

# Ground Systems Automation – Advantages in Spacecraft Testing

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#### Ground Systems Automation Advantages in Spacecraft Testing





#### SPACECRAFT TESTING

#### ANY SPACECRAFT BUILT BY ISRO UNDERGOES RIGOROUS TESTING BEFORE LAUNCH (APPRX. 4 TO 6 MONTHS)





#### INTEGRATION PHASE

DIS-ASSEMBLED IST

#### **ASSEMBLED IST**







#### LAUNCHPAD OPERATIONS

SOLAR PANEL

**DYNAMIC TESTS** 

**THERMOVAC-IST** 







### SPACECRAFT TESTING



- Checkout Team is responsible for Testing the S/Cs (GEO, RemoteSensing & Small Sats) from Integration Phase till Launch.
- All the required H/W & S/W are designed and developed in-house, few with Industry support
- Spacecraft Checkout Systems (SCS) are fully AUTOMATED.
- SCG has designed and developed (in-house)
  Checkout Command Language (CCL) to cater to S/C checkout operations.

# WHY AUTOMATION?



- Complexity of the satellites is increasing
- Automation reduces time required for system level testing of complex spacecrafts
- Reduces errors which may creep in manual operations
- Reduces operator workload
- Automation ensures repetivity of tests
- Cost Savings

### **SPACECRAFT CHECKOUT SYSTEM (SCS)**

SCS consists of:

Power Feeding and Measurement Systems

- Battery Simulators
- Solar Array Simulators
- StimuliGenerators & Measurement Equipments
- Uplink and Down link Equipments
  - Data Acquisition Systems
  - Telecommand Encoders

Spacecraft Checkout Computer (SCC)

- Nerve Centre of all Checkout Activities



# A TYPICAL SCS



#### A TYPICAL SPACECRAFT CHECKOUT SYSTEM CONFIGURATION

Key software packages of checkout which aid in achieving automation

- ✓ Automatic Checkout Software System (<u>ACSS</u>) heart of checkout operations.
- Checkout software for Remote Sensing P/Ls (CSRSP)
- ✓ Communication Payload Checkout Software (COMPACS)
- ✓ Checkout S/W for Met.P/Ls (CSMTP)
- ✓ RF Checkout Software (RFCS)
- ✓ Special Checkout System Controller Software(SSCS)

Checkout Software packages...Contd.



- Payload Checkout DataCentre (PCDC) part of CSRSP to distribute P/L data to outside users.
- Payload Status Display and Commanding Software (PASDACS) – Part of COMPACS.
- Transponder Characterization PLOT S/W (TxPLOT)- part of RFCS & COMPACS.
- Oracle based Databases Generation and Data Analysis Software TTSDBM & DARAP – Part of Support S/W package of ACSS.

Checkout Software packages...Contd.



- Platforms used UNIX, WINDOWS, LINUX
- Technologies Client/Server, COM/DCOM
- Languages used C, C++, VB, VC++, JAVA, C#
- Databases SQL Server, ORACLE
- ALL C/O S/Ws follow ISPD guidelines based on IEEE12207.
- Well defined process of reviews, tests and systems level T&E before deploying for any S/C checkout operations.
- > Total migration to *LINUX* is in progress



- ACSS is a set of software packages in conjunction with the associated hardwares required for a spacecraft testing
- ACSS has standardized interfaces with the hardwares that support automation
- ACSS uses Checkout Command Language (CCL) for generating S/C test procedures.

### **ACSS FEATURES**

- Single Point Control
- Multi-stream, multi-format Data Acquisition
- In-house developed Checkout Command Language (CCL) to generate Test Procedures TM Page Display System
- Multi-user operation
- Commanding
- Real-time graphical visualization
- Archival, retrieval, and playback
- Uses Standard database for TM,TC and Configuration
- Modular data processing
- Network data distribution
- CCSDS Compliant







#### ACSS CAPABILITIES



## **Test Procedure**

File Name: MMU-Cable.Tst This procedure is to verify commanding through Cable link

- 10 TESTNAME MMU-Cable.Tst
- 20 REMARK CHECK RF/CABLE ENABLE SWITCH IN CABLE
- 30 REMARK I NTERFACE UNIT
- 40 DISPLAY TTC
- 50 EXPECTED Test-Cmd-Sts= Enable
- 60 SEND MMU-TST-CMD-Set
- 70 EXPECTED DECODER-TEST = Disable
- 90 SEND MMU-TST-CMD-Rst
- 100 REMARK BOTH COMMANDS TESTED THROUGH CABLE &

110 END

SEND MMU-TST-CMD-SET C9002044 SEND MMU-TST-CMD-RST C9002044	а ок 4 ок	
Sub sus :	TEST SEQUENCER	
Step : Inst :END	Gsat4 Dis-Asm Test :	Wed,15-JUL-2009 10:11:20 Mode : Interactive
DECODER: 1 Source : CHN-1, Enc_Sel: 1, 1, 0 TM CHK :	TC_Mode: ON_OFF CRP_Sts: SRC_Sel: 1 Fr_Miss: To Sent:	
TCL nfm: TCL_cnt1: AuxReg1:	Tc_Echo: No_chg : Tc_cnt2: AuxReg2:	
Test file : []		

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## **ACSS TASKS**

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LINEW TRSTS

SUPPORT SOFTWARE PACKAGES

TASK OFFLINE SOFTWARE PACKAGES Off - RET (TC, Test, Stimuli)



### CHECKOUT COMMAND LANGUAGE(CCL)



- In-house designed and developed test language for checkout purposes.
- Simple **ENGLISH LIKE** Instructions
- Enables checkout engineer to prepare the test files well in advance.
- CCL instructions support commanding, checking TM parameters, instrs. for Control of EGSE, Instrs. for Display, PLOT, Print of results etc.
- CCL has instructions to link test files, provide Remarks
- Procedures written in CCL can be executed in AutoMode, SingleStep Mode or Interactive Mode





# Automatic Test Scheduler

- Test Schedule preparation
- Test Schedule Receiver & Validation
- Schedule queues , Scheduler Table
- Scheduling and Execution
- Automatic Test Report Generation
- Limit Profile Definition
- Test Schedule Manager

# Automatic Test Scheduler





#### > ADVANTAGES ACHIEVED BECAUSE OF IMPROVED AUTOMATION:









## CONCLUSION AND FUTURE DIRECTIONS

### **Conclusions:**

- It's important to Automate to Improve Overall Reduction in Testing time with less manpower and for error free operations
- Helps in saving costs and creating *Knowledge Base* for Satellite testing.

#### **Future Directions:**

- MULTI SEQUENCING to parallel tests on different subsystems simultaneously
- **DATAMINING** concepts to improve s/c data analysis
- Design of an **EXPERT SYSTEM** for s/c testing



