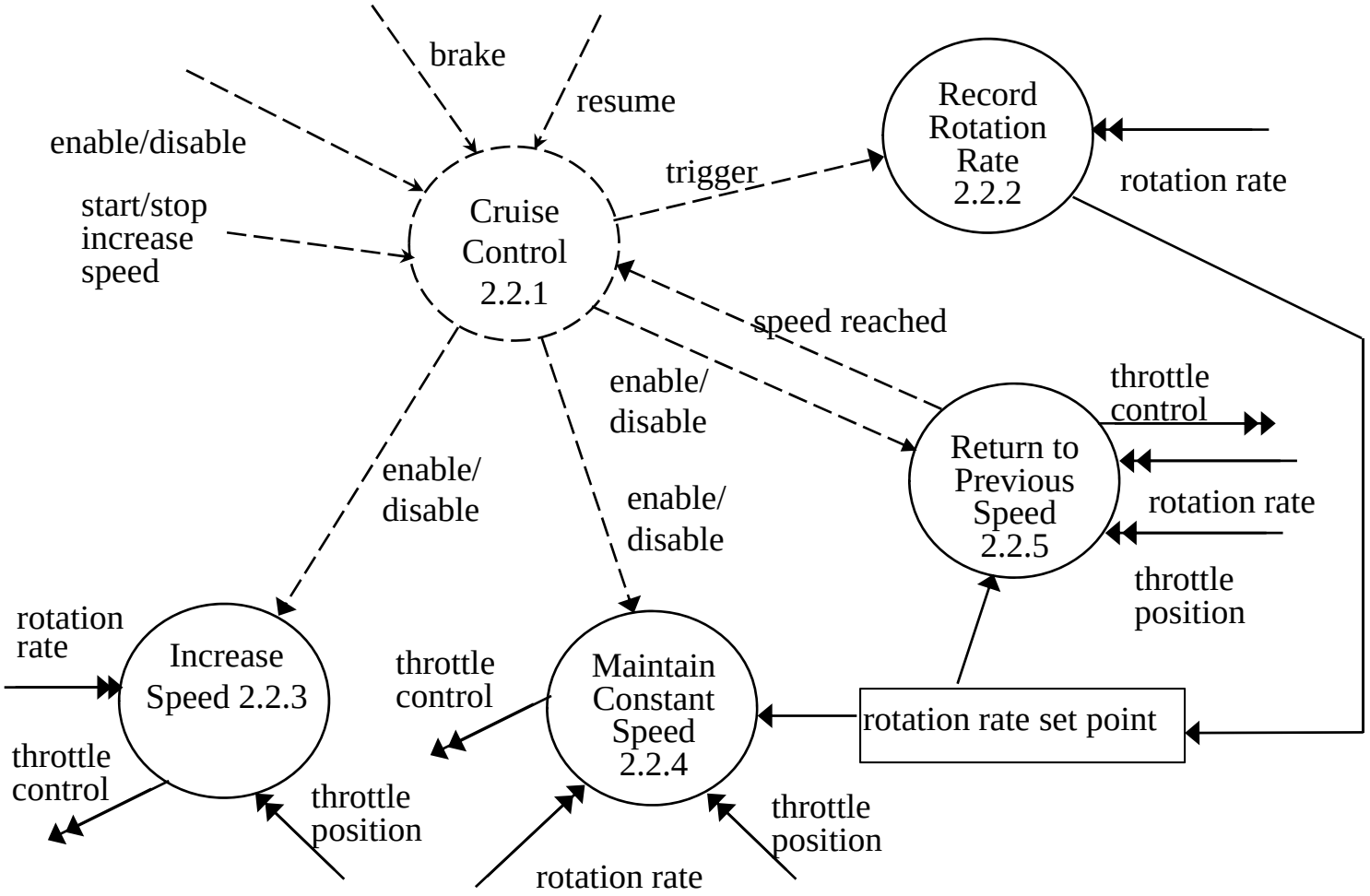


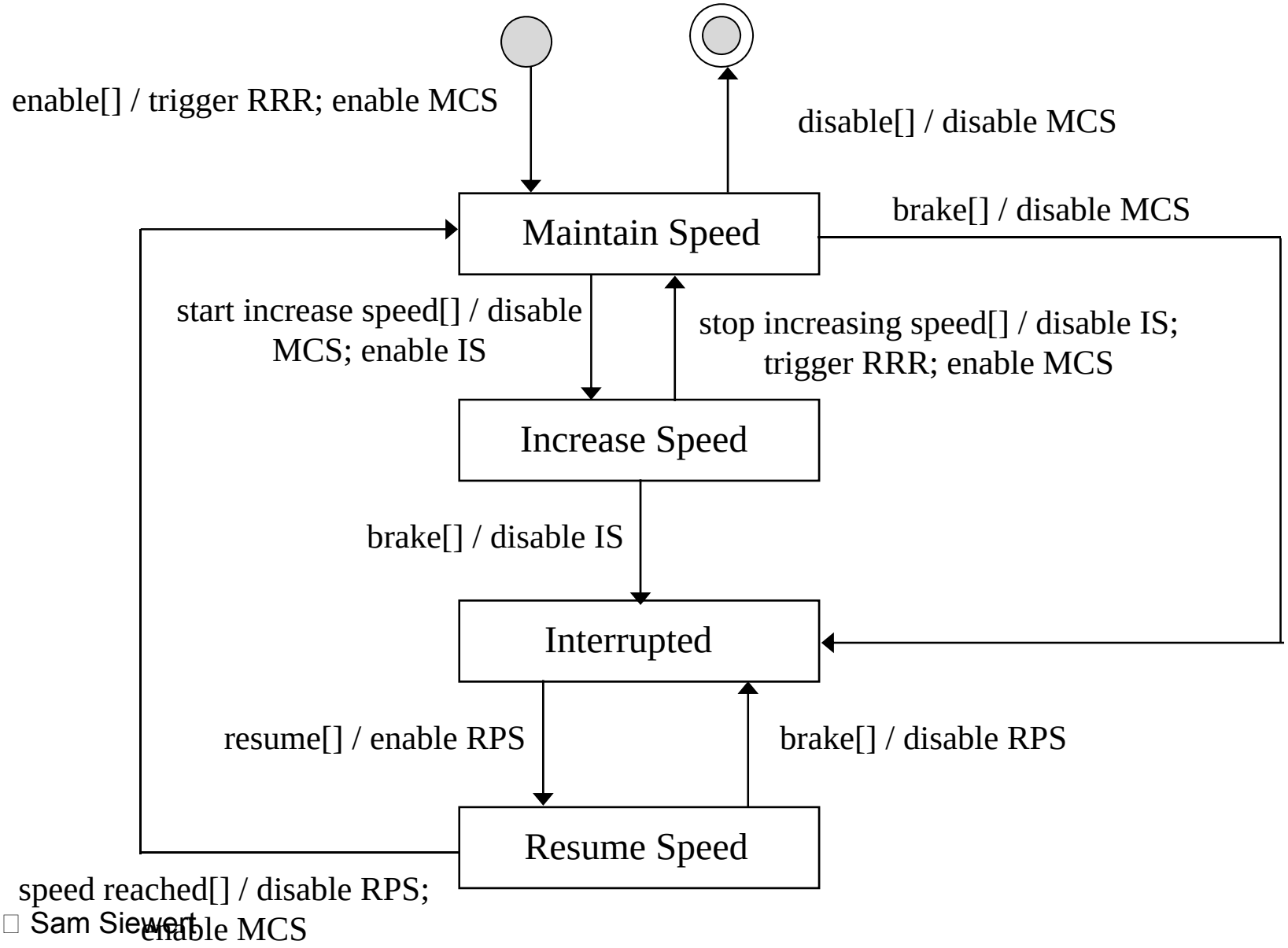
Z is composed of Two subsets provided by two different predecessor processes.



All of Z is provided by either one of two predecessor processes.

CFD/DFD Cruise Control Example





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