

DATE: September 12, 2012

LOCATION: Regents Park III

SUBJECT: HSF NSG EFT-1 and EFT-1 Network Overview Splinter Minutes

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INTRODUCTION

Mr. Mike Marsh convened the September 12, 2012, Network Support Group (NSG) Exploration Test Flight (EFT)-1 and EFT-1 Network splinter meeting to provide an updated EFT-1 overview and discuss EFT-1 support requirements and Integrated Network (IN) support requirements (refer to the presentations, *EFT-1 Network Status Splinter Meeting*, *Space Network [SN] Low-Density Parity-Check [LDPC] Code Implementation [SLI]*, and *EFT-1 Voice Proposed Changes*).

MEETING

- A. The EFT-1 Orion will be launched on a Delta-IV heavy. The Launch Abort System (LAS) motor will be inert while the separation motor will be operational. There will be no Orion communications with the Tracking and Data Relay Satellite (TDRS) for approximately the first 6 minutes of the flight until LAS separation.
- B. Critical periods are from launch through separation/landing. Essentially, the entire mission will be considered a critical support (approximately 4.5 hours). Mr. Steve Jordan noted that the Orion will have no mobility control until separation; the Delta upper stage will be in control for most of the mission.
- C. Mr. Marsh reviewed some discussion points. Launch will occur in daylight. The LAS covers the Crew Module (CM) antennas blocking the view to TDRS until LAS separation. The vehicle will experience a number of BBQ rolls for thermal control as there are no solar panels; the antennas will switch every 3 minutes. There will be 25 ms dropouts at each antenna switch which will be an EFT-1 only configuration. Ms. Kim Simpson stated that this needs to be characterized during the Live Sky tests. There will be very few commands from the Mission Control Center (MCC); the vehicle will be auto-sequenced. The Orion transponder will operate in the non-coherent mode.
- D. Mr. Marsh reviewed the Feb 2012 Interim reference Trajectory diagram. There will be an approximately 6 minute LAS blockage period on launch. There will be a 6 minute 15 second Zone of Exclusion (ZOE). There will be an S-band blackout during re-entry. West coast C-band radar will **not** have view of re-entry. KWAJ has view, but is very expensive. Ephemeris will be provided by the Launch Vehicle (LV). Mr. Joe Aquino stated that Johnson Space Center (JSC) had submitted a requirement for up to five C-band passes. A program decision has not been made on KWAJ. Mr. Gary Morse stated that a requirement is needed so that funds can be budgeted.
- E. Mr. Marsh discussed the 3-hour Launch Window Example. The launch windows are not known yet, but could be from 3 – 7 hours. A launch Scheduling Order (SHO) will begin at L-30 minutes. TD-46 will be needed for approximately 6 hours and TD-171 for approximately 7 hours. Mr. Jim Bangerter stated that a waiver will have to be submitted for the TDRS extended coverage. The nominal timeline has Orion powering down at splashdown plus 15 minutes, but if conditions permit, a command will be sent from the MCC to extend the power-up period until 1 hour after splashdown. Single Access (SA) support will be needed for both Orion and the Delta LV. Overlapping SHOs will be needed for approximately 5 hours.
- F. Mr. Marsh reviewed new information items of interest. A Radio Frequency (RF) analysis was performed. TD-46 and 171 were used in the analysis. There is a communications gap as Orion passes through the Space Network (SN) ZOE. The gap is at approximately L plus 46 minutes. The gap is worst when both TDRS satellites are at their most northern

latitudes and shortest when both satellites are at their most southern latitudes. The gap is approximately 12 seconds at the southern latitude and 8 minutes 15 seconds at the northern latitude.

G. Mr. Marsh reviewed the schedules.

1. There is a MCC-21 blackout period from June – September 2014 for MCC-21 transition. At this time, EFT-1 is planned for April 2014. Ms. Simpson stated that there is a CR in the system to move the flight to September 2014. Mr. Bob Marriott stated that MCC-21 is on schedule. He stated that the SN Ground Segment Sustainment (SGSS) is on schedule for those dates. The previous plan for support is impacted if the CR is approved. Ms. Simpson asked if the impacts can be quantified. Mr. Marriott stated that there are funds associated with MCC-21. Mr. Gary Morse stated that Mr. Bill Marinelli would be the Point-of-Contact (POC) to discuss SGSS impacts.
2. Mr. Dave McGill stated that there is an action with the possibility of switching rooms by the time of End-to-end (ETE) test 03. It would be prudent to switch rooms prior to ETE-03 and Live Sky. Ms. Simpson stated that she thought this was in the window for the Low Density Parity Check (LDPC) capability without the rolling racks. Mr. Morse responded that the slip to September will not make a difference; SGSS is scheduled to be online Fiscal Year (FY) 15 and there are schedule problems with SGSS as well. It was stated that the Serial Conversion Processor (SCP) replacement will have an impact; leaving the configuration in the legacy mode will have an impact. Mr. McGill stated that JSC does not want a dual maintenance situation. Would be possible to switch EFT-1 to the new configuration now? Mr. Marriott stated that the last opportunity for an ETE test is when the vehicle is in the Operations and Checkout (O&C) building at L-6 to 9 months. If there are changes to the communications architecture, there needs to be a strategy for re-verification. Mr. McGill stated that this is why switching prior to the ETE and Live Sky tests is desirable.
3. Mr. Marsh reviewed the EFT-1 Flight Ops Overview schedule.
 - (a) The schedule contained major events of interest highlighted
 - (b) Two tests will be conducted with the Navy (one dry run and one underway test). Navy connectivity will be provided by DoD communications. Mr. Aquino stated that Det 3 will get data from the vessel to the West Coast to the Kennedy Space Center (KSC) Communications Distribution and Switching Center (CD&SC). This has not been finalized yet. If negotiations break down, then there will be a need to discuss Communications Service Office (CSO) NASA Integrated Services Network (NISN) services to the West Coast.
 - (c) The Flight Director (FD) wants a simulation in the MCC prior to the underway test.
 - (d) Mr. Morse noted that event number 1 is the Program Flight Readiness Review (FRR) and event 8 is the JSC Mission Operations Directorate (MOD) FRR.
 - (e) JSC would like to conduct as many mission rehearsals as possible.
 - (f) It is not known what capabilities will be available or what the data source will be. Ms. Simpson stated that there is no requirement to support downlinked Developmental Flight Instrumentation (DFI). There could be video on descent. Mr. Aquino stated that there is a DRAFT requirement in the Mission Support

Requirements Document (MSRD). Ms. Simpson stated that she has objectives for the stationary test that she will forward to Mr. Bangerter. The Live Sky test is scheduled for May. The O&C to MCC data flow will move out. There is engineering to be completed; there is an air gap that will be taken care of. Testing is tied to O&C power up. What is the operational sync point? Objectives need to be defined. The date will move out past the O&C power up. CM power up is March 2013.

- (g) Mr. Marriott asked if there are POCs for JSC and KSC engineering. Ms. Simpson stated that the requirement is in the LMSR. Mr. Vic Colaluca stated that KSC still needs SCPs from Dr. Norman Kluksdahl. Mr. McGill stated that there will be two things not exercised during the Live Sky test. There are Working Group (WG) meetings. Ms. Simpson stated that she will get engineering POCs to Messrs. Lee Zapp and Vic Colaluca.
 - (h) Mr. Aquino stated that KSC and CSO were pushed to provide a 3-Mbps link and now the tests are moving out. This should not keep happening.
 - (i) Live Sky and compatibility testing will be at Denver. Risk mitigation testing will occur prior to that in the March – April time frame. JSC will be operating out of the WFCR at that time.
- H. Mr. Dave Shefsky provided an overview of the White Sands Complex (WSC) LDPC initiative to support EFT-1.
1. Space Communications and Network Services (SCNS) Task Order (TO)-84 was begun in April 2011. EFT-1 will be supported, but without impacting high-priority SN projects. The EFT-1 support architecture is to be easily installed and removed.
 2. SN LDPC Code Implementation (SLI) will add ½-rate LDPC at WSC. There will be no ZOE support from the Guam Remote Ground Terminal (GRGT). There will only be S-band services; non-coherent without Tracking Data Messages (TDM) or User Performance Data (UPD). The Space-to-ground Link Terminals (SGLT) have not been selected yet. Pre-mission risk mitigation and compatibility testing will be supported as well as the approximately 4.5-hour EFT-1 mission. This will be an interim installation not connected to the entire SN architecture.
 3. Mr. Shefsky reviewed the SLI-supported data rates.
 4. Mr. Shefsky discussed the key EFT-1 mission characteristics impacting SN support. The ½-rate LDPC is not currently supported by the SN. The CM uses four Phased Array Antennas (PAA). The antennas slew at ½ degree per second. Dropouts are expected every 3 minutes.
 5. During SN transition, the Narrow Band (NB) modems lose lock and need to regain lock. The new modems are working on re-acquiring for longer than 24 ms outages. Ms. Simpson asked if the impact to the CPI protocol is being investigated. Mr. McGill stated that there will be a loss of packets. Mr. Shefsky stated that a Programmable Telemetry Processor (PTP) is being used to simulate data. The modem will drop frame. This should not affect one-way re-acquisition lock. Ms. Simpson asked if the frame drops are across the 3CI boundary. Mr. McGill stated that it will be dropped and not reconstructed. He asked if there will be a full file dump. Ms. Simpson stated that the loss needs to be characterized. Mr. Shefsky stated that the higher the data rate, the faster the re-acquisition. It is hoped that the drop can be limited to 2 – 5 frames.

6. When you receive LDPC data, it is error free. SGSS and User Services Subsystem (USS)-Component Replacement (CR) will add LDPC. SGSS will not be in time for pre-mission testing. USS-CR is buying new NB modems. These will only be at the White Sands Ground Terminal (WSGT) on SGLTs 4 and 5. The schedule does not support pre-mission testing or the mission schedule. WSC will borrow spare modems. An interim implementation will be used.
7. Mr. Daryl Hester asked if changes to the NB modem design for EFT-1 will be passed back to the USS-CR. Mr. Shefsky stated that there is only one minor firmware change to support EFT-1. He stated that he does not know if this will be passed back; although, it is likely it will be. Mr. Hester stated that EM-1 and -2 need to be considered as well. Mr. Morse stated that the thought is the 1/2 rate was a one-time use only. Mr. Shefsky stated that the modems support both the 1/2 and 7/8 rates. The timeline is important.
8. Mr. Marriott stated that the Multi Purpose Crew Vehicle (MPCV) configuration is not known.
9. Mr. Hester asked if there is a way for JSC to know if frames are not being received. Mr. Shefsky stated that the frame status will be monitored at WSC. JSC will be notified of any change of the download status from the modems to the SCPs. This will be a voice notification.
10. Mr. Shefsky reviewed the current SN configuration.
11. Mr. Shefsky reviewed the S-band Single Access (SAA) configuration. Only one chain will be used.
12. Mr. Shefsky reviewed the SLI interface architecture. The architecture supports any WSGT/Second TDRS System (TDRSS) Ground Terminal (STGT) combination. SLI equipment is only at WSGT. There will be one prime and two backup modems. The equipment will be isolated from legacy equipment.
13. Mr. Shefsky reviewed the SLI return and forward services. Mr. Marsh stated that only the SCP at WSGT will be used. Ms. Simpson asked if this provides redundancy. Mr. Marsh stated that there is redundancy. The ISS will have 3 SCPs and EFT-1 will have 3 as well. No additional equipment is needed for EFT-1.
14. Mr. Marsh stated that if overlapping SHOs were required, four SCPs would be needed. It is not possible to do overlapping SHOs in the three-SCP configuration. Mr. Aquino stated that the SHO could go to the end of the mission. Mr. Marsh stated that a Hand over (H/O) is needed. Mr. Marriott stated that the bottleneck is the switch. If there are two active events, select the stream. Mr. Bill Foster stated that a manual action is required. Mr. Rick Kraesig stated that if separate SHOs are scheduled, it is still manual. Mr. Glasscock stated that the operators will coordinate with the technicians at both sites. There will be a dialogue with the GC as to which source to use. Two SHOs can be run simultaneously. There will only be one manual change. Mr. Aquino asked if there is an issue with the TDRS not in view trying to track. Mr. Bangerter stated that there is software to handle that. This procedure will be tested. The first time this will be exercised is the Live Sky tests. WSC Technical Operation and Analysis (TO&A) will control the modems. There will be extensive training. Mr. Bangerter stated that there will be LOPs in place. Mr. Marriott stated that in initial testing there were a lot of issues that the POCs need to work out. Mr. Bangerter stated that TO&A is the POC, start with Mr. Glasscock's personnel.

- I. Mr. Marsh opened a discussion on MCC SCP management. There is one ground terminal for ISS and one ground terminal for EFT-1. The switch is made at the interface switch. Mr. Lee Zapp stated that Comm Control will have ISS status and control. There will be some 'red lights', but there will be situational awareness. Mr. Lipford stated that his group has no problem with this plan. Both terminals will be configured. The SCPs will be manually taken from ISS. The system will sense a failure. We will be aware of that. Will ISS only use the STGT TDRS? Mr. Bangerter stated that it will have to; when the ISS is on the WSGT TDRS, it goes through WSGT and there is no crossover. ISS events will have to be scheduled on STGT. Mr. Glasscock stated that WSC does not want to have to perform manual switching during ISS. Mr. Bangerter stated that it has always been assumed that TDRS would have to be configured in a certain way for testing and flight.
- J. Mr. Marsh opened the discussion on EFT-1 voice loops.
 1. Mr. Marsh stated that during the voice loop test there were dropouts; these need to be chased down by everyone. Ms. Sylvia Segura stated that KSC is waiting on Denver to connect all keysets. KSC will be adjusting the VOX level on the Mission Operations Voice Enhancement (MOVE) switch. When everyone is online, the levels can be adjusted during testing. Mr. Marsh stated that Mr. Ken Jones is confident the levels are the issue. Mr. Marriott stated that the MOVE default setting needs to be adjusted. He agreed that everyone needs to be online when this is redone. Ms. Simpson stated that full voice checks will be filled in during other data flow tests; conduct full performance testing. Ms. Segura stated that KSC does not want to do full performance testing until the voice levels are adjusted.
 2. Mr. Steve Jordan stated that there will be 24 voice loops extended to Denver. Loops from ULA will be extended. Range loops will be added. Mr. Jordan outlined proposed loop name changes. The loop names were provided by ULA. Ms. Segura stated that KSC will have to make the names match. She stated that historically, the Launch Director has his own loop. Mr. Brian Austin stated that he thinks the loops are available. Mr. Jordan stated that the MSRDR will be updated. He will work with Ms. Segura to verify the loop names and ensure there are no duplications. Mr. Marsh stated that the GSFC loops need to be added. Mr. Morse asked if all the loops are recorded. Ms. Simpson stated that the only recording requirement is in the MCC. Mr. Marriott stated that when the O&C is standalone without the MCC, there is no recording. Mr. Austin stated that the tests need to be recorded. Mr. Jordan stated that it is desirable to have the ability to request that the tests be recorded. There are now 32 loops and all will not be extended to Denver. Ms. Simpson stated that Denver only has the capability to receive 24. Ms. Segura stated that Denver has only 24 keysets, but KSC can extend as many loops as needed. Ms. Simpson stated that this will be discussed at the FOP and MSWG and then the MSRDR will be updated. Mr. Aquino stated that he will coordinate with the MSWG. This has to be approved at the FOP level. LM has to write the recording requirement. Ms. Simpson stated that the requirement needs to be distinct between testing and operations.
 3. Mr. Morse asked if there are any P AO or HQ requirements. Mr. Marsh stated that none have been received to date.

K. Ms. Simpson discussed network open items.

1. *As per Section 7.0 of the MSRD, unclear whether SN/TDRSS State Vector data exchange from FDF to MCC would only be needed during pre-mission Orion comm pointing trajectory analysis? Or if it would also be need to be exchanged in real-time during the mission. Current MSRD guidance for SN/TDRSS State Vector data flow from FDF to MCC just says "when required".* For tracking purposes, TDRS points to Orion post separation. This is based on predicts and the service is non-coherent. Mr. Syed Hasan stated that the Flight Dynamics Facility (FDF) uses the data to send launch and ascent predicts. Post-insertion, FDF will provide OD and updates. This support will be like other Visiting Vehicle (VV) support. This is assuming that FDF receives any data. Mr. Marriott stated that post separation is the issue and this needs to be worked offline.
2. *In the Spec Tree, need to clarify SCan support docs for LV comm coverage?* There is a specification tree. What is required to update the LV communications products and what is the schedule? Mr. Bangerter stated that he has a POC. Mr. Greatorex stated that the LV communications system is unchanged. It was stated that there could be some unique aspects. There is Orion data embedded in the Delta data stream. Delta requirements have to be worked. A working group with Delta is scheduled for October. Requirements will be worked via the Delta Program Requirements Document (PRD).
3. *What's the difference between LTAS data and Radar Tracking (C-band) data?* Launch Trajectory Acquisition System (LTAS) data is high-speed data between the radar sites. Radar data is low-speed data. The Range uses the term LDES vice LTAS.
4. *When is C-band Radar Tracking officially initiated? During on-pad or right after launch? Unlikely on-pad, but need to confirm.* C-band tracking is initiated for ascent; the Range initiates the C-band tracking 5 – 10 minutes prior to launch. One radar has view of the Delta on the pad and another picks it up 12 – 14 seconds after launch. Loss of Signal (LOS) is approximately 10 minutes. MCC can bring in the ULA data. A requirement is needed if there is a need for the raw ULA C-band data. The interface no longer exists. There is a MCC LTAS requirement, but not for high-speed C-band to the MCC.
5. *Final deployment of the SCPs at WSC needs to be clarified; specifically, will additional SCPs be installed for redundancy?* There will be no additional SCPs at WSC.
6. *A flow of "Pointing/Ephemeris" data from GSFC/FDF to SN/TDRSS for TDRSS pointing is implied by MSRD 7.0, but there's a more concrete need for a governing requirement/agreement for this flow.* Mr. Aquino stated that there is a standard FDF requirement. Two Line Elements (TLE) and Improved Interrange Vectors (IIRV) will be provided to the Range. Mr. Tim Kaufman stated that the MSRD only addresses MCC and not TDRSS. Mr. Aquino stated that it is JSC's requirement to get the data to the Range and the FDF does that. Ms. Simpson stated that there needs to be traceability. It has to be known if this is a capability that exists. All existing capabilities need to be validated. Most EFT-1 capabilities are traceable to requirements. Mr. Marriott stated that there are tiers of requirements. Mr. Austin stated that this is a LM mission and LM needs to know; LM needs a path to show that

the capability was requested. Ms. Crystall Ramirez stated that she has provided language for a rewrite of FDF VV requirements. Ms. Simpson stated that she will point to those requirement documents.

7. *Driving Requirement for the JSC Move Switch to GSFC Move Switch for voice loops connectivity in the MSRD is TBD.* Voice loops were discussed during the course of the meeting.

ACTION ITEM REVIEW

No formal action items were assigned at the September 12, 2012, HSF NSG EFT-1 mission overview and Network support splinter meeting.

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