

# **Procedure Automation: Sharing Work with Users**

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# Motivation

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- Software agent to assist trained users operating complex equipment in high-risk environments
- Safety is more critical than speed



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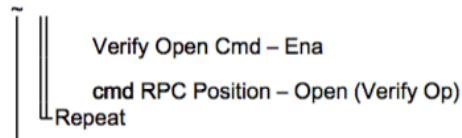
# Approach

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- Use existing standard operating procedures as the basis for autonomy
  - Already understood by users
  - Well-thought out
  - Can degrade to manual operations easily
  - Support shared task models between operators and software assistant



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- MCC-H
8. **SHUTTING DOWN CMG 1**  
For CMG 1
    - | Perform [2.202 CMG SHUTDOWN](#), all (SODF: MCS: NOMINAL: CMGS), then:
  9. **CONFIGURING CETA LIGHTS**
    - 9.1 **Verifying S1-1, S3-1 and P3-1 CETA Light Htr Pwr**  
S1: RPCM S12B A: RPC 04  
**RPCM S12B A RPC 04**  
'RPC Position'  
  
✓RPC Position – Cl  
S3: RPCM S32B A: RPC 02  
**RPCM S32B A RPC 02**  
'RPC Position'  
  
✓RPC Position – Cl  
P3: RPCM P32B A: RPC 02  
**RPCM P32B A RPC 02**  
'RPC Position'  
  
✓RPC Position – Cl
    - 9.2 **Activating LAB and S1-2 CETA Lights**  
To activate the LAB and S1-2 CETA Lights, perform [1.244 CETA LIGHT ACTIVATION](#), step 2 (SODF: EPS: ACTIVATION AND CHECKOUT: SECONDARY POWER SYSTEM), then:
  10. **CONFIGURING PORT SARJ**  
P3: EPS: Port SARJ  
**Port SARJ**

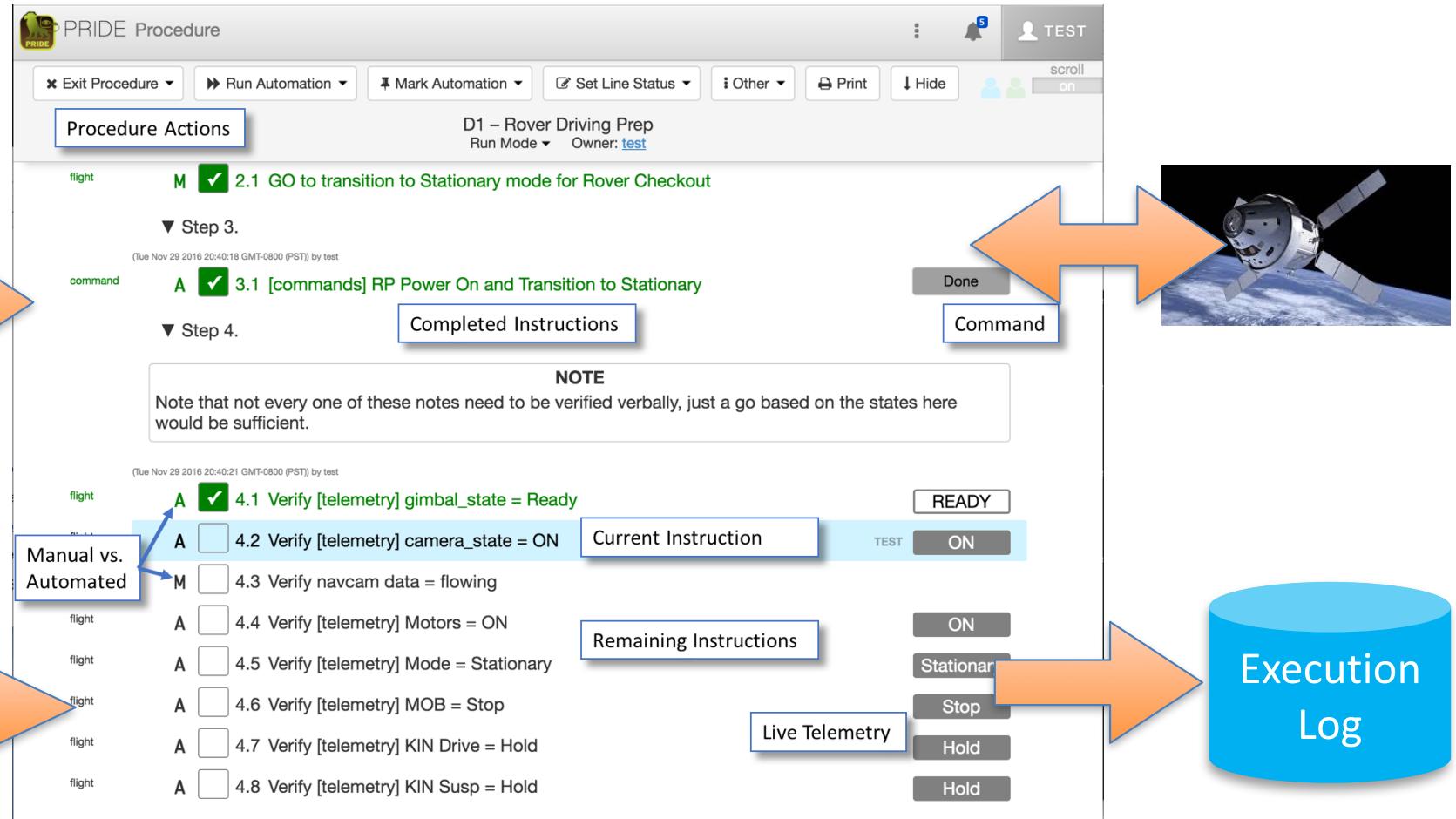
PCS

If String 1 Mode – Commanded

- | Perform [2.143 PORT \(STARBOARD\) SARJ STRING 1 TO STRING 2 MANUAL SWITCHOVER](#), all (SODF: EPS: NOMINAL: PRIMARY POWER SYSTEM), then:

If String 1 Mode – Monitor

# Procedure Agent Interface



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[Exit Procedure](#)[Run Automation](#)[Mark Automation](#)[Set Line Status](#)[Other](#)[Print](#)[Hide](#)scroll  
on

1.7021 ATCS Activation

1.7021 – ATCS Activation  
Run View [Owner: test](#)

Procedure Objective: Activate the Active Thermal Control System

## ▼ Step 1. Verify power flowing to ATCS

- ⌚  1.1 Verify RPCM LSSMA41B4AA Fuse 2 Position = Close

TEST

closed

- ⌚  1.2 Verify RPCM LSSMA41B4AA Fuse 3 Position = Close

closed

- ⌚  1.3 Verify RPCM LSSMA41B4AA Fuse 4 Position = Close

closed

## ▼ Step 2. Configure Heat Exchanger for cooling

- ⌚ 2.1 Is Heat Exchanger Isolation Valve Position - closed?  Yes  No

closed

*If YES then do the following*

- ⌚  2.1.1 Cmd Heat Exchanger Isolation Valve Enable Cmd - ena

Send

- ⌚  2.1.2 Verify Heat Exchanger Isolation Valve Cmd Status = ena

ena

- ⌚  2.1.3 Cmd Heat Exchanger Isolation Valve - iso\_open

Send

- ⌚  2.1.4 Verify Heat Exchanger Isolation Valve Position = open

closed

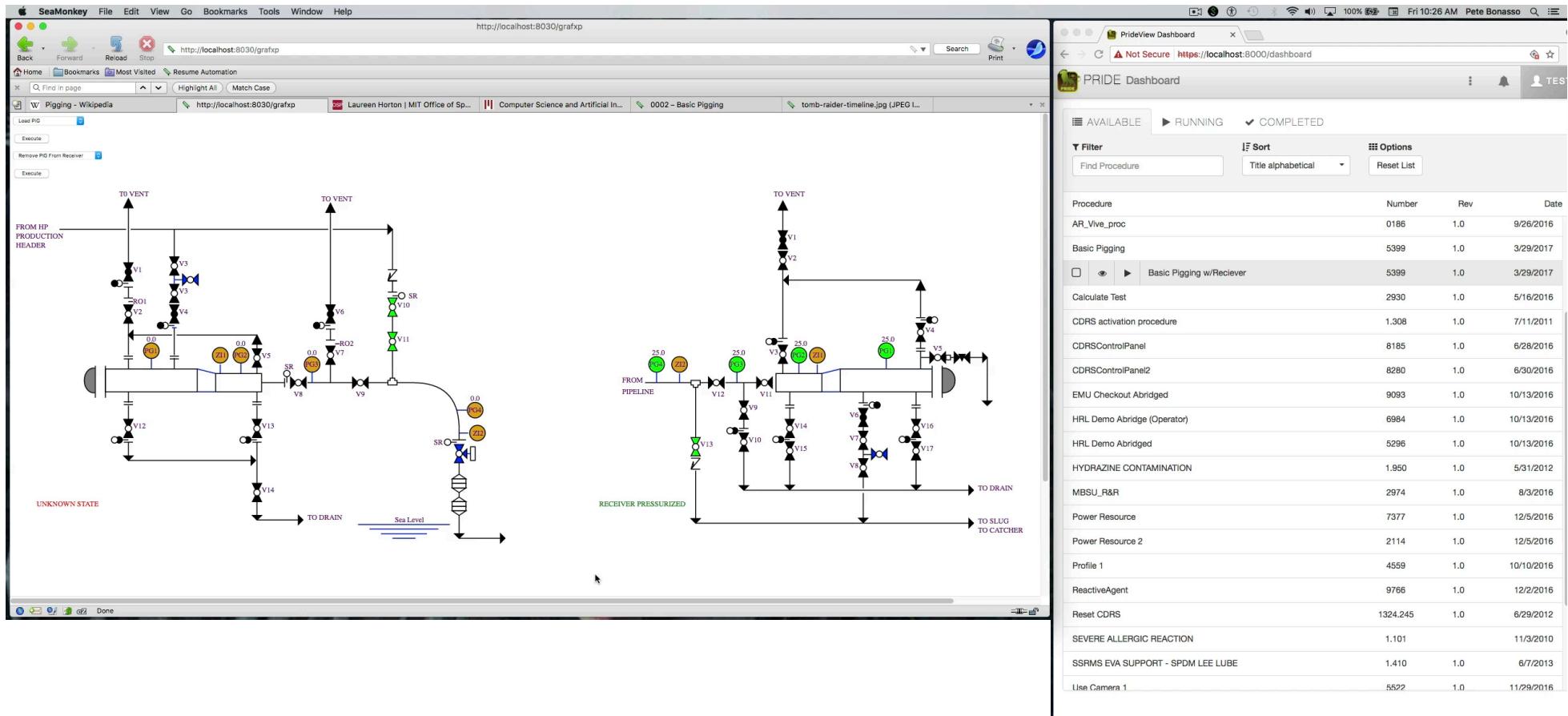
- ⌚ 2.2 Is Heat Exchanger Bypass Valve Position - bypass?  Yes  No

bypass

*If YES then do the following*

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# Procedure Agent Interface



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# Procedures and Robots

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## **Robonaut 2 Mars World PHARAOH Demonstration**

**Stephen Hart   Jim Kramer   Seth Gee   Robert Burridge**



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# Conclusions

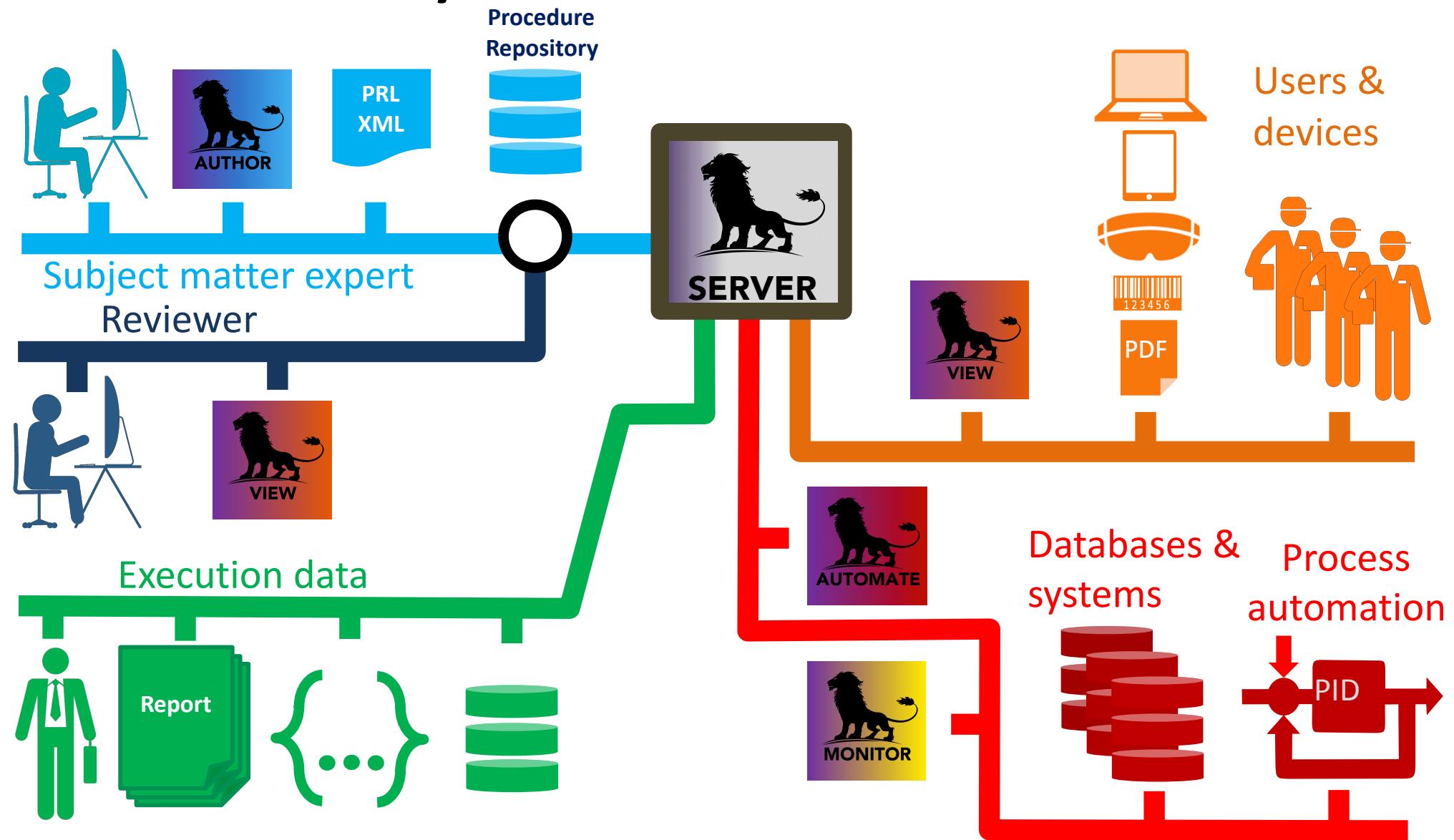
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- Reductions in error rates in procedure execution (second paper)
- Key design issues
  - Trust in underlying autonomy
  - Situation awareness
  - High-level goal achievement



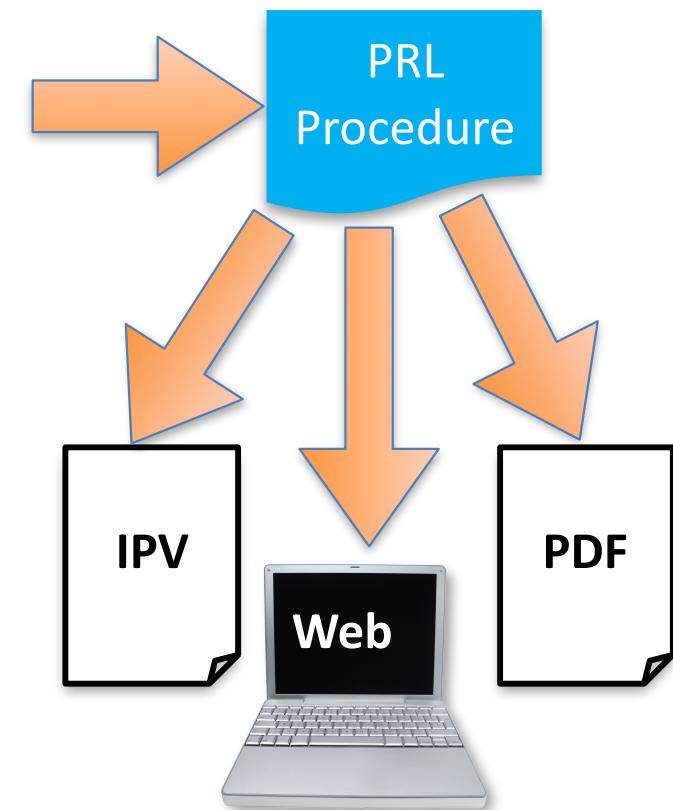
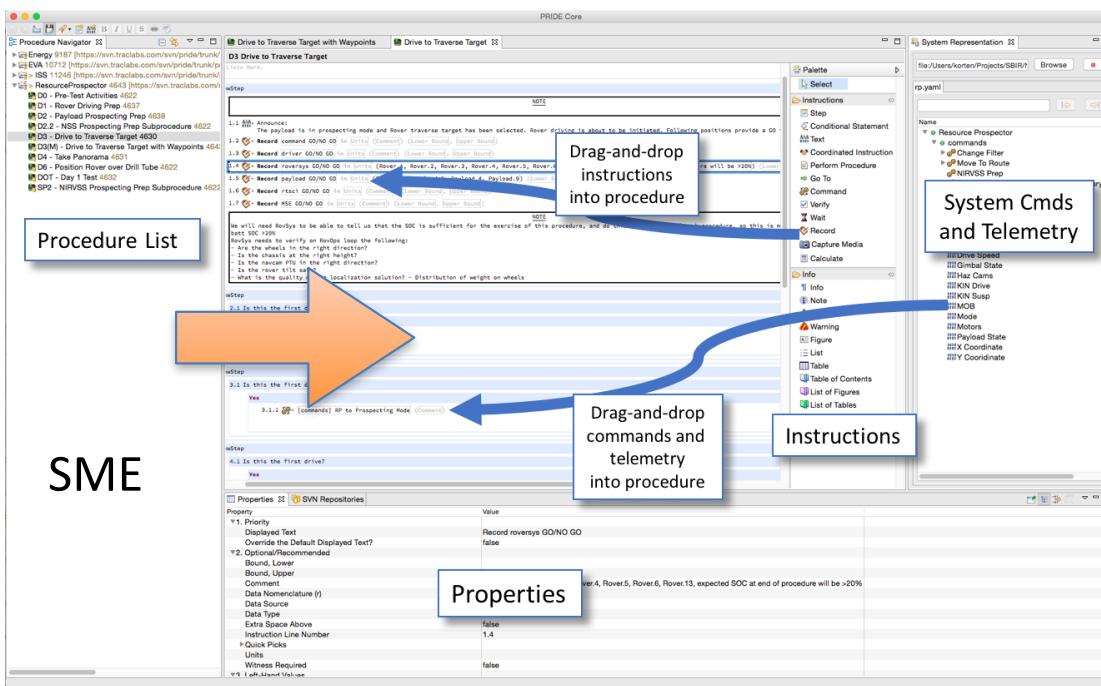
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# System Architecture



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# Procedure Authoring



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