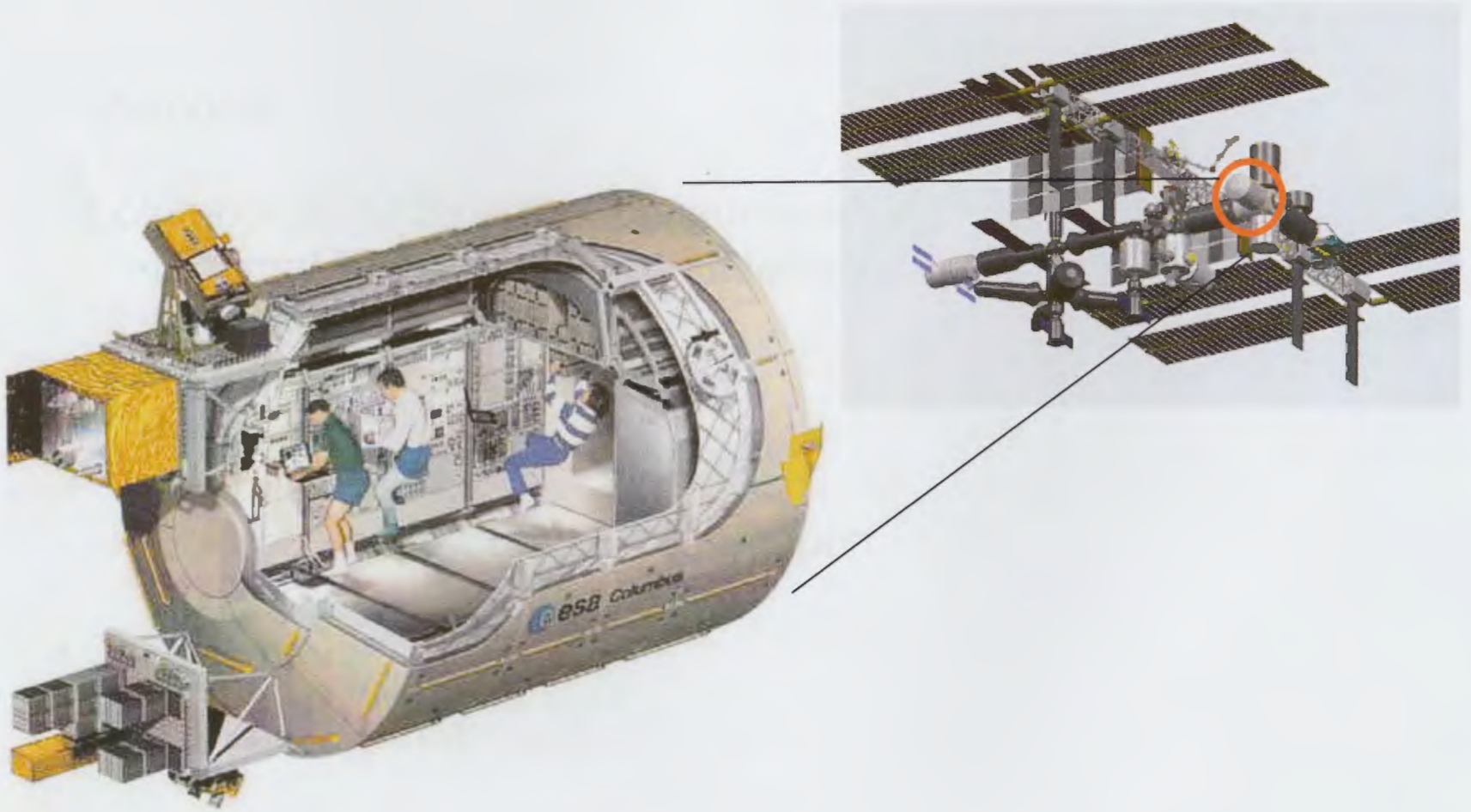
Columbus APM Qualification Review (QR 2)
Technical Presentation

EADS SPACE TRANSPORTATION



Columbus APM Qualification Review (QR 2)
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- Overview

- Columbus APM System Configuration
  - External Configuration and Interfaces
  - Internal Configuration
  - Structure and Mechanisms
  - Avionics
  - Thermal Control
  - Environmental Control, Life Support

- Operations

Note: Modifications since QR 1 highlighted

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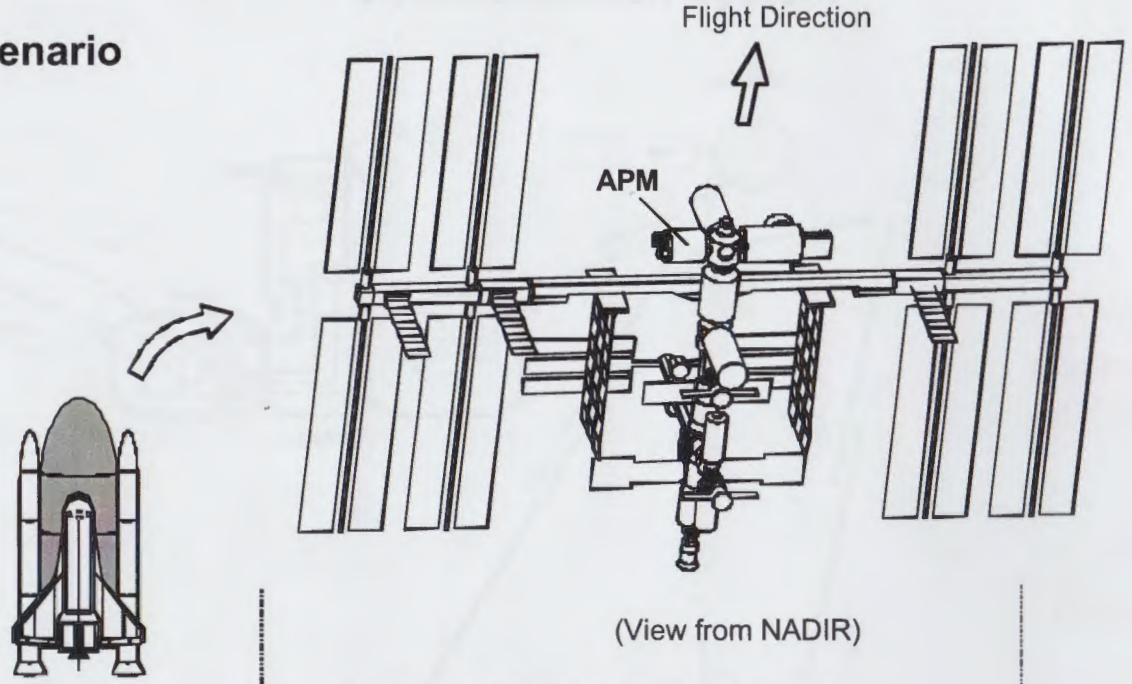
Mission Scenario



- APM launch with NSTS
- Initial European Payload Complement integrated in APM at launch
- External Payload Complement launched separately on same flight

(View from NADIR)

- Berthing to SSMB by Remote Manipulator
- Permanently attached to ISS during complete life time
- Distributed Autonomous Operations Concept incl Payload operations from Europe
- Resupply and Payload completion/reconfiguration via ISS logistics scenario

End of Life destructive Re-entry with ISS

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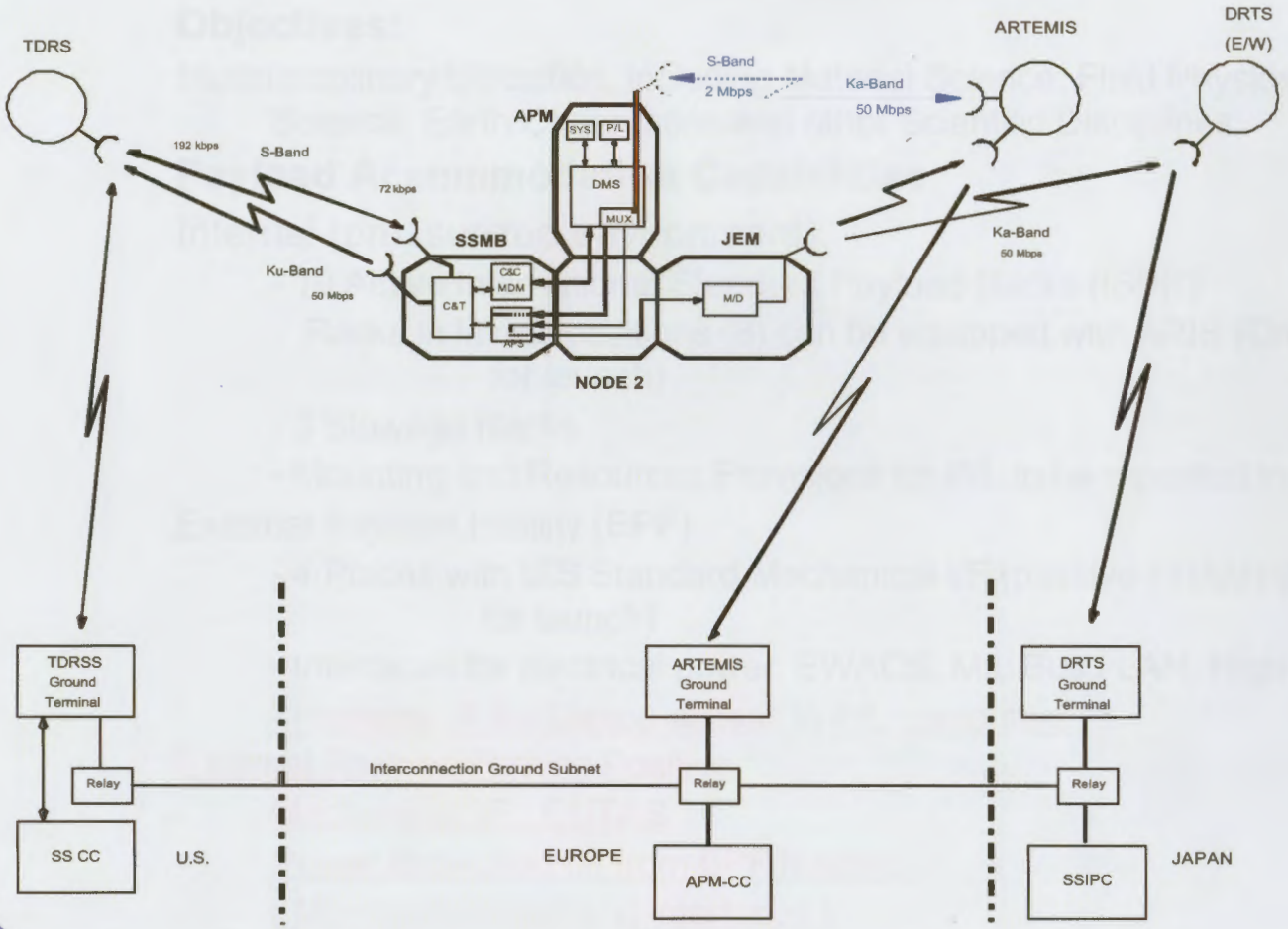
Communication System



- Provisions for on-orbit accommodation of COL Terminal

- Potential Useage:
  - Improved Telescience
  - Back-up for TDRS

Mission Scenario

Objectives:

Multidisciplinary Utilization, including Material Science, Fluid Physics, Life Science, Space Science, Earth Observation and other Scientific Disciplines;

Payload Accommodation Capabilities:

Internal (pressurized environment)

- 10 Active International Standard Payload Racks (ISPR)
- Racks in lateral positions (8) can be equipped with ARIS (On orbit configuration / not for launch)
- 3 Stowage Racks
- Mounting and Resources Provisions for P/L to be mounted in the APM Centre Aisle

External Payload Facility (EPF)

- 4 Places with ISS Standard Mechanical I/F (passive FRAM) (On orbit configuration / not for launch)
- Interfaces for electrical power, EWACS, MIL Bus / LAN, High data acquisition
- Harness I/F for Laptop access to P/L computers

External Payload Parking Position

- Mechanical I/F : EUTAS
- Power (branched off from EPF feeders)
- (Monitoring/command interfaces)

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APM Main Design and Performance Features

· Design Life:	15 years via on-orbit maintenance
· Overall Dimensions:	approx. 8 m Length; 4.5 m Diameter
· Launch Mass:	12,775 kg (incl. 2,500kg P/L)
· On-Orbit Mass:	21000 kg max.
· Electrical Power:	For Payload: 120 VDC, sized for max 20kW Subsystems: 120 VDC and 28 VDC
· Data / Communications:	≤ 32 Mbps downlink via ISS or JEM ≤ 10 kbps uplink via ISS (actual data rates depending on link ISS operational scenario) Provisions for COLUMBUS Terminal > 50 Mbps down (direct 10/100 T Base LAN I/F) / 2 Mbps up
· Environmental Control:	Sized for up to 3 crew members
· Resources:	All Resources except Data Processing by ISS
· Launch Vehicle:	NSTS (Shuttle/Orbiter)
· Servicing;	In Situ via IVA and EVA using NSTS 90 days resupply cycle

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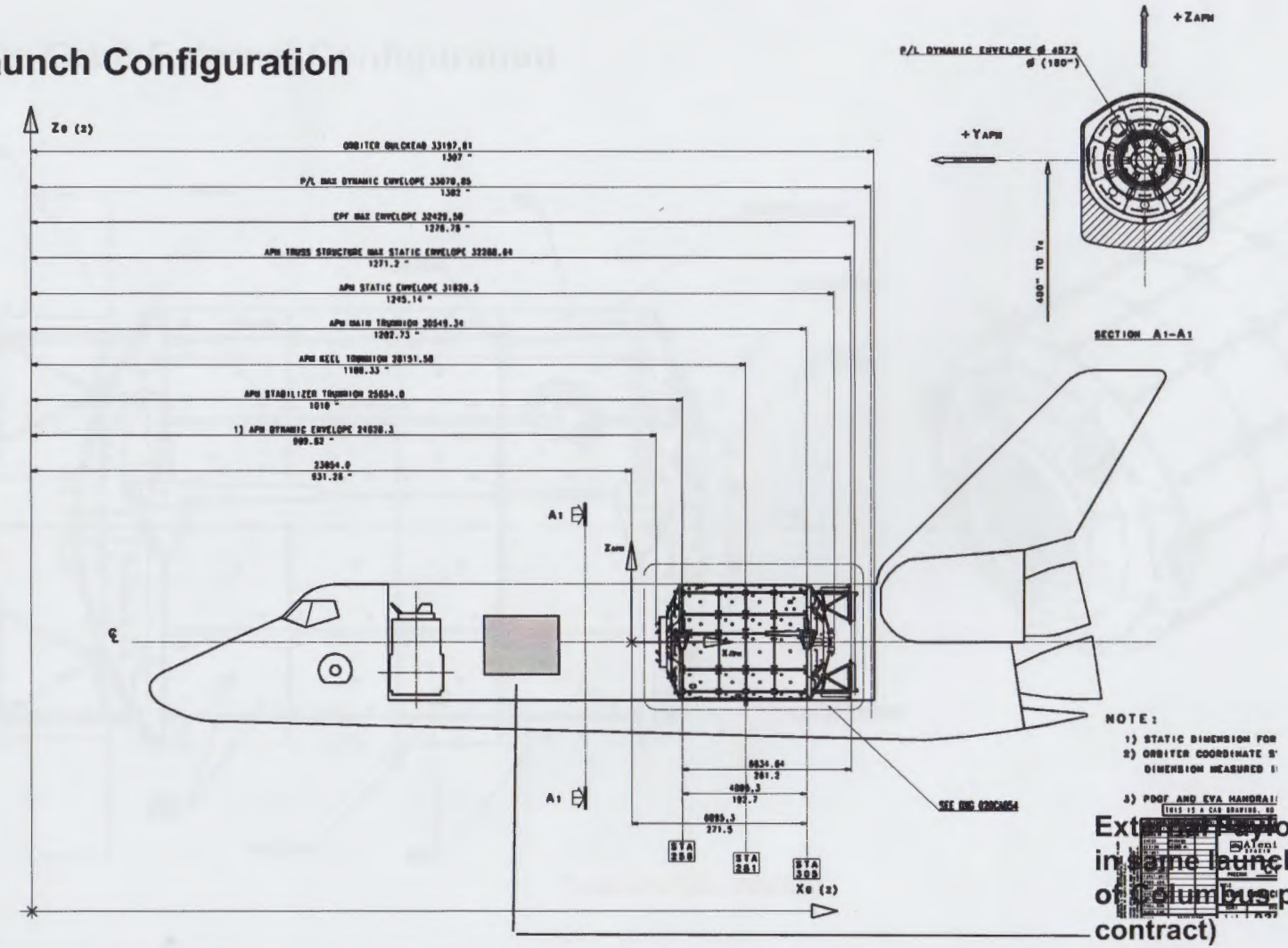
Launch Configuration



External Payload included in same launch (not subject of Columbus phase C/D contract)

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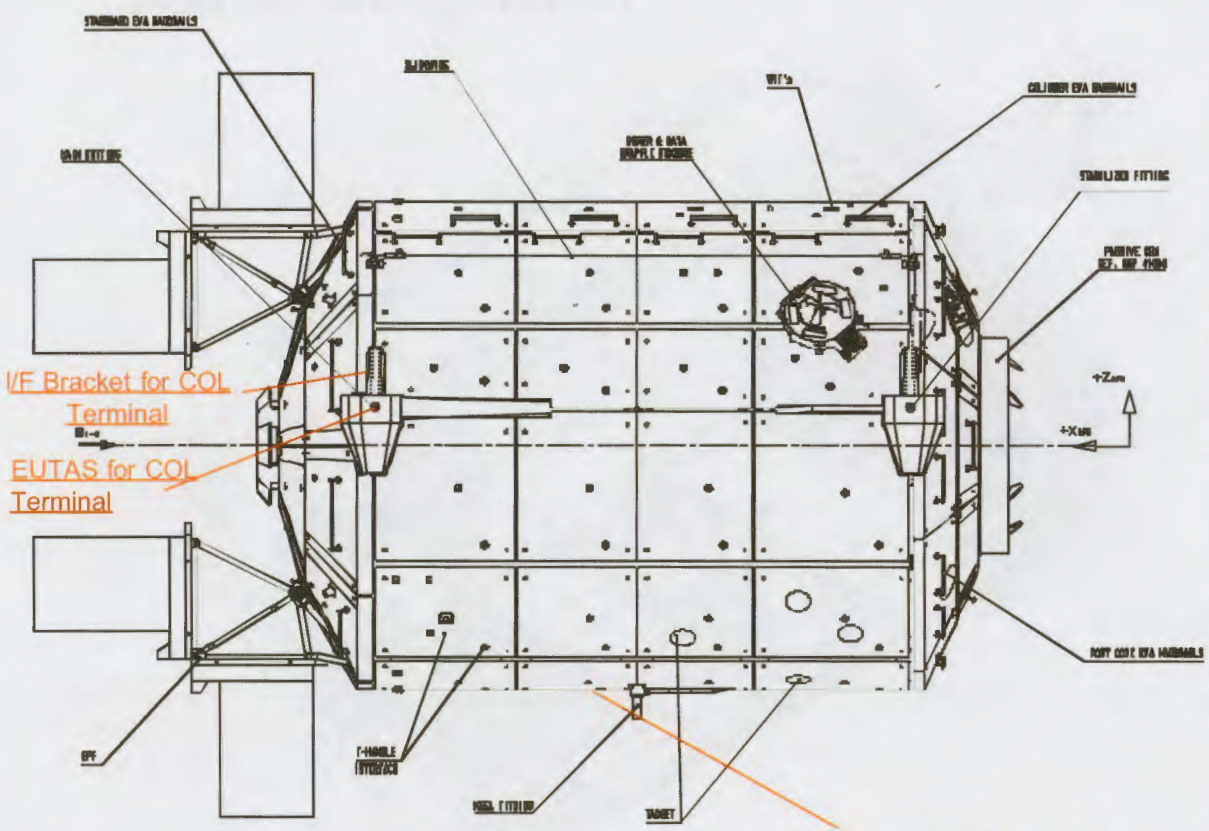
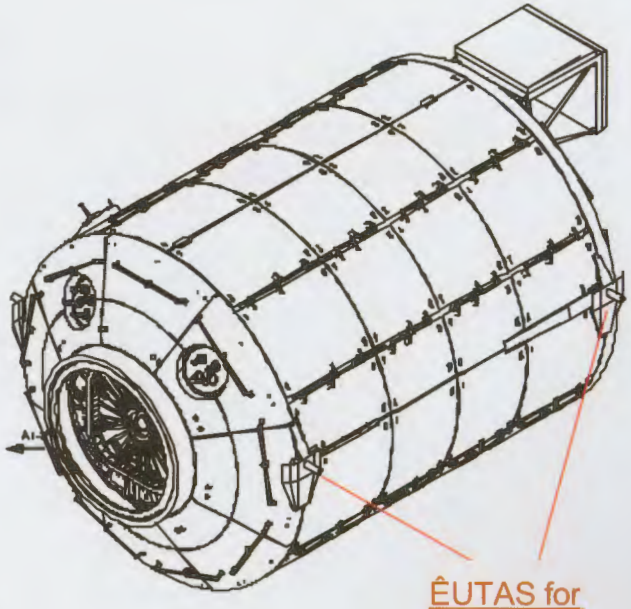
On-Orbit External Configuration





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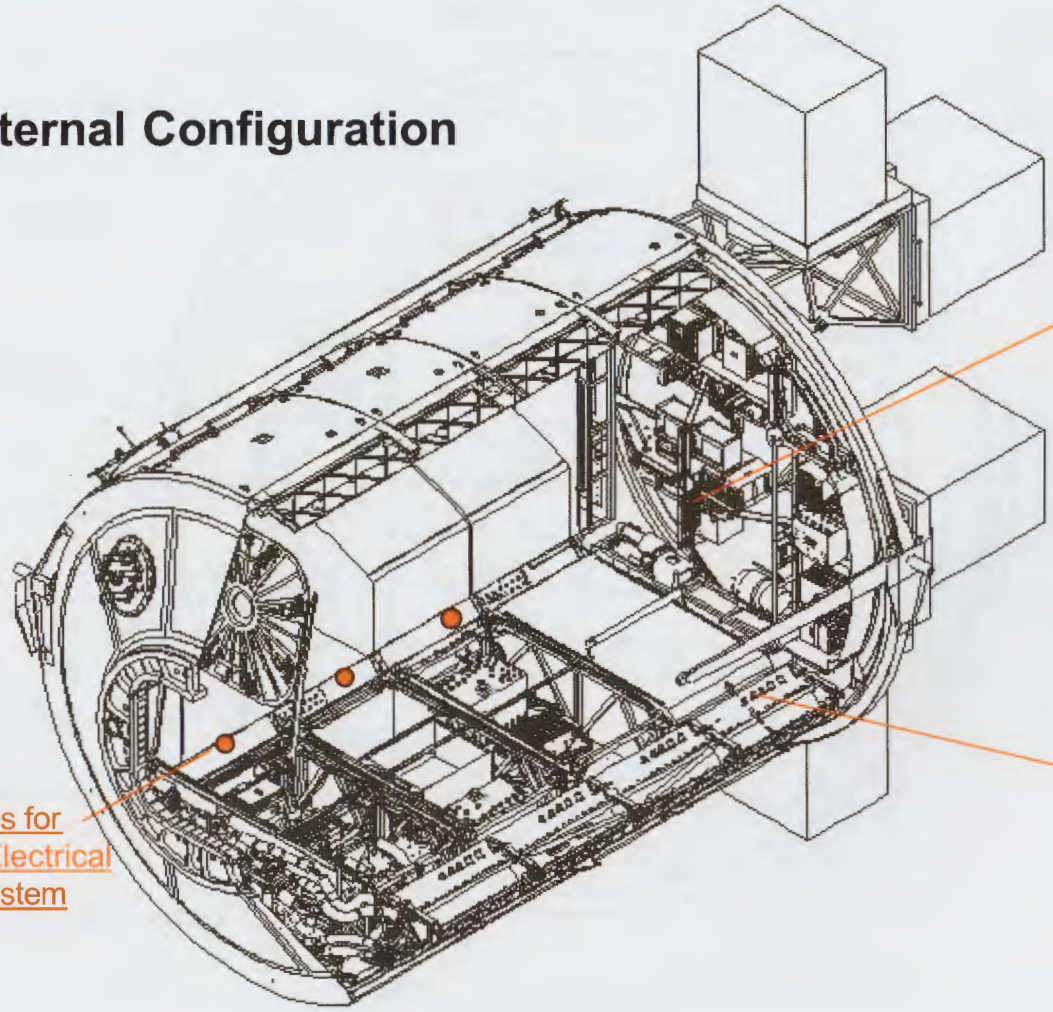
Internal Configuration



Interface bracket for P/L
Laptop to EPF computers

Interface bracket for
Interconnection to ISS
OPS LAN

Interfaces for
Digital, Electrical
Video system

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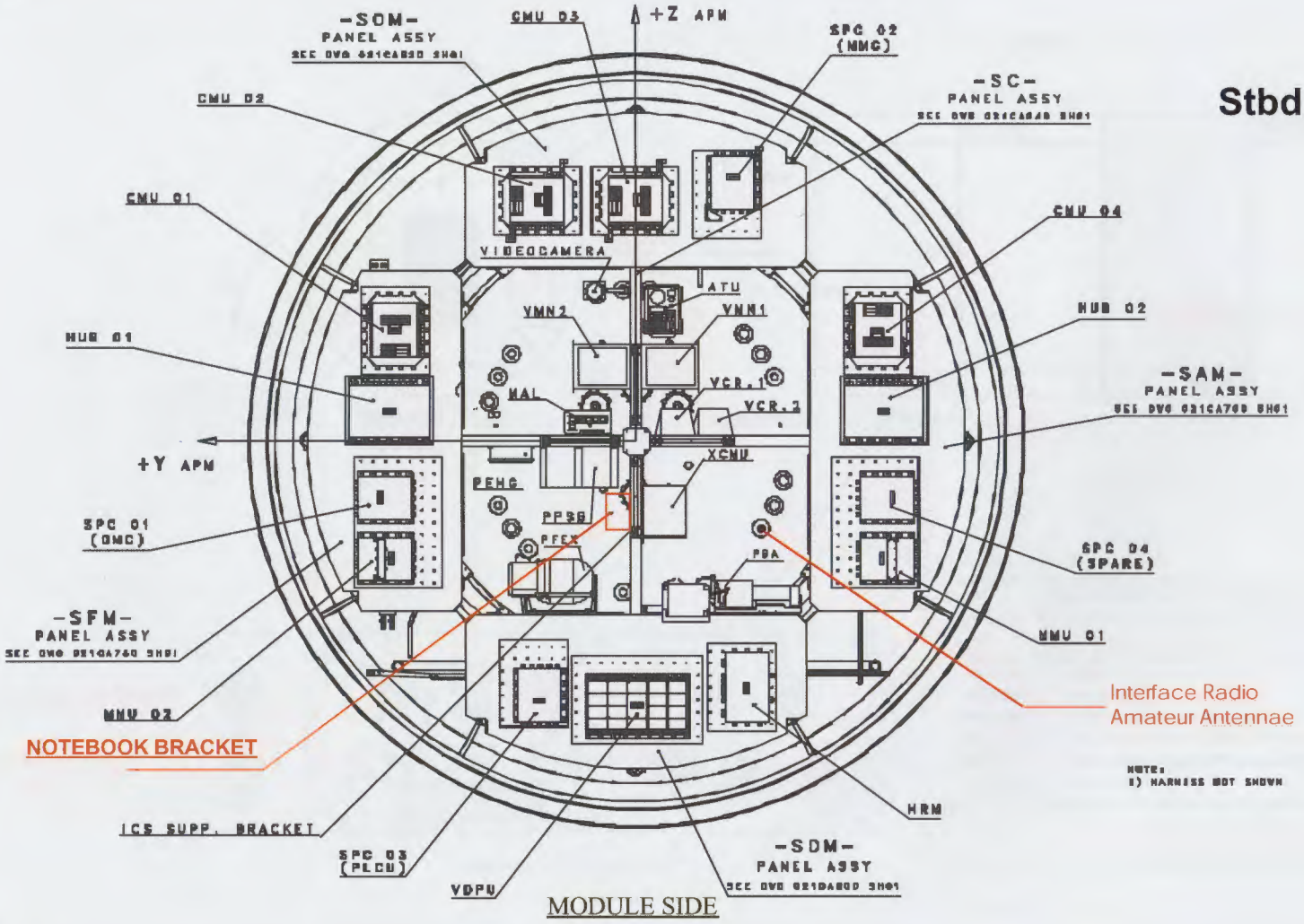
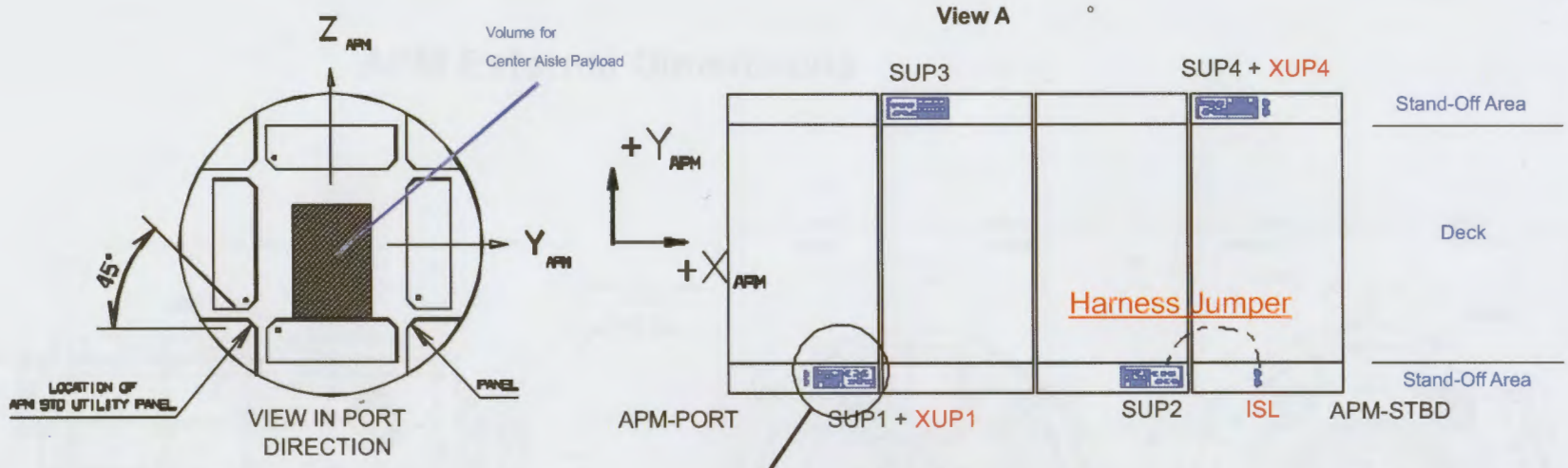
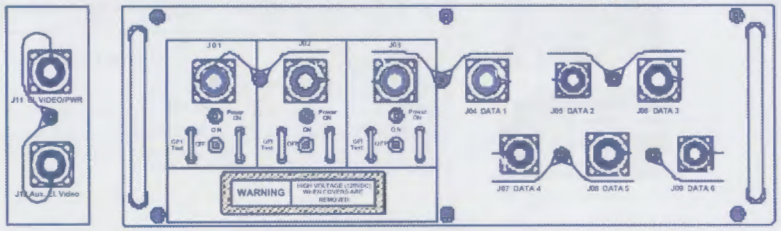
Stbd Cone (inside)







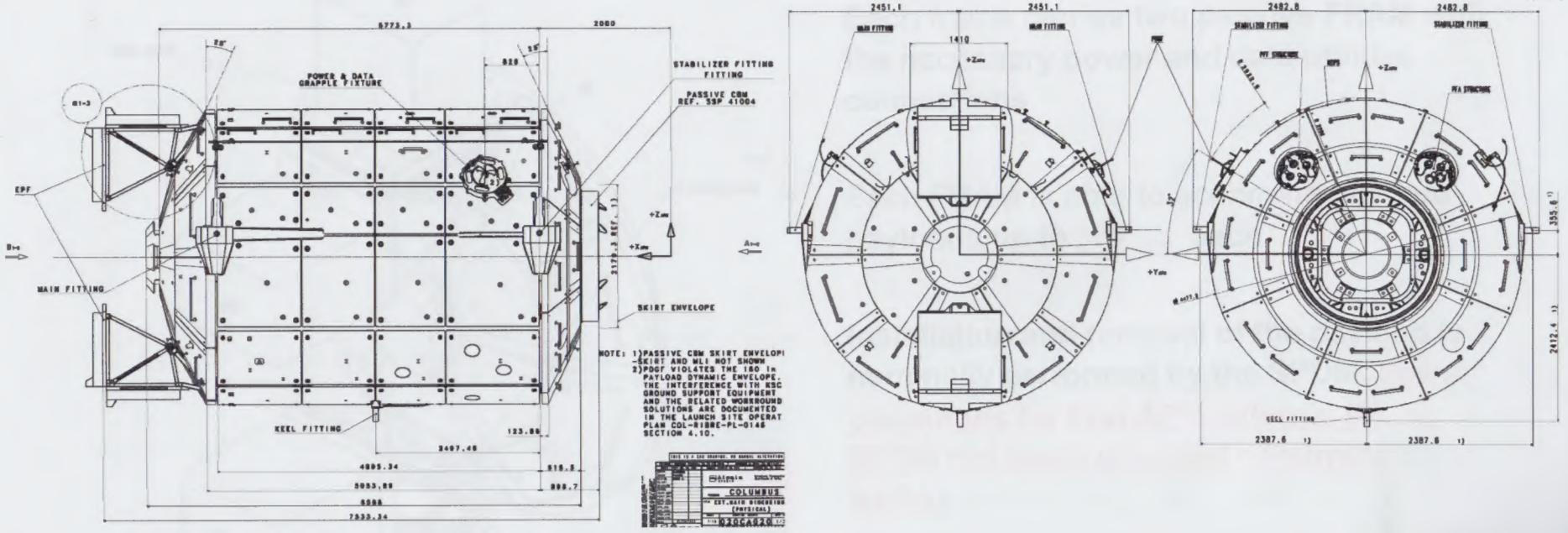
Standard Utility Panel (SUP)

Extended Utility Panel (XUP) /

Interstation LAN I/F (ISL)Panel

Connector	ALLOCATIONS
J01	120 VDC, ISS C&C Bus (SUP2: Bus1, SUP3: Bus2) or CHECS Bus (at SUP 1&4)
J02	120 VDC, US P/L Bus (at SUP 2&3 only)
J03	120 VDC, US P/L LAN-2 (SUP1 & SUP4); US OPS LAN (SUP2)
J04 Data 1	APM P/L Bus (at SUP 1&4 only)
J05 Data 2	APM LAN_N
J06 Data 3	Video (FO) (at SUP 1&4 only)
J07 Data 4	P/L Fire/Smoke/EWACS (at SUP 1&4 only)
J08 Data 5	Video (analog electrical signal and DC supply) (at SUP 1&4 only)
J09 Data 6	APM LAN_R
J11 (XUP)	Digital Electrical Video and DC supply (Harness Provision for Video Mk2)
J12 (XUP)	Digital Electrical Video (Harness Provision for Video Mk2)
J21 (ISL)	APM LAN
J22 (ISL)	APM LAN

APM External Dimensions



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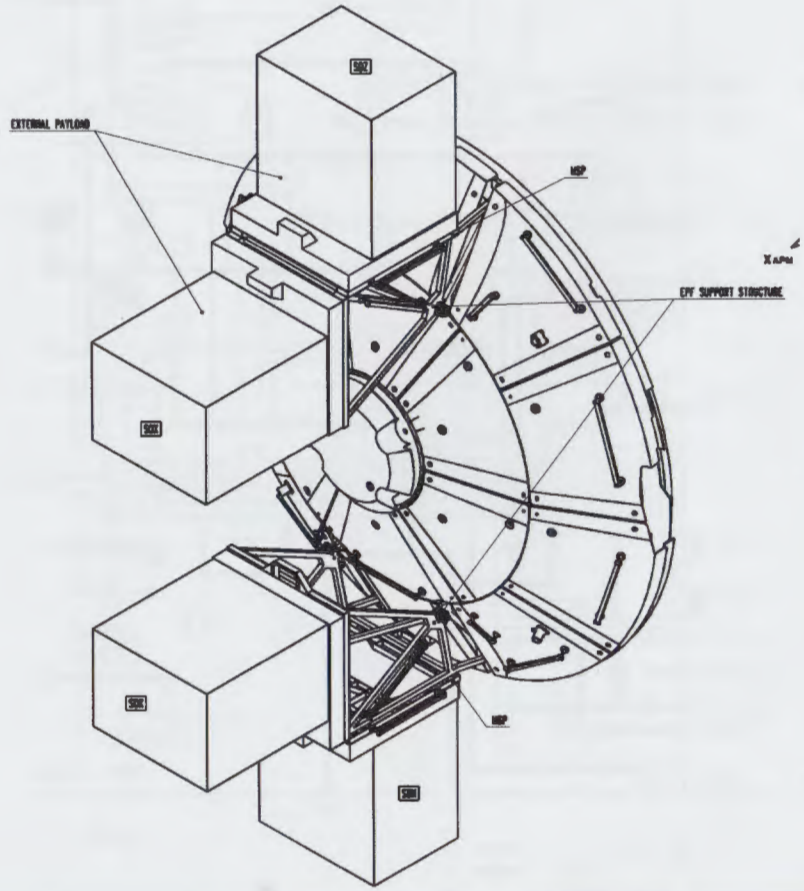
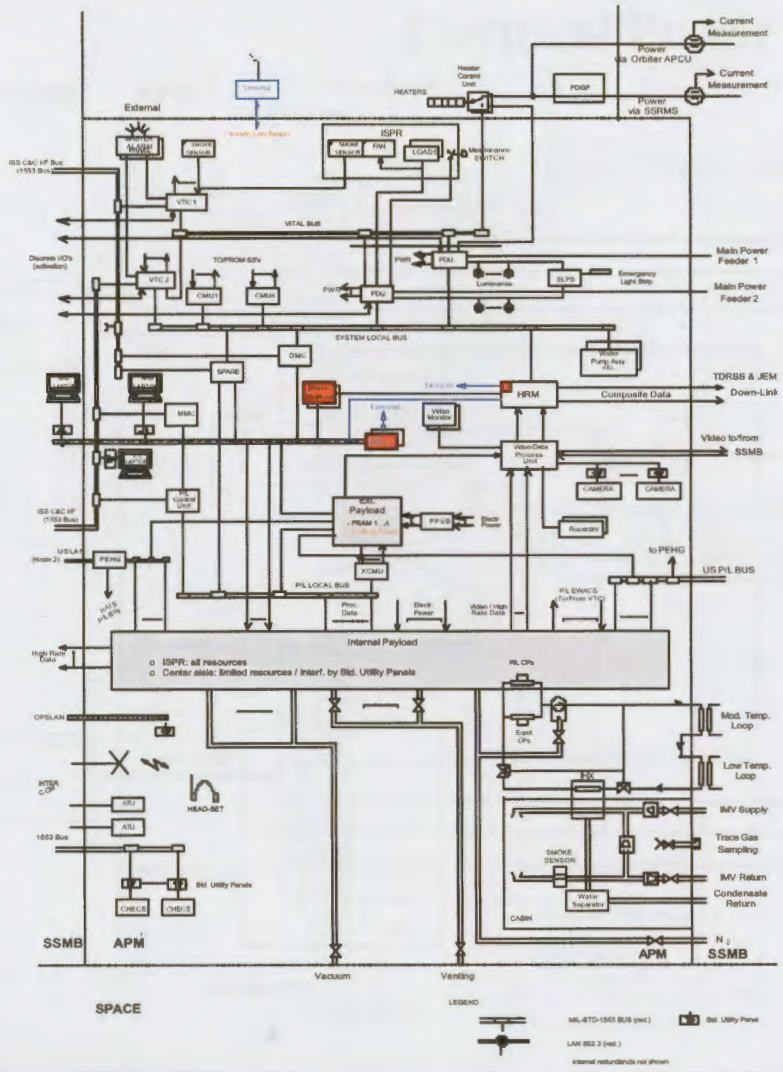
External P/L Facility (EPF)



- EPF composed of two separate frames hinged on the starboard cone/cylinder ring for access to MDPS / structure
- Each frame carries two passive FRAM with the necessary power and data utilities connections
- Each FRAM is able to accommodate two payloads up to 370 kg each
- Installation and removal of the payload is nominally performed by the SPDM, manual operations for first APM external P/L as SPDM not ready (concept confirmed by NASA)
- ICD controlled interfaces on stbd cone for both the SPDM (H-Fixtures) and EVA crew (WIF) operations



Functional Architecture

-Electrical Power Distribution

-Vital Data Management System: EMERGENCY, WARNING an CAUTION visual annunciation and SAFING

-Nominal Data Management System:APM System management (incl. FDIR) - LAN Switch / Solid State MMU

-Video / High Data Rate Acquisition and Distribution -- Provisons for Digital, Electrical Video System

-Voice Communication (incl. EMERGENCY & WARNING aural annunciation

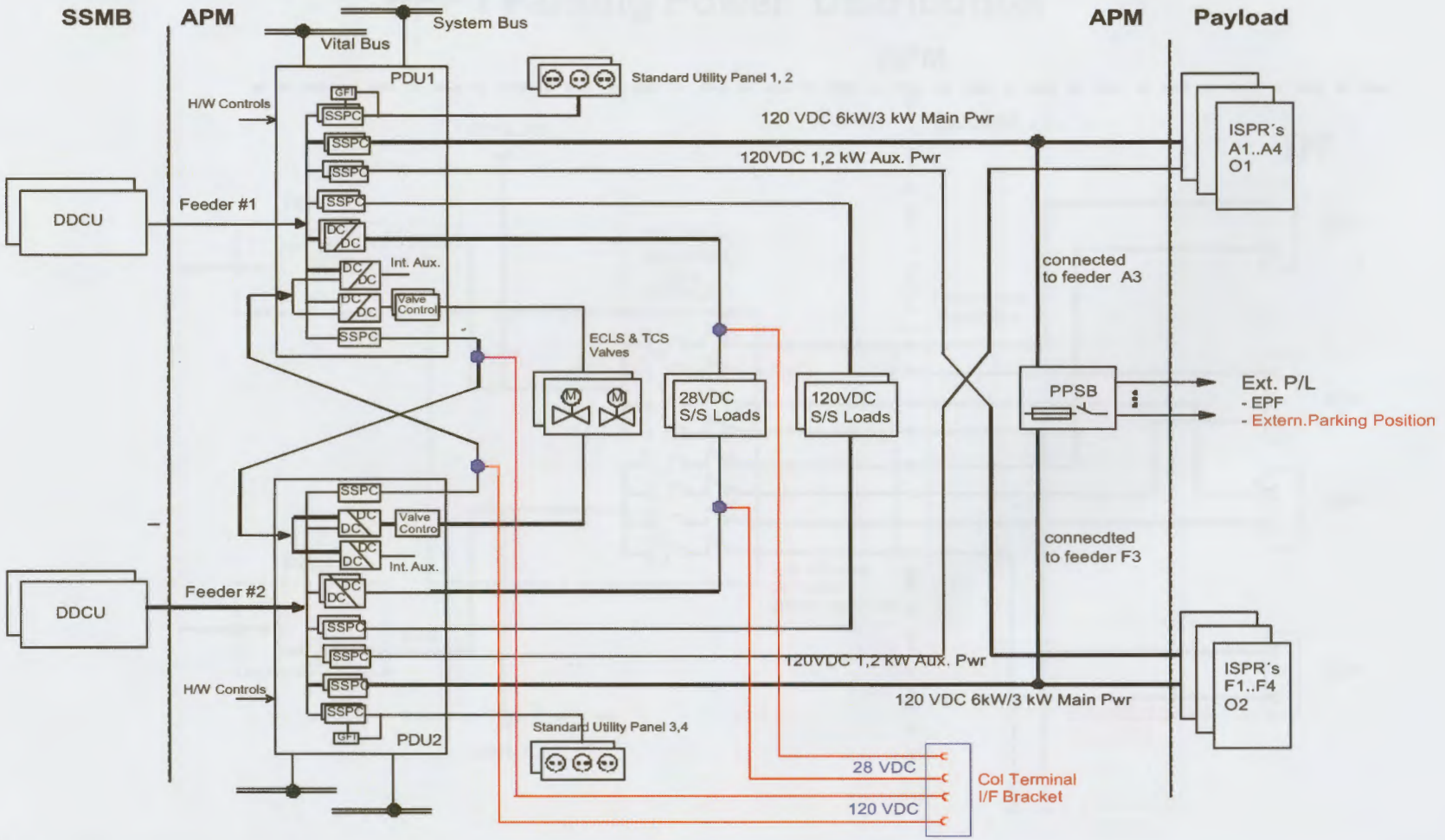
-Illumination

-Environmental Control / Life Support System

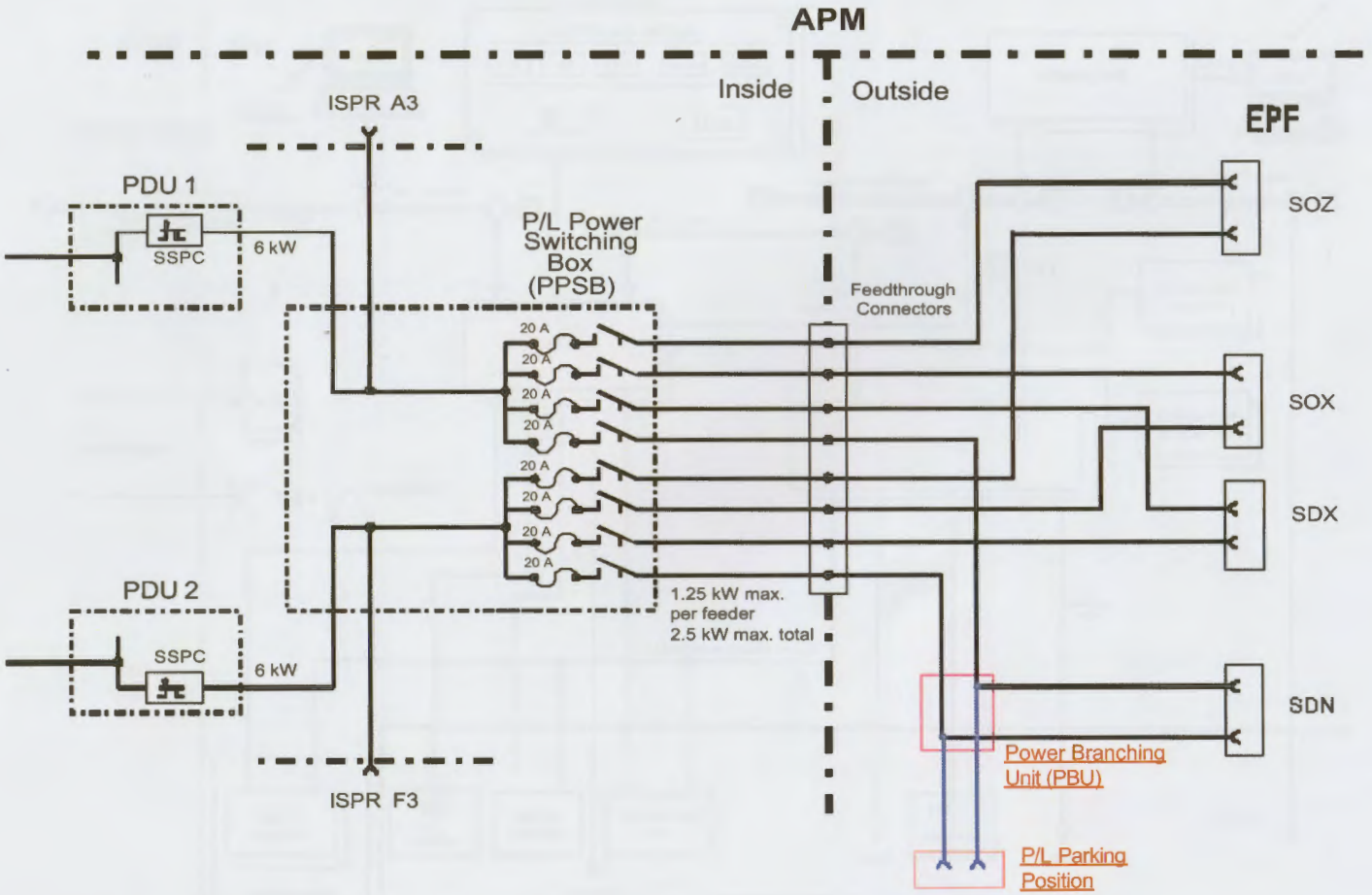
-Active Cooling System (internal: water loop, external: heaters)

EADS SPACE TRANSPORTATION

Electrical Power Distribution



EPF / Parking Power Distribution



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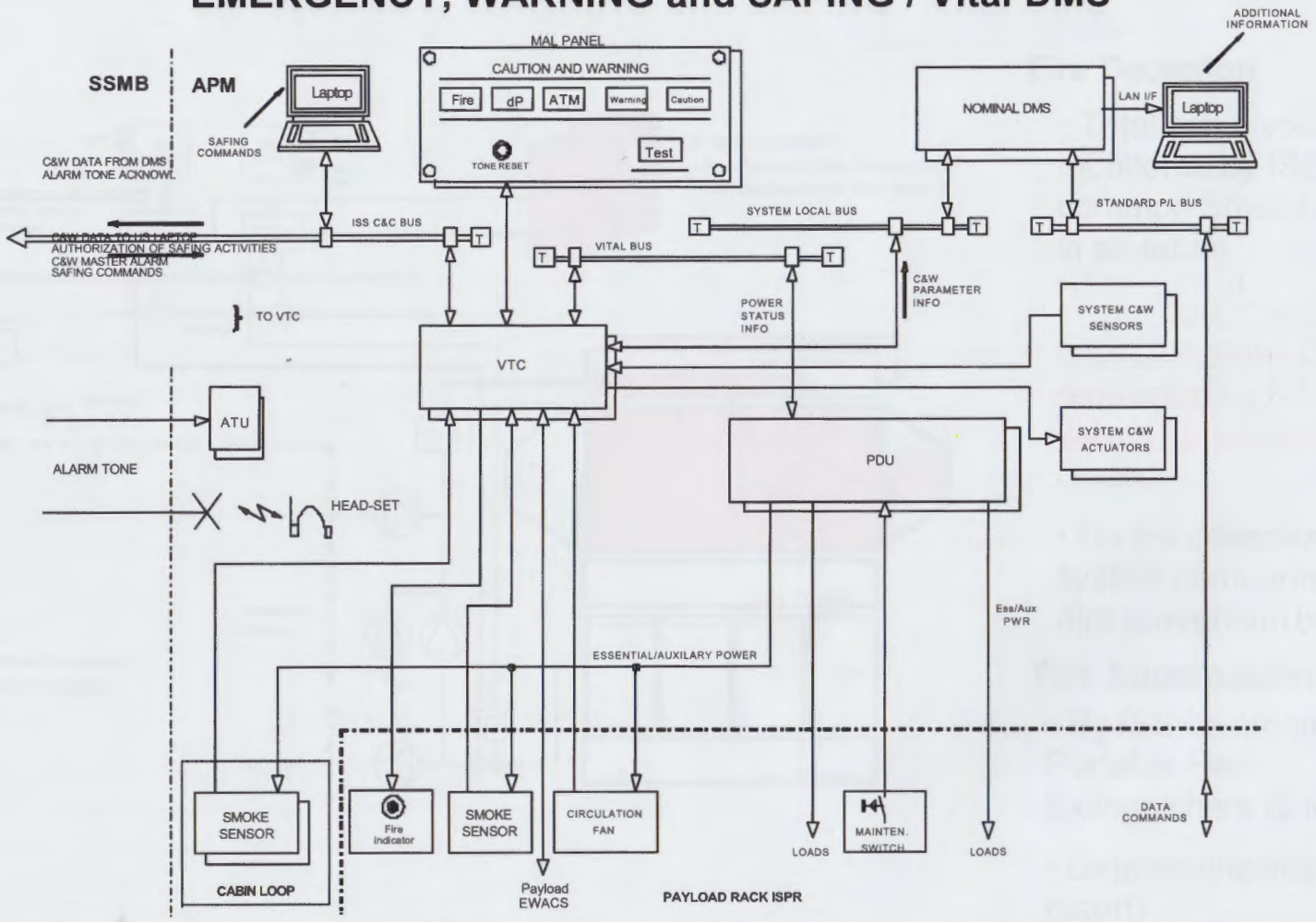
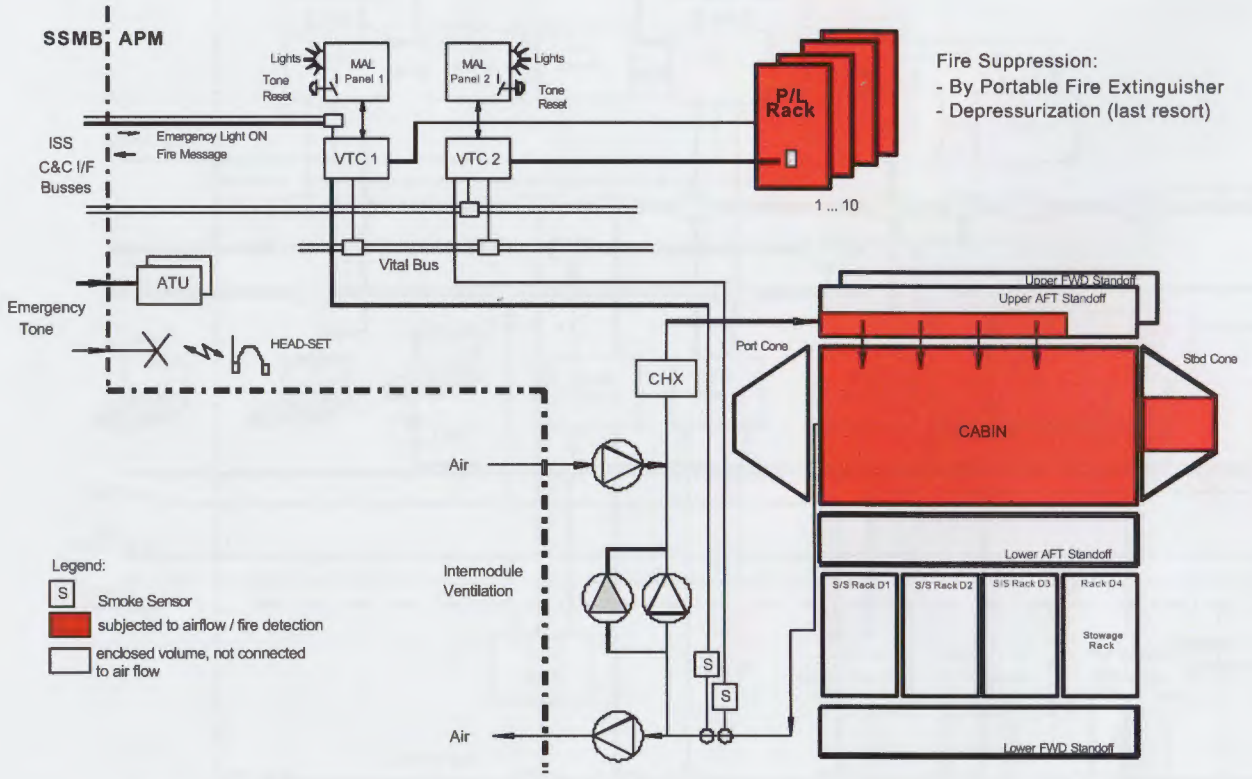
EMERGENCY, WARNING and SAFING / Vital DMS



EMERGENCY, WARNING and SAFING / Vital DMS



Fire Detection

- Total cabin volume monitored by ISS common Smoke Sensor in air return
- After confirmed fire cabin fan stays ON as requested by NASA / IMV valves automatically closed
- No fire detection in other system compartments (fire prevention by FDIR)

Fire Suppression

- By ISS common Portable Fire Extinguishers (2 in APM)
- Depressurization (last resort)

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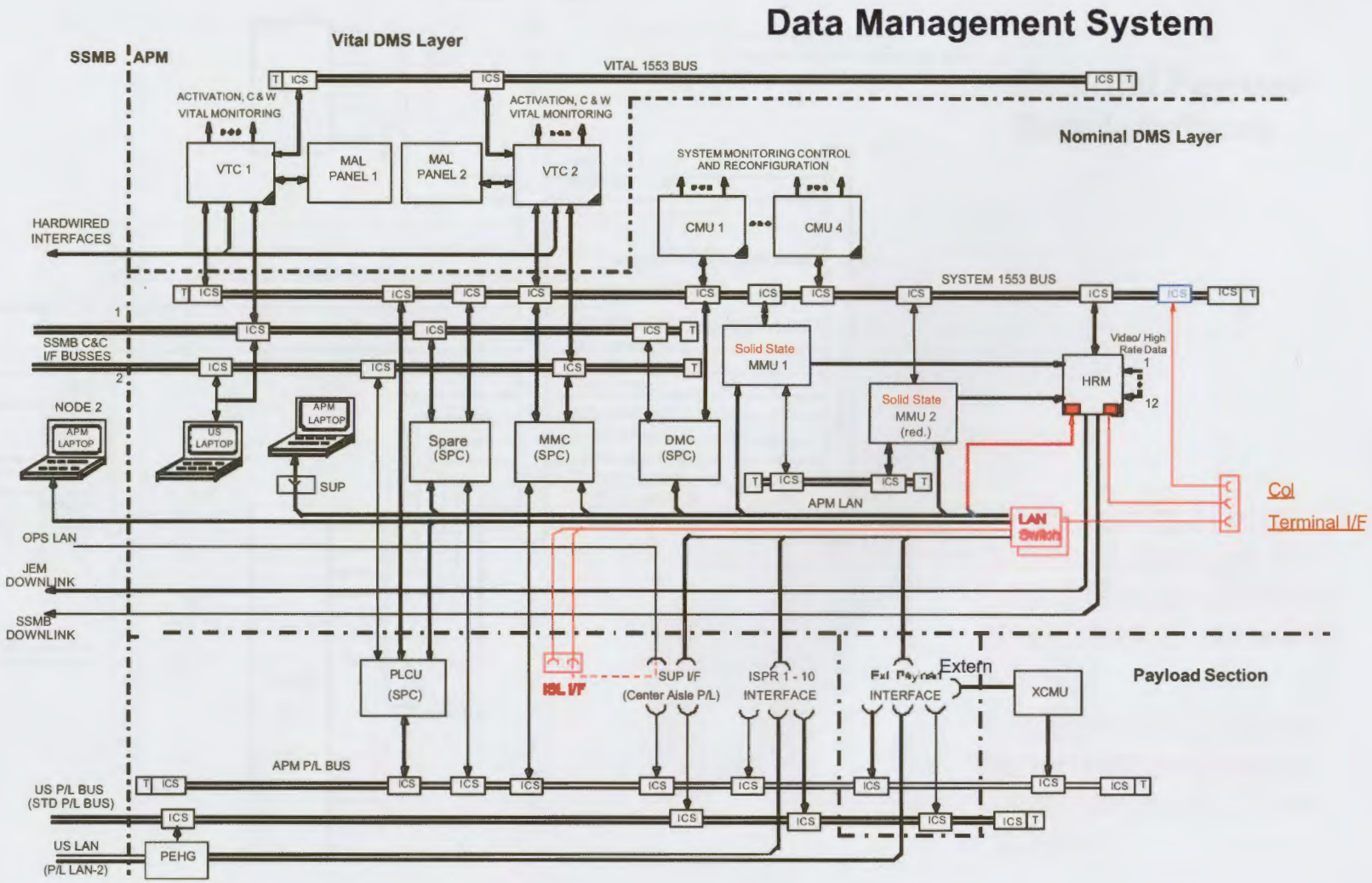

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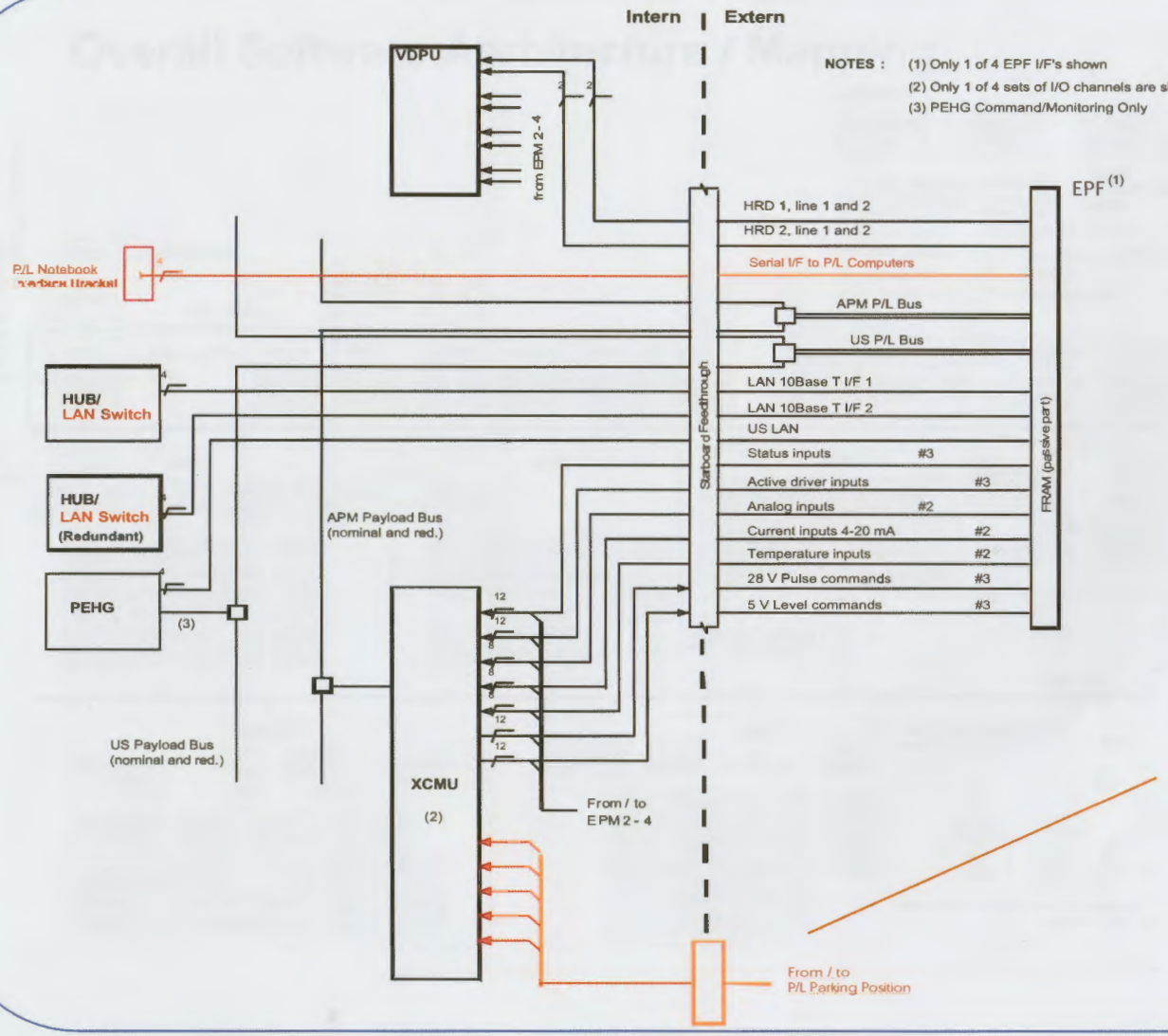
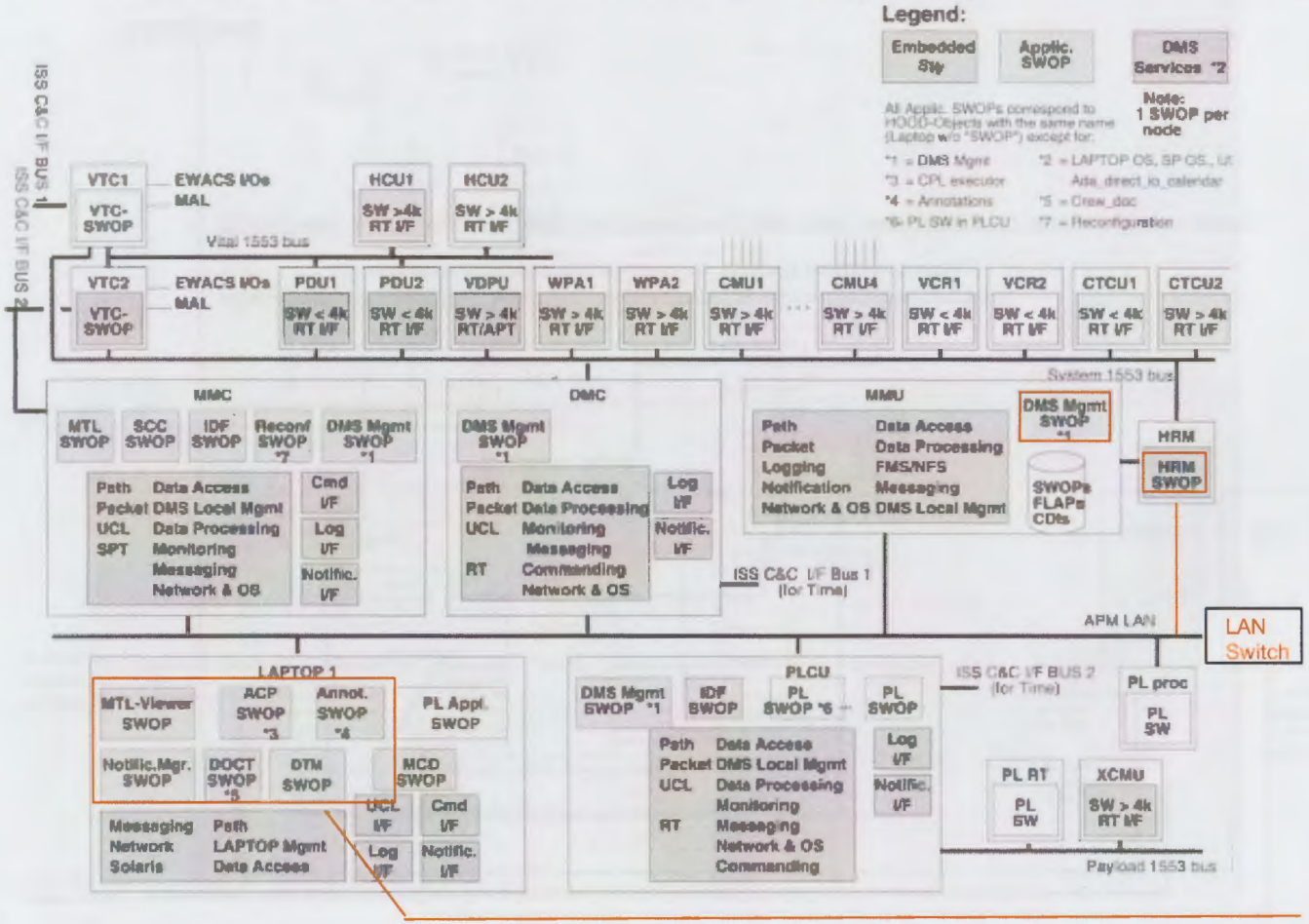


External Payload Data Interfaces

- Addition of monitoring / command interfaces to Payload Parking Position not yet required by CSRD 4/B
- Implementation already started (not yet covered coherently in QR 2 Data Package)

Overall Software Architecture / Mapping



- File Transfer between MMU and Portable Work Stations
- Down-linking of multiple files; events generated on-board send to ground
- LAN traffic in separate domains (on-orbit reconfigurable); two virtual channels
- LAPAP changes as requested by Astronauts (further modifications in LAPAP mark II)

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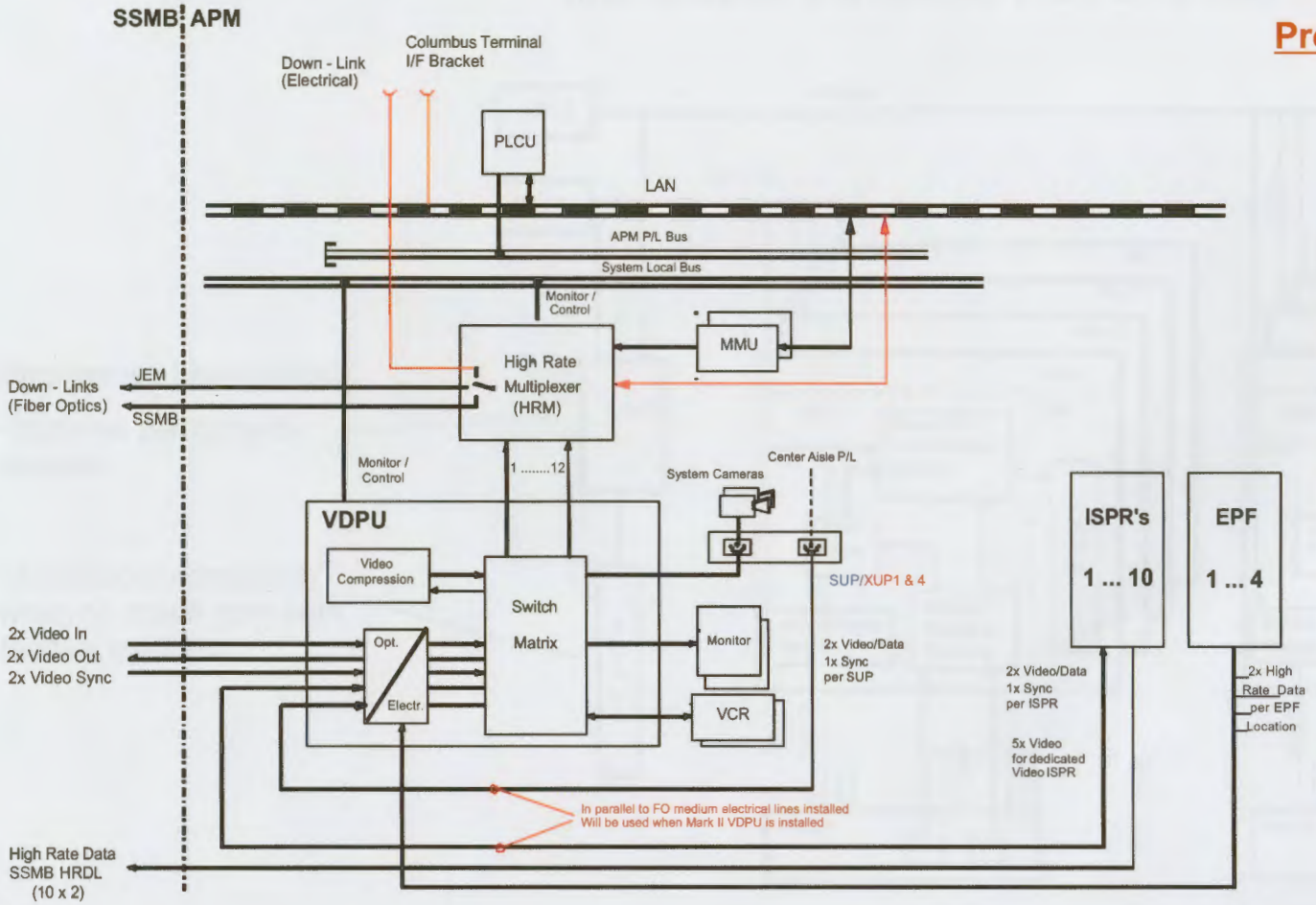
Video / High Data Rate Acquisition and Distribution



Provisions for COL Terminal

- Additional HRM output to COL Terminal
- Direct LAN Interfaces for increased data transfer rates

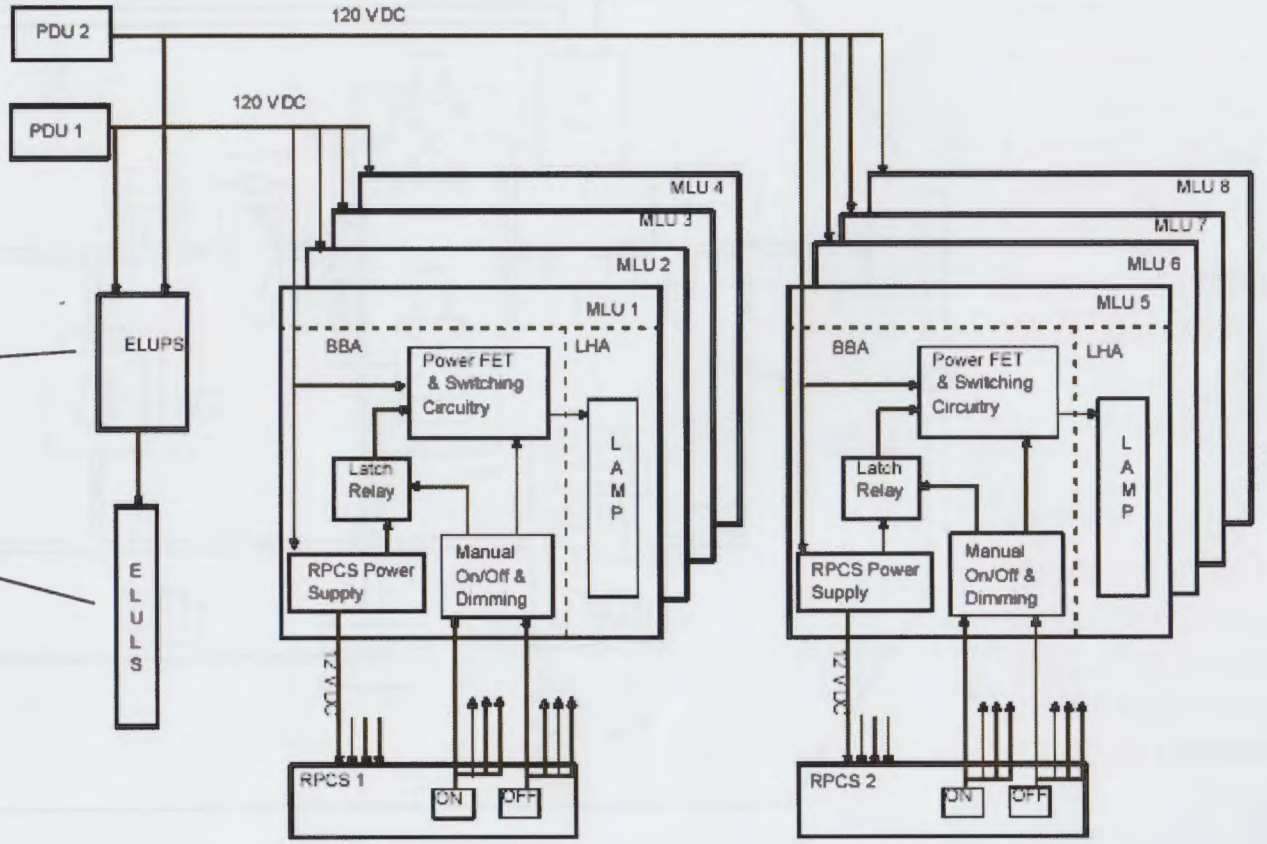
Video System Mark II

- Present VDPU will be replaced on-orbit by VPDU Mark II (Identical unit interfaces)
- Commercial, digital Video Standard
- Downward compatibility by Payload Adapter Kits (PAK) converting P/L FO Interfaces to electrical, digital signals as necessary

Illumination (All hardware ISS common)

Emergency Illumination :

- Batteries permanently charged
- Activated automatically when no power from both feeders available



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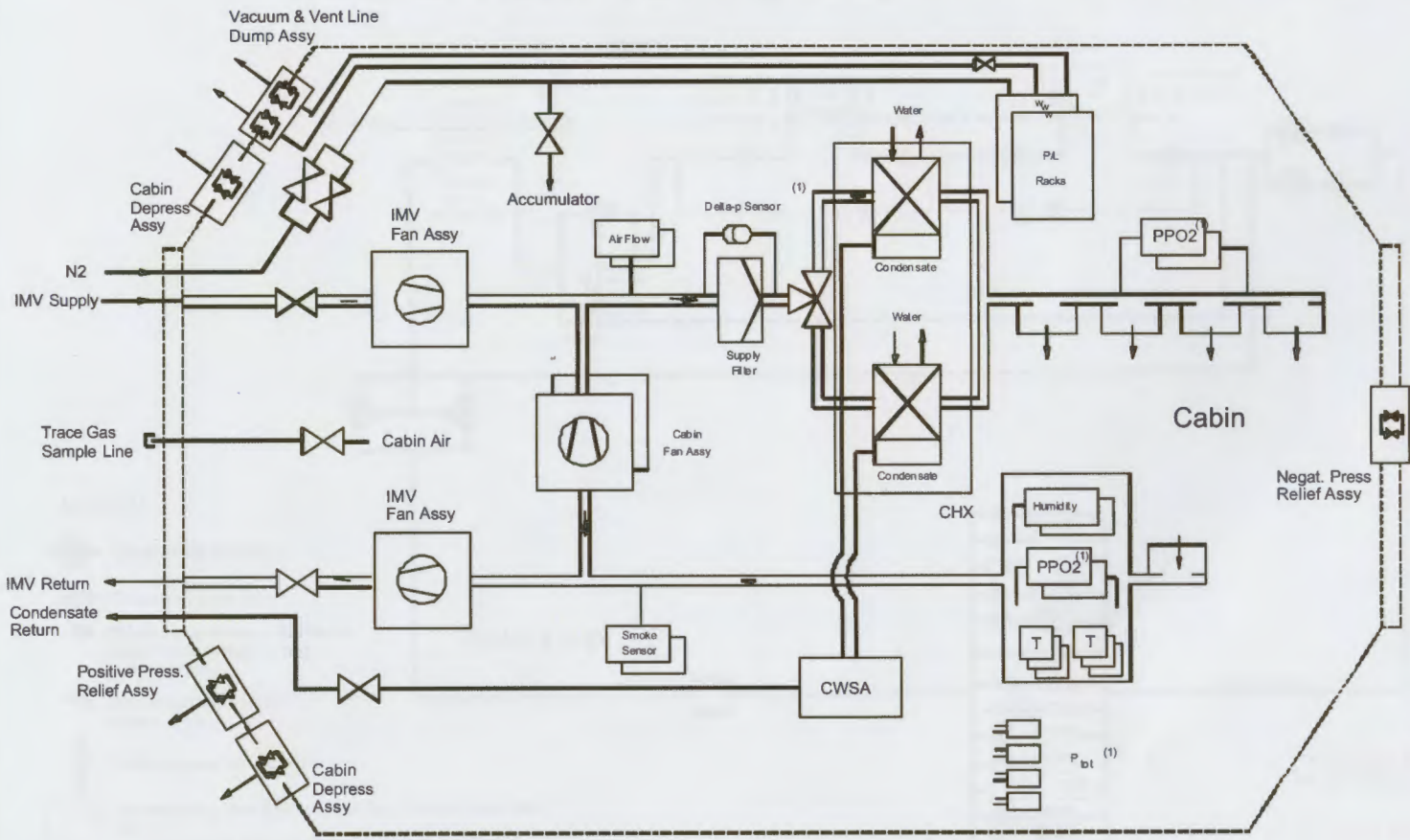
Environmental Control / Life Support System



Note: (1) C & W sensors

- For new monitoring/ command interfaces for external P/L Parking Position additional feedtrough-connectors needed on STBD cone
- NPRV will be relocated in IMV duct / removed on-orbit after berthing (same concept as for other modules)

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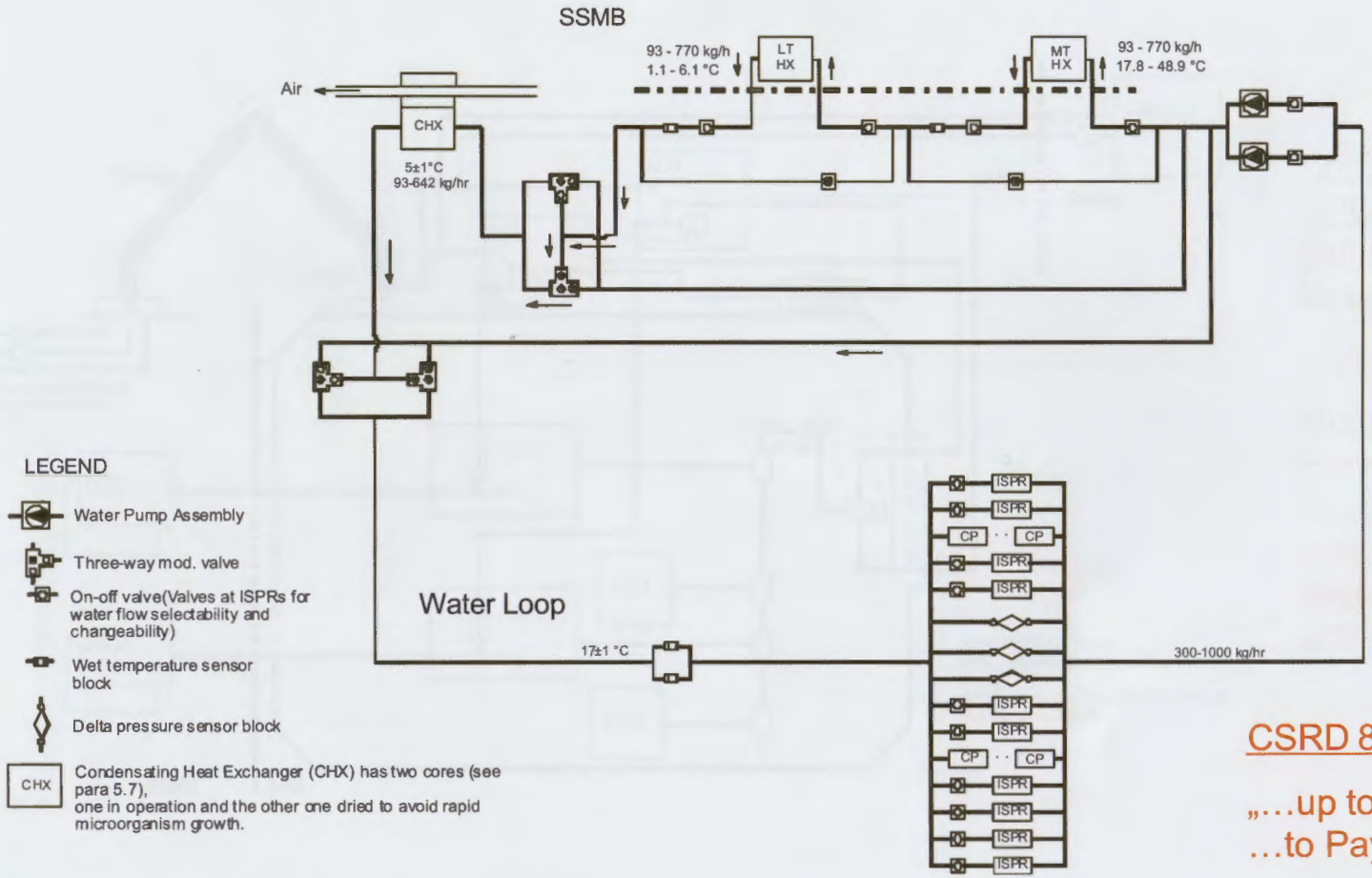
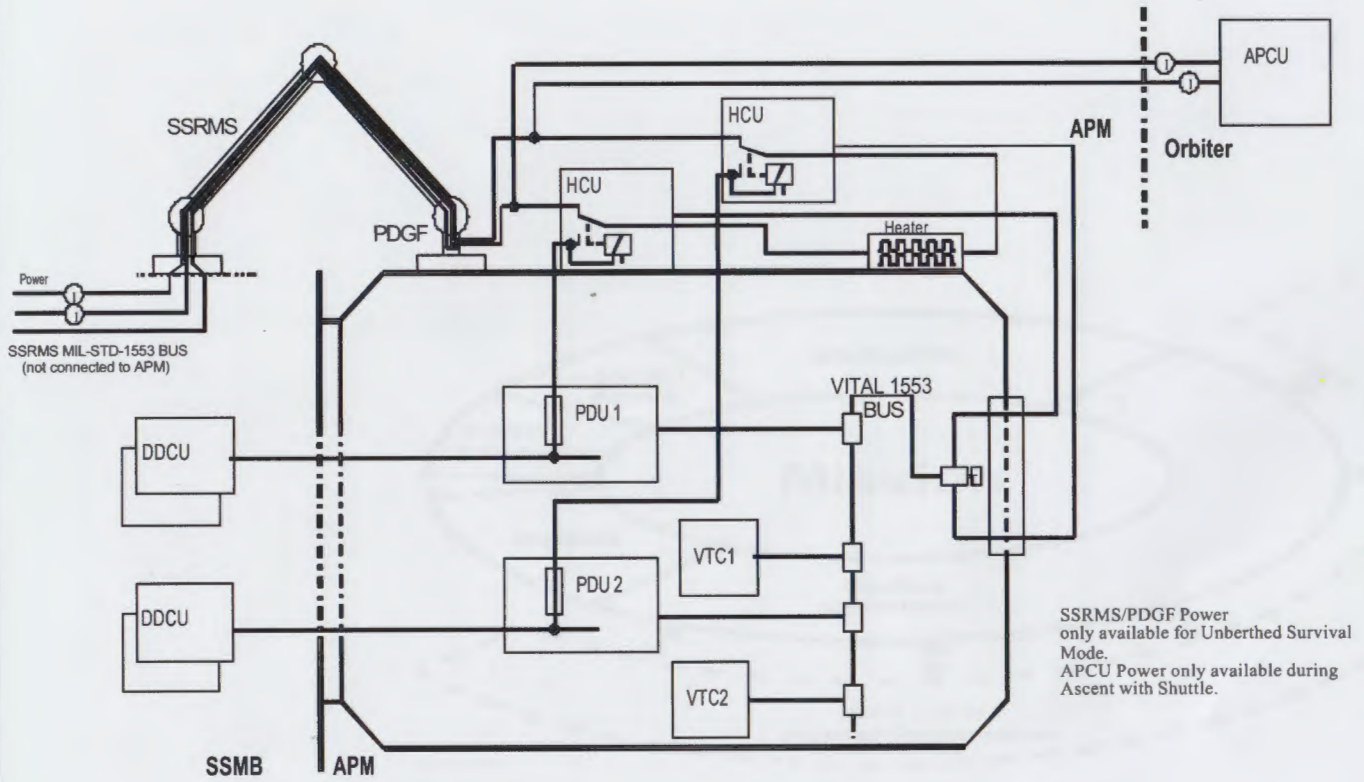
Internal Water Cooling Loop



CSRD 8.2.6.6(new):

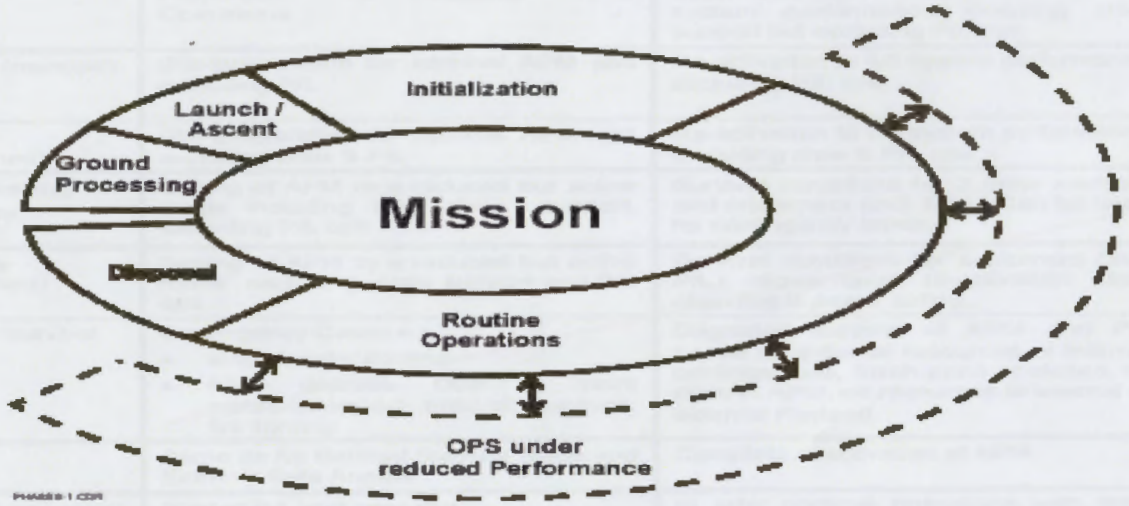
„…up to 750 kg/hr flow rate
…to Payload Complement"

External Active Temperature Control



- In Shuttle ICD agreed that APCU Feeders have two independent switching layers
- As required by Safety Panel Operational Procedure to ensure that connection to APCU is removed before SSRMS grapples PDGF

Main Mission Phases



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Mission Phases	Modes	Start Event	Qualitative Description
Ground Proc.	Passive	APM transport configuration at the AIV site	Transport of the APM to and preparation for launch at the launch site
Launch/Ascent	Passive	NSTS Orbiter lift off	Transport of APM by NSTS Orbiter to the transfer orbit
	Unberthed Survival	Orbiter cargo bay doors open and power to APM heating system	Transport of APM by NSTS Orbiter to the ISS
Initialization	Unberthed Survival	Grapple by SSRMS and switch on of SSRMS power to APM	Minimum survival mode of APM by provision of power via SSRMS to APM for thermal conditioning only.
	Berthed Survival	Connect utilities, availability of power for essential CMD & Contr. functions.	Survival mode of APM based on external resources from ISS.
	Support	Preparation for nominal APM Operations	Initial activation from survival to full system performance including crew support but excluding P/L ops.
Operations under Reduced Performance	Support (manned)	(Re-)preparation for nominal APM ops excluding P/L	Re-activation to full system performance excluding P/L ops.
	Support (unmanned)	(Re-)preparation for nominal APM ops excluding crew & P/L	Re-activation to full system performance excluding crew & P/L ops.
	Housekeeping (Stand-by, manned)	Setting of APM to a reduced but active mode including min. crew support excluding P/L ops	Survival conditions for 2 crew member and equipment (incl. P/L). Can be used for contingency repair.
	Stand-by (unmanned)	Setting of APM to a reduced but active mode excluding crew support and P/L ops	Survival conditions for equipment (incl. P/L); allows quick re-activation. Main objective is power saving.
	Berthed Survival	Contingency Cases e.g.: • stop of water cooling • APM depress. Due to micro meteorite impact, toxic atmosphere, fire fighting	Degraded survival of APM and P/L based on external resources or internal contingencies, hatch open or closed, no crew in APM, no resources to internal or external Payload.
	Passive	Same as for Berthed Survival Mode and Extreme Beta Angles.	Complete deactivation of APM.
Routine Ops	Nominal (manned)	Start of P/L and crew ops.	In orbit nominal operations with crew including maintenance and servicing
	Nominal (unmanned)	Start of P/L ops	In orbit nominal autonomous operations.
Disposal	Passive	End-of-Life	Destructive reentry

Berthed Suvival Mode also used during Solar Flare

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Summary

- All technical descriptions / data (system level) are provided in the QR 2 Data Package Volume 2

- Technical desriptions / data (product level) are available at Astrium for review