NASA E3 Y2K ACTIVITIES

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NASA-WIDE EEE ACTIVITY SUMMARY

- NASA HEADQUARTERS: Shuttle Program EMC Safety Investigation.
  Unmanned Spacecraft Grounding Architecture and On-orbit Internal Charging Mitigation Handbooks. SEE Program Oversight & Funding.
- MSFC/SEE: Integrated Circuit Electromagnetic Immunity Handbook.
  Suplement to 1999-issue on Electrical Switching Transients.
  EMC Design/Control Handbook & Environmental Workbench.
- JSC: Shuttle Program External Environment Definitions.
  Box-level Interference Analysis & Safety Margin Definitions.
  ASRS Incident Database & Shuttle Program EMC Program Safety.
- GSFC: Spectrum Needs for SAR Systems & TDRS Downlinks.
  EMC Testing Flight Hardware Failures. Power Supply Protection.
  Facility & Instrumentation Modernization & Anechoic Conversion.
- KSC: ISS Multi-Element Integration Testing at KSC.
  ISO 14302, EMC Standard for Space Systems Compatibility.
  NWI 214, EMI Test Methods for Spacecraft.

NASA HEADQUARTERS SAFETY

- Shuttle Program EMI Safety Investigation. Triggered by White Paper Complaint to OSC. Earlier Report to NSRS/ASRS Not Resolved.
- Concerns based on Numerous Box-level Interference Exceedances and Planned Conversion of Shuttle Fleet to Modern "Glass" Cockpits. Radiated Susceptibility Test Specification at 1V/m.
- 6-dB "Safety Margin" (Successful Susceptibility Test Levels vs Box-level Generated Interference Signal Levels) not Feasible to Prove.
- History of 100 Successful Flight Missions with only Minor Nuisance Interference. Comprehensive Test Program Planned for Glass Cockpits.

Headquarters Sponsored Technical Documents

- NASA Handbook 4002 "Avoiding Problems Caused by Spacecraft On-Orbit Internal Charging Effects"
  - Problem Avoidance – no interaction between electronic systems & space plasma.
  - Geostationary Electron and other Earth Plasma Environments
  - Charging Analyses; Test Methods; & Data Sources

- NASA 4001 "Electrical Grounding Architecture for Unmanned Spacecraft"
  - Power Distribution System and Ground Fault Isolation of Main Power Bus
  - Power Sources and Power Users
  - General Interface Signal Circuits and Attitude Control Systems
  - RF Interfaces, Pyro Firing Units, and Special Devices

- SEE Program "Space Environmental Effects" and NSRS/ASRS

MSFC E3 ACTIVITIES

- Home of Space Environmental Effects Program – HDQTRS FUNDED
  - Released New "Integrated Circuit Immunity Handbook" and Supplement to 1999 "Switching Transients Handbook".
  - Previously Published (6/95) MEDIC 153-p EMC Design and Interference Control Handbook. (CDDF Final Report, Project #93-15)
  - Developing Bonding Standard for NASA-Related Issues
  - Also Numerous Space-Environment Documents not Related to EMC.
- Home of the Environmental Workbench
  - Defines Orbit-related Parameters for Variety of Environments
  - Interactive Windows-Based Application Package

KSC/ISO E3 Activities

- Monitoring RF environment on Pad 17 from 100 MHz – 40 GHz. Controlling environment especially above 16 GHz for Microwave Anistropy Probe payload.

- ISS Multi-Element Integration Testing II is underway at KSC with participation from JSC and MSFC. Current measurements and Bulk Current Injection (BCI) are being performed at many ISS interfaces to ensure compatibility.

- ISO 14302, Space Systems Electromagnetic Compatibility Standard is ready for Draft International Standard voting, but is awaiting the French translation before Final voting can occur.

- NWI 214, EMI Test Methods for spacecraft equipment is being proposed as a new standard by Germany. The vote will occur this spring. If accepted, it will be crucial for EMC engineers knowledgeable in test methods to participate on the standard.

GSFC E3 ACTIVITIES

- Goddard Environmental Verification Specification Update
- Modernization and Anechoic Conversion of the Large EMC Test Facility
- Increased Functionality of the 40-ft Coil Magnetic Test Facility
- Flight Hardware Test Failures During Conducted Susceptibility Testing
- Problems Related to TWT Amplifiers for Radiated Susceptibility Testing Above 18-Ghz.
- Dipole Moment Testing in Earth's Magnetic Field Environment
- Quiet Ground Specification and Installation

JSC E3 ACTIVITIES

- Shuttle Program External Environment Definitions
- Box-Level Interference Analysis Techniques
- Test Facility Upgrade Requirements for Mil-Std-461E
- Implementation of Shuttle Safety Investigation Recommendations

Shuttle EMI Requirements Upgrade

- Tailor Mil-Std-461E Requirements
- Incorporate Applicable Common Requirements with ISS
- Complete the Definition of All Operational Environments
  - Launch/Landing Environments Critical
  - Relative Significance of On-orbit Possible Interference Sources
- RF environment data used to define RS103 and CS114 test limits.

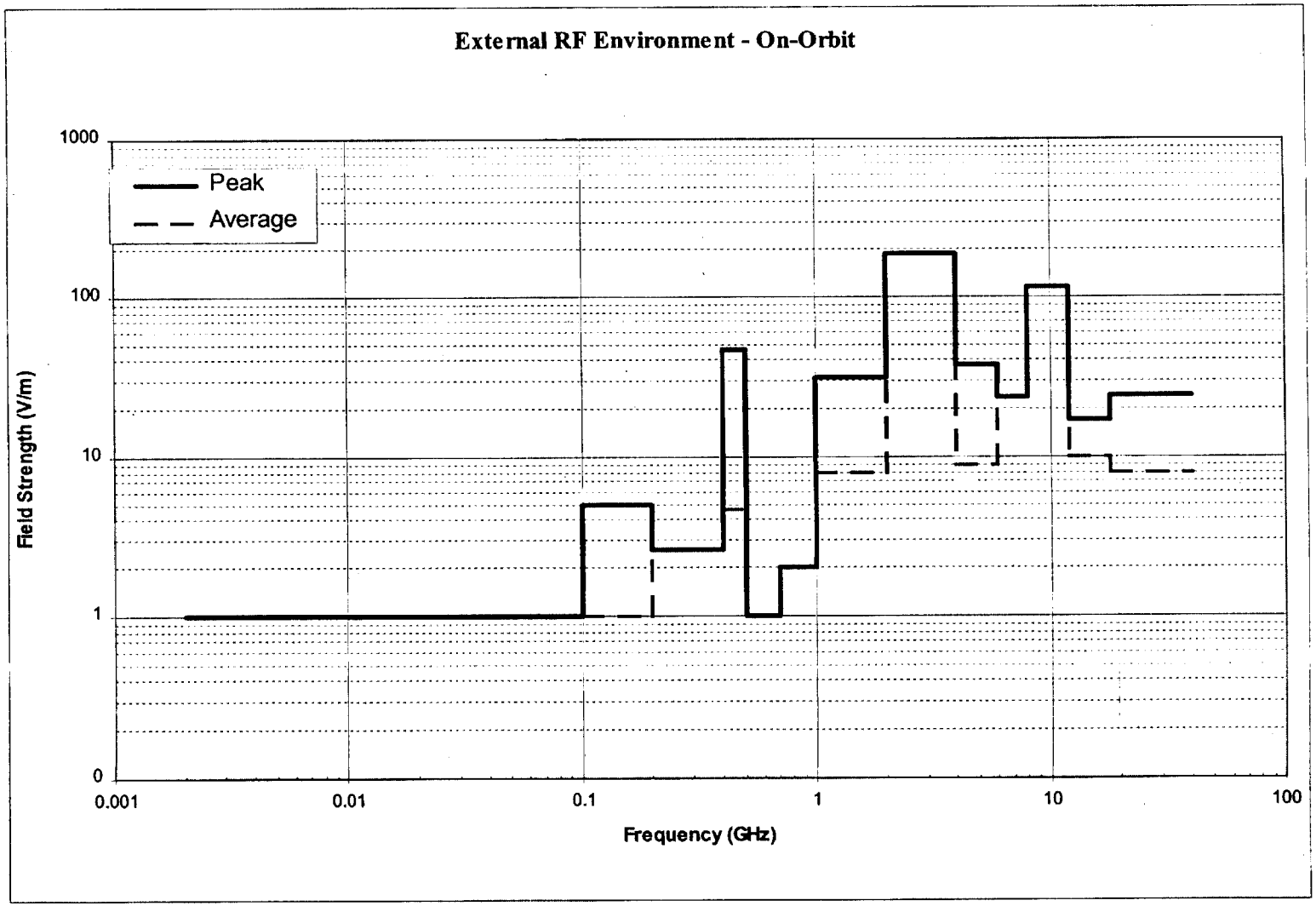
SSV External Launch Environment Summary

EXTERNAL RF LAUNCH ENVIRONMENT		
	FIELD STRENGTH (V/m)	
FREQUENCY BAND	PEAK	AVERAGE
2 - 35 MHz	1	1
35 - 70 MHz	13	3
70 - 100 MHz	1	1
100 - 200 MHz	1	1
200 - 400 MHz	1	1
400 - 500 MHz	7	5
500 - 700 MHz	1	1
700 - 1,000 MHz	1	1
1 - 2 GHz	2	2
2 - 4 GHz	17	9
4 - 6 GHz	214	6
6 - 8 GHz	5	5
8 - 12 GHz	17	3
12 - 18 GHz	14	2
18 - 40 GHz	1	1

SSV External Landing Environment Summary

EXTERNAL RF ENVIRONMENT		
LANDING		
	FIELD STRENGTH (V/m)	
FREQUENCY BAND	PEAK	AVERAGE
2 - 35 MHz	2	2
35 - 70 MHz	7	2
70 - 100 MHz	1	1
100 - 200 MHz	3	3
200 - 400 MHz	1	1
400 - 500 MHz	1	1
500 - 700 MHz	1	1
700 - 1,000 MHz	4	1
1 - 2 GHz	58	5
2 - 4 GHz	221	68
4 - 6 GHz	614	27
6 - 8 GHz	107	54
8 - 12 GHz	622	261
12 - 18 GHz	123	53
18 - 40 GHz	19	6

SSV External On-Orbit Environment



GSFC New Technology Spectrum Needs

- Search and Rescue using Synthetic Aperture Radar
- Global Personnel Recovery System using GPS
- Advanced Communications
- Advanced Space Operations Mission Office

Remote Sensing Using Search & Rescue SAR

Wide area, all weather, day/night searches of remote areas by high altitude aircraft or satellite

Used when radio beacons fail to operate (75% fail)

Low frequency radar penetrates forest canopy

Greatly improved response time in difficult searches

- Reduce search time from weeks to hours

Spectrum Requirements (200 - 1200 MHz):

- UHF - Foliage penetration
- L-Band - Improved Geographic Mapping
- Frequency Coordination required, but SARs used in extreme remote areas only

National SAR Committee (NSARC) GPRS

- National SAR Committee (NSARC) - R&D Working Group, in cooperation with U.S. DOD, is developing *Global Personnel Recovery System* (GPRS) as a significant improvement to both civilian and military satellite-aided Search and Rescue.
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  - Superior performance and global detection and location
  - Full constellation could be in orbit in 15 years
- Concept
  - Public Segment provides:
    - 406 MHz "bent-pipe" repeaters on future GPS satellites
    - Fully compatibility with existing and future 406 MHz beacons
    - 406 MHz downlink freely available internationally
    - Possible two-way return link using S-Band

Advanced Communications

Demonstration Using TDRSS

Primary objective is to demonstrate the SOMO Technology Commercialization hardware end to end, applicable to multiple types of data such as SAR2, Medical, and Earth and Space Sensor Images using the NASA/GSFC Radio Frequency Simulation Operations Center (RF SOC).

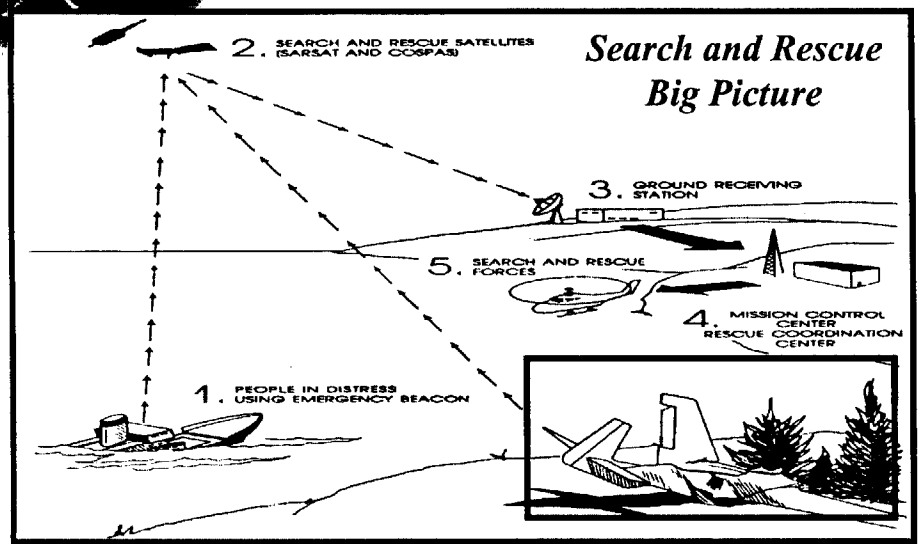
Develop telemetry ASIC components which will enable operation up to 600 Msps channel; such as packetizer, Virtual channel generator and multiplexer, Reed-Solomon Encoder/Decoder, and FQPSK,OQPSK or 8PSK modulation

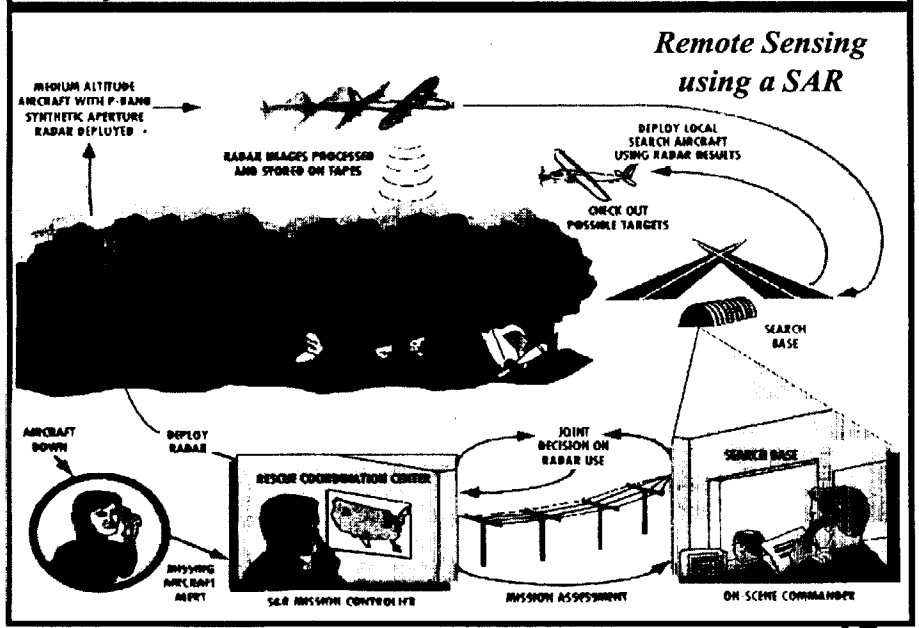
Integrate and test with a Ka-Band phase array antenna and the all digital parallel receiver with data acquisition board using the RF SOC.

Spectrum requirements

Demonstration will be done at Ka-Band. Reverse banding will be used, however permitted in the TDRS H,I, &J Spectrum Certification from NTIA

Search & Rescue - Synthetic Aperture Radar



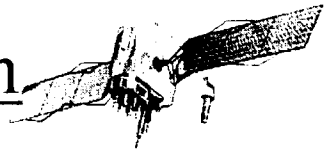


Search and Rescue Synthetic Aperture Radar (SAR)²

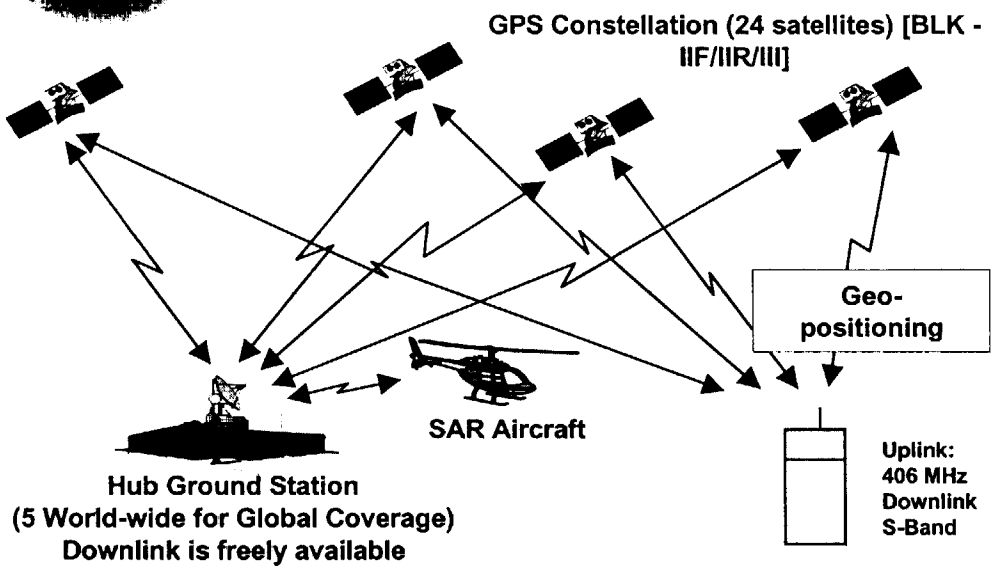
SAR² System Requirements

- **Minimum of one frequency band: between 200 to 1200 MHz (TBD), but desirable to have two simultaneous bands, such as UHF and L-band. C-band would also be desirable to allow improved geographic mapping.**
- **Simultaneous recording in full polarimetric mode for each radar band**
  - **At least four recording channels per radar band (HH, HV, VH, VV)**
  - **requires eight simultaneous recording channels, if two bands are provided**
- **Need 0.75 - 1.5 meter resolution, with wide swath width**

Global Personnel Recovery System



ersonal Recovery System (GPRS) - Public Segment



Concept

- State-of-the-art combined military/government and public search and rescue system carried by future GPS satellites
- Public Segment provides:
  - 406 MHz "bent-pipe" repeaters on future GPS satellites
  - Fully compatibility with existing and future 406 MHz beacons
  - 406 MHz downlink freely available internationally
  - Possible two-way return link using S-Band (part of military/government segment)

Current Status

- GPRS is a natural follow-on to 1970's developed Cospas-Sarsat program
- NASA attempting to fund and support Public Segment prototype development
  - Study underway to confirm GPRS system performance in terms of location accuracy, link margins, capacity and optimal location algorithms
  - GPRS is presently being considered for funding as new NASA initiative beginning in FY01
    - Funds complete space segment
    - Single prototype ground station
- GPS Public Segment satellite hardware is designed and space qualified
- Potential first GPRS equipped satellite launch in 2005
  - IOC Status attained five years after first launch
    - Data would immediately augment Cospas-Sarsat
  - FOC Status attained after ten years
- Two-Way link NOT included until Government segment is approved