



**SPACE SHUTTLE PROGRAM**  
**Flight Software Office**  
NASA Johnson Space Center, Houston, Texas



# **Flight Software Office (FSO) STS-126 In-Flight Anomaly Review**

**SR 4363**

**David Rutishauser/MS4**

**SICB Dec. 9, 2008**

**PRCB Dec. 11, 2008**



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### FSO STS-126 IFA Review, Overview

Presenter **D. RUTISHAUSER**

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Tracking #	Description
STS-126-I-001 (MER-08, AR 3595, AR 3596, CHIT 006660)	SM GPC Failure to Send GCIL Commands



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### FSO STS-126 IFA Review Discussion

Presenter **D. RUTISHAUSER**

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- **STS-126-I-001, SM GPC Failure to Send GCIL Commands :**

- On FD1, the MPLM environment checks could not be completed, because the PSP could not be configured properly. The system management software command to configure the PSP failed, but a ground-initiated command worked correctly.
- Failure of automatic handover of antenna management to Ku-Band from S-band, and vice-versa
- Cause isolated to an inadvertent data shift affecting PSP port moding and Ku automatic handover commanding only (pre-OI-33 capabilities), introduced by an unrelated change in OI-33
  - OI-33 SCR 93122 "PSP Reject Indicator Fix to DR 122444" inserted data item into COMPOOL shared by affected commanding data
  - Inserted data caused shift in subsequent data that rendered three downstream commands inaccessible by the I/O processor (IOP)
- Issues were addressed during the mission via ops workarounds
  - Ku-auto handover: Reverted to INCO procedures used before capability added in OI-27 (1997)
  - PSP port moding: Accomplished with ground commanding (MPLM checks completed)
- FSW team mission support included
  - Verification and isolation of cause of command failure through analysis and SPF testing
  - Complete audit of OI-33 COMPOOL changes; Verified no other erroneous data shifts present



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### FSW STS-126 IFA Review Discussion, cont.

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- **IFA Status and forward plan:**

- Corrective action:

- FSW DR126366 dispositioned by SASCB 12/4/08

- Authorizes patch to STS-119 and STS-127 OI-33 systems

- Patch is small, not complex, only impacts the affected functions, and is fully testable

- Patch scheduled for release 12/15/08, SAIL testing complete 1/9/08

- Source mod to OI-34 systems

- Will audit all OI-34 COMPOOL changes for proper data alignment

- Preventative action:

- Team engaged in full root cause analysis

- Examining all levels of inspection/review/verification

- Verification procedures/philosophies/scope

- Facility capabilities/limitations

- Missed opportunities to have exposed problem

- NESC Software Fellow engaged in reviews



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### FSW STS-126 IFA Review Discussion, cont.

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- **Schedule**

- All analysis results and preventative action plan scheduled to be reported to SICB/PRCB January 13/15<sup>th</sup>, per MMT action 126-MMT-001

- **Hazard Report Impacts**

- IFA currently tracked as integrated due to potential impacts to IFSW-01 “FLIGHT SOFTWARE PROBLEMS CAN CAUSE LOSS OF VEHICLE COMMAND AND CONTROL”
- Impacts under investigation pending completion of root cause analysis



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<h1>FSW STS-118 IFA Review</h1>	Presenter <b>D. RUTISHAUSER</b>	
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# Backup



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### FSW STS-126 IFA Review Discussion, cont.

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- **Key findings to date:**

- Condition (maintenance trap) was introduced in OI-20 (June 1989)
  - Existing programming standards/methods to force output data alignment not used
  - Warnings to maintain alignment placed in code via comments
  - Subsequent changes to COMPOOL increased size to point that comments were well removed from location OI-33 data was inserted
- Since the OI-33 changes functioned correctly, regression (system health) tests of non-related functions most likely verification step where problem could have been uncovered
- Limitations exist in verification and training facilities for exercising the affected functions
  - No GCIL or PSP models in SPF, but output data stream can be logged and inspected
  - No SPF models to compute Ku-band signal strength for exercising handover function in a closed loop test, but functionality can be exercised with manual intervention
  - SMS uses simplified model of GCIL hardware interface which did not expose handover problem



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### FSW STS-126 IFA Review Discussion, cont.

Presenter **D. RUTISHAUSER**

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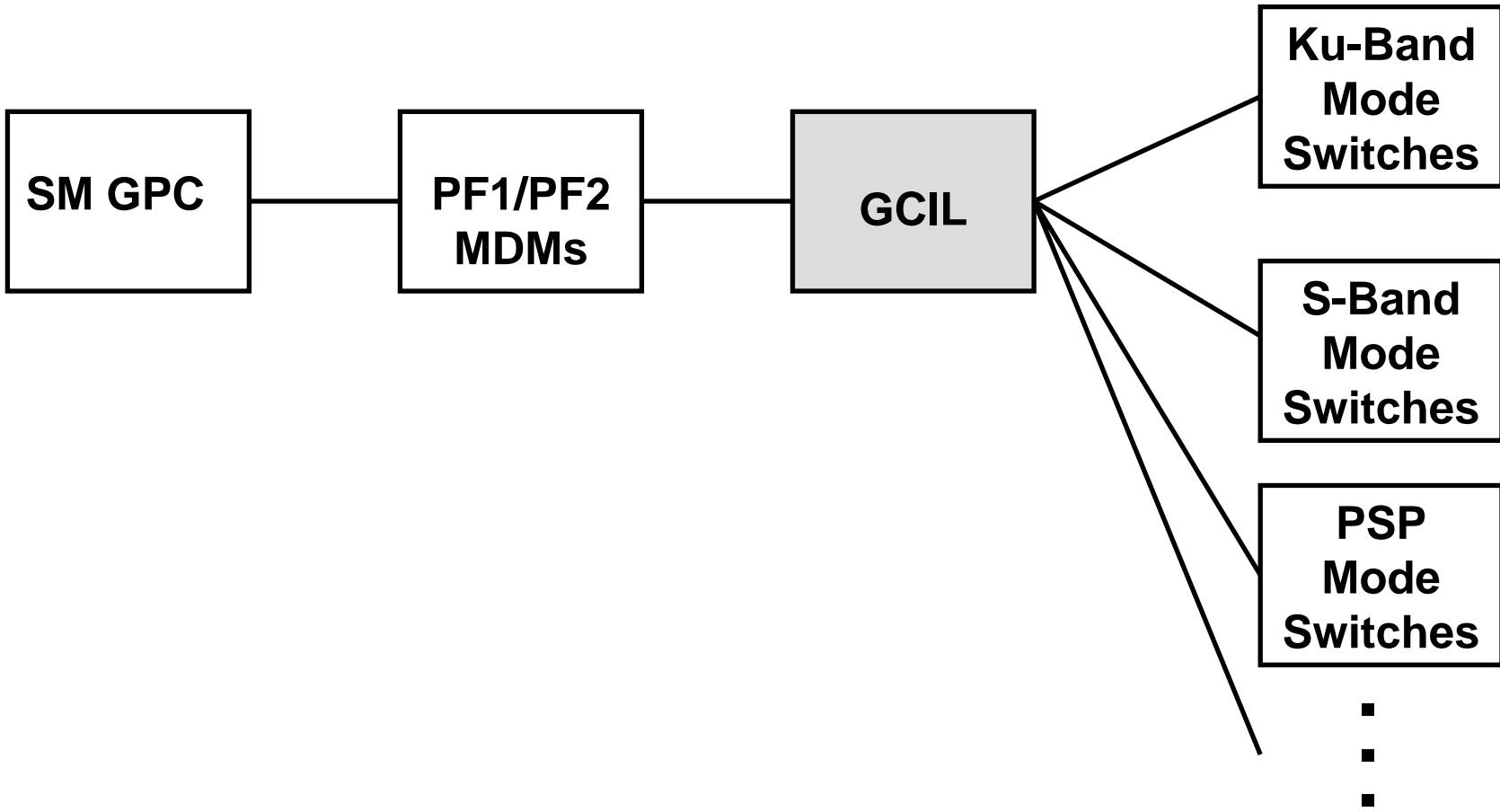
- **Key findings to date, cont:**

- Opportunities still existed to uncover the error in verification:
  - SAIL uses GCIL and PSP hardware for verification
    - Ku auto-handover test performed, but was successful due to test sequence and the initial state of the hardware
    - Handover exercised again as the result of a configuration change in the test procedure and failed, but it was not identified or noticed because this transition was not a test requirement
    - PSP port moding still under investigation
  - PSP port moding rejected command identified in ODRC data from SMS development run, but was not a test requirement and was not identified at the time
  - KSC did not exercise PSP port moding functions during STS-126 vehicle processing
    - Not typically done for station flights





<b>Simplified flow of automatic GCIL commanding via SM GPC</b>	<b>Presenter</b> D. RUTISHAUSER	
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<h2>Data Alignment Description</h2>		Presenter <b>D. RUTISHAUSER</b>	
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**OI-32**

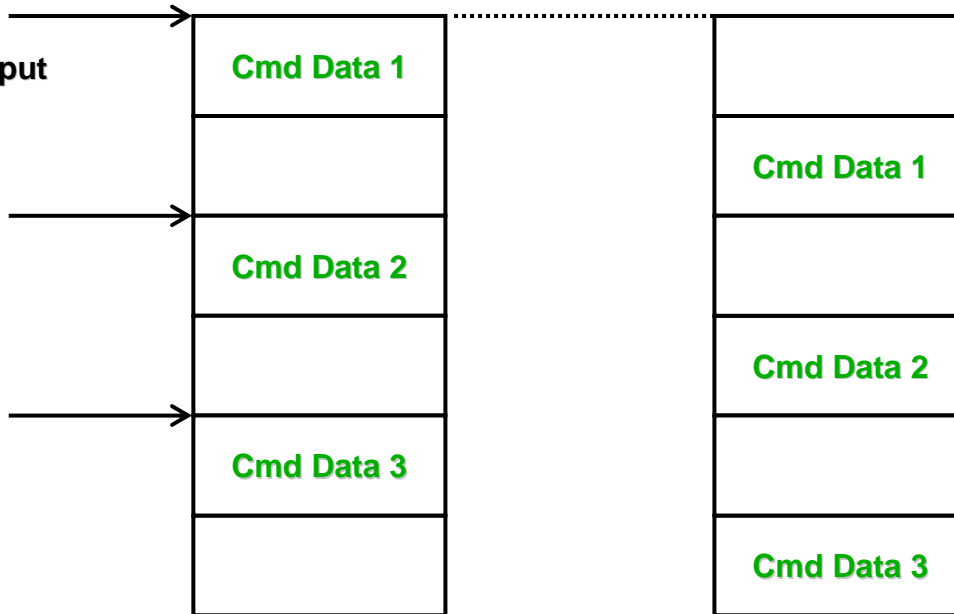
⋮

**OI-33**

⋮

OI33 new data  
inserted

Even Addresses  
(picked up for output  
by IOP)



- Design choice to add a new piece of OI-33 data above the GCIL command words in the data “compool” resulted in the inadvertent shift of that data from even to odd addresses

- Additional action should have been taken to ensure GCIL command data stayed on even addresses

FSW DR MANAGEMENT

DR NUMBER: 126366

ORIG. DATE: 12/01/08

REV: DATE:

DR TITLE: IFA STS-126-I-001, SM GPC Failure to Send GCIL Commands

FOUND BY: STS-126 ASSIGNED TO: PASS SEVERITY CODE: 2N LOG DATE: 11/17/08

DESCRIPTION OF PROBLEM:

The OI-33 software change for SCR 93122 "PSP Reject Indicator Fix to DR 122444" added a data parameter to an SM compool which inadvertently caused the PSP port moding and the Ku-band/S-band auto handover GCIL command data to shift to an odd memory address. The Input/Output Processor (IOP) only functions with output data that is on an even Memory address. The result of the shifted data causes the IOP to issue GCIL commands using the preceding (incorrect) halfword location. For PSP port moding, both the reset command (which should result in an ALL ZERO command state) and the set (DATA) commands are in error. For Ku-band/S-band auto handover, only the reset command is in error.

HOW USER SEES EFFECTS:

The GCIL will not respond to a set command that is not preceded by a reset command. INCO controllers observed this behavior during the STS-126 mission. Workaround procedures are required to manually command Ku-band/S-band handovers (with the FSW automatic handover function inhibited). PSP automatic port mode switching will not function and separate GCIL uplink commands are required to switch between RF and umbilical PSP configurations.

REQUIREMENT (REQ VIOLATED/INADEQUACY):

SS-P-0002-580, Sections 4.9.4.2 and 6.4

SS-P-0002-550, Section 4.27

DISPOSITIONS:

FLT	SYSTEM	CLOSURE	CLOSURE CODE DEFINITION	ACTIONEE
STS-126	OI33	4A	Waiver Required	USA/PASS
STS-119	OI33	2B	Patch To Mass Memory	USA/PASS
STS-127	OI33	2B		
	OI34	2A	Source Mod Via Flight Build	USA/PASS

RATIONALE FOR DISPOSITIONS:

A waiver will retroactively apply to STS-126, the first OI-33 mission. A fix will be made via MM patch or source mod to all remaining missions until the end of the Shuttle Program. These dispositions represent no significant increase in risk.

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