TDRS-K
Level 6 Testing

For Users Participating in

Level 6 End-to-End Services

On-Orbit Testing

September 12, 2012

cheryl.j.gramling@nasa.gov

Network Updates Include TDRS K for User Services

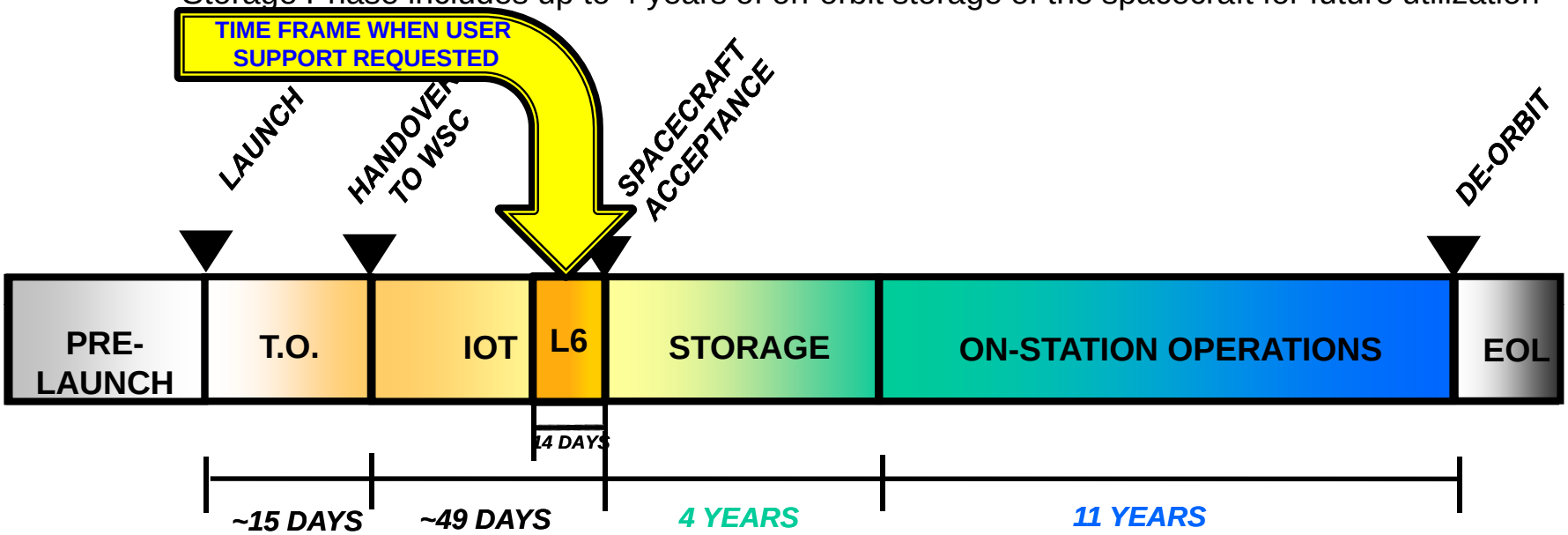
- **NCCDS database updates for TDRS K, L, M for user scheduling**
  - NCCDS modifications complete.
  - (Scheduling of TDRS K-M is currently disabled in the NCCDS.)
  - SNAS Release 5 includes database updates to support TDRS K; ORR slated for November 2012.
    - ORR preceded by an acceptance test period. Customers to participate in SNAS acceptance testing.
- **Flight Dynamics Facility updates for TDRS K, L, M for relay and user orbit determination services and acquisition data**
  - All modifications to accept and process TDRS-K tracking data ready for operations.
  - Updates for acquisition data generation ready for operations.

Current Status on TDRS-K & -L

- TDRS-K prepared to ship to Cape Canaveral end of September; ship early November
- TDRS-K Launch – No Earlier Than December 13, 2012
- TDRS-L preparing for antenna integration
- TDRS-L – vibe late November 2012

TDRS-K Operational Lifetime

- TDRS K spacecraft have mission life of 15 years after IOT
  - Storage Phase includes up to 4 years of on-orbit storage of the spacecraft for future utilization



  - Pre-launch Phase
  - Transfer Orbit (T.O.) includes the time between launch and handover to WSC.
  - In-Orbit Test Phase (IOT) includes the bus and payload testing, Spacecraft/WSC compatibility, and ***Space Network Level 6 E2E testing at WSC including users***.
  - On-station Operations includes the utilization of spacecraft with payload on and ACS in service mode.
  - End of Life (EOL) is the boost from GEO and shutdown of the spacecraft.

User support requested starting at Launch+50 days through Launch+64 days

TDRS Environment for Level 6 Testing

Location:

- TDRS-K spacecraft will be located at ~150° West longitude for On-Orbit Testing (approximately over Hawaii)
- Geosynchronous orbit; 7° inclination
- During OOT, TDRS-K spacecraft will perform all maneuvers necessary to maintain longitude box and momentum state

Test Operations:

- Minimum 5 days per week, 16 hours per day, 2 week duration;
- Considering increasing time to 24hrs x 14days to accommodate user contacts on a non-interference basis to users
- RF compatibility verified prior to contacts with user
- Transmissions from WSC to external entities verified prior to contacts with users
- Test environment, therefore, no guarantee of service
- Notification to users at 23 days prior to start of L6
  - Allows time to schedule contacts

Requests to Users

- Schedule TDRS-K time on a non-interference basis to nominal SN contacts
- Determine how much time per day you can schedule TDRS-K contacts outside of nominal mission requirements
  - Provide minimum and maximum availability and constraints (e.g. no more than 2@40-minute contacts within 2 hour period) to cheryl.j.gramling@nasa.gov by end of October, 2012.
- Provide prioritized listing of operational modes and associated constraints
  - TDRS-K can ensure RF compatibility prior to direct user contact
- Complete User Report for each contact
  - Report format under development; quick-look format; to be provided to users prior to testing
  - Highlight problems or concerns

BACKUP

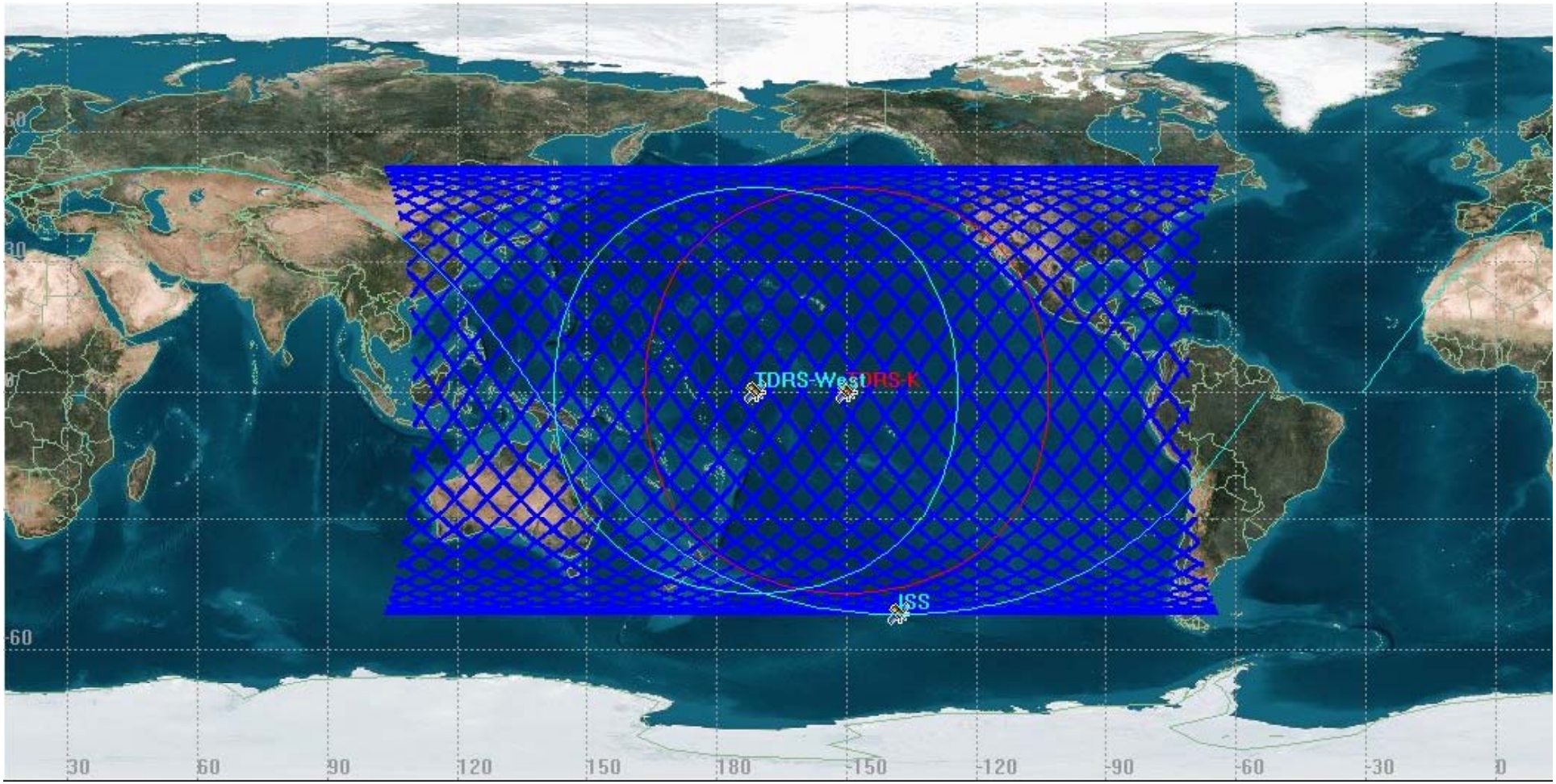
Level 6 Test Summary (1 of 2)

Test	Test Description
Multiple Access Beamforming Equipment (MABE)/Demand Access Service (DAS)	Use EET system and Targets of Opportunity to validate MABE and DAS support; characterize forward and return performance; evaluate bit error counts, BER vs Eb/No curves, carrier to noise ratios, beam angles, tracking data. **Customers: schedule SMA communication and tracking services on TDRS-K, potential as shadow support to TDRS in west location**
S-band Single Access (SSA) Services	Use EET system and Targets of Opportunity to validate SSA support; characterize forward and return performance in DG1 and DG2; evaluate bit error counts, BER vs Eb/No curves, carrier to noise ratios, beam angles, tracking data. **Customers: schedule SSA communication and tracking services on TDRS-K, potential as shadow support to TDRS in west location**
Ku-band Single Access (KuSA) Services	Use EET system and Targets of Opportunity to validate KuSA support; characterize forward and return performance in DG1 and DG2; evaluate bit error counts, BER vs Eb/No curves, carrier to noise ratios, beam angles, tracking data. **Customers: schedule KuSA high rate program track communication and tracking services on TDRS-K, potential as shadow support to TDRS in west location**
Ka-band Single Access (KaSA) Services	Use EET system and Targets of Opportunity to validate KaSA support; characterize forward and return performance in DG1 and DG2; evaluate bit error counts, BER vs Eb/No curves, carrier to noise ratios, and beam angles. **Customers: schedule KaSA on TDRS-K, potential as shadow support to TDRS in west locat**
Simultaneous MA/SA Services	Use EET system to verify there is no interference between SSA and MAFservices; measure MAF passive intermodulation (PIM) across SSA frequency range and antenna pointing geometries
SA Antenna Pointing Disturbance (series)	Use EET system and Targets of Opportunity to verify attitude control system provides adequate compensation to accurately point the SA antenna when the TDRS-K undergoes a disturbance (SA antenna slew, maneuver, solar array motion, combination); evaluate under max acceleration/deceleration; evaluate gimbal angles, pointing error, body attitude and rate errors, tracking data **Customer: schedule service on TDRS-K KuSA w/tracking data**
Simultaneous SA Antenna Slew	Use EET system and Targets of Opportunity to verify worst case slewing of SAs will not impact Space-to-Ground link or MAR beam pointing; monitor SGL unit vector, body attitude, and P-receive on MA

Level 6 Test Summary (2 of 2)

Test	Test Description
Simultaneous SA Services for Launch Support	Verify TDRS-K and ground systems processing of vector and maneuver sequences for launch support; potential to use launch vehicle as Target of Opportunity, otherwise use simulated vectors for launch sequences **Customer: Launch vehicle at western range, with shadow support from TDRS in west location**
Extended Elliptical Field of View (EEFOV) SA Antenna	Use EET and simulated sequences or Target of Opportunity to demonstrate that EEFOV operations will not delay start of a customer SHO event, also analyze SA antenna thermal profile; from max outboard angle perform interservice slew to EET; monitor lock status, evaluate gimbal angles and tracking data **Customer: Schedule EEFOV service on TDRS-K with tracking data (THEMIS-type)**
Sequential Loading to Full Service Load	Use EET in DG2 to add services sequentially to verify that incrementally adding services to TDRS-K SGL does not degrade services; monitor BER vs Eb/No, gimbal angles, tracking data, if available
Simultaneous Loading of Full Service Load	Use EET to demonstrate simultaneous scheduling and support of all available services, resulting in a worst-case command load uplink to TDRS-K, does not adversely impact customer support **Customers: schedule SSA communication and tracking services on TDRS-K, potential as shadow support to TDRS in west location**
KSA Autotrack Acquisition	Use EET and Targets of Opportunity to verify autotrack support requirements; after established service, off-point SA antenna by the pull-in radius, then enable autotrack; measure C/No; perform in both Ku- and Ka-bands **Customer: schedule SA2 or MA services on TDRS-K, and configure customer mission to match test conditions**
Thruster Calibration	Perform a series of small operationally representative maneuvers to calibrate the thrusters for operations
Operational Handover from K-band SGLT to S-band TT&C and Return	Demonstrate monitor and control of TDRS-K during Ku-band to S-band TT&C handover; no user services involved
Flight Dynamics Facility Navigation Acceptance	Use all available radiometric tracking data, vector-driven events, gimbal angles, and Operations Messages throughout the Level 6 test period to verify that the interfaces and data required for navigation and network service support meet specifications. **Customer: Support is scheduled throughout Level 6 test period**

Overlap Visibility Between TDRS 171 and TDRS-K for Level 6 Testing



The blue ground track indicates the overlapping visibility region between a TDRS at 171° West and a TDRS at 150 ° West for a 500 km 51° inclination user.

(Red circle is TDRS-K unsteered MA beam; blue circle is same for TDRS-W)