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International Space Station Payload Operations Integration Center (POIC) Overview

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POIC Purpose, Goals & Objectives

- **PURPOSE**
  - Primary facility and systems responsible for 24x7 real-time ISS payload operations management, integration, and control

- **GOALS & OBJECTIVES**
  - Maintain and operate the POIC and support integrated Space Station command and control functions
  - Provide software and hardware systems to support ISS payloads and Shuttle for the POIF cadre, Payload Developers and International Partners
  - Provide design, development, independent verification &validation, configuration, operational product/system deliveries and maintenance of those systems for telemetry, commanding, database and planning
  - Provide Backup Control Center for MCC-H in case of shutdown
  - Provide certified personnel and systems to support 24x7 facility operations per ISS Program Payloads CoFR Implementation Plan (SSP 52054) and MSFC Payload Operations CoFR Implementation Plan (POIF-1006)

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Payload Operations Integration Center

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POIC provides facilities and ground systems infrastructure for ISS payload operations:

- **Telemetry**
- **Command**
- **Operational Info Management Systems**
- **Payload Planning Systems**
- **Voice**
- **Video**
- **HOSC Power Outage Contingency (4207 Annex)**

Services

- **Host Payload Operations Integration Function (POIF)**
- **Remote operations to globally distributed Payload Developers and International Partners**
- **Backup Control Center for Houston**
- **Payload science data distribution and archive**
- **Critical services availability 99.5% or greater**

Configuration Control

- **POIC utilizes the Ground Segment Control Board (GSCB) to control Interface Control Documents with remote facilities**

Certification of Flight Readiness

- **POIC provides the facility, systems and International Partner interfaces certification readiness to the POIF**

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ISS Payload Operations Distributed Architecture, POIC Services and External Interfaces

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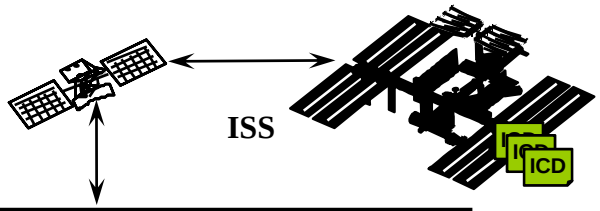
ICD I/F Control Document
IFS I/F Specs/Agreements
PGUIDD POIC/Generic User I/F Definition Document
RQMTS Requirements



White Sands Complex, New Mexico — ICD

Commands, Uplinks, Voice

Vehicle Telemetry, Voice, Video

Payload/Kuband & Vehicle Telemetry

Commands, Uplinks, Voice

IT Service & Comm. Support Rqmts [GSRT]

RQMTS — P/L Developer Teams

BCC

Mission Control Center-Houston — ICD

Commands, Uplinks

Planning Products, Voice, Ops Mgmt, Other

P/L Ops Integration Center — PGUIDD

TLM/CMD Databases

Mission TLM/CMD Databases from MBF, IMARS, PDL/PEI, STS — ICD, IFS

Simulation, Test Data

US Payload Commands, Uplinks

Payload/Kuband & Ancillary Telemetry

Planning Products, Voice, Ops Mgmt, Other

Internet

JSC MCC to International Partner Services

PRCU (MSFC, GRC, KSC) MSFC PSIVF, JSC SSTF/PTC, JSC ISIL/SDIL JSC ESTL — ICD, IFS, ICD, IFS, IFS

Russia
Europe
Japan
Italy
Canada

GRC
ARC
JSC

ICD — International Partner Facilities & Users

ICD — NASA Telescience Support Centers

US Payload User Sites

POIC S/W Capability Provided Remotely
- Telescience Resource Kit (TReK)
- Internet Voice Distribution System (IVoDS)
- Enhanced HOSC System (EHS) PC (EPC) S/W
- POIC Web Services
- JSC MCC-H S/W Tools

Payload (P/L) User Support Operational Function Provided
P/L-Unique Command/Telemetry Processing
Mission Voice Services For Ground Operator and Onboard Crew Comm
System-Wide POIC ISS P/L Operations Telemetry/Command Services Access
POIC Operations Planning, Integration & Stored Telemetry Data Access
Onboard Crew Procedures & Operations Timeline Access

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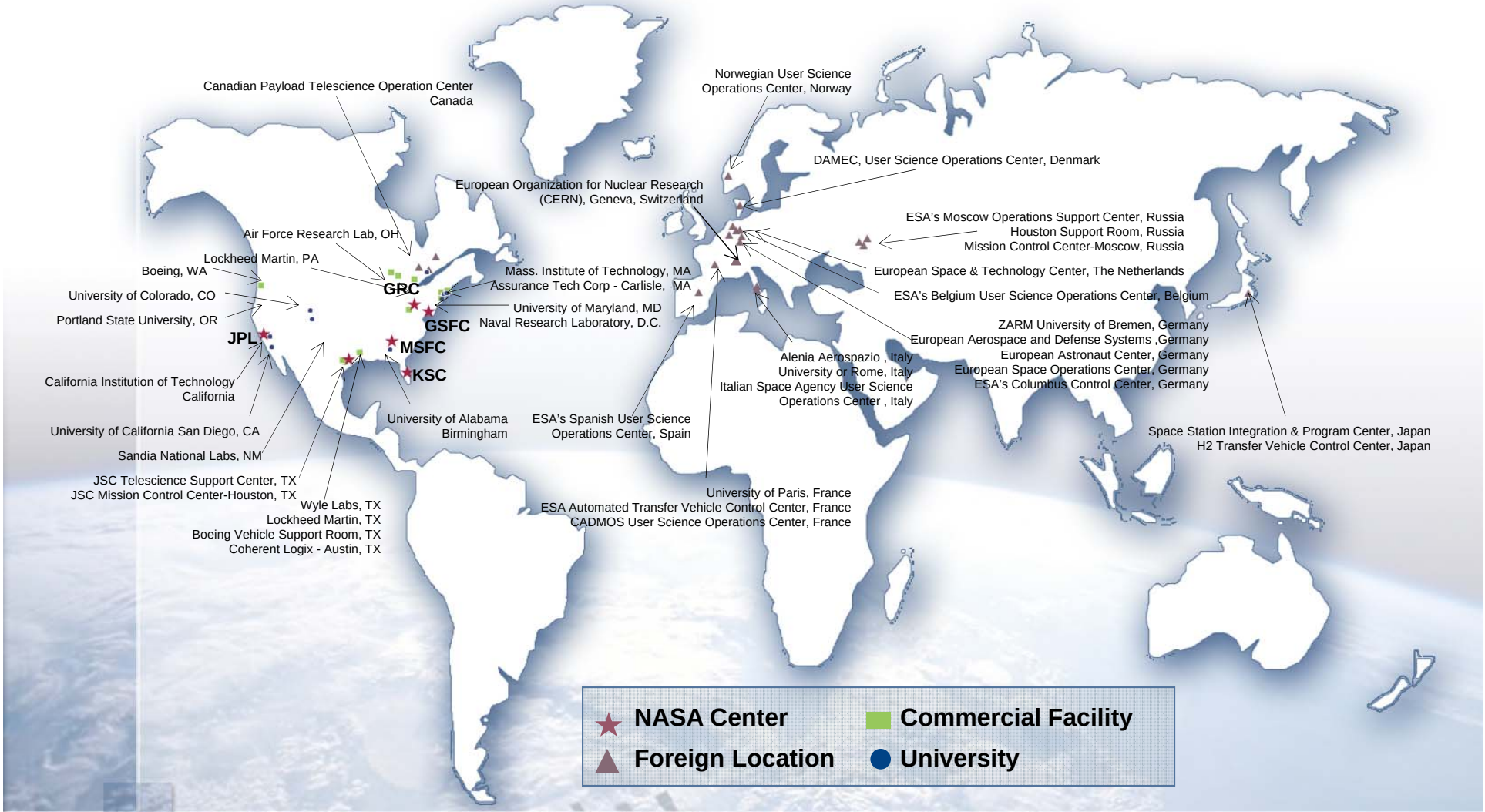
HOSC Supported Remote Sites



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HOSC General: HOSC Supported Remote Sites

U.S. Universities	Northeastern University, MA. ■ Harvard University, MA. ■ Massachusetts Institute of Technology, MA. ■ Princeton University, N.J. ■ University of California at San Diego, CA. ■ University of Wisconsin, WI. ■ University of Alabama at Birmingham, AL. ■ California Institute of Technology, CA. ■ University of Colorado, CO. ■ Colorado School of Mines, CO. ■ University of Waterloo, Waterloo, Canada
U.S. Commercial Facilities	Henry Ford Health Clinic, MI. ■ Payload Systems, MA. ■ Lerner Research, OH. ■ Intek Inc., WI. ■ National Institute of Health, MD. ■ Boeing Vehicle Support Room, TX. ■ Wyle Labs, TX . ■ Boeing, WA. ■ Lockheed Martin, TX. ■ Orbitec, WI. ■ Hamilton Sundstrand, CT. ■ Chandra Operations Control Center, MA.
Foreign Locations	European Astronaut Center, GERMANY ■ Canadian Payload Telescience Operation Center, CANADA ■ ESA's Norwegian User Science Operations Center, NORWAY ■ ESA's Belgium User Science Operations Center, BELGIUM ■ ESA's Moscow Operations Support, RUSSIA ■ University of Paris, FRANCE ■ University of Rome, ITALY ■ German Sports University, GERMANY ■ European Space Operations Center, GERMANY ■ European Space and Technology Center, The NETHERLANDS ■ University of Waterloo, CANADA ■ Thomson & Nielson Electronics, CANADA ■ ESA's Columbus Control Center, GERMANY ■ JAXA's SSIPC, JAPAN ■ Damec, DENMARK ■ Italian Space Agency, ITALY ■ ESA's Spanish User Science Operations Center, SPAIN ■ Houston Support Room, RUSSIA ■ Mission Control Center-Moscow, Russia ■ European Center for Nuclear Research (CERN), Geneva Switzerland
NASA Centers	JSC Telescience Support Center ■ JSC DOD Payload Operations Control Center ■ JSC Build 4S Crew Office ■ JSC Space Station Training Facility ■ JSC SSCC/Bio Med Support ■ JSC Increment Scientist Support ■ MSFC United States Operations Control Center ■ MSFC Payload Software Integration & Verification (Boeing) ■ MSFC Regenerative ECLSS Support Room ■ GRC Telescience Support Center ■ AMES Telescience Support Center ■ JPL Earthkam Project Support ■ KSC Space Life Sciences Lab ■ KSC Florida State Research Institute ■ KSC Space Station Processing Facility KSC Boeing ■ GSFC SEM Payload Operations ■ Backup Advisory Team (remote locations) ■ Jacob Sverdrup, Engineering and Science Contract Group, Houston, Texas (PIMS, OSTPV/MPV, Voice)

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POIC IT Security

- POIC provides secure/encrypted support/gateway services
  - Meets requirements specified in NPR 2810, including protection for vehicle and crew
  - Provides protection: between payload users; separates payload users from core systems operations; protects ISS from network/hacker/denial-of-services attacks
  - Requires significant/ongoing diligence in maintaining acceptable security posture of systems
  - Cost savings to Program
- Remote ISS Payload users/sites
  - Remote services encapsulated within COTS Virtual Private Network (VPN) technology, with upper level network, firewall, operating system and application level protections

SCIENCE OPERATIONS

POIC Integration/Services For Remote Users

Payload Command Uplink Gateway, Downlink Vehicle/Payload Telemetry Distribution, Voice Comm Control, Data Transfer Services, Planning Services, Information Systems, etc

International Space Station (ISS)

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POIC Tools and Services

Tool	Services
Telescience Resource Kit TReK MSFC	• Data Services – retrieve, process, record, playback, forward, and display data (ground based data or telemetry data). • Support for various data interfaces such as UDP, TCP, and Serial interfaces. • Command – create, modify, send, and track commands. • Command Management -- Configure one TReK system to serve as a command server/filter for other TReK systems. • Database – databases are used to store telemetry and command definition information. • Application Programming Interface (API) – ANSI C interface compatible with commercial products such as Visual C++, Visual Basic, LabVIEW, Borland C++, etc. The TReK API provides a bridge for users to develop software to access and extend TReK services. • Environments –development, test, simulations, training, and flight. Includes standalone training simulators. • Forward work to include support for CFDP and DTN.

	• Rich toolset to provide point and click creation to:
	  • Receive and display telemetry data on a user-defined display
	  • Perform computations on the received telemetry values
	  • Continuously monitor specific telemetry parameters to detect anomalies
	  • Update and uplink commands to the spacecraft
	  • Track and verify command uplinks
	  • Extensive scripting language for automated telemetry acquisition, command updates, and command uplinks
	• Can be combined with TReK to provide comprehensive processing of payload science and health and status data

EHS Web and Portal	• Secure access to mission support tools including:
	  • Programmatic access to Near Real-Time Data
	  • Command tracking and post-analysis
	  • Custom telemetry stream generations (GSE Packets)
	  • Mission configuration management (PIMS)
	  • Mission support tools (console log tool)

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POIC Tools and Services

Tool	Services

Payload Data Services	• Receive, distribute, and archive payload science data
	  • 2 year archive requirement
	• Receive, process, distribute, archive ISS core and health and status data
	  • 2 year archive requirement

	• Automates planning, scheduling, and integration of payload operations during
	• pre-increment planning, weekly planning and realtime execution
	• User Requirement Collection Tool (URC) – Enter payload planning
	  • Crew time
	  • Power
	  • Thermal
	  • Data
	  • Video/Photography
	  • Operational constraints

DICES VoIP	• Internet voice solution
	  • Monitors up to 24 loops/conferences simultaneously
	  • User selects from authorized subset of available voice loops/conferences
	  • Talk on one of the 24 loops
	  • Volume control and mute for individual loops
	  • Differentiate between talk and monitor privileges
	  • Show lighted talk traffic per loop
	  • Custom group configuration

Video	• Integration of NASA provided ISS downlink video services with customer operating location.

 Mission Planning & Integration	• Ground System Integration Support
	  • Ops Concept Development
	  • Requirements analysis and integration
	  • Interface Configuration
	  • Interface Testing
	  • Payload &Test & Checkout Support
	  • Ground System Flight Readiness Certification
	  • Customer Support Services

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Overall Systems and Interfaces for ISS Payloads

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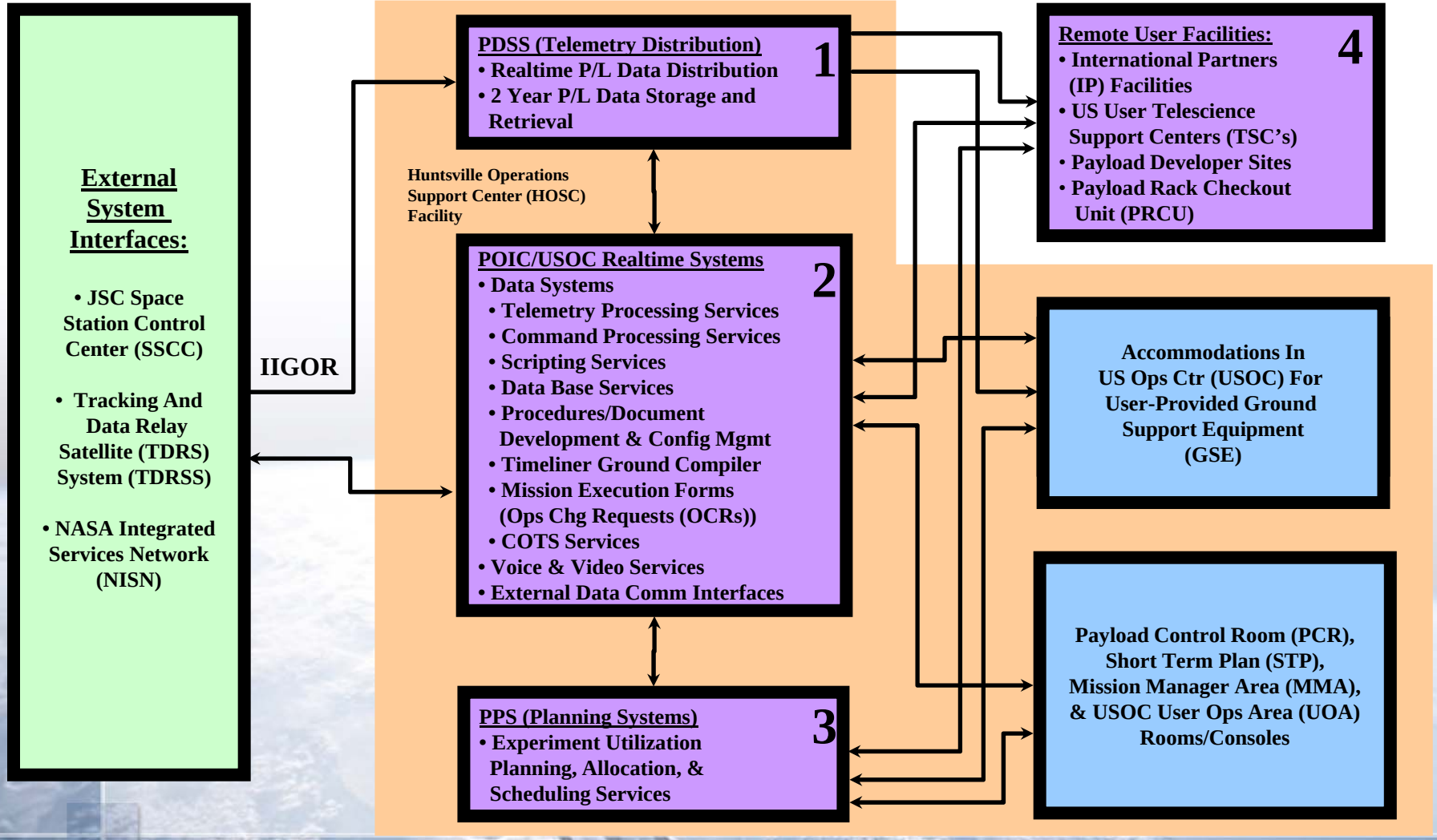

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Telemetry Distribution
Payload Data Services System (PDSS) (Box 1)

- PDSS Realtime Services
  - Receive and process ISS payload (Ku-band) and core systems (S-band) CCSDS telemetry streams; embedded video and audio discarded
  - Distribute to local/remote users/systems (POIC, International Partners, US Users/Telescience Centers, US Ops Center Ground Support Equip)
  - Receive test/simulation data from other external sources (e.g., JSC Space Station Training Facility) for distribution
  - Collect and report statistics on users' downlink data
  - Provides intermediate capability for realtime data buffering
- PDSS Non-Realtime Services
  - Store ISS payload/science data, payload health and status, flight ancillary data, and data quality statistics
  - Retain for up to 2 years
  - Web access for user-requested "data sets"
    - Playback
    - File transfer
  - Data processing reports

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Realtime Systems (Box 2)

- Data Acquisition and Distribution
  - Front-End Processor (FEP) acquires and distributes Time Division Multiplexed (TDM) telemetry to other systems
- Telemetry Processing Server-Based Functions
  - Receive/process packet data from POIC FEP and PDSS
  - Raw telemetry data stored for recall
  - Web-based user interface to request telemetry measurement reports and packet/stream playbacks
  - Telemetry extraction, conversion, calibration, and limit/expected state sensing
- Command/Telemetry Database Services
  - Input and conversion of project unique telemetry/command databases into POIC compatible format
  - Web-based user interface
  - Multiple databases processed per flight/increment
    - Preliminary, interim and final versions
    - Backup Control Center (BCC)
- Command Processing Server-Based Functions
  - Vehicle/Payload commanding for users with all command transactions logged
  - Hazardous command operations system design (certified by JSC Safety Office)
  - Command database partitioned by users with facility controls to enable/disable
  - Secure remote facility/user programmatic command services

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Realtime Systems (Box 2) (cont)

- Exception Monitoring:
  - Provides for continuous automated monitoring of user-selected telemetry data to indicate Caution & Warning (C&W), Redline, Expected State, and Delta Limit violations; with associated textual message output.
- EHS PC (EPC) Scripting:
  - Provides user capability to easily build, validate and operate scripts for monitoring telemetry; and initiate conditional/automated responses (including Command update/uplink).
- EPC Computation Services:
  - Provides user capability to easily build, validate, and execute comps on telemetry, with outputs available locally or globally to other users. Comps supported on servers or locally on PC.
- EPC Display Services:
  - Provides capability for users to easily generate, validate, and operate displays containing text/graphical telemetry representations and background information; with input support for command uplinks, scripting directives, etc.
- EPC/Workstation Command Services:
  - Provides capability for user to uplink commands/command groups/files, in addition to updating modifiable commands/command groups from user-defined forms. Provides command system visibility including command track, command history, and command delog support.

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Realtime Systems (Box 2) (cont)

- Mission PC (MPC) Systems (MPS)
  - Supplemental operations support for POIC Cadre
    - COTS Tools: MS Office, JAVA, Internet Explorer, etc.
    - JSC Tools: Manual Procedures Viewer (MPV), Onboard Short Term Plan Viewer (OSTPV), Inventory Management System (IMS), JSC Web Sites/Services, Orbital Data Reduction Complex (ODRC) JAVA Mission Evaluation Workstation Software (JMEWS), Hazardous Material (HAZMAT), etc.
    - Payload Planning Tools
  - External User access to MPV/OSTPV products (read only capability)

- Other Externally Developed Systems
  - JSC ISS Antenna Management
  - JSC Orbital Communications Adapter (OCA) System
  - JSC Space Station Training Facility (SSTF) Remote Area for Payloads Support (RAPS) System
  - Cadre G2 Services
  - ACES Desktop

- Payload Information Management System (PIMS)
  - Electronic/online operations request and processing services provided for Operations Change Requests (OCR's)
  - Mission documentation configuration management, notification and distribution services
  - Timeliner Ground Compiler automated procedures development
  - Storage and configuration management of files uplinked/downlinked
  - Web-based user interface

- ISS Unique Operations Control Management System (OCMS) Tools
  - File Ground Mgmt Tool (FGMT)
  - Automated Procedures Ground Mgmt Tool (APGMT)
  - Command Plan Mgmt Tool (CPMT)
  - Timeliner Master Bundle Generator (MBGEN)

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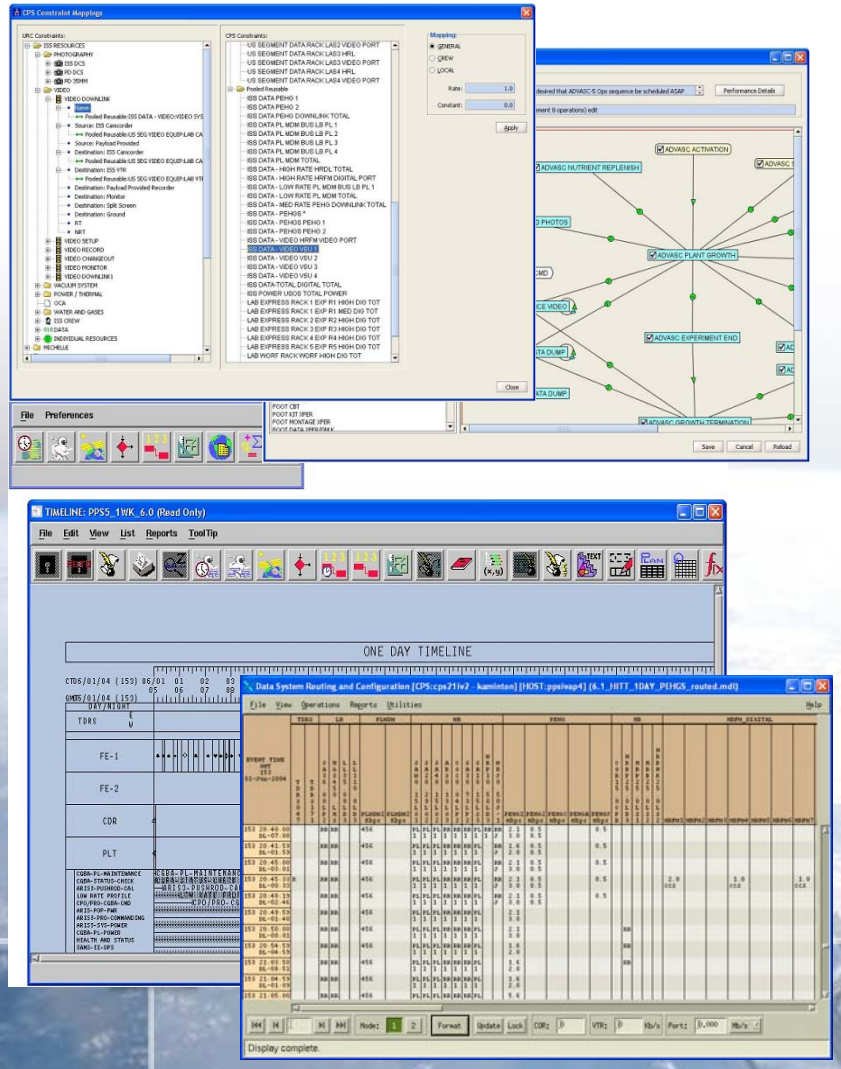
Payload Planning System (PPS) (Box 3)

POIC-developed software system used to plan ISS payload operations supporting the POIC Cadre, International Partners (IPs), Payload Developers (PDs) and other NASA centers



- User Requirements Collection (URC)
  - Collection of Payload Developer's payload science requirements for the development of ISS on-board execution timelines. PD requirements are input as constraints into a representation of the ISS system constraints.
- User Requirements Integration (URI)
  - POIC Cadre represents the complex ISS payload system and provides the level of detail needed to define the station's layout to meet both the ISS system constraints and PD constraint requirements.
- Data System Routing and Configuration (DSRC)
  - The POIC cadre plans, schedules, executes, controls and monitors the end-to-end data flow of payload and video data operations in support of ISS.
  - Models the ISS on–board data system resources and scheduling constraints for the ISS Command and Data Handling (C&DH) components, on-orbit Communications and Tracking (C&T) components, Telemetry Data Relay Satellite (TDRS) space-to-ground communications services support, and ground data and video systems operations.
- PPS interfaces with the Consolidated Planning System (CPS) developed and managed at JSC.

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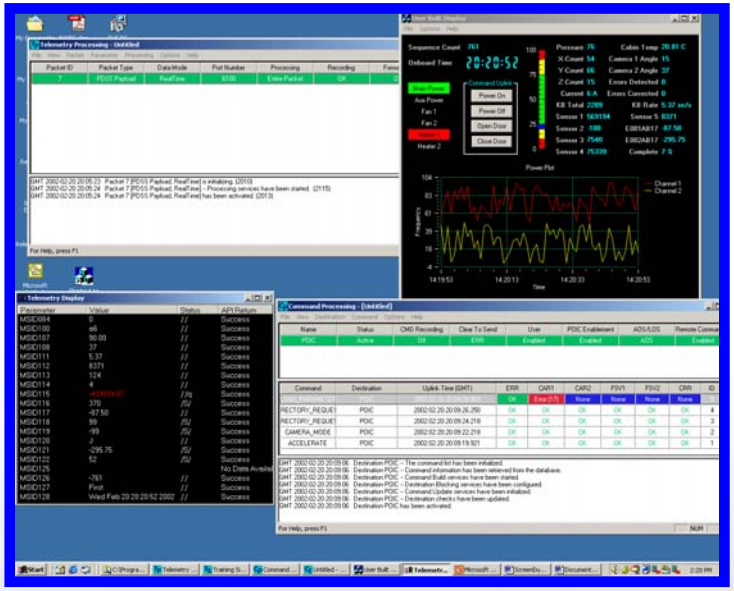
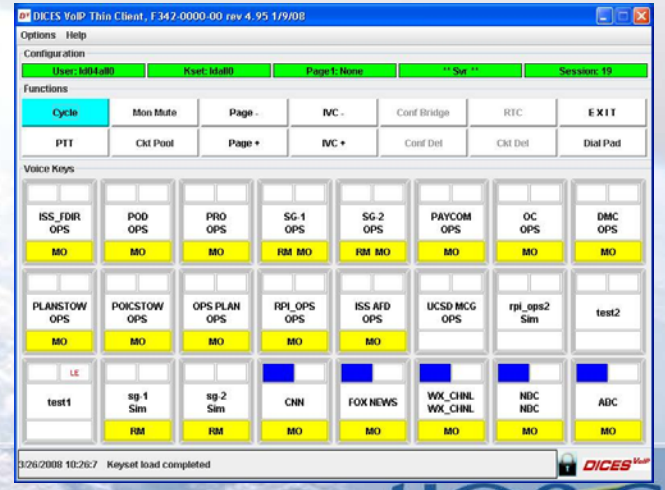
Remote User Services (Box 4)

- Telescience Resource Kit (TReK)
  - POIC-developed software provided to remote users
    - Hosts individual P/L user-centric command and telemetry applications on Windows-based PC
    - Significantly improves ISS P/L customer command, control, and science data processing capabilities while eliminating redundant end-user data processing implementations
    - Greatly reduces P/L user ground-flight system integration complexities/cost and recurring engineering
    - Applications custom-tailored by end-user thru software Application Programming Interface (API)
    - In use by significant majority of ISS payload users



- Internet Voice Distribution System (IVoDS)
  - Vendor software provided to remote users
    - Windows PC-based
    - Secure multiple voice loop talk/monitor capability
    - Eliminates very costly custom-built hardware voice instruments and dedicated data communications infrastructure of conventional mission voice implementations
    - Used by ISS payload users requiring mission voice not within NASA TSC



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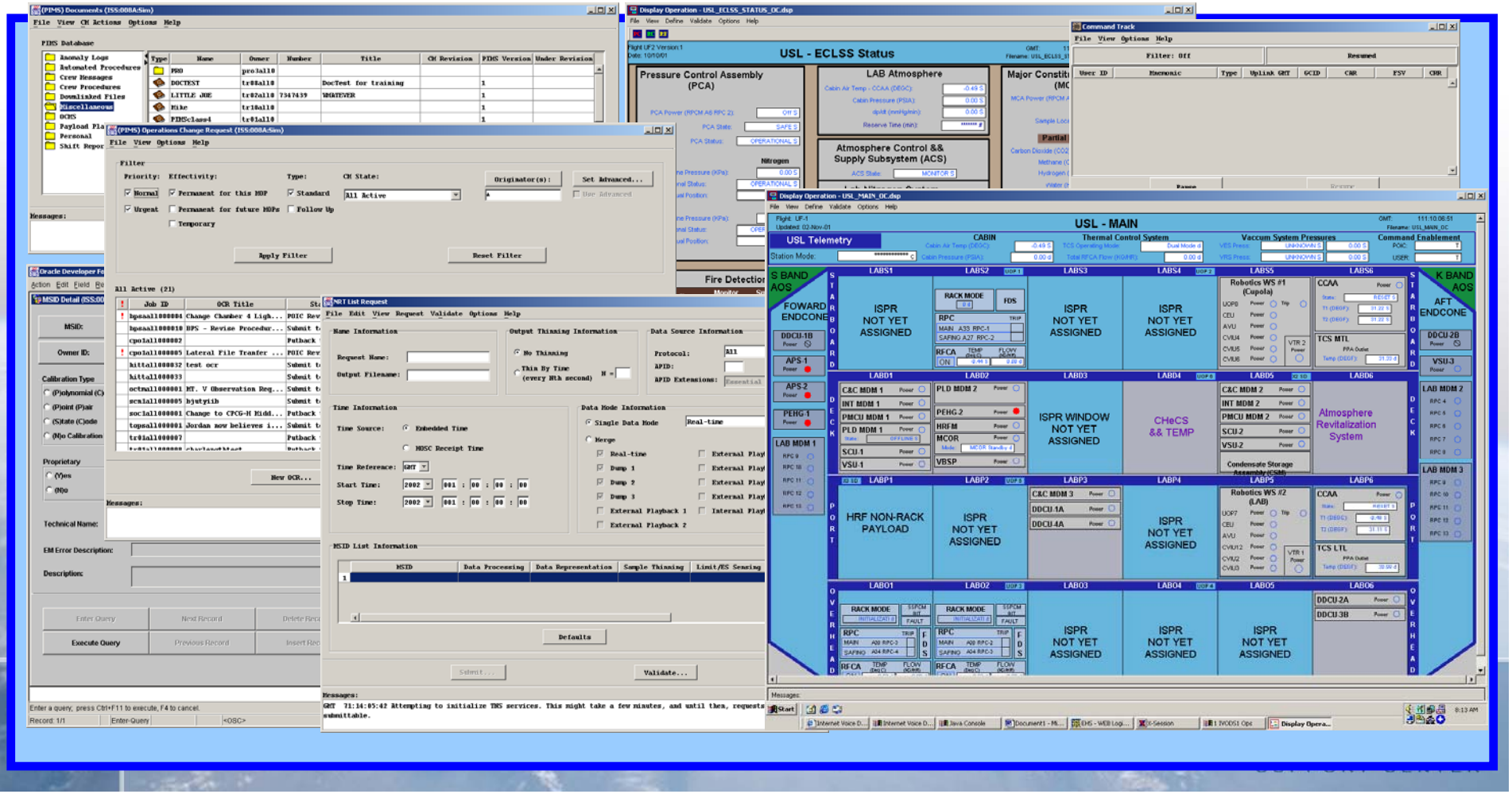
Remote User Services (Box 4)

Enhanced HOSC System (EHS) Web Services

- Provides remote user web-based access to command/telemetry database, information management systems, planning systems data, telemetry recall data, etc for integrated operations
- Runs on JAVA compliant Windows platform

Enhanced HOSC System (EHS) PC (EPC) Services

- Provides users with access to POIC telemetry processing/display and command/uplink system services
- Runs on Windows platform
- Provides end user low-cost method to quickly build and validate mission products for system-wide sharing & integrated ops



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