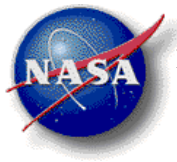


Johnson Space Center
Engineering Directorate
Software, Robotics and Simulation Division

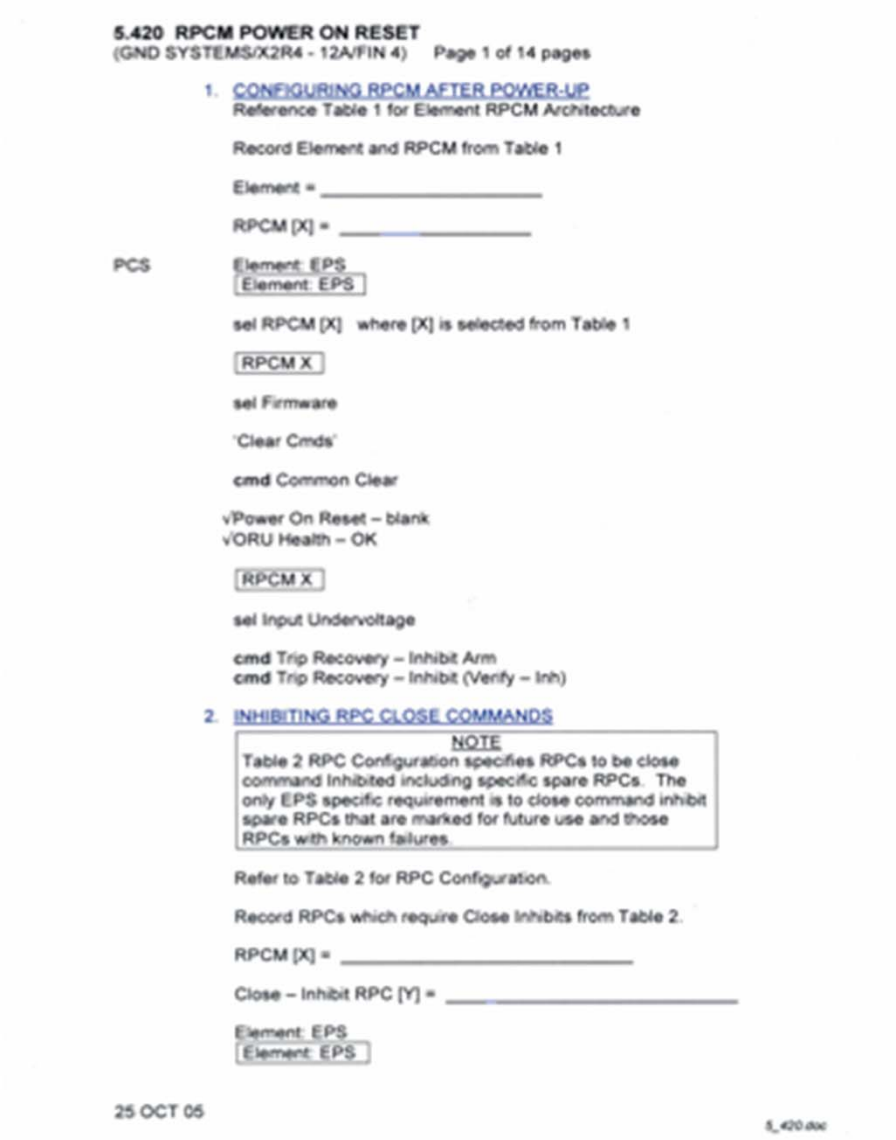
Electronic Procedure and Medical Operation

Lui Wang
Spacecraft Software Engineering Branch / ER6
Software Robotics & Simulation Division / ER
NASA JSC

May 2014

Flight Procedure

- Procedures are critical to conduct any complex operation
- Procedures contain knowledge about how to operate systems to achieve mission goals
- Procedures are the approved means by which a user operates a system
- Users of procedures include crew, flight controllers, instructors, mission designers, payload community, etc.



5.420 RPCM POWER ON RESET
(GND SYSTEMS/X2R4 - 12A/FIN 4) Page 1 of 14 pages

1. CONFIGURING RPCM AFTER POWER-UP
Reference Table 1 for Element RPCM Architecture

Record Element and RPCM from Table 1

Element = _____

RPCM [X] = _____

PCS Element: EPS
Element: EPS

sel RPCM [X] where [X] is selected from Table 1

RPCM X

sel Firmware

'Clear Cmds'

cmd Common Clear

√Power On Reset – blank
√ORU Health – OK

RPCM X

sel Input Undervoltage

cmd Trip Recovery – Inhibit Arm
cmd Trip Recovery – Inhibit (Verify – Inh)

2. INHIBITING RPC CLOSE COMMANDS

NOTE
Table 2 RPC Configuration specifies RPCs to be close command Inhibited including specific spare RPCs. The only EPS specific requirement is to close command inhibit spare RPCs that are marked for future use and those RPCs with known failures.

Refer to Table 2 for RPC Configuration.

Record RPCs which require Close Inhibits from Table 2.

RPCM [X] = _____

Close – Inhibit RPC [Y] = _____

Element: EPS
Element: EPS

25 OCT 05

5_420.doc

Procedure Requirements

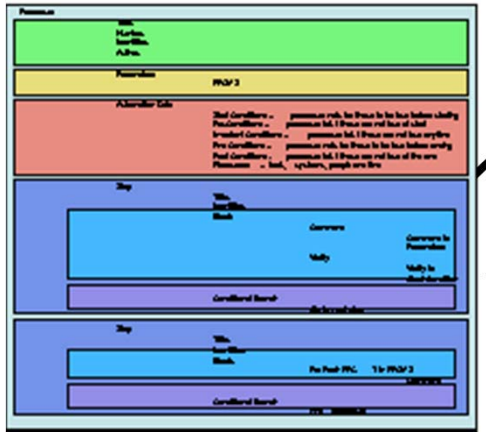
- Need support for automating procedure execution
  - Commands and telemetry
  - Safety conditions/context
  - Explicit control structures
- Don't want to lose human readability
  - Capturing "look-and-feel" of current procedures
  - Presentation of procedure content in a human-friendly way
- Improve quality of execution
  - Improved ease of use
  - Reduction of human error
  - Improved situational awareness
- Interleave human actions with automated scripts

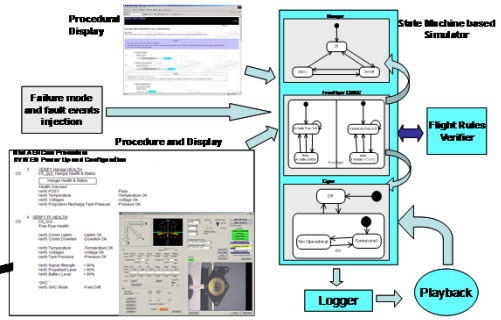
- Use *Procedure Representation Language*
  - Capture and formalized the above stated requirements
  - Started from NASA ODF standards and construct support automation

Uses of PRL

Procedure Representation Language (PRL) file

Procedure Authoring Tool (PAT)



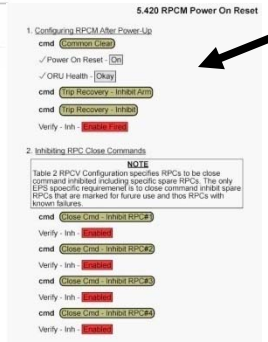


Procedure Verification Tools

Translator

Paper Procedure

Procedure Displays



Send
Command foo
Command bar
Wait 10 secs
Command foo2

Ground Control Tools (e.g., Thin Layer)

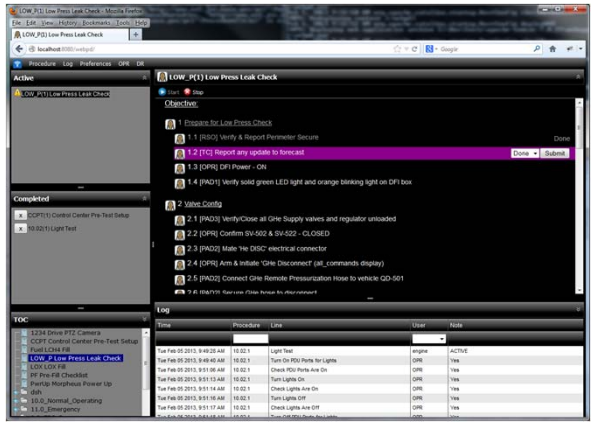
Orion eProc (RPL XML)

SCL
Execute foo
Verify bar
Wait 10 secs
Execute foo2
End

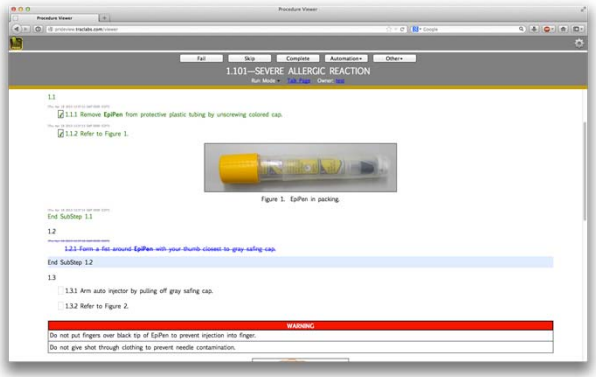
Automated Scripts (e.g., SCL)

Johnson Space Center
Engineering Directorate
Software, Robotics and Simulation Division

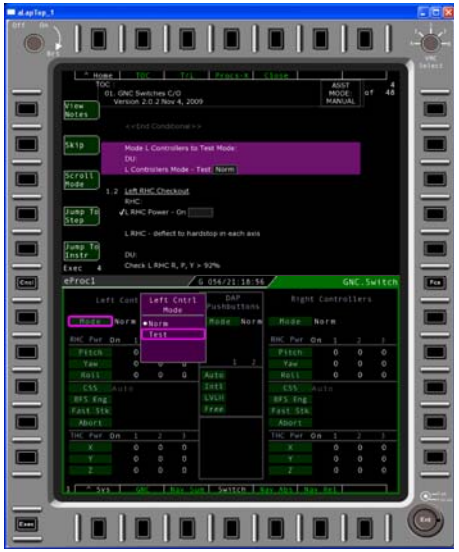
Procedure Viewer & Executor



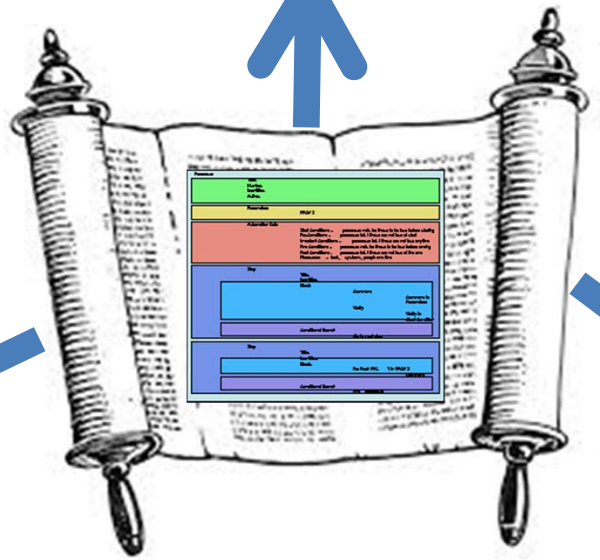
WebPD – Focus on C&W Integration



PRIDE View – focus on Procedure performance tracking



Orion eProc–Flight Deck – focus on Edge Keys Display & Keyboard-less interaction



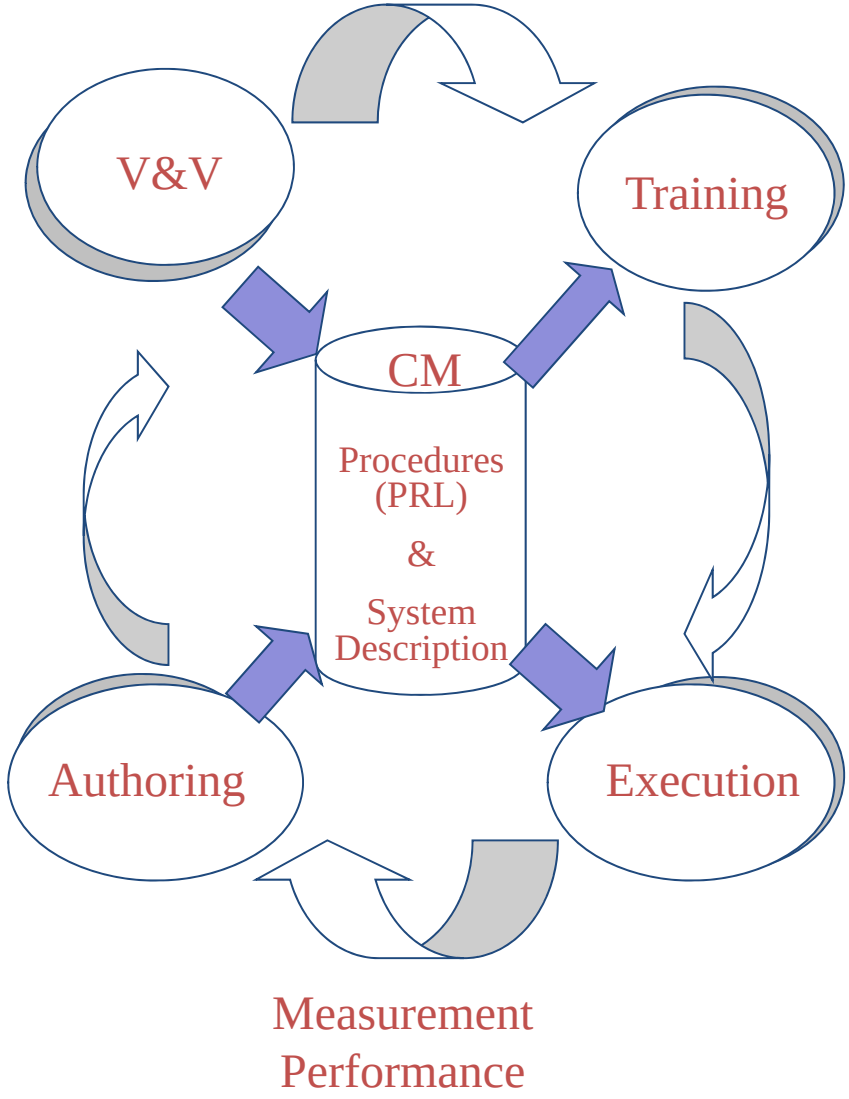
Google Glass – Focus on Mobility & mobile interactions

AR-eProc– Focus on mixed reality interaction

Capture Rich Procedure Content Once and Use It Everywhere!!

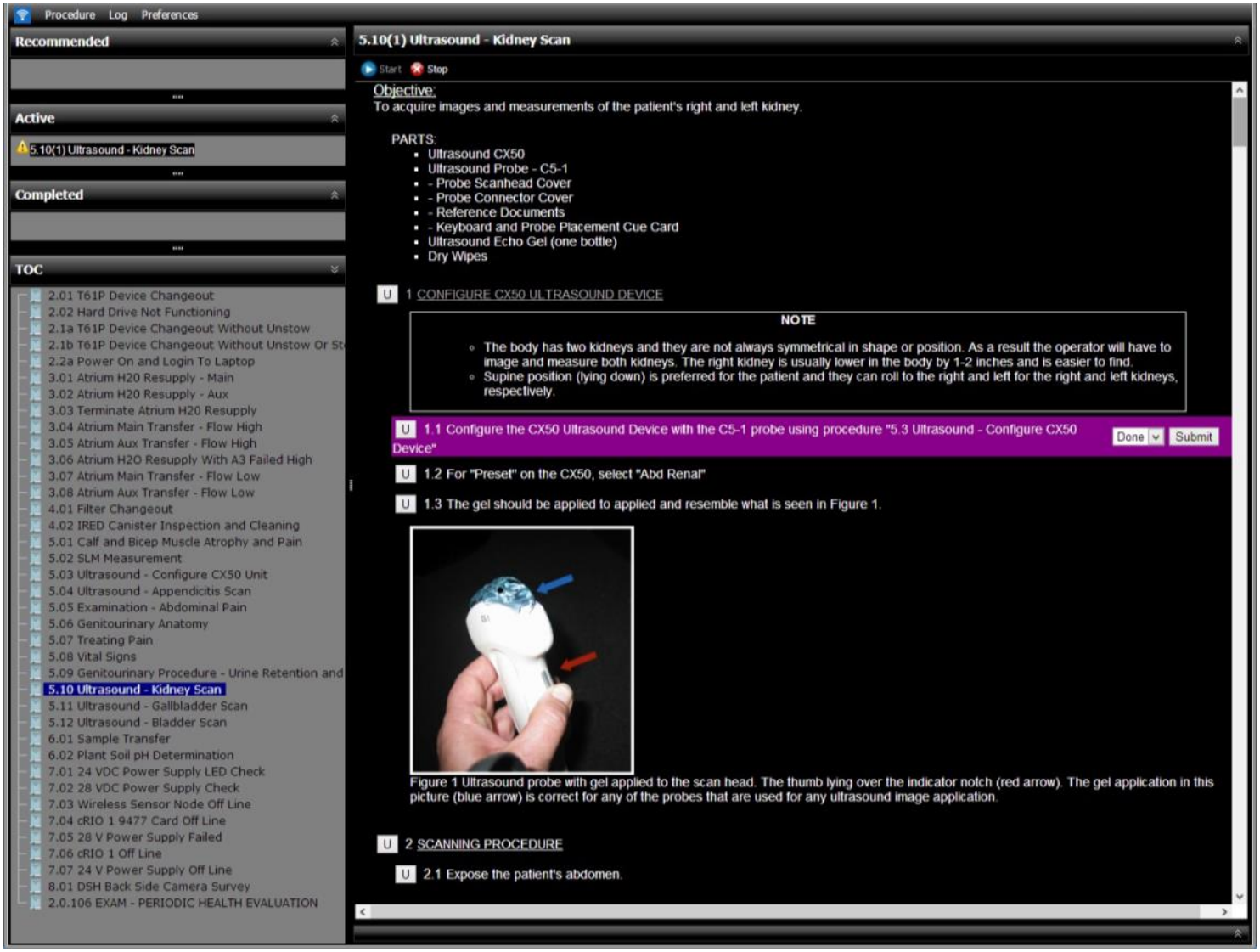
Procedure Lifecycle Development

- **Procedure Authoring Tool (PAT)**
  - Procedure authors currently use IPV (Licensed software & not easy to use)
  - Need an easy-to-use authoring environment
  - Need an easy method to add telemetry & commands
- **Procedure verification & validation (PV)**
  - Procedure verifiers are human intensive
  - Need for desktop verification tools to catch simple mistakes
- **Procedure Library Admin. (PLA)**
  - Configuration control works reasonably well today
  - Need to be integrated with Procedure Repository and Procedure approval system
- **Procedure Viewer/Executor (PVE)**
  - Integration with crew time and Caution & Warning system
  - Need to view/execute/track anywhere and any configuration (stationary, mobile, hand-free. Etc.)
- **Procedure training**
  - Integration with Workflow CR and procedure verification and validation
  - Measure and track performance



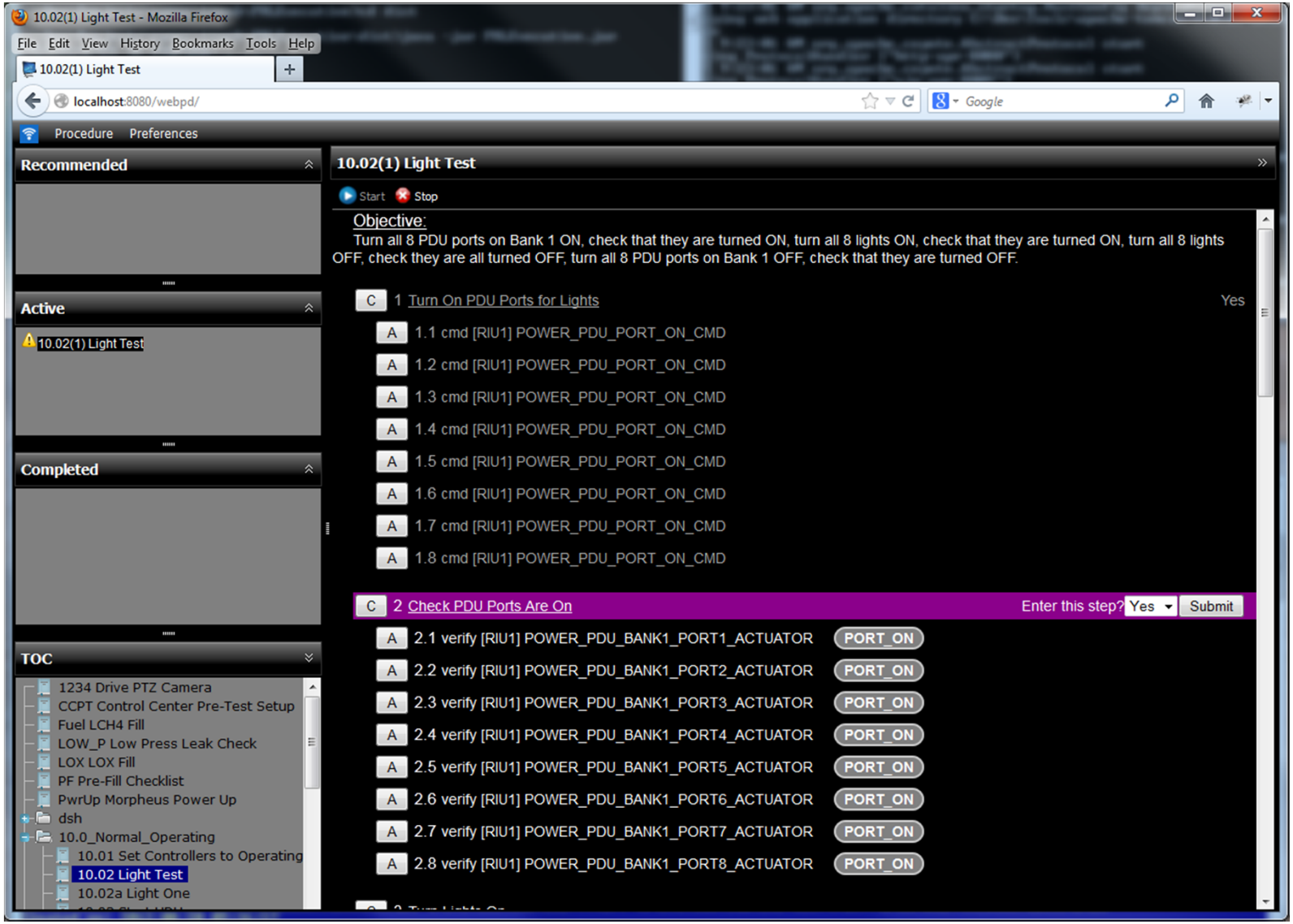
System Representation

- Procedure language describes how to operate any system. They do not describe the system itself
- System representation needs to define
  - Telemetry
  - Commands and command parameters
  - System hierarchy and classes
    - e.g., commanding the Orion Display Pages
- Must be available during procedure editing, validation and execution
- We selected XML Telemetric & Command Exchange (XTCE) -- an industry and NASA standard

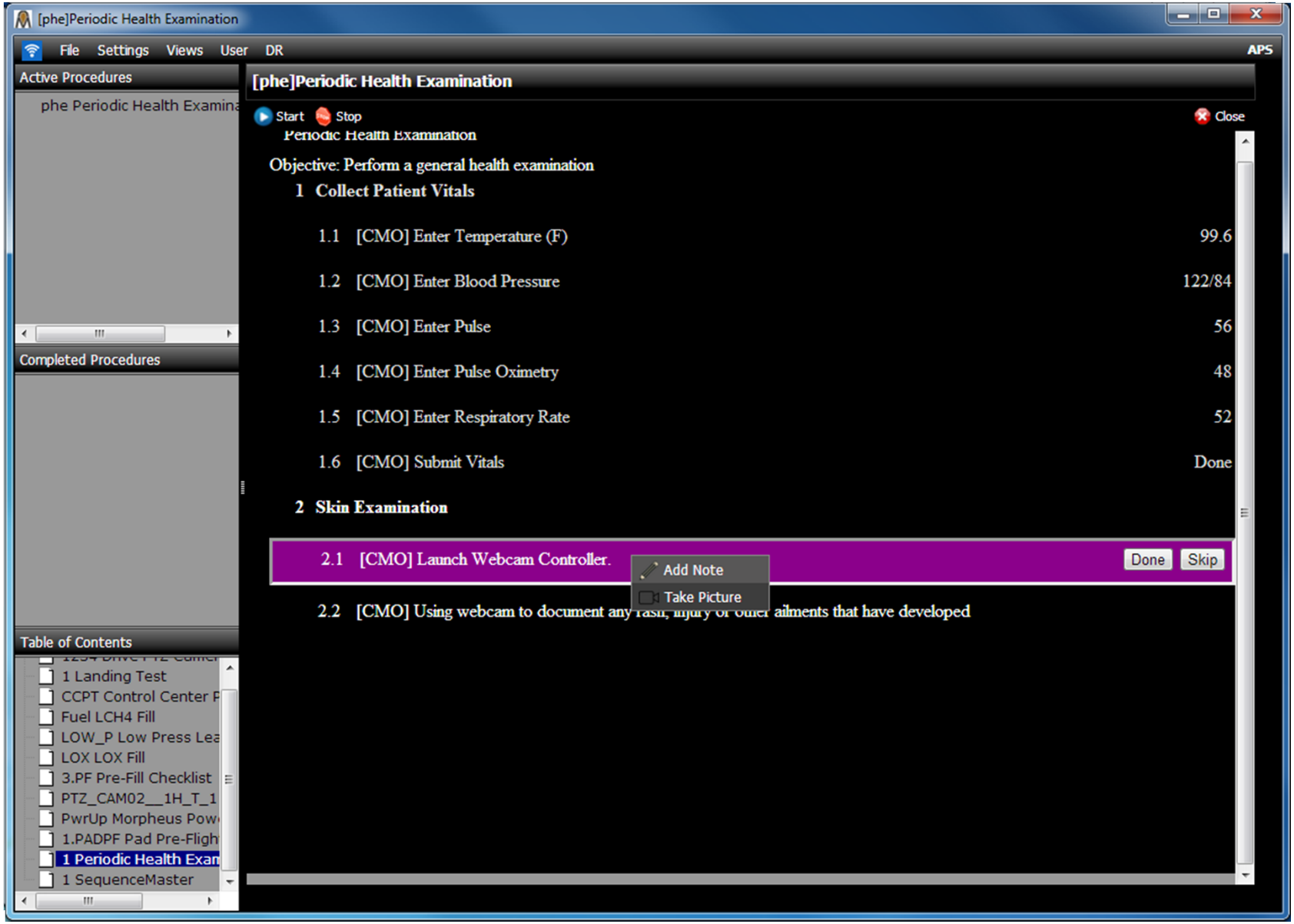

Procedure Log Preferences
Recommended
Active
5.10(1) Ultrasound - Kidney Scan
Completed
TOC
2.01 T61P Device Changeout
2.02 Hard Drive Not Functioning
2.1a T61P Device Changeout Without Unstow
2.1b T61P Device Changeout Without Unstow Or St
2.2a Power On and Login To Laptop
3.01 Atrium H20 Resupply - Main
3.02 Atrium H20 Resupply - Aux
3.03 Terminate Atrium H20 Resupply
3.04 Atrium Main Transfer - Flow High
3.05 Atrium Aux Transfer - Flow High
3.06 Atrium H2O Resupply With A3 Failed High
3.07 Atrium Main Transfer - Flow Low
3.08 Atrium Aux Transfer - Flow Low
4.01 Filter Changeout
4.02 IRED Canister Inspection and Cleaning
5.01 Calf and Bicep Muscle Atrophy and Pain
5.02 SLM Measurement
5.03 Ultrasound - Configure CX50 Unit
5.04 Ultrasound - Appendicitis Scan
5.05 Examination - Abdominal Pain
5.06 Genitourinary Anatomy
5.07 Treating Pain
5.08 Vital Signs
5.09 Genitourinary Procedure - Urine Retention and
5.10 Ultrasound - Kidney Scan
5.11 Ultrasound - Gallbladder Scan
5.12 Ultrasound - Bladder Scan
6.01 Sample Transfer
6.02 Plant Soil pH Determination
7.01 24 VDC Power Supply LED Check
7.02 28 VDC Power Supply Check
7.03 Wireless Sensor Node Off Line
7.04 cRIO 1 9477 Card Off Line
7.05 28 V Power Supply Failed
7.06 cRIO 1 Off Line
7.07 24 V Power Supply Off Line
8.01 DSH Back Side Camera Survey
2.0.106 EXAM - PERIODIC HEALTH EVALUATION
5.10(1) Ultrasound - Kidney Scan
Start Stop
Objective:
To acquire images and measurements of the patient's right and left kidney.
PARTS:
Ultrasound CX50
Ultrasound Probe - C5-1
- Probe Scanhead Cover
- Probe Connector Cover
- Reference Documents
- Keyboard and Probe Placement Cue Card
Ultrasound Echo Gel (one bottle)
Dry Wipes
U 1 CONFIGURE CX50 ULTRASOUND DEVICE
NOTE
The body has two kidneys and they are not always symmetrical in shape or position. As a result the operator will have to image and measure both kidneys. The right kidney is usually lower in the body by 1-2 inches and is easier to find.
Supine position (lying down) is preferred for the patient and they can roll to the right and left for the right and left kidneys, respectively.
U 1.1 Configure the CX50 Ultrasound Device with the C5-1 probe using procedure "5.3 Ultrasound - Configure CX50 Device"
Done Submit
U 1.2 For "Preset" on the CX50, select "Abd Renal"
U 1.3 The gel should be applied to applied and resemble what is seen in Figure 1.
Figure 1 Ultrasound probe with gel applied to the scan head. The thumb lying over the indicator notch (red arrow). The gel application in this picture (blue arrow) is correct for any of the probes that are used for any ultrasound image application.
U 2 SCANNING PROCEDURE
U 2.1 Expose the patient's abdomen.

Johnson Space Center
Engineering Directorate
Software, Robotics and Simulation Division

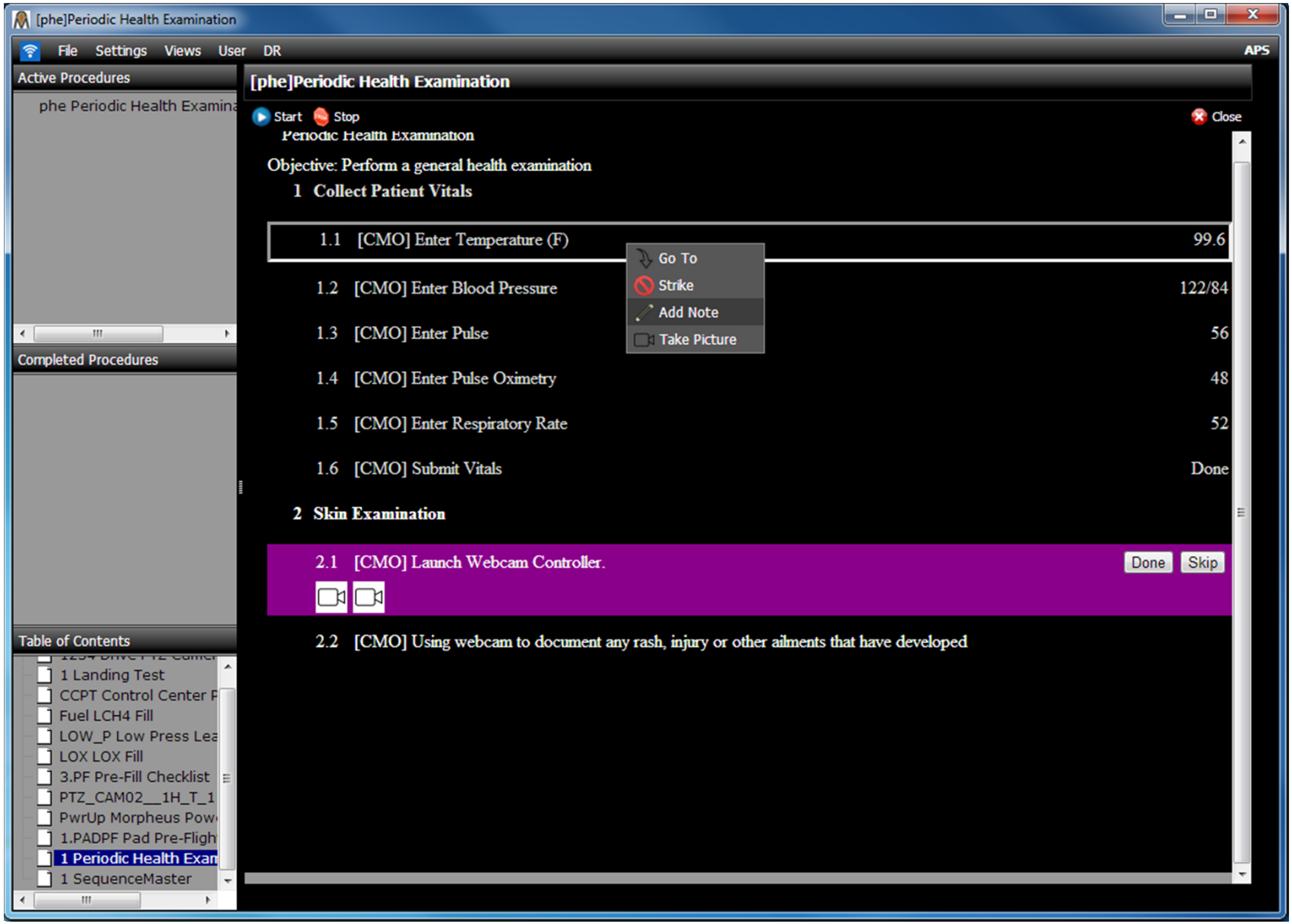
WebPD - Automation



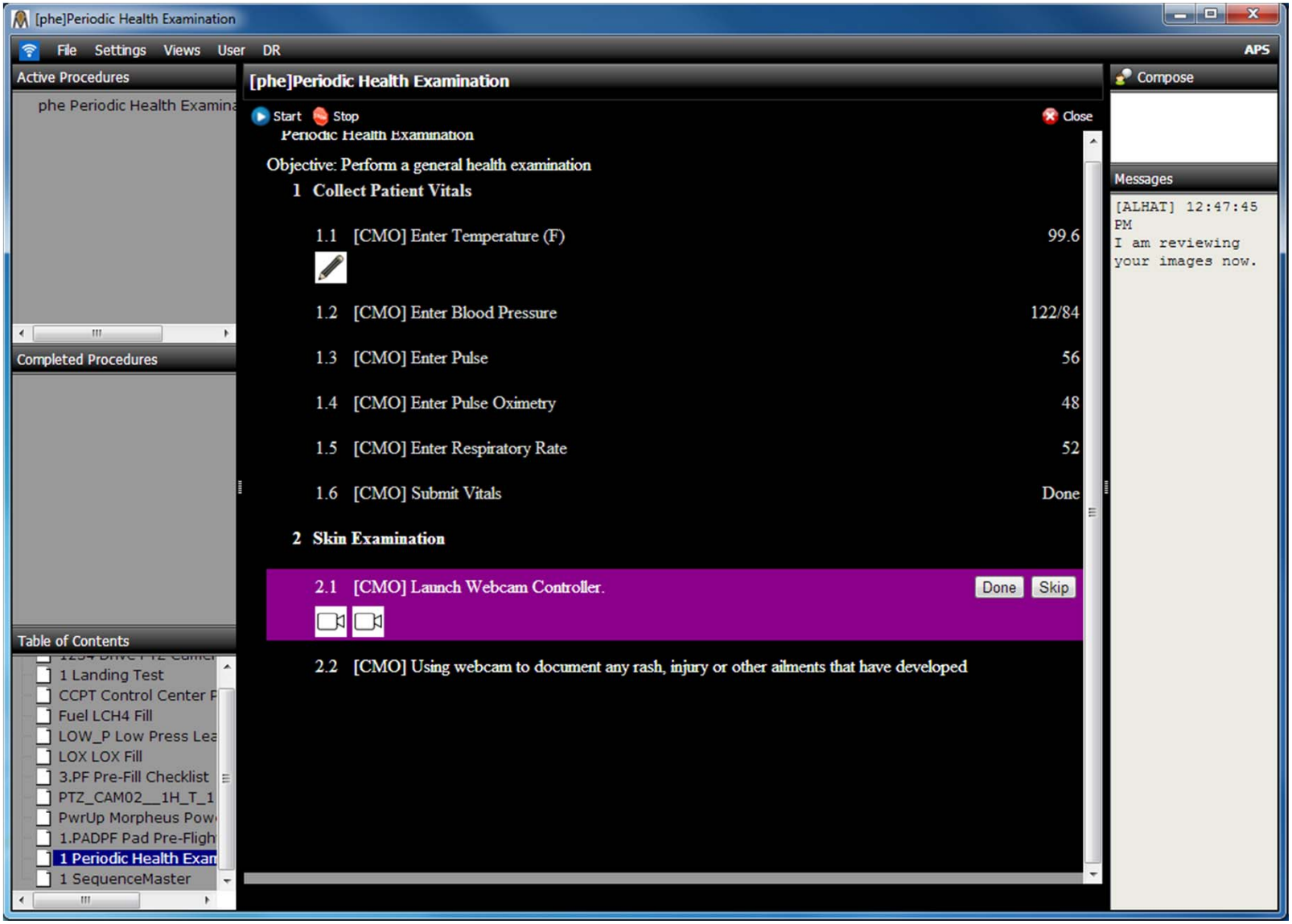
WebPD – Adding Image Notes



WebPD – Adding Text Notes



WebPD - IM


[phe]Periodic Health Examination
File Settings Views User DR
APS
Active Procedures
phe Periodic Health Examina
[phe]Periodic Health Examination
Start Stop
Close
Periodic Health Examination
Objective: Perform a general health examination
1 Collect Patient Vitals
1.1 [CMO] Enter Temperature (F) 99.6
1.2 [CMO] Enter Blood Pressure 122/84
1.3 [CMO] Enter Pulse 56
1.4 [CMO] Enter Pulse Oximetry 48
1.5 [CMO] Enter Respiratory Rate 52
1.6 [CMO] Submit Vitals Done
2 Skin Examination
2.1 [CMO] Launch Webcam Controller. Done Skip
2.2 [CMO] Using webcam to document any rash, injury or other ailments that have developed
Compose
Messages
[ALHAT] 12:47:45 PM
I am reviewing your images now.
Completed Procedures
Table of Contents
1 Landing Test
CCPT Control Center P
Fuel LCH4 Fill
LOW_P Low Press Lea
LOX LOX Fill
3.PF Pre-Fill Checklist
PTZ_CAM02__1H_T_1
PwrUp Morpheus Pow
1.PADPF Pad Pre-Fligh
1 Periodic Health Exam
1 SequenceMaster

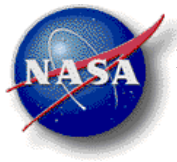
Johnson Space Center
Engineering Directorate
Software, Robotics and Simulation Division

Medical Exam Electronic Procedure

Use Case

EMSD Vision

The Exploration Medical System Demonstration (EMSD) will utilize the ISS as a test bed to demonstrate that several medical technologies and medical informatics tools, needed for collecting and managing evidence and decision making on an exploration mission, can be integrated into a single system and used by the on-orbit crew to optimize medical care delivery and data management.

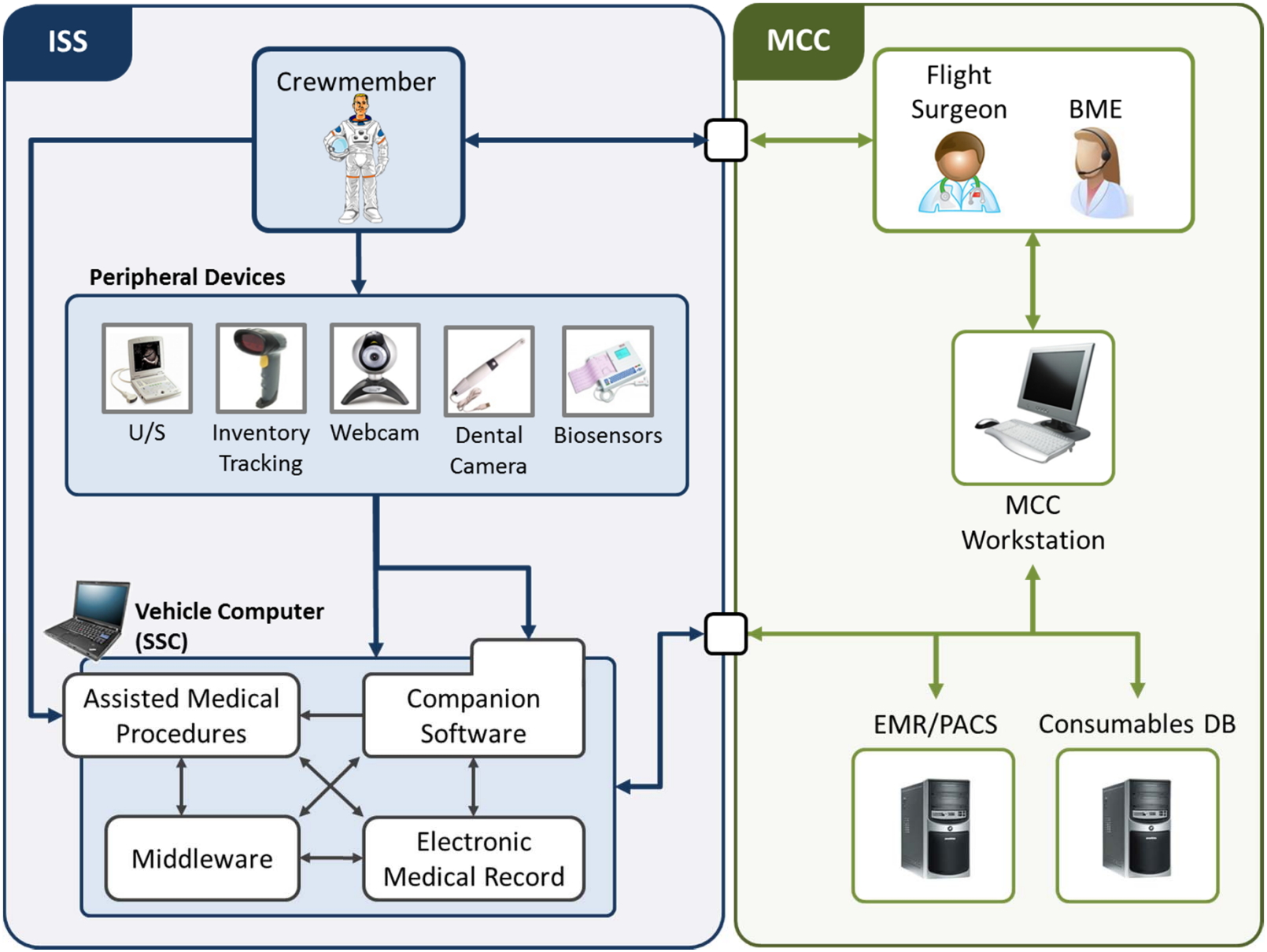


Johnson Space Center
Engineering Directorate
Software, Robotics and Simulation Division

EMSD

OPERATIONAL CONCEPT

EMSD System Overview



Johnson Space Center
Engineering Directorate
Software, Robotics and Simulation Division

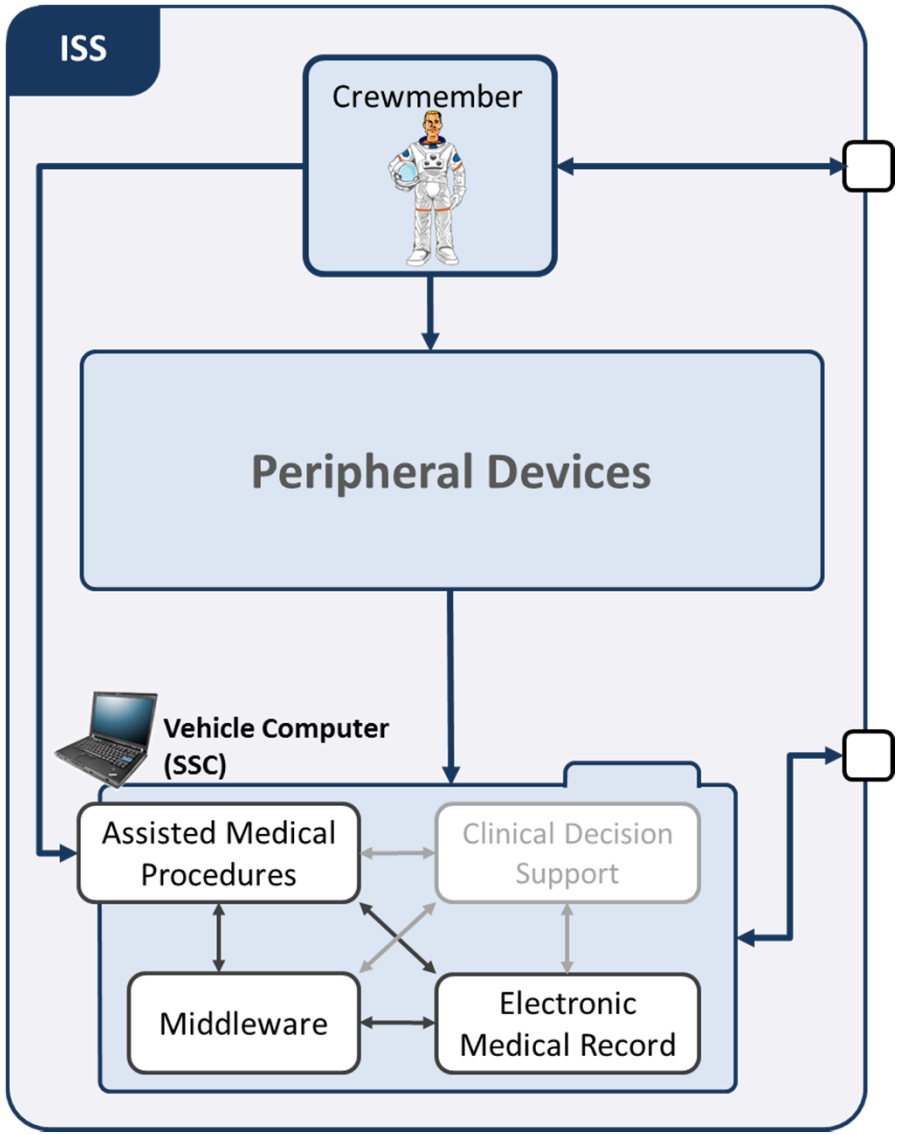
EMSD Core Components

Electronic Medical Record
- Medical Data Storage

Assisted Medical Procedures
- User Interface to System
- Procedure Authoring
- Procedure Execution

Middleware
- Commanding
- Data Transfer Brokering
- Scalability

Clinical Decision Support
- Future Development



EMSD Peripheral Devices

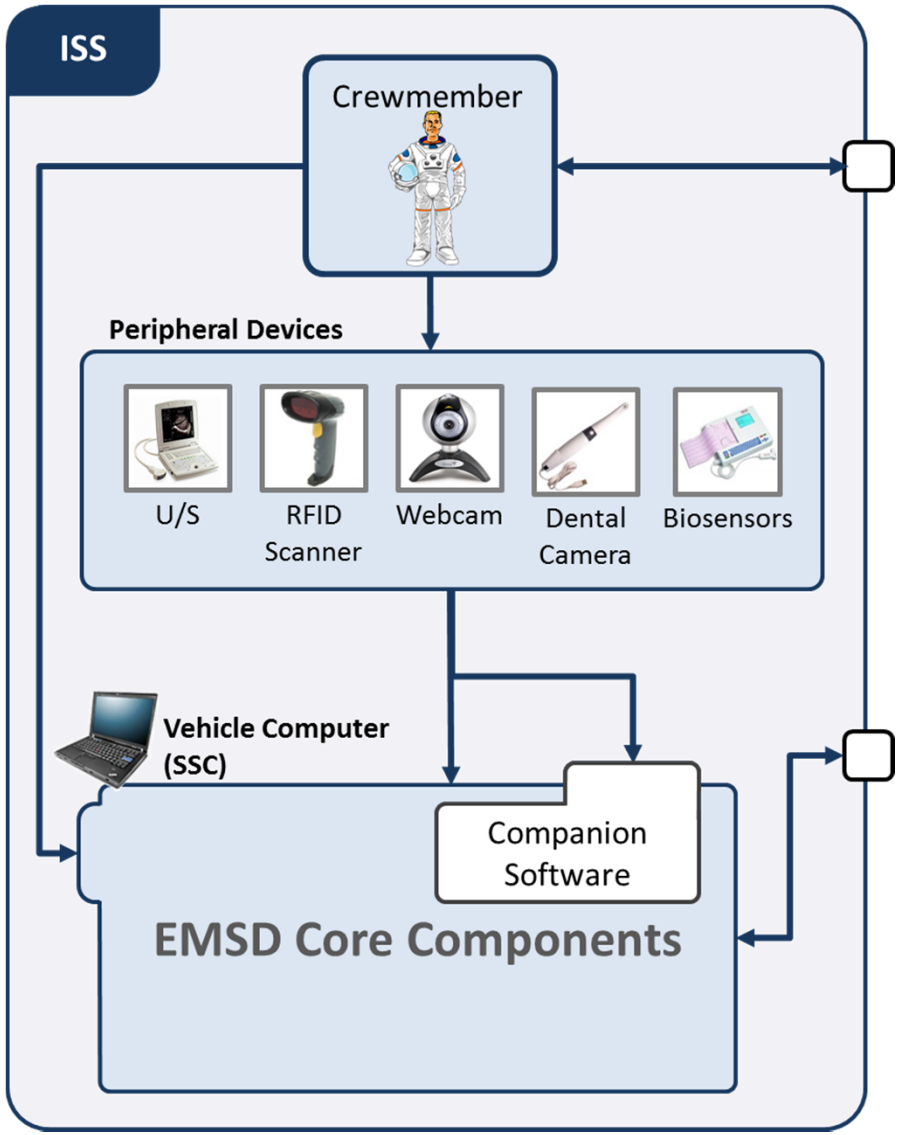
Ultrasound (U/S)
- Data File Import
- Streaming Video

Inventory Tracker
- Data File Import

Webcam + Dental Camera
- Streaming Video
- Image/Video File

Biosensors (ECG)
- Commanding
- Data File Import

Crewmember
- Data Entry
- Navigation



Johnson Space Center
Engineering Directorate
Software, Robotics and Simulation Division

EMSD

SYSTEM DESIGN

Component Selection

Assisted Medical Procedures	Procedure Authoring Tool Web Procedure Display (WebPD)
Electronic Medical Record	OpenEMR/CouchDB
Middleware	OpenDDS
Image/Video Capture	HTML5/VSee

Methods for Data Integration

File Transfer

Create files of shared data for others to consume and consume files that others have generated

Shared Database

Store the data they share in a common database

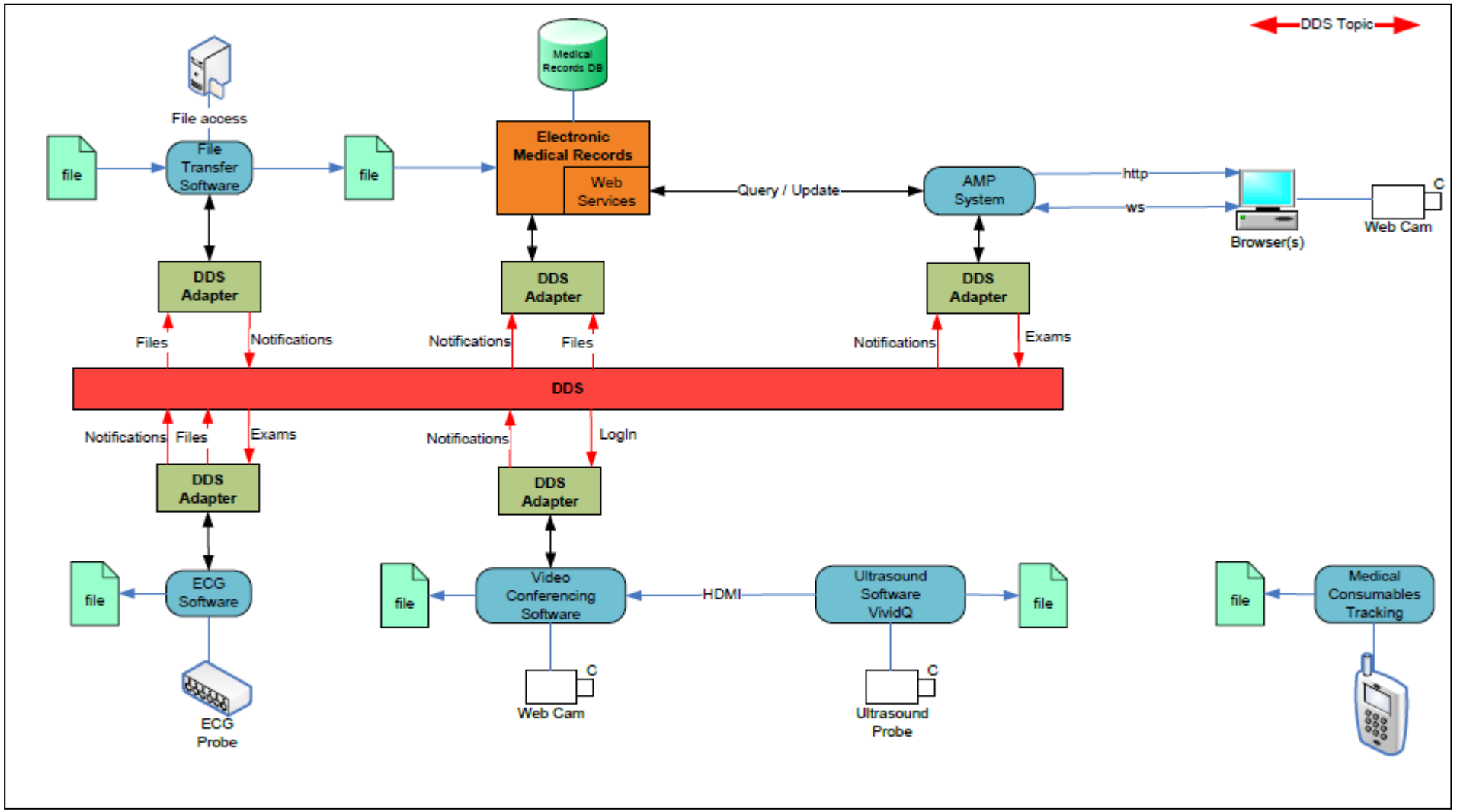
Remote Procedure Call

Expose some procedures that can be invoked by others remotely to initiate behavior and exchange data

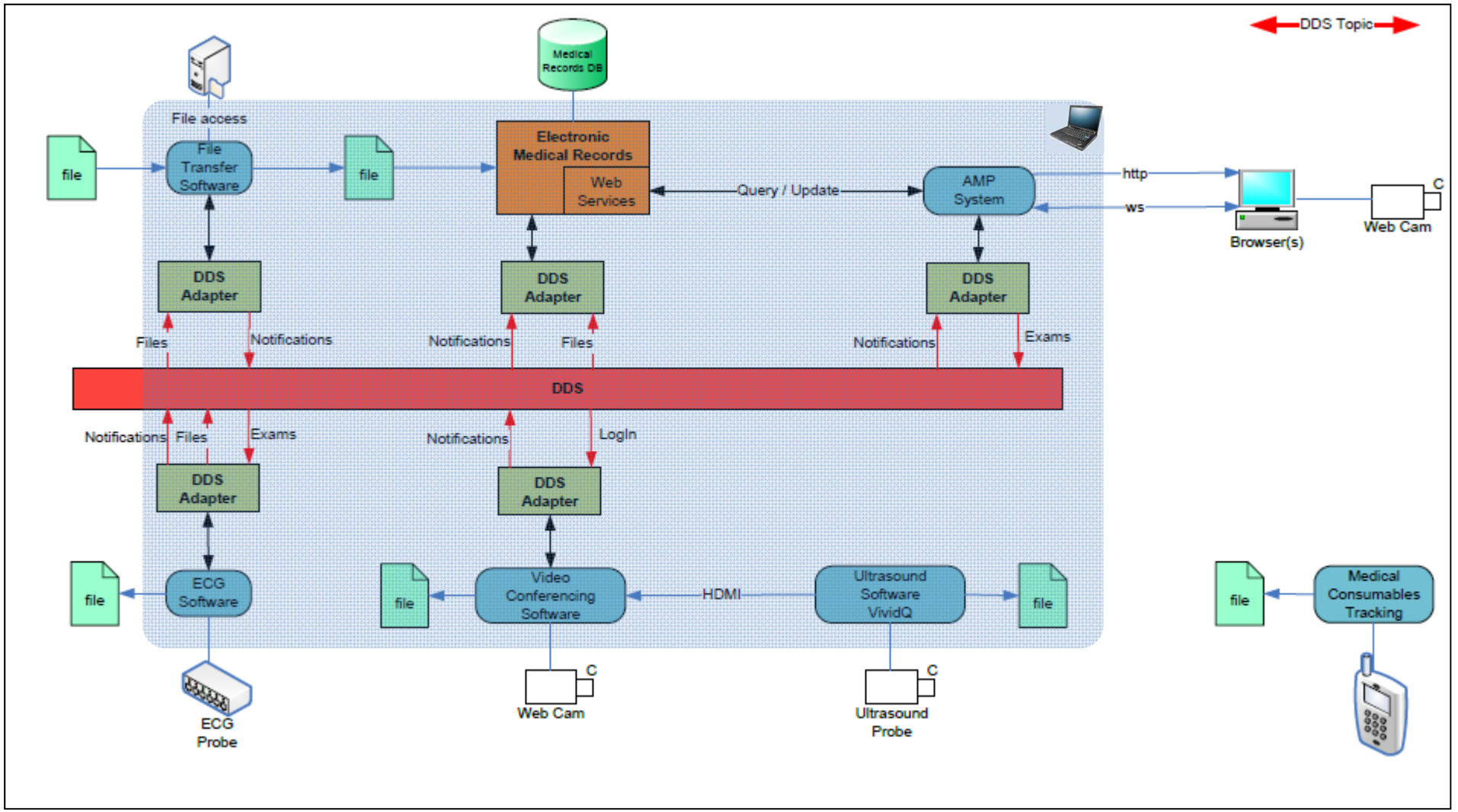
Messaging

Applications connect to a common messaging system to exchange data and invoke behavior using messages

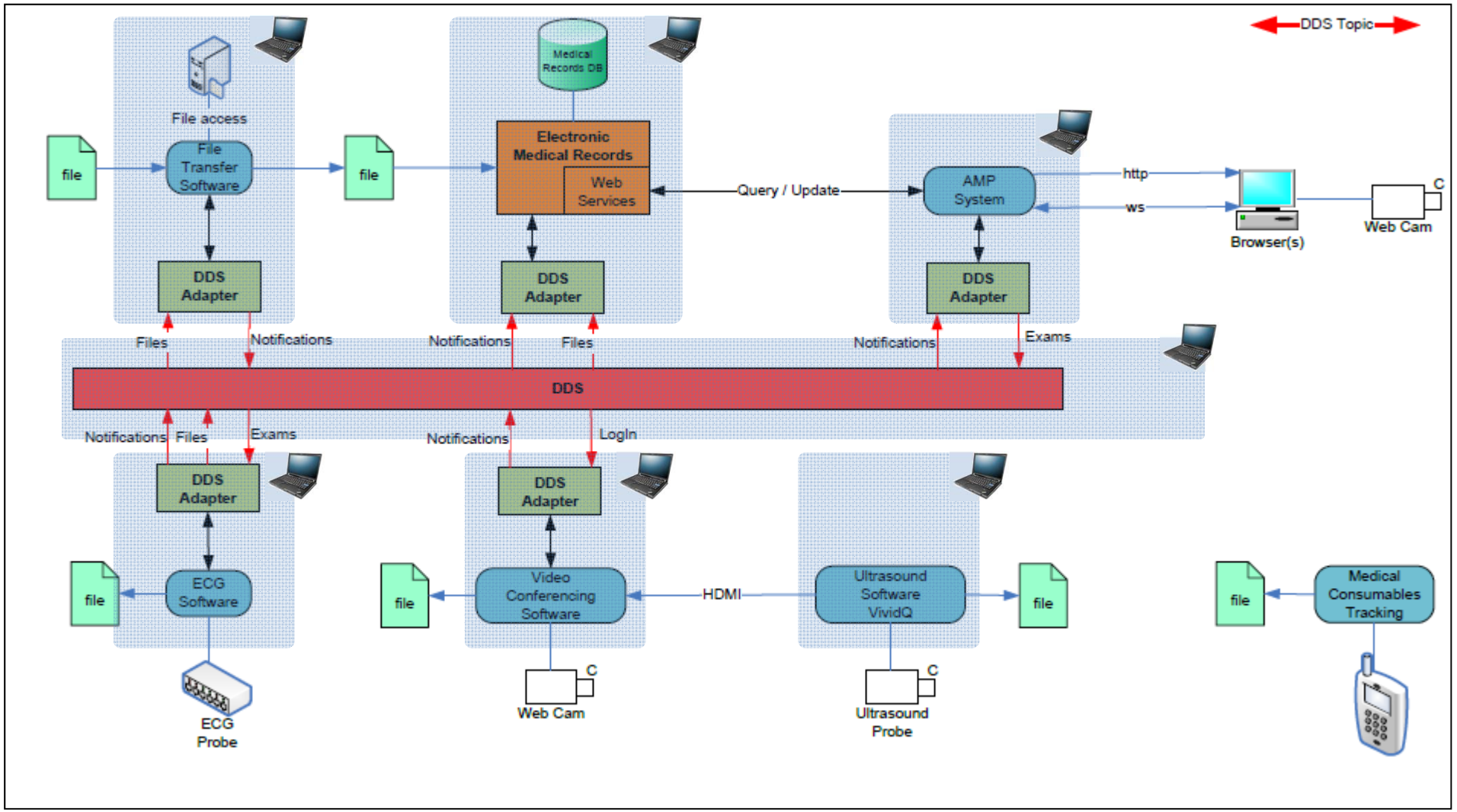
EMSD Architecture Overview



Physical Implementation – Single Host



Physical Implementation – Multiple Hosts

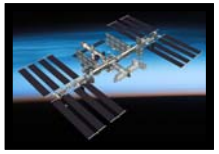


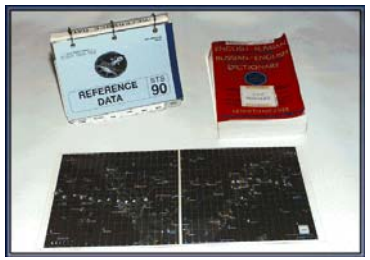
What's next?

Johnson Space Center
Engineering Directorate
Software, Robotics and Simulation Division

Evolution of Procedures

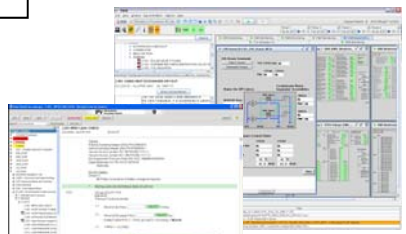




Apollo & Space Shuttle—Paper

Early ISS—PDF



Current ISS—IPV/XML

- No Automation or Computer Oversight

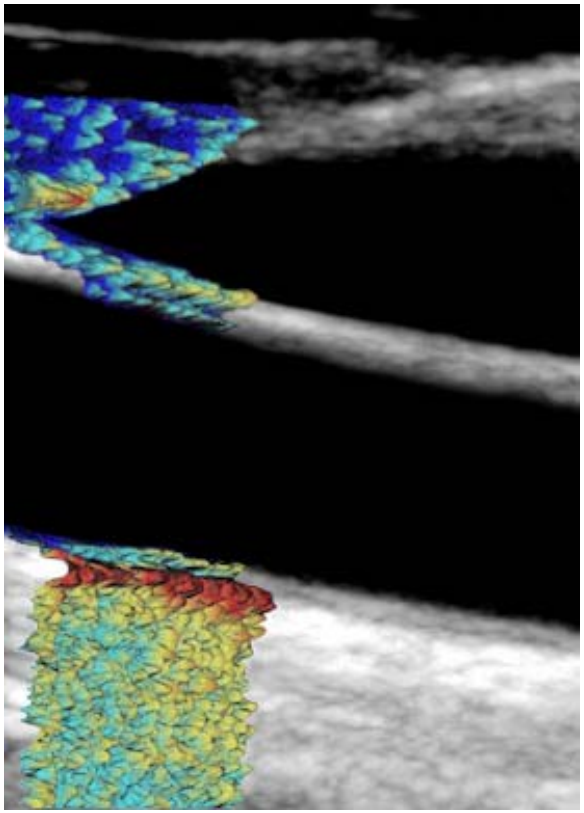
Orion; Enhanced XML (PRL)

- Computer Oversight
- Automation

Deep Space Exploration- AR-eProc;

- PRL Extension
- Machine Vision and Marker-less Registration

Future Direction: Autonomous Ultrasound Ops.



1. Image detection software depiction of anatomical landmarks which define an adequate carotid image superimposed over an actual carotid artery ultrasound image

2. Robonaut 2 being remotely guided through carotid artery ultrasound imaging technique

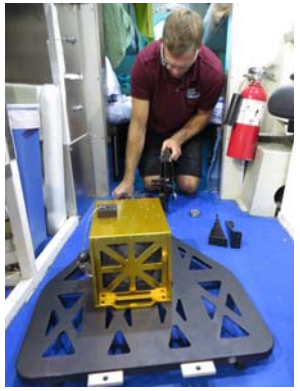
Backup

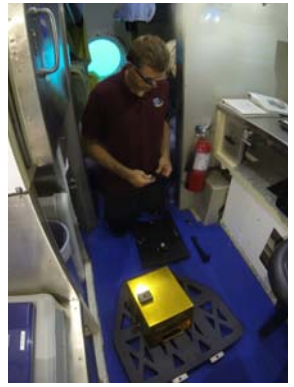
SEATEST II: Just-in-time training & procedure execution with Glass

Miniature Exercise Device (MED):

a. Equipment Assembly Task

b. Equipment Dis-Assembly Task





Just-in-time (JIT) training of a Sani-tank purge

After the task was completed using the Google Glass – the same JITT material was viewed on an iPad

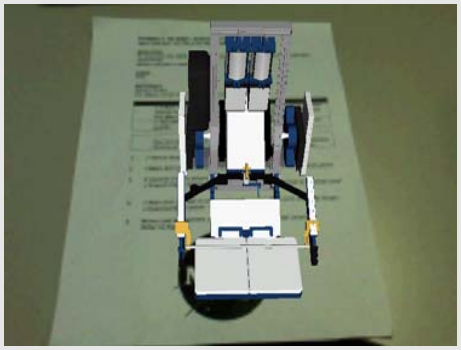
Return

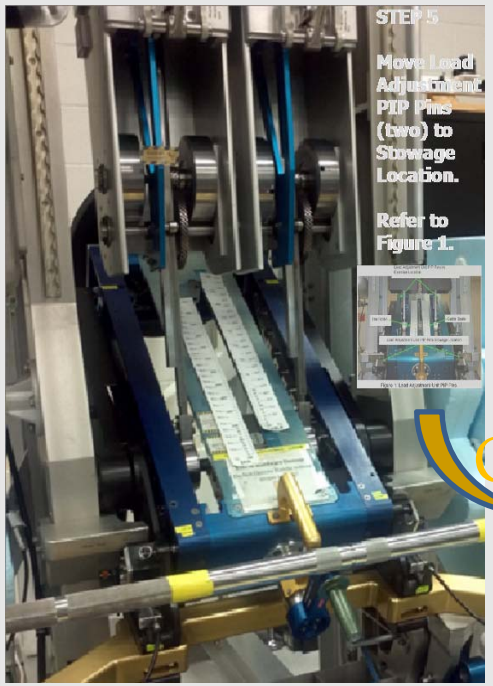
Johnson Space Center
Engineering Directorate
Software, Robotics and Simulation Division

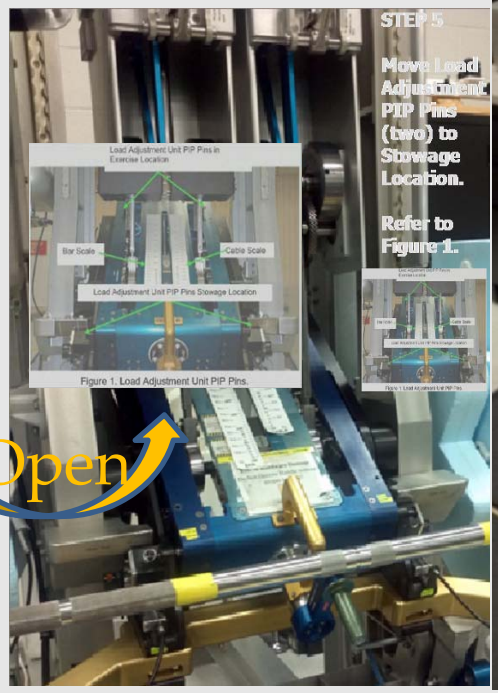
Augmented Reality to Enhance Crew Medical Training

Johnson Space Center
Engineering Directorate
Software, Robotics and Simulation Division

Augmented Reality (AR-eProc ARED)







Open