



**Mid InfraRed
Instrument**

**Optical System
Critical Design Review (CDR)
Flight Software Summary**

**Presented by:
Mori Khorrami, JPL**

Logo

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- **The MIRI FSW presentation covers**
 - Optical System FSW only and Cooling System FSW is covered at its CDR
 - An overview
 - Requirements & Interfaces
 - Relationship with the ISIM FSW
 - FSW Design Drivers & Solutions
 - Resource Allocations & Reserves
 - Development Environment & Status
 - Verification & Delivery Plans
 - Documentation & Summary
 - Need to explain how common elements will be covered?



08-2

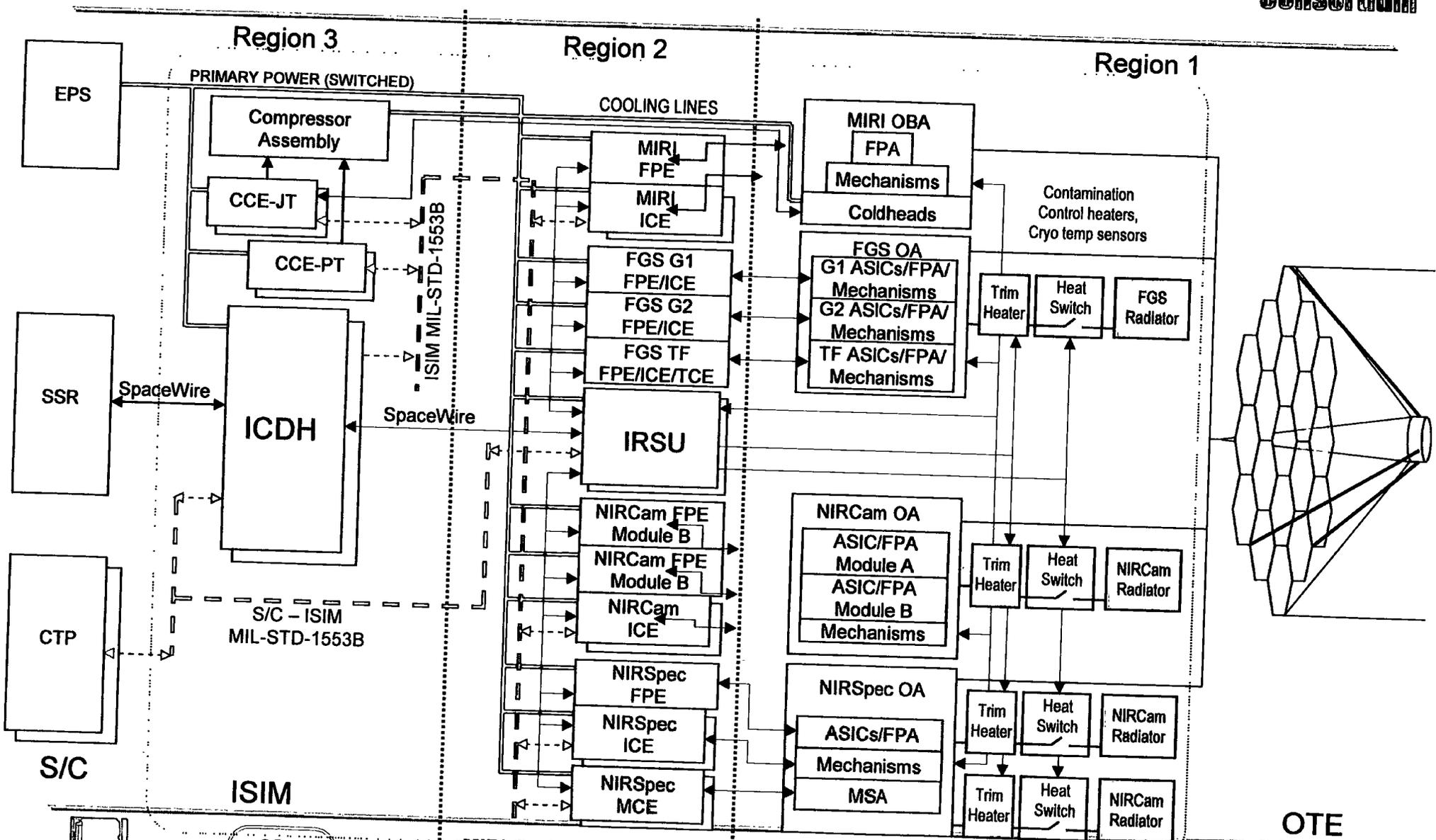
- **Some Key Features of MIRI FSW**

- Accept Commands from ISIM & Activity Description and Process them when Verified & Validated
- Configure Focal Plane Electronics
- Control Mechanisms
- Heater and Temperature Control
- Provide Housekeeping Telemetry Packets
- Provide Command Completion Packets to Activity Description
- Monitor Health & Safety parameters
- Fault Management
- Interface with Bus Drivers (Spacewire & MIL-STD-1553B)



ISIM Reference Architecture

MIRI European Consortium



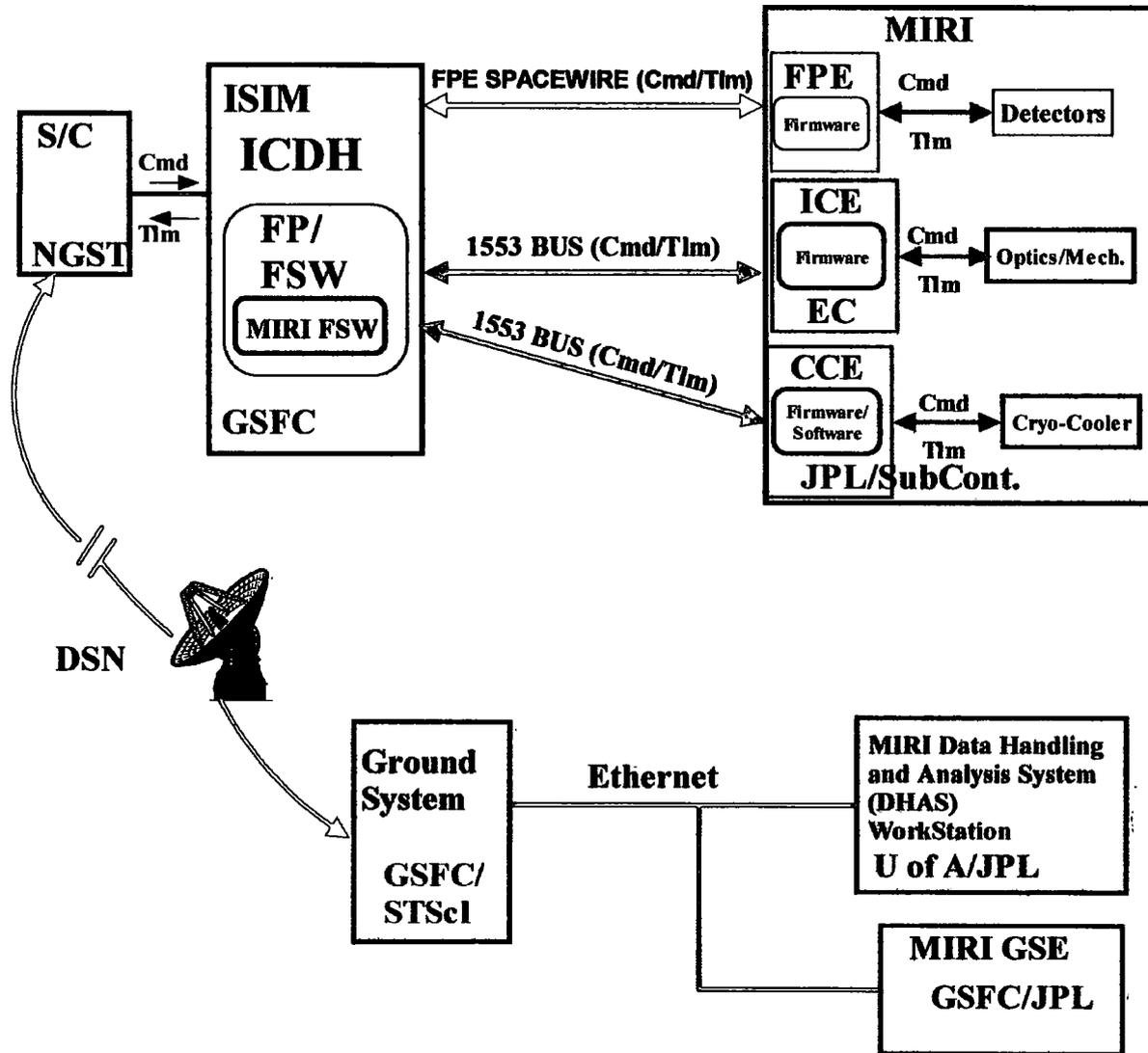
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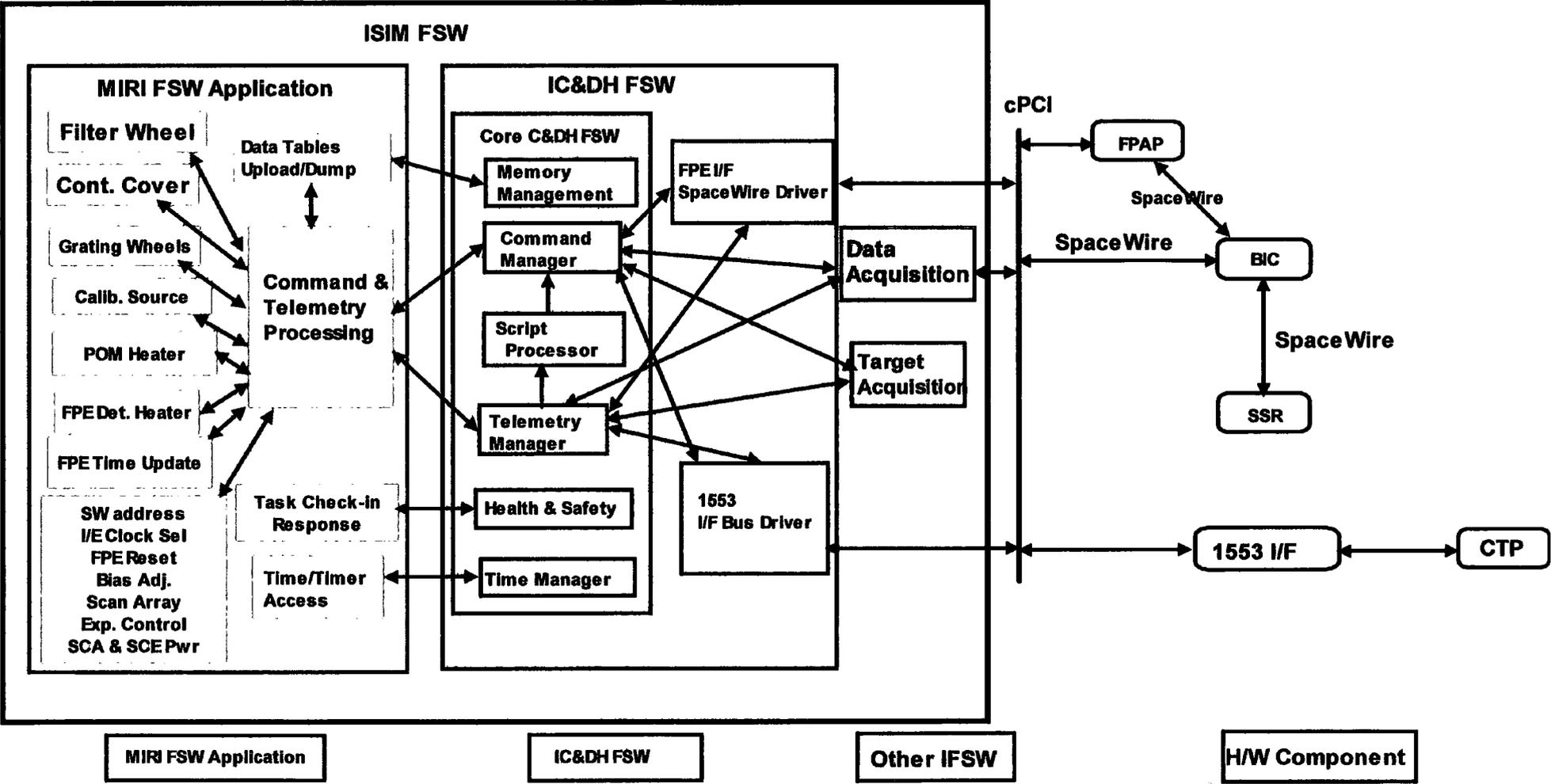
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MIRI FSW Concept



MIRI FSW System I/F Architecture



Some FSW Key Requirements & Interfaces

REQID	Para.	Title	Requirement	Units	Performance	Basis	Comment
SRD-2, IRD:IMU -1381	3.2.2	Command Interface & Processing	The MIRI FSW shall interface to ICDH using the ISIM application architecture, message structures and protocols as defined.	N/A	Comply	Design	MFSW complies with ISIM Flight Software requirements. MIRI FSW Uses ISIM architecture and message structure for communication.
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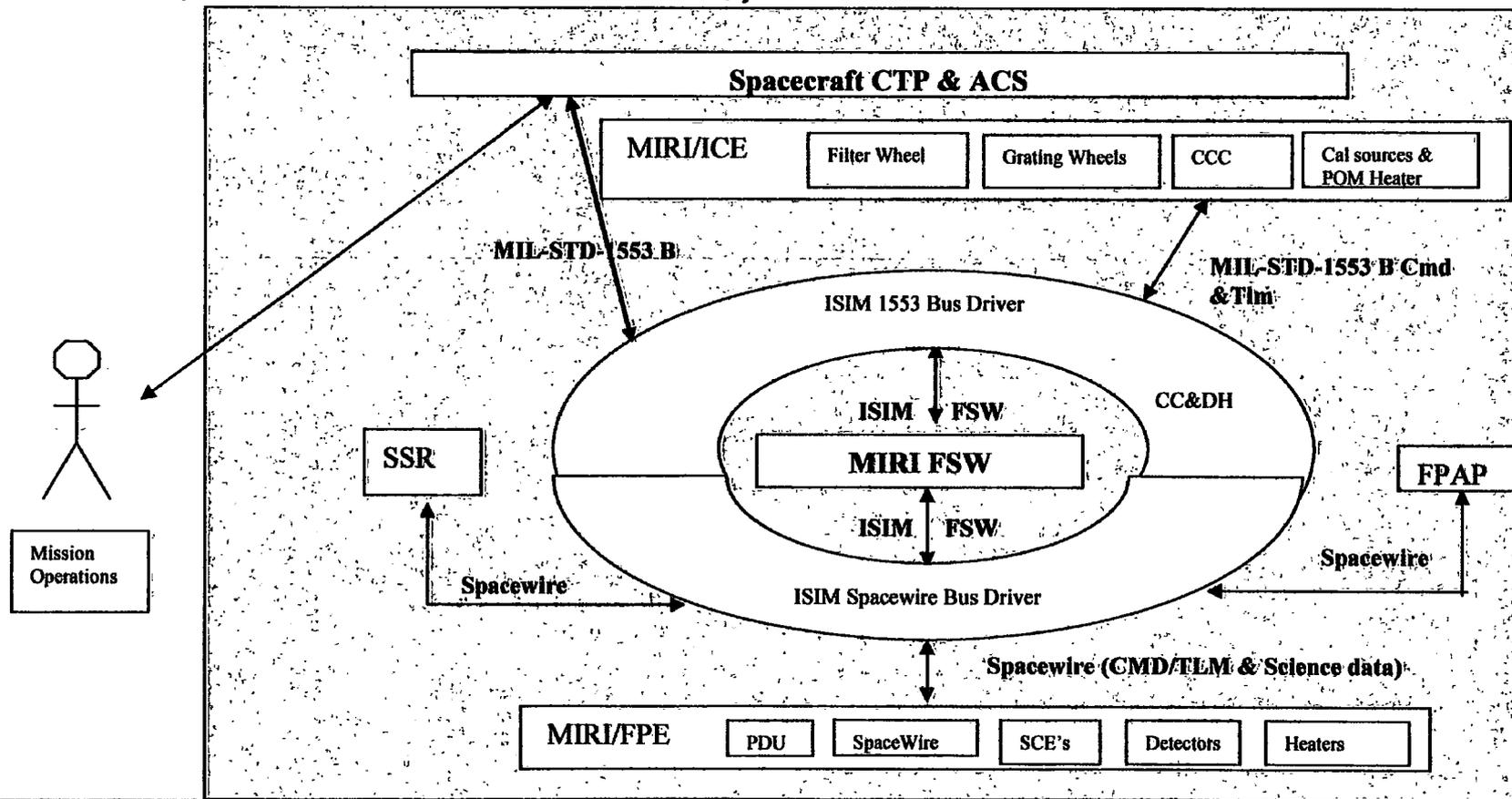
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- **MIRI FSW meets and complies with all of its requirements**

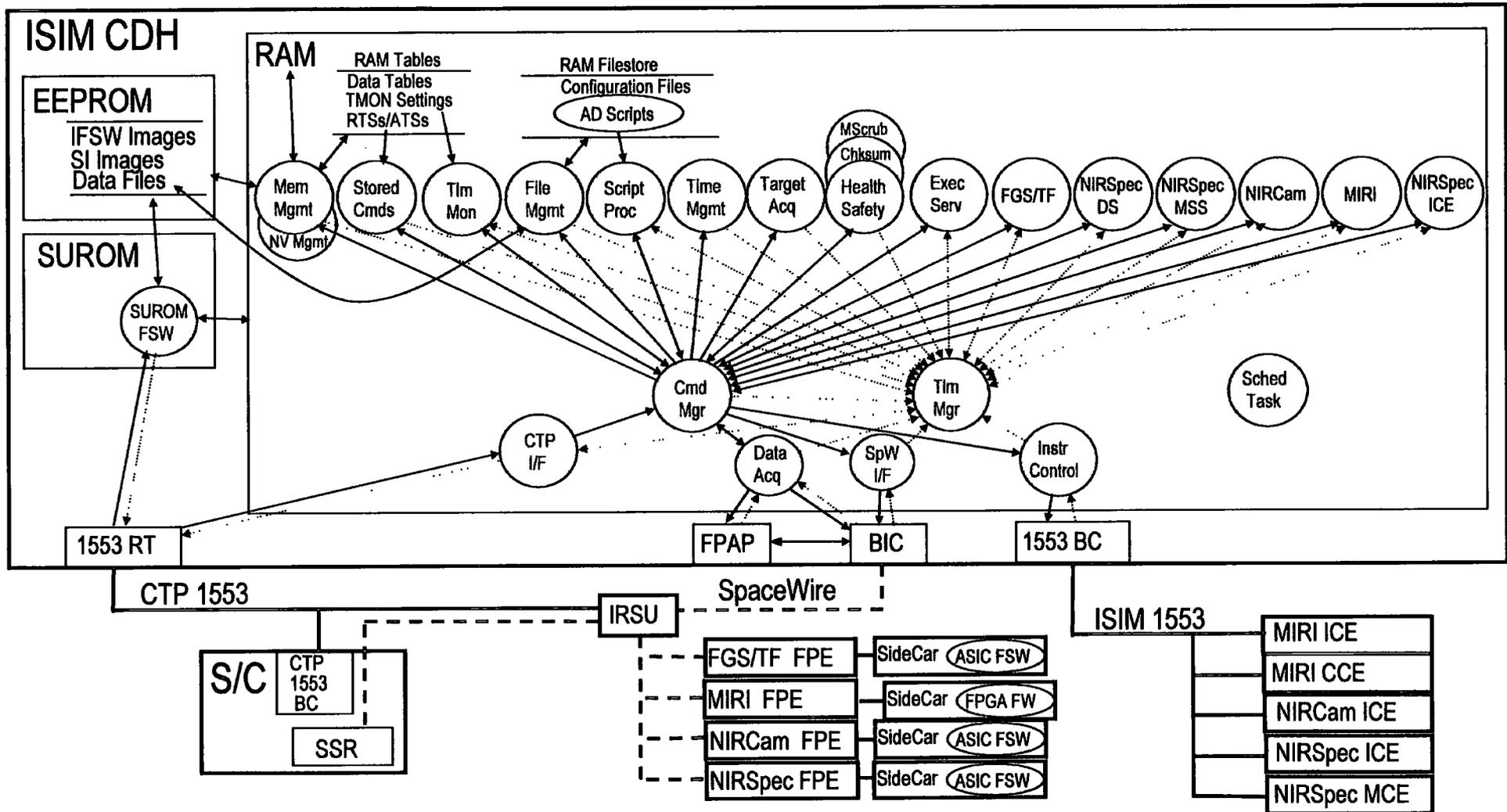


MIRI FSW Within ISIM Command & Data Handling

- Not the usual Architecture and Implementation
- Single Processor Used for all Payload SIs (No dedicated Flight Processor for MIRI, No direct access to RTOS)



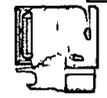
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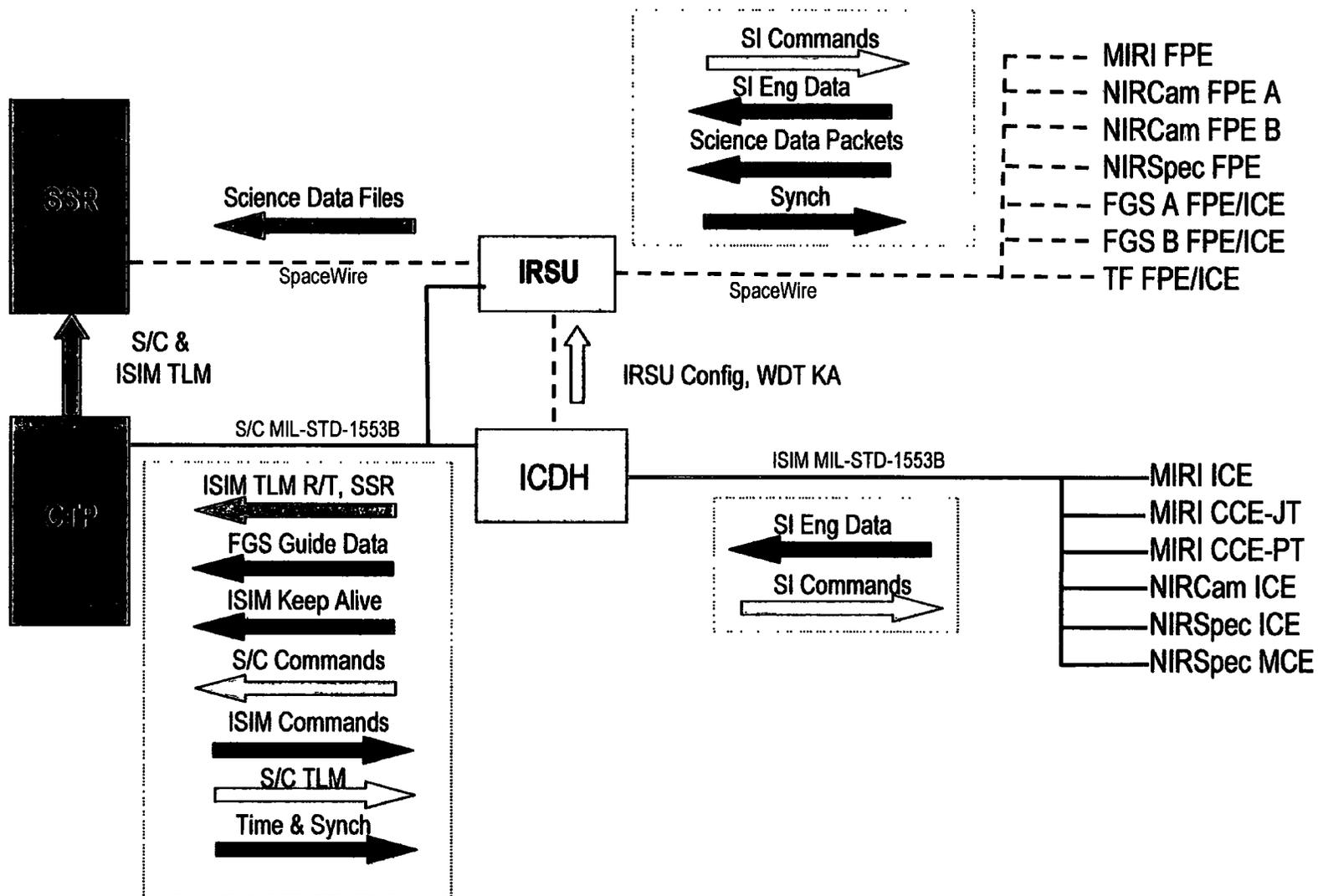
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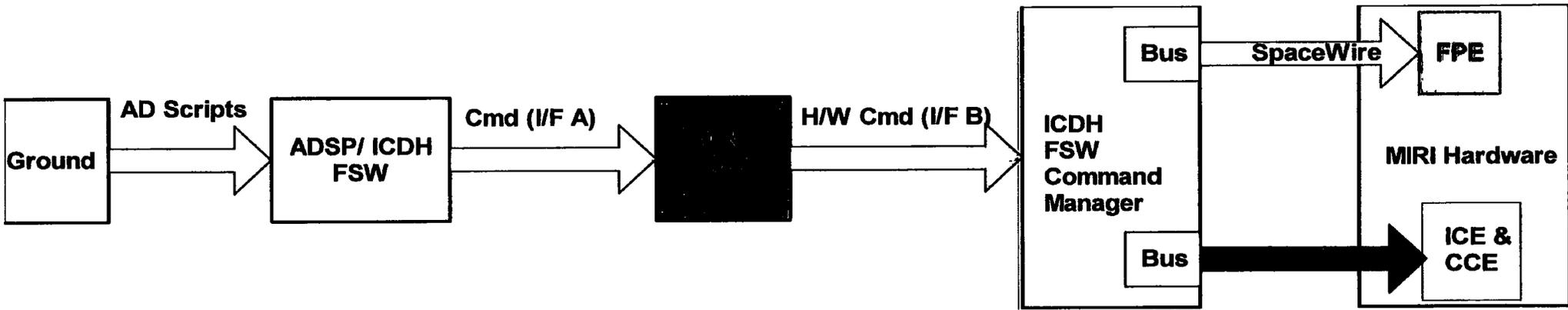
ASIC FSW



Command & Data Flow at ISIM level



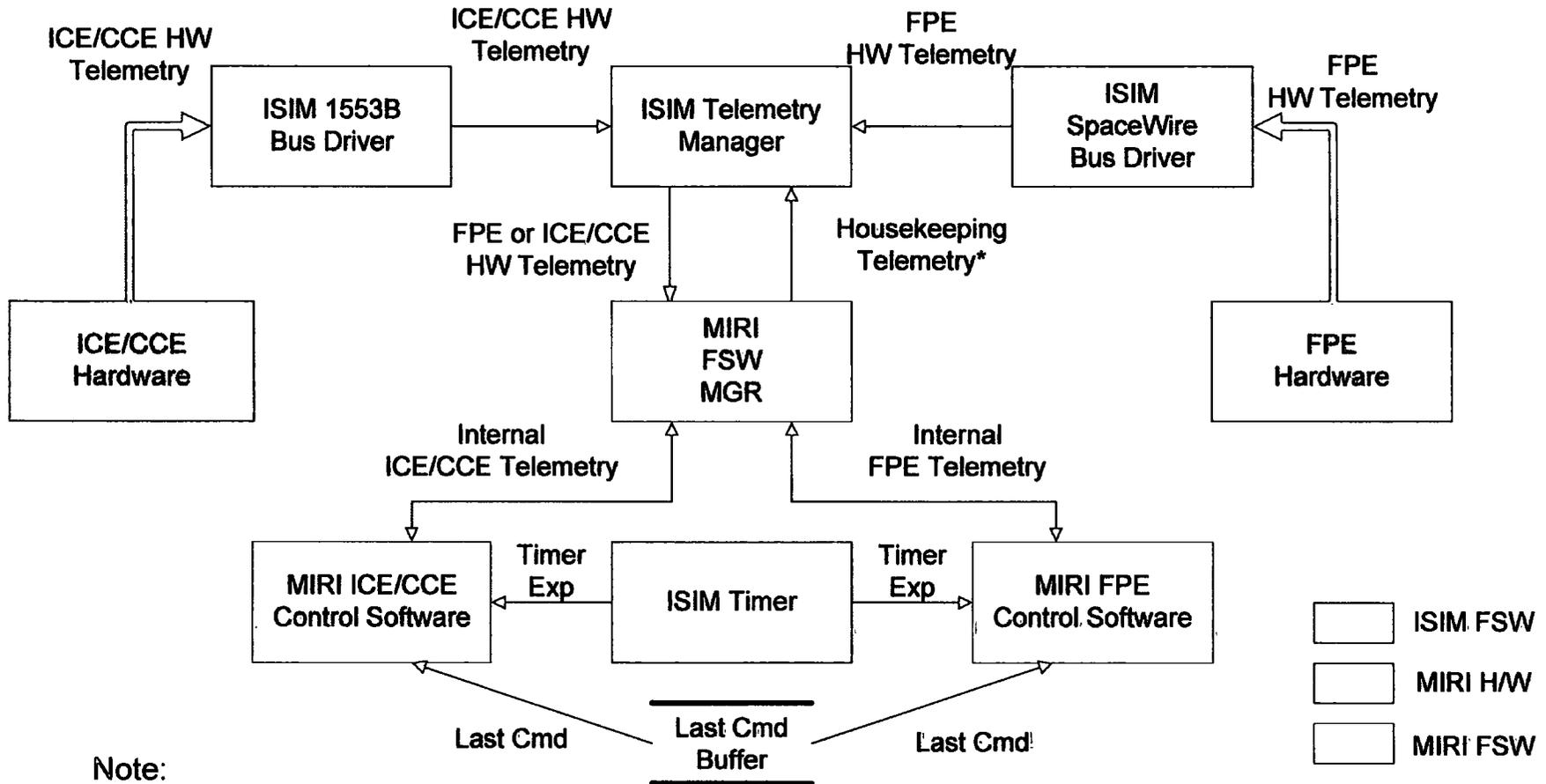
MIRI Command Flow



- AD** Activity Description
- ADSP** Activity Description Script Processor
- Cmd** Command
- ICE/CCE** Instrument/Cooler Control Electronics
- FPE** Focal Plane Electronics
- FSW** Flight Software
- ICDH** ISIM Command & Data Handling
- I/F A** Interface A commands (e.g., Move filter wheel to Pos X)



MIRI FSW Telemetry Flow



Note:

1. All telemetry packets exchanged between ISIM FSW and MIRI FSW are in CCSDS format
 2. MIRI FSW has no requirements to collect science data
 3. MIRI Housekeeping Telemetry will include FSW, FPE, ICE and CCE Configuration Data
- * Instrument Housekeeping Packet (MIRI FSW generates)



FSW Design Drivers & Solution (TBD)

**MIRI European
Consortium**

- **Summarise key design drivers**
- **Summarise solution adopted and very briefly why**



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FSW Resource Allocation & Reserves

- MIRI meets ISIM C&DH allocation with large margin**

DATA BUS	BANDWIDTH ALLOCATION	PREDICTED (Peak)	MARGIN
1553B Command (ICE)	512 words/sec (8192 bps)	32 words/sec (512 bps) 512 words/sec 8192 bps	75% (See Note 1)
1553B Telemetry (ICE)	768 words/sec (12288 bps)	352 words/Sec (5632 bps)	54%
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SpaceWire Science (FPE)	66 Mbps ⁽²⁾	40.96 Mbps ⁽³⁾	>38%
<p>1) ISIM has agreed to support peak 1553-B bandwidth for transitory MIRI motor waveform transmissions to ICE. Waveform data rate is well within existing ISIM margin (GSFC 1553 Data Bus Specification).</p> <p>2) Includes all 3 detector data streams, SpaceWire overhead (5% Flow Control Token, and Packet header). Additional margin held by ISIM.</p> <p>3) Includes all 3 detector data streams, SpaceWire overhead (5% Flow Control Token, and Packet header) and required 25% margin. Frequency was changed from 66 to 60 MHz for the Flight.</p>			

- ISIM FSW also keeps additional margins**



FSW Development Environment (including CM)

- **JPL CMMI Level 2-certified FSW Standards are followed**
- **The MFSW requirements, design, and code are developed using the Rational Rose Real-Time Tool set**
- **The Object Oriented Design (OOD) methodology is used. Unified Modeling Language (UML) diagrams represent the design. Rational Rose Real-time is used to develop and maintain the design diagrams**
- **VxWorks is used as the COTS Real-Time Operating System (RTOS) for the PowerPC-750 target processor**
- **C++ is the implementation source language and will be generated by the Rational Rose RT Tool and augmented with manual modifications**
- **Rational ClearQuest & Rational ClearCase provide change and configuration control**



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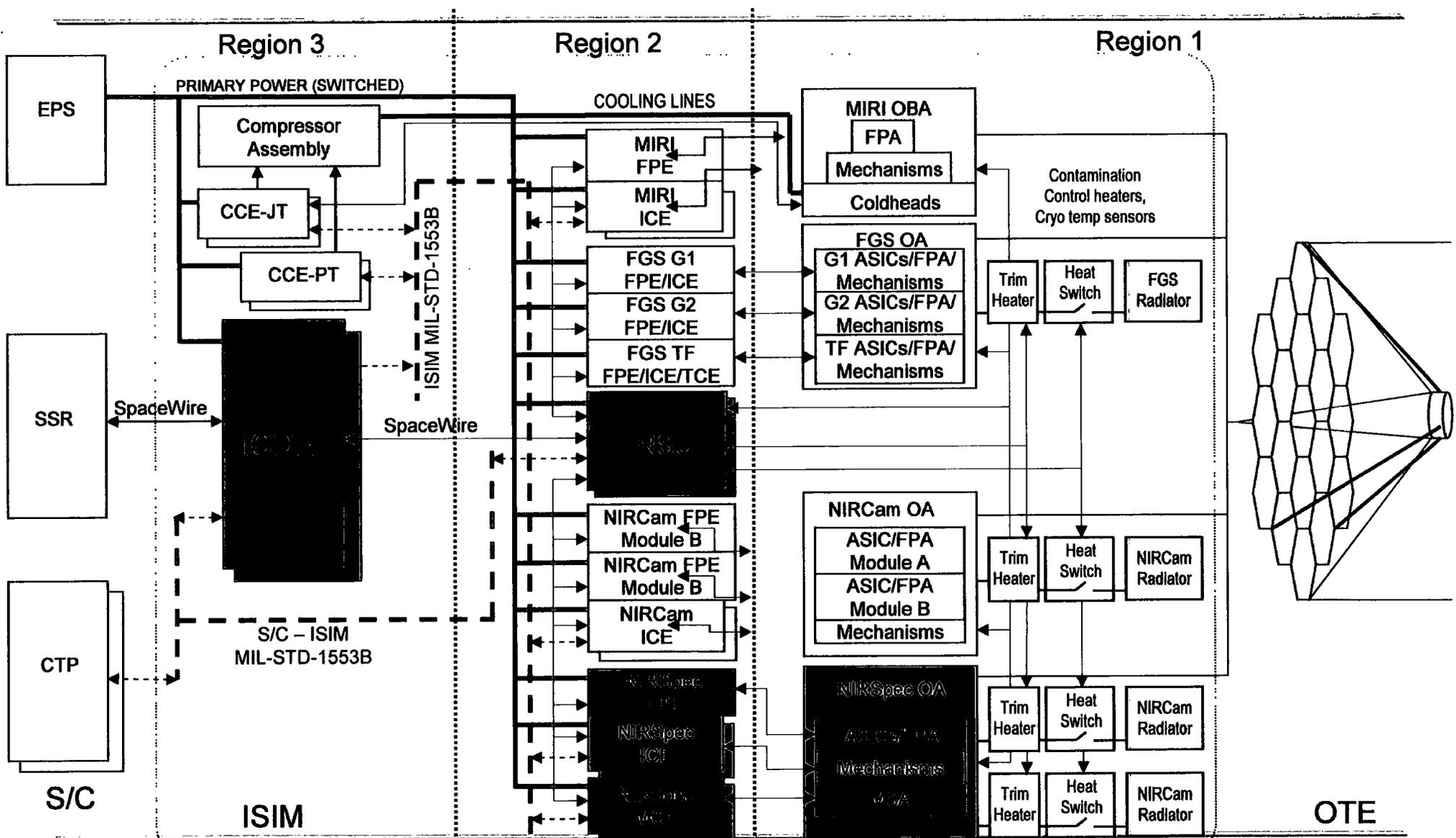


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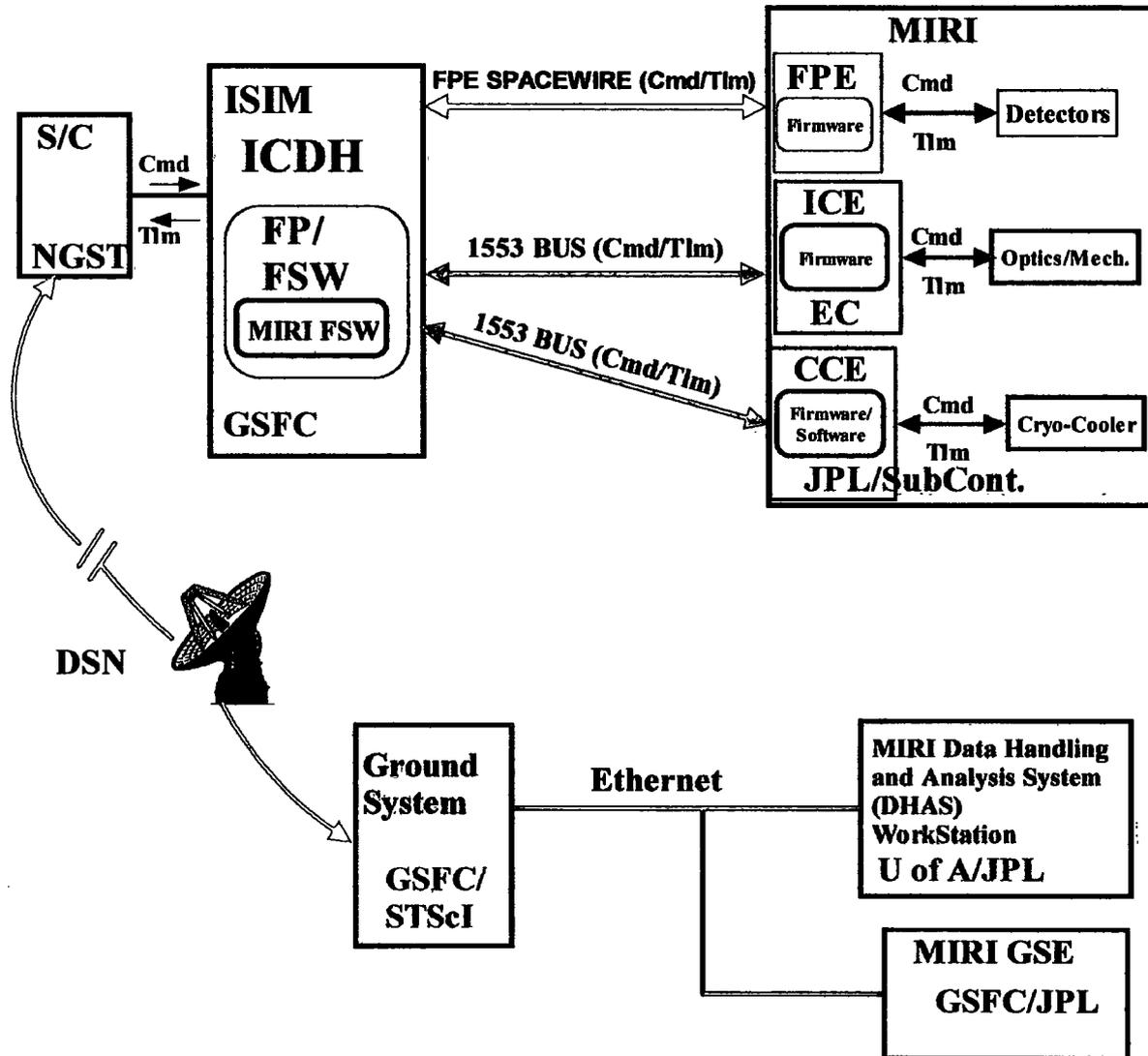
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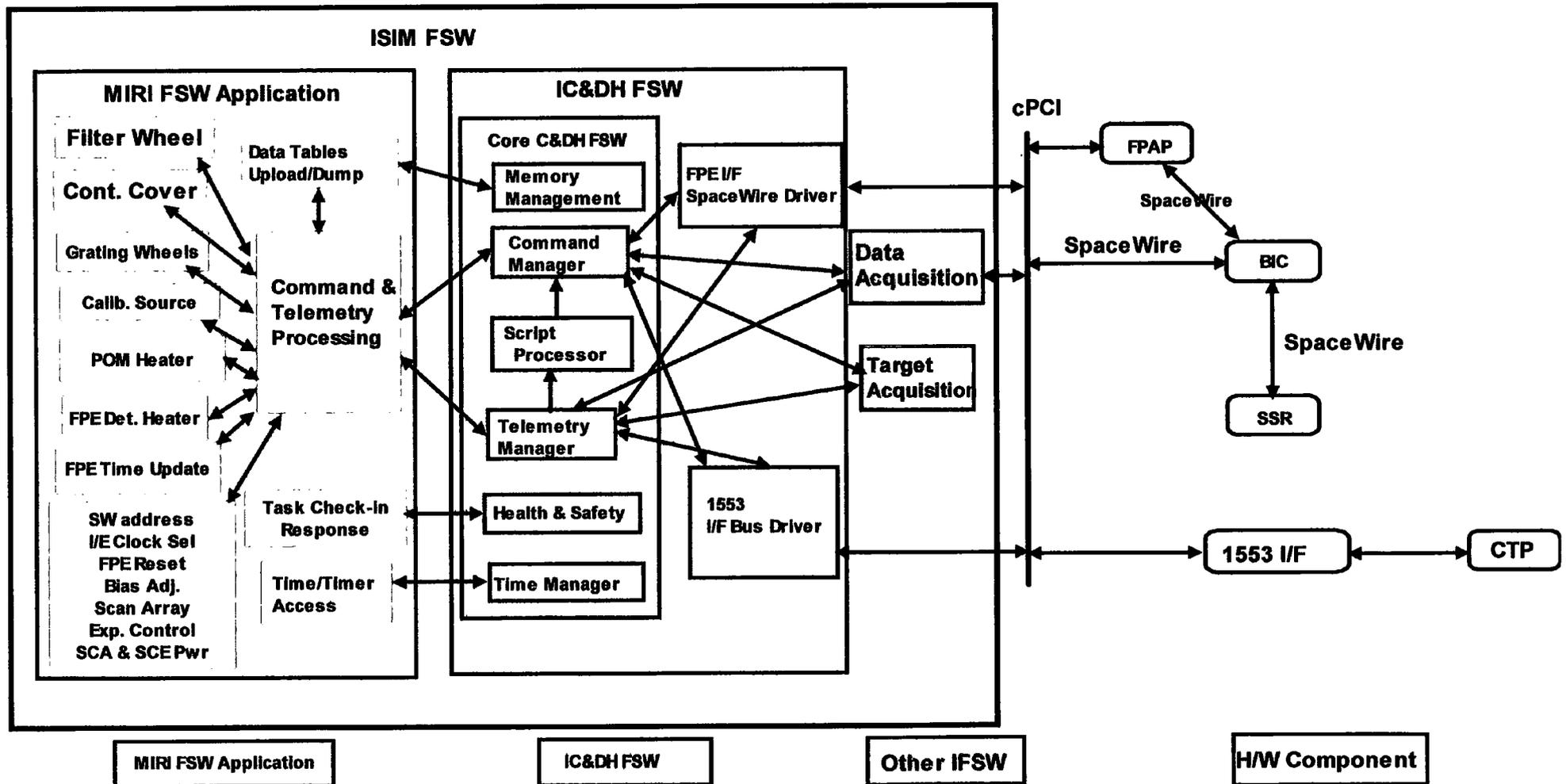
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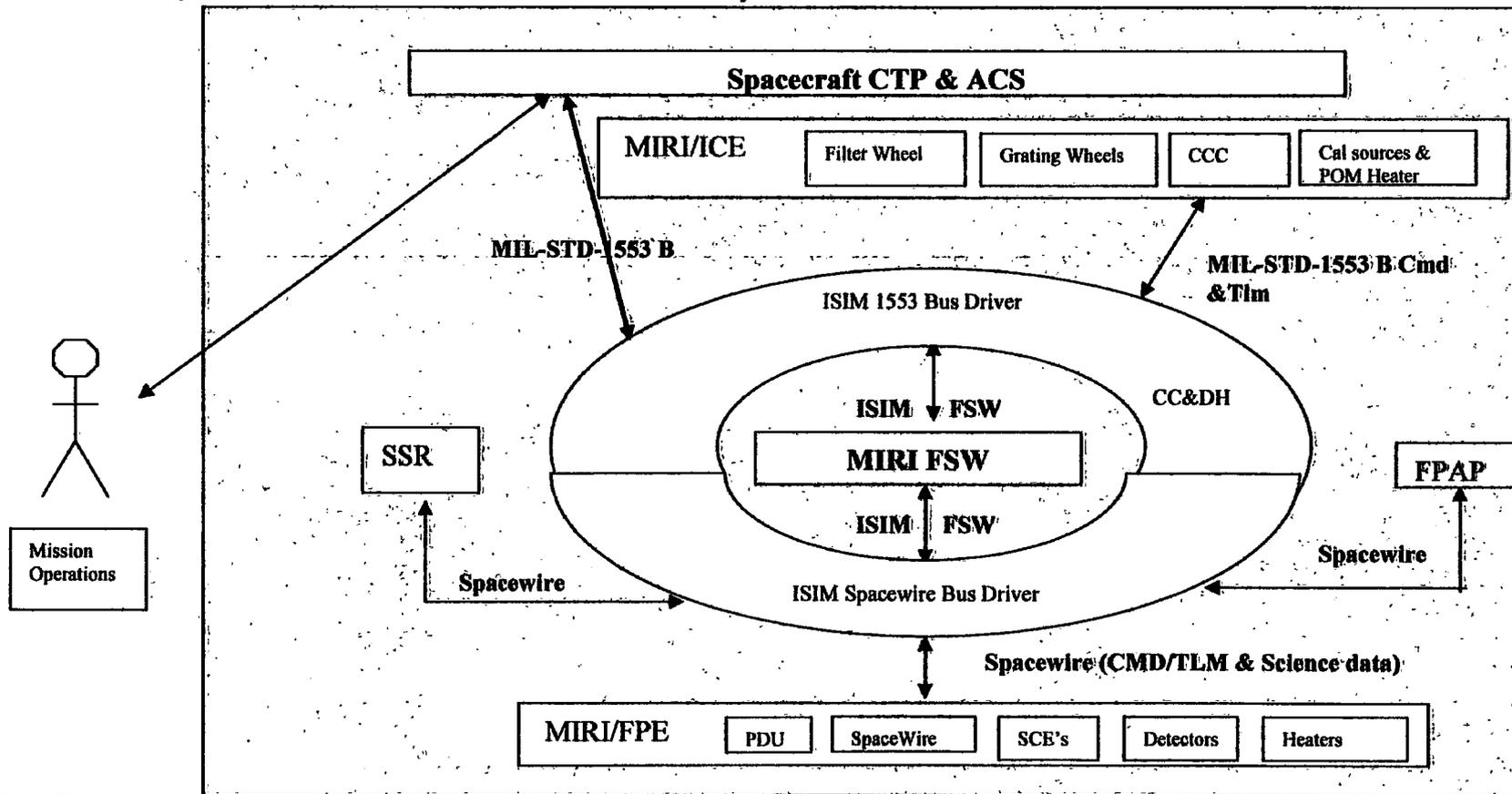
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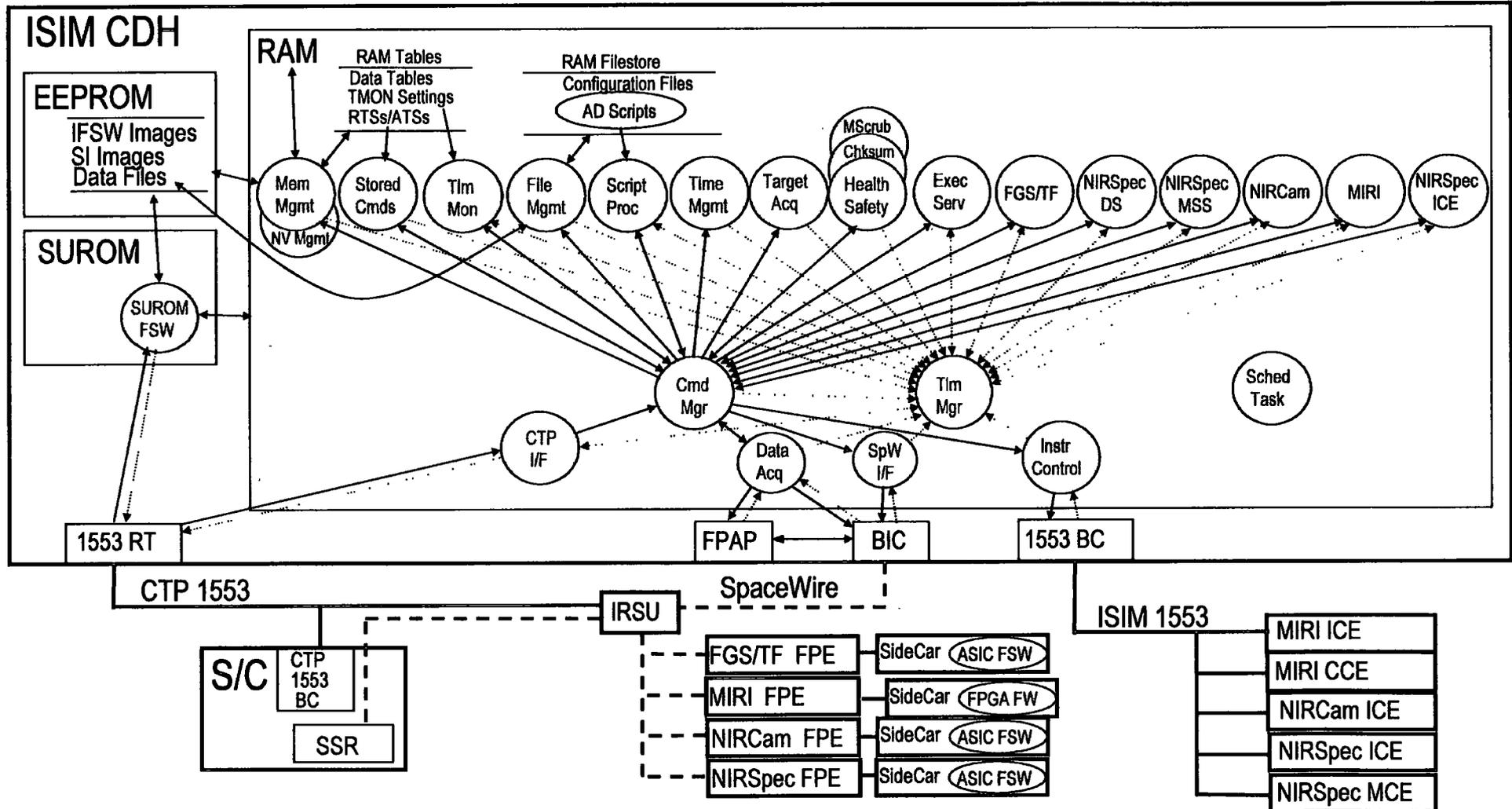


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MIRI Command & Data Handling FSW



Core C&DH GSFC | ISIM Application GSFC | ISIM Application SI | STSci | Common ASIC FSW

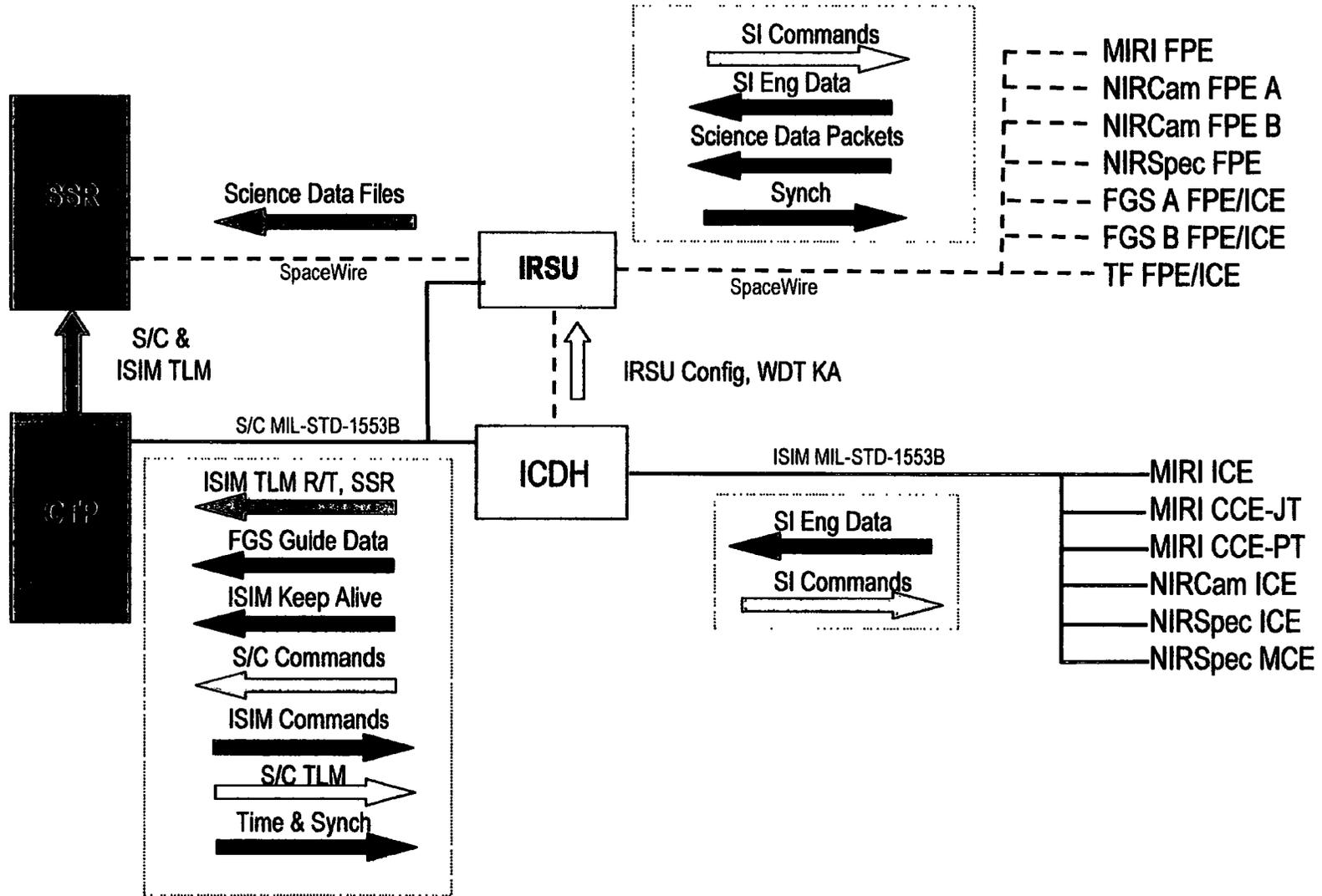
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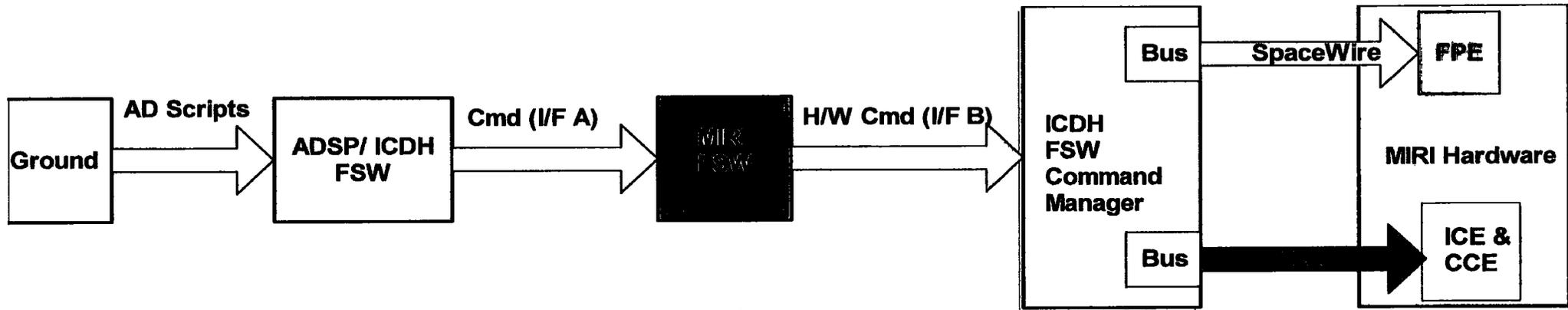
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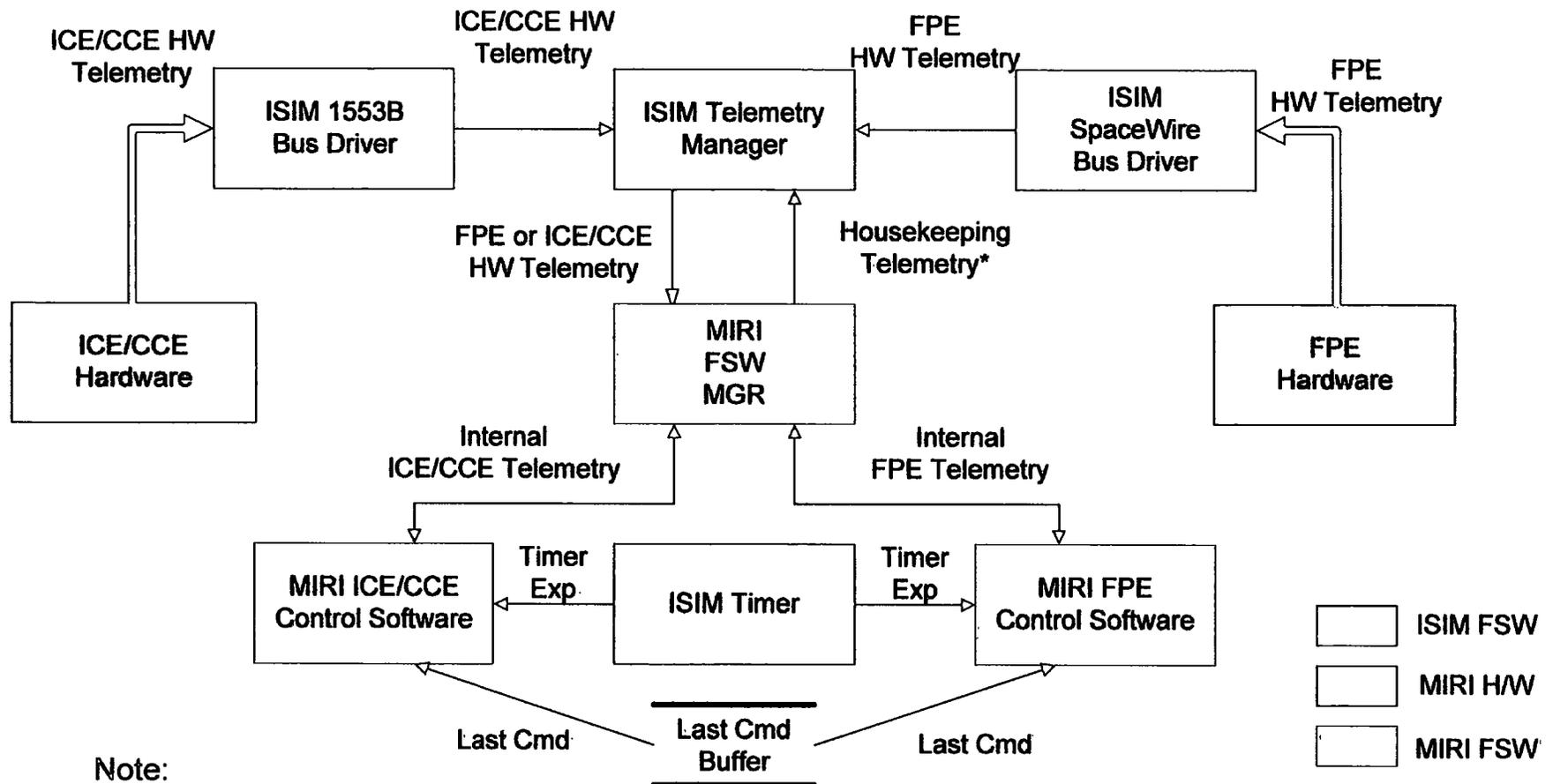
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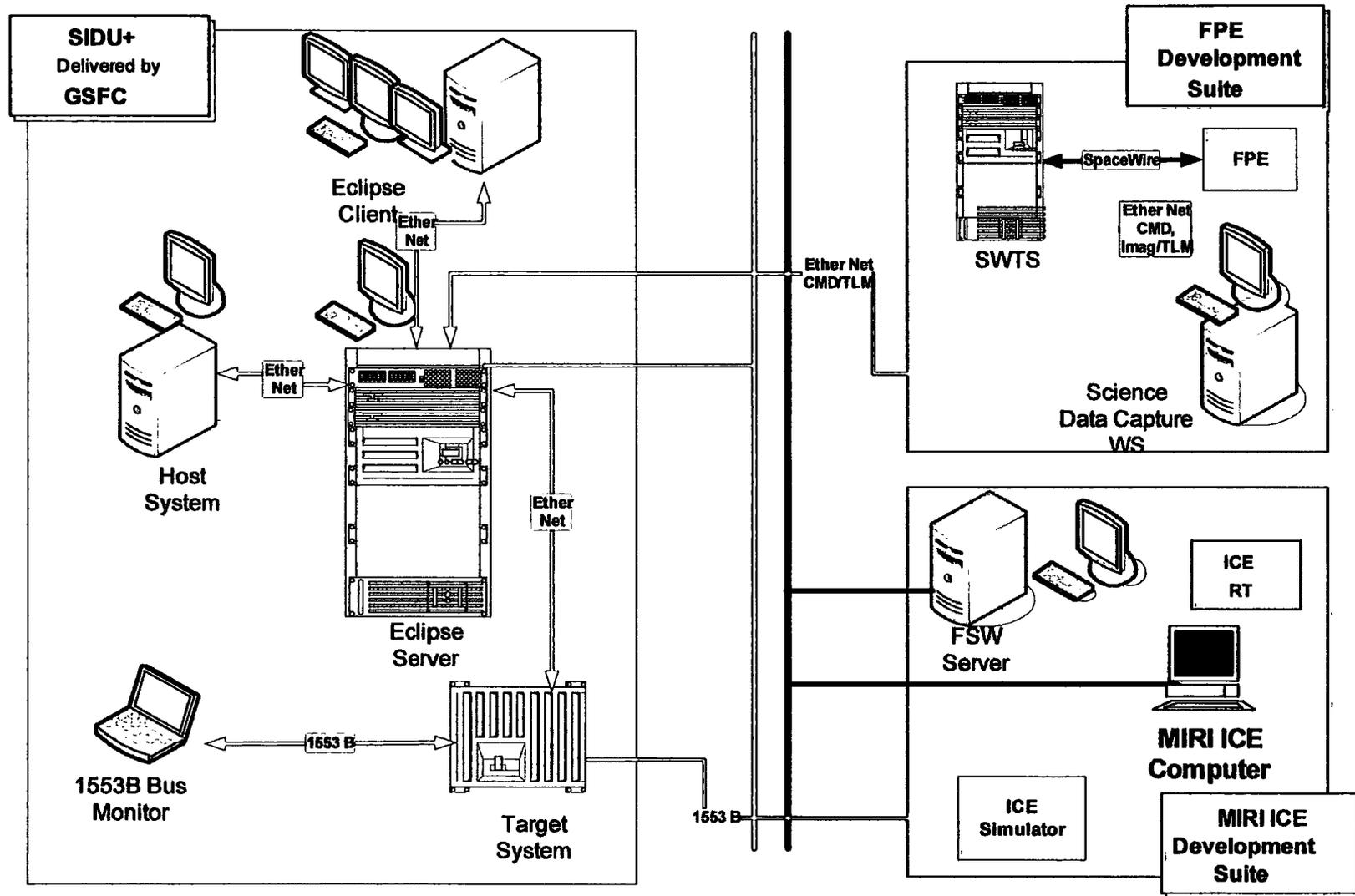
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Science Instrument Development Unit (SIDU)

MIRI European Consortium



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FSW Development Status

- **The MIRI FSW is developed using an iterative Build approach**
- **Initial builds are developed on Commercial Test systems and custom breadboards; later builds are developed on flight-like hardware**
- **MFSW has been designed for the FPE & ICE control**
- **FPE Software has been integrated and tested with the Breadboard and EM version of the FPE**
- **ICE Interface S/W has been tested with the ICE Software Simulator (provided by EC)**
- **MIRI FSW EM version 1.0 will be ready for delivery with the EM Focal Plane System (FPS) early 2007**
- **MIRI FSW EM version 1.0 supports testing with the ICE Verification Model at RAL**



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- **Verification testing is performed by FSW Test team to verify MFSW functional and performance requirements**
- **Requirements mapped to test scenarios, which are reviewed by FSW Test Team, system engineers, EC partners and GSFC**
- **Tests are performed in a controlled environment (MFSW Build Verification Test String). The string is defined by the contents of the build to be tested (i.e., Breadboard hardware, Simulators, or flight-like hardware)**
- **All requirements implemented to date are tested in every possible situations, every test is re-run for every build and delivery**
- **All test results documentation is reviewed by FSW Test Team, system engineers, developers, EC partners and GSFC to confirm success/failure**
- **Regression test analysis will be performed when any changes are made to any Build Tested FSW image**



FSW Delivery Plans

**MIRI European
Consortium**

- **Delivered a prototype version to GSFC and RAL (MIRI EM V 0.1) Jan'06 (included ISIM interfaces & FPE breadboard I/F)**
- **Delivered Version EM 0.2 to support FPE HW Simulator testing at RAL (included ISIM Interfaces, FPE HW Sim, and ICE Software Sim version 0.4 support) Nov'06**
- **Will deliver Version 1.0 for VM testing at RAL (includes ISIM Interfaces, FPE & ICE Sim 1.0 support) Jan'07**
- **Will deliver Version 2.0 for FM testing at RAL (includes ISIM Interfaces, FPE & ICE FM support) Apr'08**
- **State integrated with overall OBA schedule (double check dates with Derek!)**



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FSW Documentation (All included in Data Package)

**MIRI European
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- **MIRI Flight Software Management Plan (JPL D-25716)**
- **MIRI FSW Requirements Document (JPL D- 24160)**
- **MIRI Flight Software Design Document (Architectural) (JPL D- 31406)**
- **MIRI Flight Software Test Plan (JPL D- 30506)**
- **MIRI Flight Software User's Guide (JPL D-31409)**
- **MIRI Flight SW to FPE Interface Requirements Control Document (JPL D-29345)**
- **Provided inputs to OBA Design Document for the FSW design overview**
- **Provided inputs to ISIM-MIRI Interface Control Document**



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- **MIRI Flight Software has completed “Software Requirements Review”**
 - Was held on October 13th 2004
 - 18 RFAs and all were closed

- **MIRI Flight Software Completed “Design Review”**
 - Was held on November 2nd 2005
 - Total of 5 RFAs and all were closed

- **MIRI Flight Software Supported other Project level reviews with no outstanding issues**



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- **Provided an overview of the MIRI FSW and its environment**
- **Have experienced staff and other resources in place**
- **MIRI FSW Team Understands the ISIM, Interfaces, subsystem requirements and the Test environment**
- **Excellent relationship with our European partners**
- **Looking forward to Verification Model (VM) delivery and test support**
- **Ready to proceed to the next phase**



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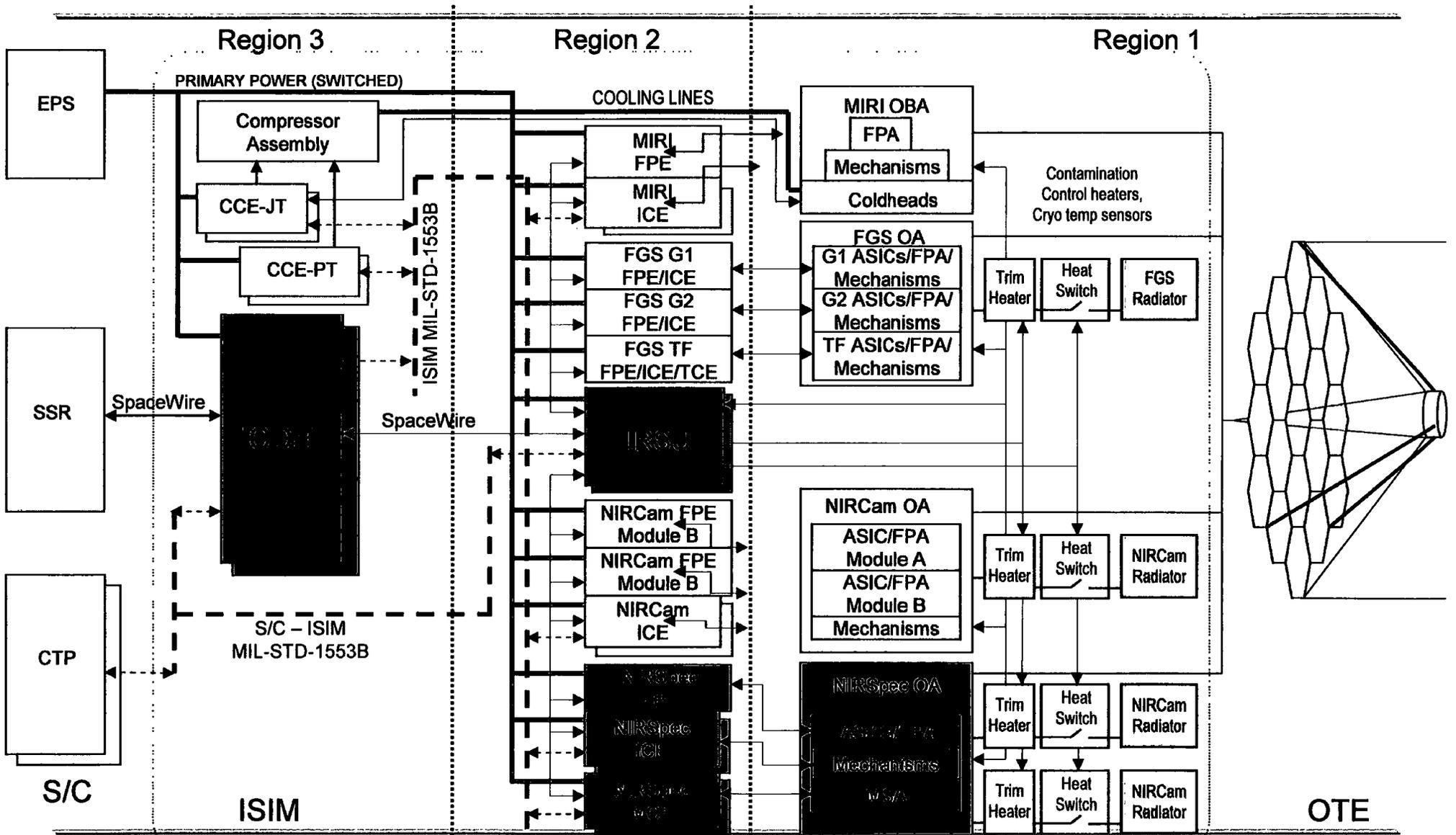


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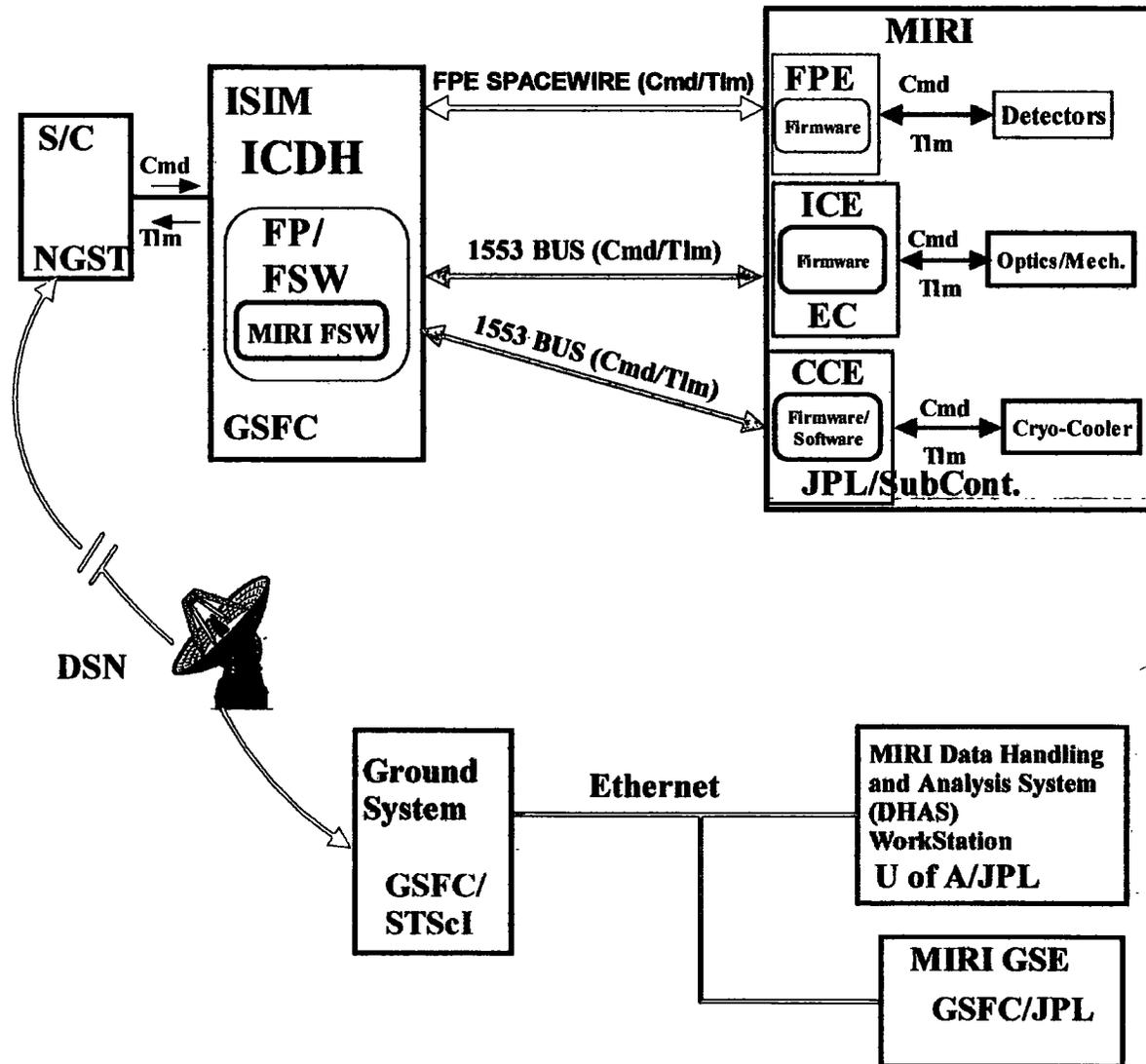
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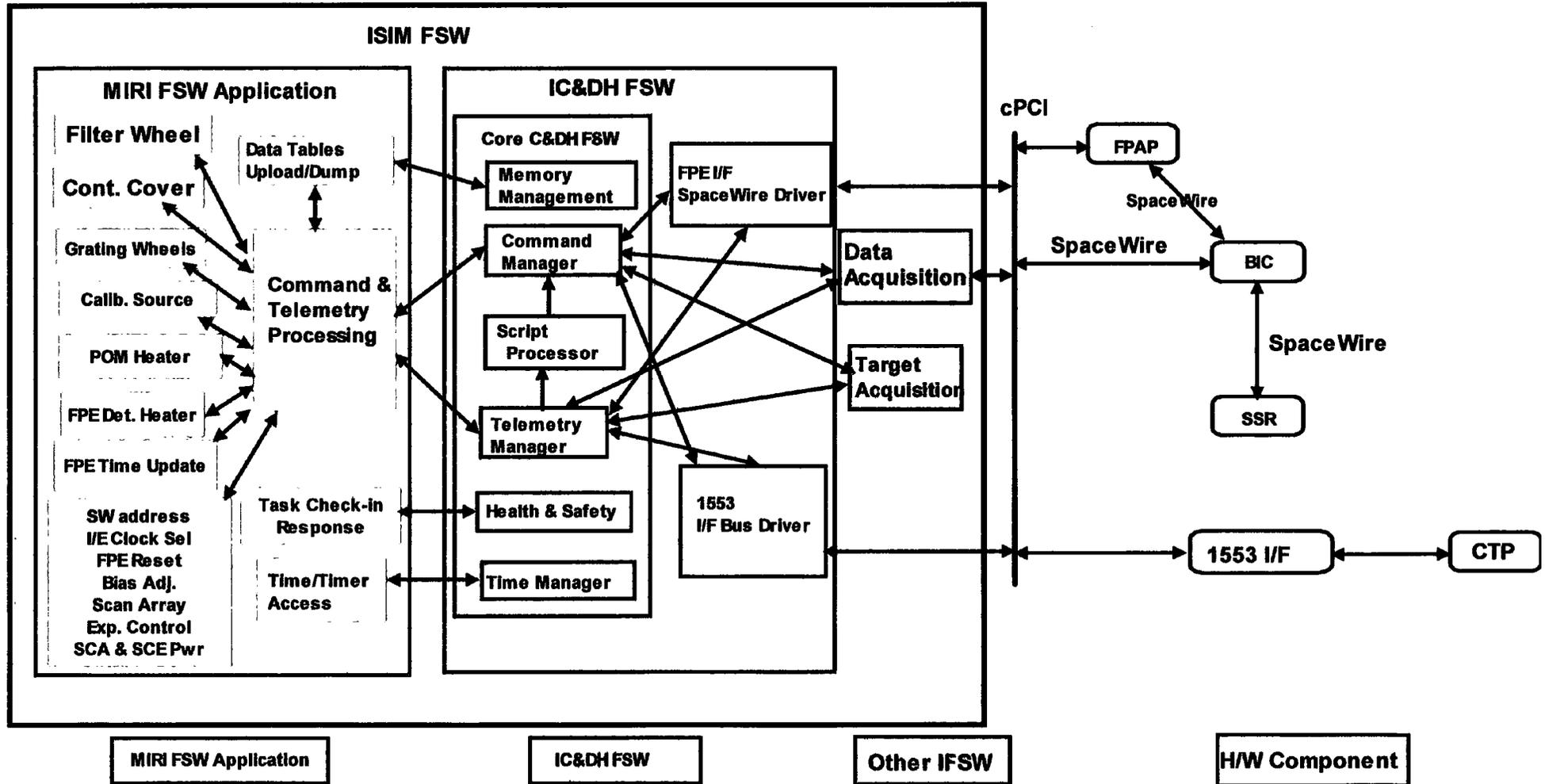
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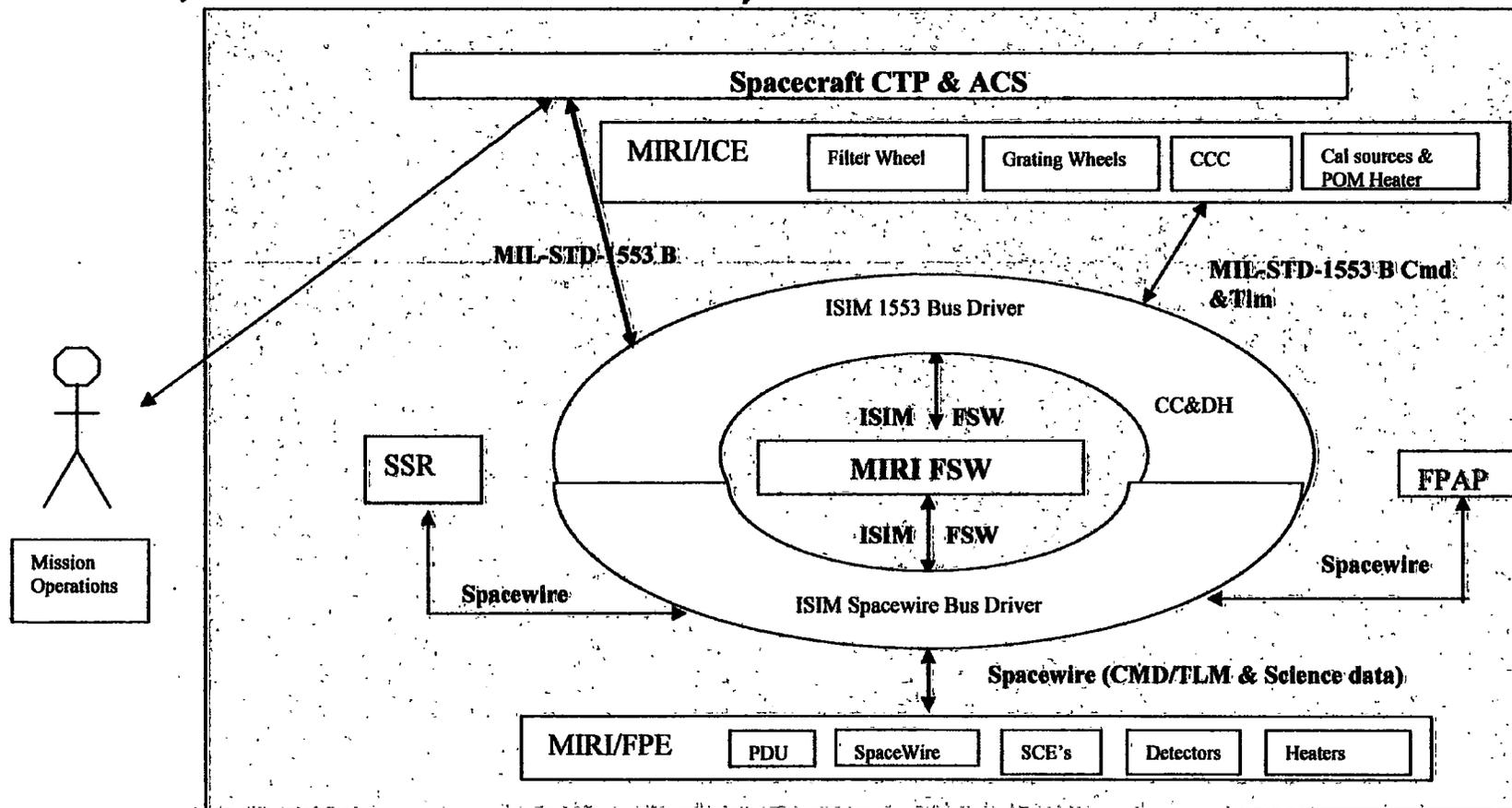
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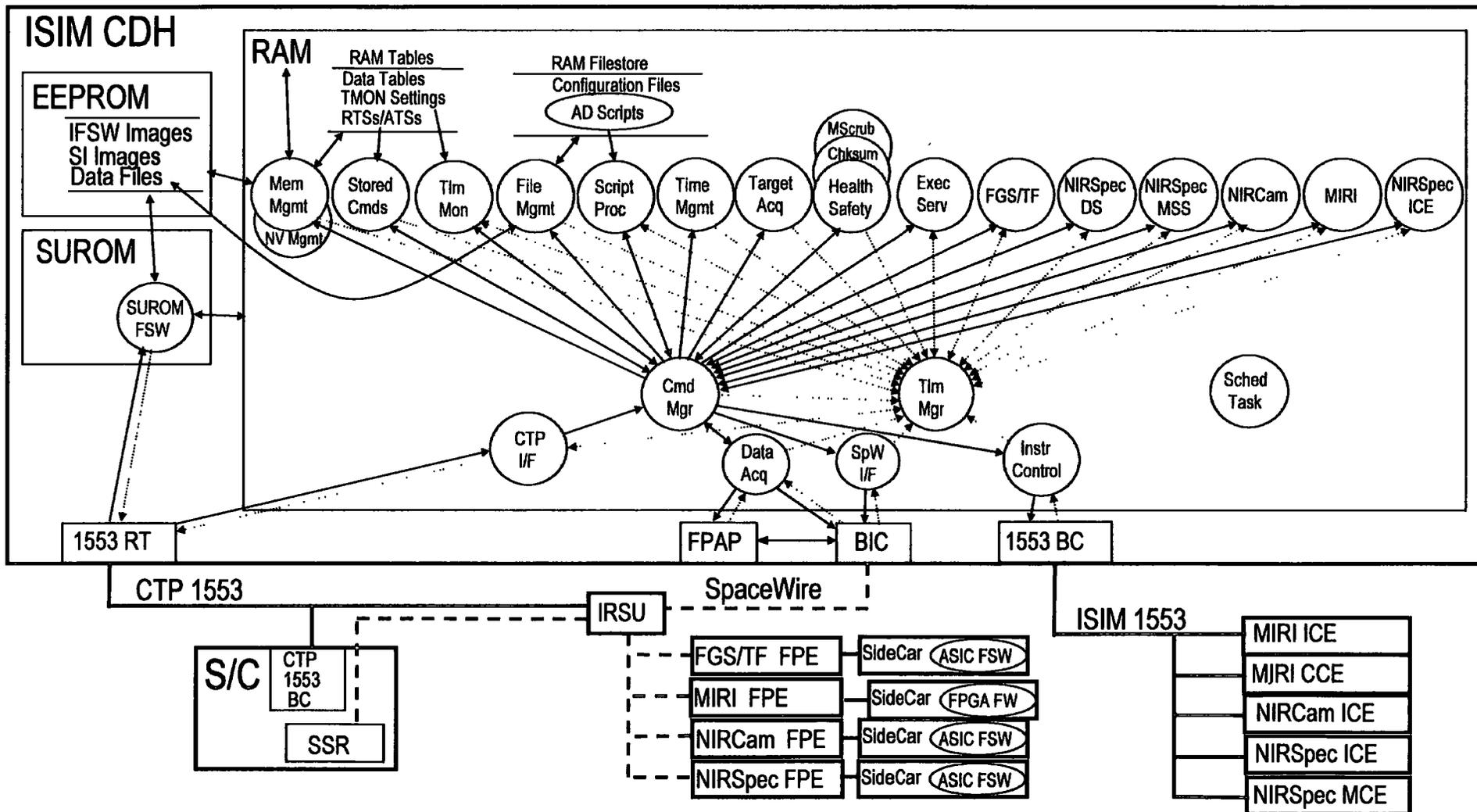


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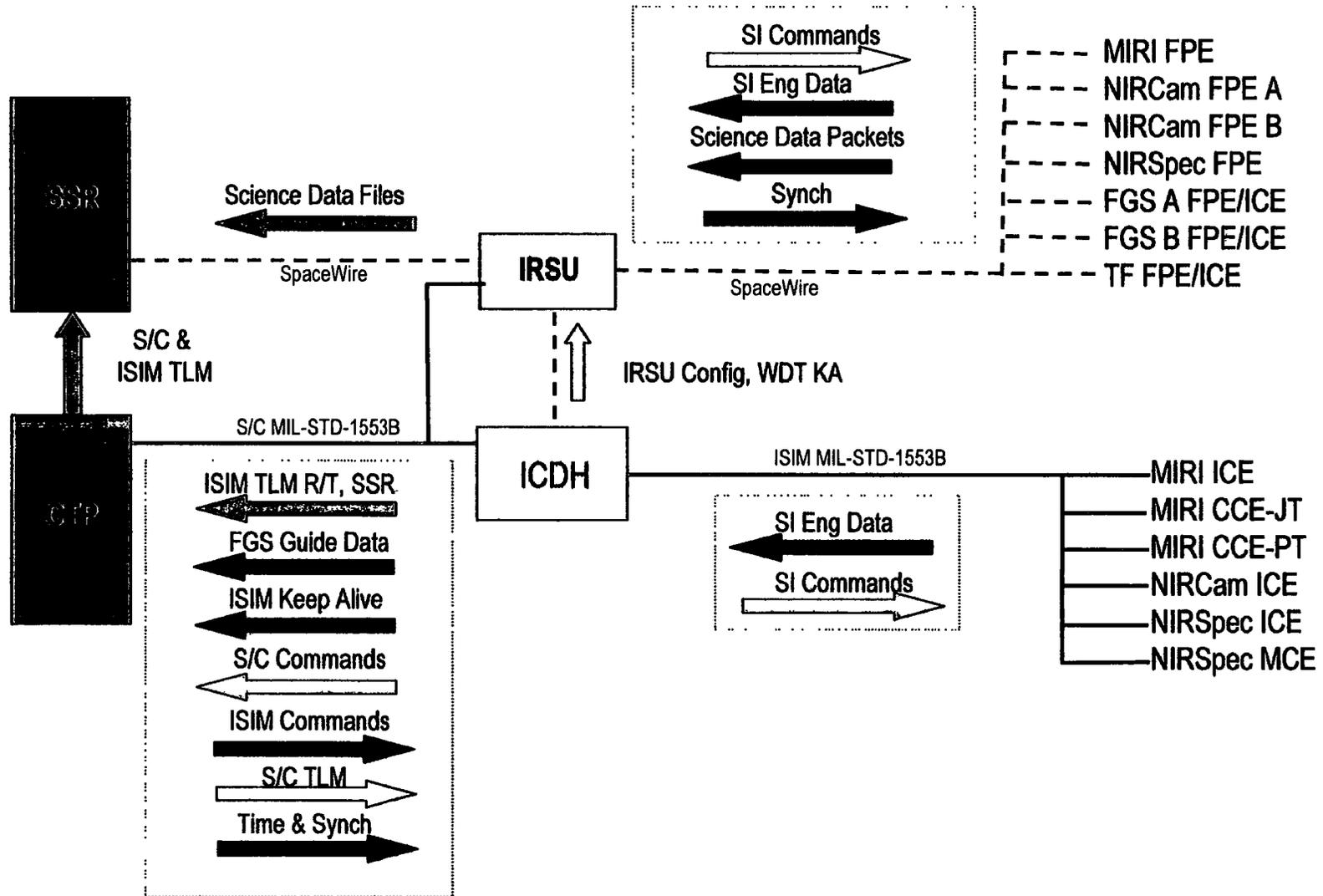
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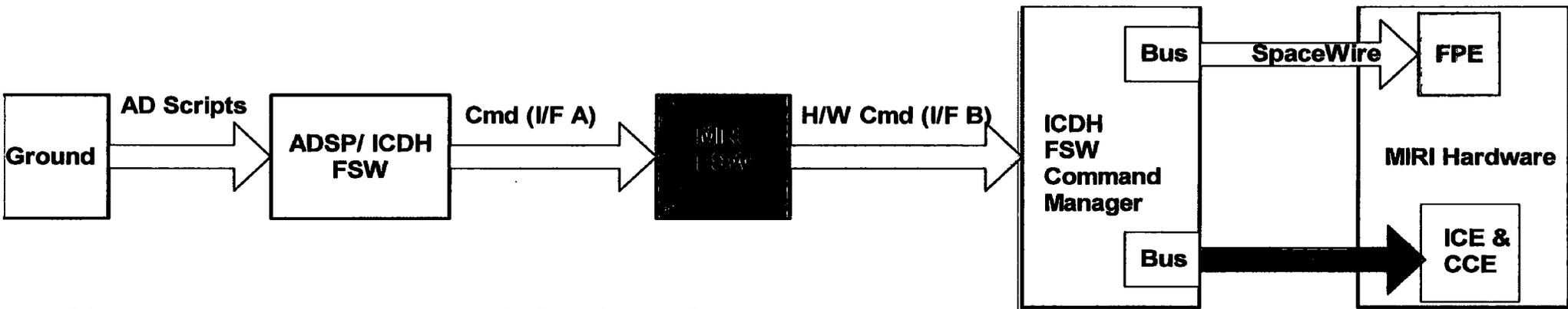
ASIC FSW



Command & Data Flow at ISIM level



MIRI Command Flow



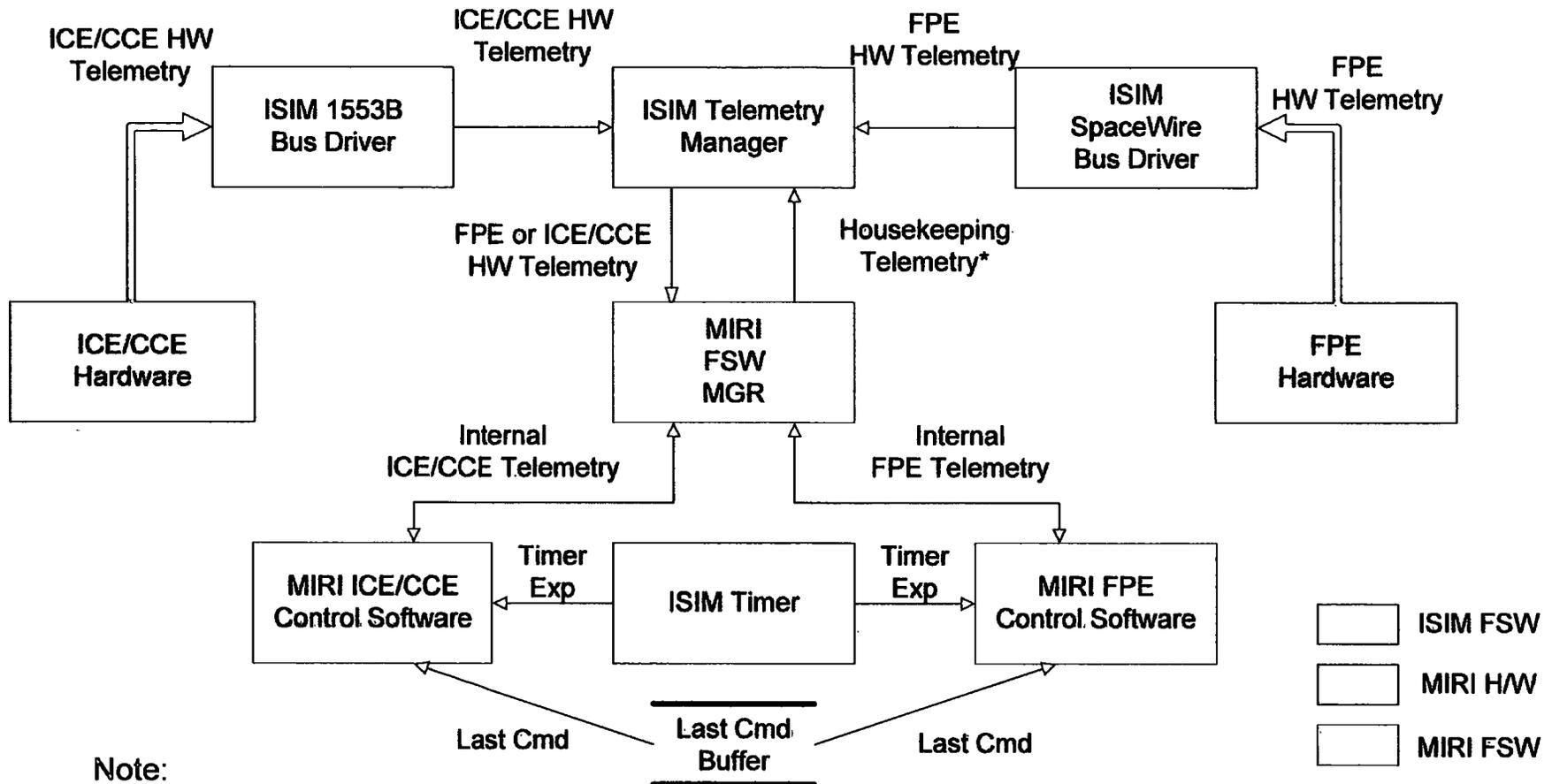
- AD** Activity Description
- ADSP** Activity Description Script Processor
- Cmd** Command
- ICE/CCE** Instrument/Cooler Control Electronics
- FPE** Focal Plane Electronics
- FSW** Flight Software
- ICDH** ISIM Command & Data Handling
- I/F A** Interface A commands (e.g., Move filter wheel to Pos X)



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MIRI FSW Telemetry Flow



Note:

1. All telemetry packets exchanged between ISIM FSW and MIRI FSW are in CCSDS format
 2. MIRI FSW has no requirements to collect science data
 3. MIRI Housekeeping Telemetry will include FSW, FPE, ICE and CCE Configuration Data
- * Instrument Housekeeping Packet (MIRI FSW generates)



FSW Design Drivers & Solution (TBD)

**MIRI European
Consortium**

-
- Summarise key design drivers
 - Summarise solution adopted and very briefly why



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FSW Resource Allocation & Reserves

- MIRI meets ISIM C&DH allocation with large margin**

DATA BUS	BANDWIDTH ALLOCATION	PREDICTED (Peak)	MARGIN
1553B Command (ICE)	512 words/sec (8192 bps)	32 words/sec (512 bps) 512 words/sec 8192 bps	75% (See Note 1)
1553B Telemetry (ICE)	768 words/sec (12288 bps)	352 words/Sec (5632 bps)	54%
SpaceWire Housekeeping (FPE)	10 kbps	100 words/sec (1.6 Kbps)	84%
SpaceWire Science (FPE)	66 Mbps ⁽²⁾	40.96 Mbps ⁽³⁾	>38%
<p>1) ISIM has agreed to support peak 1553-B bandwidth for transitory MIRI motor waveform transmissions to ICE. Waveform data rate is well within existing ISIM margin (GSFC 1553 Data Bus Specification).</p> <p>2) Includes all 3 detector data streams, SpaceWire overhead (5% Flow Control Token, and Packet header). Additional margin held by ISIM.</p> <p>3) Includes all 3 detector data streams, SpaceWire overhead (5% Flow Control Token, and Packet header) and required 25% margin. Frequency was changed from 66 to 60 MHz for the Flight.</p>			

- ISIM FSW also keeps additional margins**



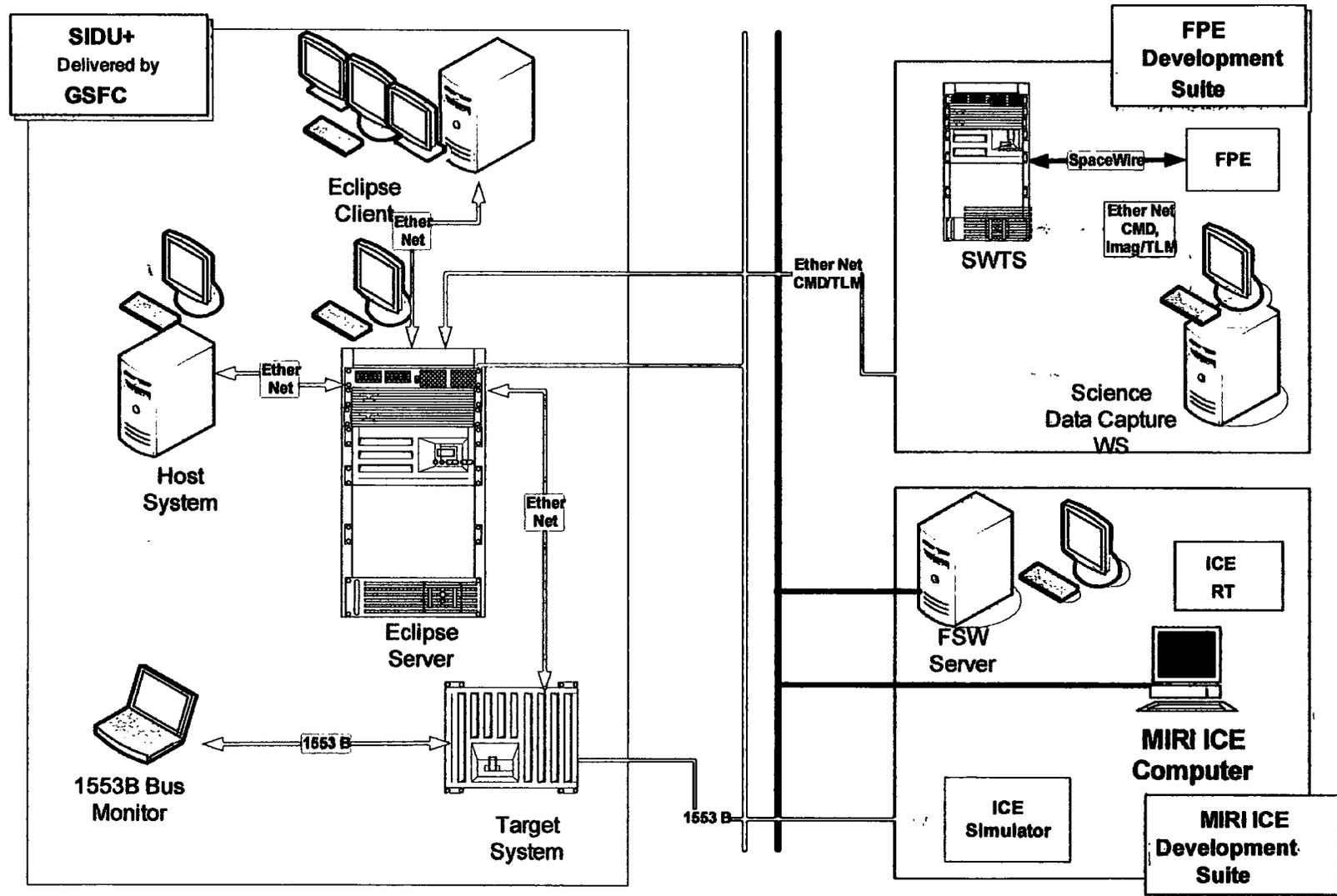
FSW Development Environment (including CM)

- **JPL CMMI Level 2-certified FSW Standards are followed**
- **The MFSW requirements, design, and code are developed using the Rational Rose Real-Time Tool set**
- **The Object Oriented Design (OOD) methodology is used. Unified Modeling Language (UML) diagrams represent the design. Rational Rose Real-time is used to develop and maintain the design diagrams**
- **VxWorks is used as the COTS Real-Time Operating System (RTOS) for the PowerPC-750 target processor**
- **C++ is the implementation source language and will be generated by the Rational Rose RT Tool and augmented with manual modifications**
- **Rational ClearQuest & Rational ClearCase provide change and configuration control**



Science Instrument Development Unit (SIDU)

MIRI European Consortium



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FSW Development Status

- **The MIRI FSW is developed using an iterative Build approach**
- **Initial builds are developed on Commercial Test systems and custom breadboards; later builds are developed on flight-like hardware**
- **MFSW has been designed for the FPE & ICE control**
- **FPE Software has been integrated and tested with the Breadboard and EM version of the FPE**
- **ICE Interface S/W has been tested with the ICE Software Simulator (provided by EC)**
- **MIRI FSW EM version 1.0 will be ready for delivery with the EM Focal Plane System (FPS) early 2007**
- **MIRI FSW EM version 1.0 supports testing with the ICE Verification Model at RAL**



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- **Verification testing is performed by FSW Test team to verify MFSW functional and performance requirements**
- **Requirements mapped to test scenarios, which are reviewed by FSW Test Team, system engineers, EC partners and GSFC**
- **Tests are performed in a controlled environment (MFSW Build Verification Test String). The string is defined by the contents of the build to be tested (i.e., Breadboard hardware, Simulators, or flight-like hardware)**
- **All requirements implemented to date are tested in every possible situations, every test is re-run for every build and delivery**
- **All test results documentation is reviewed by FSW Test Team, system engineers, developers, EC partners and GSFC to confirm success/failure**
- **Regression test analysis will be performed when any changes are made to any Build Tested FSW image**



FSW Delivery Plans

- **Delivered a prototype version to GSFC and RAL (MIRI EM V 0.1) Jan'06 (included ISIM interfaces & FPE breadboard I/F)**
- **Delivered Version EM 0.2 to support FPE HW Simulator testing at RAL (included ISIM Interfaces, FPE HW Sim, and ICE Software Sim version 0.4 support) Nov'06**
- **Will deliver Version 1.0 for VM testing at RAL (includes ISIM Interfaces, FPE & ICE Sim 1.0 support) Jan'07**
- **Will deliver Version 2.0 for FM testing at RAL (includes ISIM Interfaces, FPE & ICE FM support) Apr'08**
- **State integrated with overall OBA schedule (double check dates with Derek!)**



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FSW Documentation (All included in Data Package)

**MIRI European
Consortium**

- **MIRI Flight Software Management Plan (JPL D-25716)**
- **MIRI FSW Requirements Document (JPL D- 24160)**
- **MIRI Flight Software Design Document (Architectural) (JPL D- 31406)**
- **MIRI Flight Software Test Plan (JPL D- 30506)**
- **MIRI Flight Software User's Guide (JPL D-31409)**
- **MIRI Flight SW to FPE Interface Requirements Control Document (JPL D-29345)**
- **Provided inputs to OBA Design Document for the FSW design overview**
- **Provided inputs to ISIM-MIRI Interface Control Document**



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-
- **MIRI Flight Software has completed “Software Requirements Review”**
 - Was held on October 13th 2004
 - 18 RFAs and all were closed

 - **MIRI Flight Software Completed “Design Review”**
 - Was held on November 2nd 2005
 - Total of 5 RFAs and all were closed

 - **MIRI Flight Software Supported other Project level reviews with no outstanding issues**



- **Provided an overview of the MIRI FSW and its environment**
- **Have experienced staff and other resources in place**
- **MIRI FSW Team Understands the ISIM, Interfaces, subsystem requirements and the Test environment**
- **Excellent relationship with our European partners**
- **Looking forward to Verification Model (VM) delivery and test support**
- **Ready to proceed to the next phase**



End of File

