FORMOSAT-3/COSMIC Program Status

National Space Organization
Taiwan

August 24, 2005
Program Matrix

**FORMOSAT-3/COSMIC**

- **Launch Vehicle Services**
  - USAF/OSC-LSG
  - Minotaur Launcher

- **Space Segment**
  - **Spacecraft Bus**
    - Orbital/NSPO Constellation MicroSat
  - **Payload**
    - Orbital /JPL/ NRL GPS/MET Receiver (GOX)
    - Tri-Band Beacon (TBB)
    - Tiny-Ionospheric Photometer (TIP)

- **Ground Segment**
  - **NSPO Ground System**
  - **Fiducial Network**
  - **Oversea Ground Station**
    - UCAR Fairbanks / Alaska
    - Kiruna/ Sweden

- **Science Data Center**
  - **TACC**
  - **CDAAC**
    - CWB/NSPO At Central Weather Bureau, Taiwan
    - UCAR At UCAR

- **Science Teams**
  - **Taiwan Teams**
  - **Foreign Teams**
    - UCAR TACC CDAAC
    - NSPO Weather/ Climate Group
    - Ionospheric Research Group
    - Geodesy/ Engineer Science Group

**CDAAC**: COSMIC Data Analysis and Archive Center
**TACC**: Taiwan Analysis Center for COSMIC
System Architecture

6-Satellite COSMIC Constellation

TT&C

RGS MMC

Operations

NSPO/ RGS

RTS Kiruna

RTS Fairbanks

TBB Stations

NMC USN

TACC (CWB)
Taiwan Analysis Center for COSMIC

CDAAC
COSMIC Data Analysis and Archive Center (UCAR)

Science data

Archived Data

RT SOH Backup Command

S band

S band

S/S band

L band

UHF/VHF

Universities & Science Teams

NSPO Science Research Program

Domestic & Foreign Users

U.S. Universities & Mission Teams

UCAR Science Center

U.S. Users

U.S. Universities & Mission Teams

NSPO Science Research Program

Domestic & Foreign Users

U.S. Universities & Mission Teams

UCAR Science Center

U.S. Users
## FORMOSAT-3 Master Schedule

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<th>Item</th>
<th>Task</th>
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### Notes:
- PMR: Project Management Review
- ICWG: Inter-Committee Working Group
- MOWG: Mission Operations Working Group
- FDR: Final Design Review
- TDR: Technical Design Review
- ED: Engineering Design
- SAR: System Acceptance Review
- RFCT: Reduced Flight Characteristics Test
- ETE: Environmental Test Evaluation
- ORR: Operational Readiness Review
- GRR: General Readiness Review
- FRR: Flight Readiness Review
- PSR: Project Status Review
- CDR: Critical Design Review
- ET: Environmental Test
- SIT: System Integration Test
- SAT: System Acceptance Test
- O-Sim: Operational Simulation
- FR: Factory Readiness Review
- SW v1: Software version 1
- SW v2: Software version 2
- ETE#1: ETE Event #1
- ETE#2: ETE Event #2
- ETE#3: ETE Event #3
- FM1: Flight Model 1
- FM2: Flight Model 2
- MMC: Mission Management Center
- NSPO: National Space Organization
- TMD: Test Mission Design
- TSB: Test System Build
- TSP: Test System Program
- TSS: Test System Support
- TSO: Test System Operations
- TST: Test System Testing
- TMC: Test Mission Control
- TMR: Test Mission Reporting
- TMR: Test Mission Review
- TBD: To Be Determined
- S/W: Software
- H/W: Hardware
FORMOSAT-3 Satellite

- **Mission Life**: 2 years minimum.
- **Design Life**: 5 years.
- **Constellation**: consist of 6 satellites.
- **Weight**: 70 Kg/each (including propellant).
- **Dimension**: diameter 103 cm, height 16 cm; with two circular solar panel deployed at 121 degrees and 59 degree.
- **Payload Instrument**:
  - GPS Occultation Receiver (GOX) By JPL
  - Tiny Ionospheric Photometer (TIP) by NRL
  - Tri-Band Beacon (TBB) by NRL
- **Orbit Period**: ~100 minutes.
- **Mission Orbit**: circular orbit, altitude 700-800 Km, inclination 72 degree.
FORMOSAT-3 Satellite Development

- FM1 was assembled and tested, with participation of NSPO engineers, at Orbital and delivered to NSPO in July 2004.

- FM1 went through additional tests at NSPO.

- Kits for the remaining five satellites were shipped to Taiwan in summer 2004 for integration and test by NSPO team.

- NSPO started I&T work on June 1, 2004.
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<th>FM 1</th>
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Alignment Test
Magnetic Calibration
Solar Array Deployed Configuration

FM4 (Left)  FM6 (Right)
Stacked Configuration for Dynamic Test
Stacked Configuration for Acoustic Test
NSF/UCAR at NSPO I&T Facility
Launch Operation

- **USAF Minotaur LV**
  - NSPO Funded $15 M and DoD STP Funded $4.5 M
  - Three successful launches in 1/00, 7/00, and 4/05
  - Launch vehicle development in progress

- **Launch Campaign**
  - Launch site survey and range working group meeting held in August 2005
  - Launch window is being coordinated with USAF
  - Complete S/C readiness for shipment by yearend
  - The launch site operations will take approximately 75 days
Launch Vehicle (1/2)

- USAF Minotaur LV
  - The LV consists of 4-stages solid fuel motor
  - Total height: 19.21 meter
  - Total weight: 36.2 tons
- Three successful launch since 2000.
Mission Parameters
Payload Mass: NTE 416 kg
not including the SRSS
Orbit Altitude: 500 km x 537.5 km at 72+0.2,-1.0 deg

Launch Site
Vandenberg Air Force Base, CA

Launch Vehicle (2/2)

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Ground System (1/2)

- **Multi-Mission Center**
  - Upgrade NSPO system to accommodate the mission operations of FORMOSAT-3 constellation.
    - System integration and test completed in October 2004.
    - Operation readiness review successfully conducted in March 2005.

- **TT&C Stations Upgrade**
  - Upgrade Taiwan TT&C stations with CORTEX, Up/Down Converters, and Monitor and Control Unit.
    - System integration and test completed in October 2004.
    - The systems have been in operation since May 2005.
Ground System (2/2)

- Remote Tracking Stations
  - Construct RTS sites in Fairbanks, Alaska and Kiruna, Sweden.
    - Complete system acceptance test in September 2004.
    - Establish communication line (VPN/ADSL) between Mission Control Center and RTS.
    - End-to-end test is on-going.
Multi-Mission Center at NSPO
TT&C Stations at Northern/Southern Taiwan

S/S-Band TT&C Station (NCKU, Tainan)

S/S-Band TT&C Station (NCU, Chung-Li)
Remote Tracking Stations

RTS at Alaska

RTS at Kiruna
Ground Communication Network and Science Data Flow

- **Command:**
  - Normal: MMC → TT&C → SC
  - Backup: MMC → NMC → RTS → SC
- **Telemetry:**
  - Real-time:
    - SC → TT&C → MMC
    - SC → RTS → NMC → MMC
  - Back Orbit
    - Normal: SC → TT&C → MMC
    - Backup/L&EO:
      - SC → RTS → NMC → MMC
- **Payload science data (GOX & TIP)**
  - SC → RTS → NMC → CDAAC
- **Other science raw data (GPS FID, TBB)**
  - FIDNET → CDAAC
- **Science data Re-transmission**
  - CDAAC → TACC

*The system is expected to receive ~200 occultation events for every orbit. The system will then process, archive, and transmit within 3-hours to weather forecasting models.*
FORMOSAT-3 Deployment Timeline

Altitude (km) vs. Days after launch for different satellite components SC#1 to SC#6.
Payload Checkout Plan

- **Set up S/C configuration**

- **Launch**
  - L+0.5 day: Start SC Checkout
  - L+7 day: Start GOX Checkout
  - L+9 day: Start TIP Checkout
  - L+10 day: Start TBB Checkout

- **Mission Simulation**
  - L+20 day: Start Test Burn (PL are beep mode* during burns)

- **Complete SC Checkout**
  - L+52 day

- **PL Beep mode:**
  - GOX at Beep mode
  - TIP and TBB at Off mode
Data Policy (1/2)

- The Data Distribution Policy is effective for the first two years.
- FORMOSAT-3/COSMIC data will be provided at no cost or at the cost of reproduction and distribution.
- A “data use agreement” is required for the use of data and products.
- Users will register through Taiwan (TACC) site.
- The review and approval are to be made jointly by both NSPO and UCAR.
The neutral atmosphere data products will be distributed near real-time after processing to NESDIS which will distribute via the GTS to weather centers.

All Data and Product are available each day for Science Research.

The raw FORMOSAT-3/COSMIC data (e.g., GPS phase and amplitude data) will not be distributed in real time. Requests for the real-time raw data will be reviewed jointly by the NSPO Director General and the UCAR President.

Some additional limitations may be placed on data products at the request of the specific Principal Investigator’s requiring data check-out times.
Conclusions

- Satellite I&T are progressing well.
- Ground system upgrade is completed.
- Mission operation simulation and training are on-going.
- Launch vehicle development is on track.
- Range operation activities are being coordinated.
- Launch target date is March 2006
  ✓ Launch slot finalization still needs coordination among all parties.