SALT RSS-NIR
MID-TERM REVIEW
MAY 20 & 21, 2009

CONTROL SYSTEM SOFTWARE

JEFFREY W PERCIVAL
UNIVERSITY OF WISCONSIN SPACE ASTRONOMY LABORATORY
Control System Software

• Approach
  – Mimic the RSS-VIS implementation
  – Use same tools, strategies, designs already delivered
  – Enhance the Graphical User Interface with NIR controls
  – Add “NDET” in analogy to PDET for detector control

• Coming up:
  – Architecture
  – Implementation
  – Thermal & Motion Control
  – Data Flow
LabVIEW is a data flow language. Data (numbers, booleans, strings) flow along the wires and are operated on by stock or custom functions.

This is a module that latches a transient pulse.
Complexity can be a real risk. C programs tend (for technical and cultural reasons) to use no GOTO statements. Fortran programs tend to use some GOTO statements. LabVIEW consists of nothing but GOTO statements!

LabVIEW module tending toward complexity: many wires, no comments
State Machine Approach

- Control complexity with state machines
- Bubble diagrams specify all states & transitions for a mechanism
- State table is indexed by current state and desired state
- Indexed cell says what to do next, and where that takes you
- Loop over table until you land on the diagonal
- Each transition implemented just once, in its own module
- Transitions are sequenced by state table, not data flow wires
- Power-up state is sensed from the hardware: self-initialization
Example of RSS-VIS state transition module: flow is one wire in, one wire out. The sequence is:

- Is it OK to do this? (check interlocks)
- Do the transition (set digital output bit or move axis)
- Is it done yet?
System-level State Diagram

- System-level state machine ensures that PCON is never in an ambiguous state
- State changes are well defined, specified as in a ICD
- Instrument state can actually be displayed this way in a LabVIEW panel
PCON Execution Engine

- Execution Engine breaks down high-level observing macros into subsystem commands (detector, mechanisms)
- Commands are issues to appropriate LabVIEW queues
- Subsystem managers process the queues
- Subsystem managers send status (complete, fail, error) back up the hierarchy using LabVIEW queues
Subsystem Managers

- Subsystem managers divide up the work in PCON.
- They block on their queues, handle actions and events generated by the Execution Engine, and report status.
- “PXI Manager” represents the PFIS control system delivered to SALT.
- NIR control system will appear as “cRIO Manager” in this diagram.
- Commands, actions and events will be augmented with NIR items.
Graphical User Interface

- Graphical User Interface connects to PCON over the network
- Can run on any machine
- NIR configurations will be added
Development Plan

• Specify the desired functionality of the mechanisms
• Create the state diagrams that produce the desired behavior
• Code the state machines and driver-level simulators
• Embed the state machines in the higher-level configuration management modules
• Specify the commands, procedures and data clusters
• Extend the PCON program as needed
• Extend the GUI as needed

• Folding in new NIR folders and files requires a careful management of the PCON name-space.
  • Janus Brink has produced a formal filename specification
  • PCON is currently being reorganized to conform to the new specification
  • NIR modules will comply with the new specification
Implementation

- Compact-RIO instead of PXI (mass and wiring)
- cRIO needs LabVIEW 8.6, not 6.1
- Will use SALT middleware for network communications
- Can co-exist with LV 6.1 computers at SALT
- Windows XP, not 2000

Compact-RIO distributed control system
Thermal & Motion Control

• RSS-NIR will have an active thermal control system

• Control functions include
  – Pre-dewar temperature monitoring
  – Pre-dewar heater control
  – Pre-dewar skin temperature monitoring
  – Pre-dewar skin heater control

• RSS-NIR has 9 axes of motion control
  – Optics Storage Assembly
  – Filter insertion
  – Grating insertion
  – Grating rotation
  – Etalon insertion
  – Inserter rotation
  – Camera focus
  – Camera filter wheel (in dewar)
  – Camera articulation
Data Flow

• RSS-NIR will duplicate the data flow of RSS-VIS
• NDET will be a functional copy of PDET; implementation details will vary, but will be built to the same kinds of interfaces
• NDET will provide PDET-like services to PCON
  – Exposure setup (exposure time, fowler sampling)
  – Exposure control (start, stop)
  – Data readout and capture
  – Keyword collection and FITS file writing
  – Quick-look display and data reduction
• Wish to acquire NDET as a turn-key system, as with PDET