



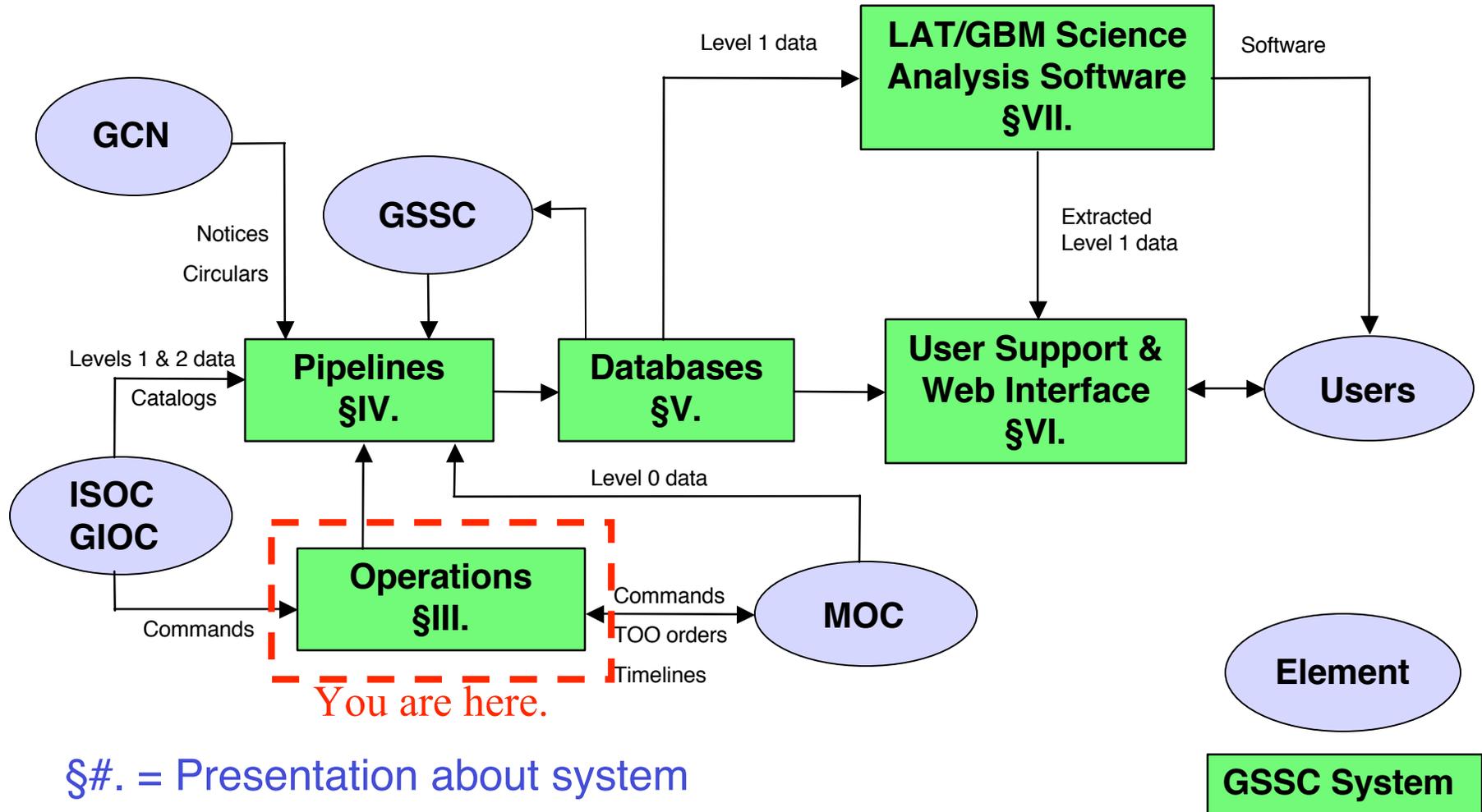
III. Operations

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GSSC Software Systems





Presentation Outline

- Introduction to GSSC Role in Operations.
 - Documentation.
 - Overview of GSSC Role in Terms of Formal Functional Requirements.
 - RFAs and Open Issues from Design Peer Review
 - GSSC Operations Overview in Diagrams.
- GSSC Operations Tools.
 - Scheduling, Planning and TOO Observations.
 - Command Processing.
 - File Transfers and Alerts.
- Software Development Plan and Schedules.
- Computers and Networks.
- Staff for Running Operations.
- Unresolved Issues at Design Peer Review (**resolutions!**).
- Responses to RFAs from Design Peer Review.



GSSC Operations Documentation

- GSSC Functional Requirements Document
- Mission Operations Concept Document – *includes GSSC Operations Concept*
- GSSC Development Plan (GSSC-0001)
- Verification Matrix (GSSC-0002)
- GSSC Design Document (GSSC-0003)
- GSSC Software Management Plan (GSSC-0004)
- Test Plan (GSSC-0005)
- MOC to GSSC/GIOC/ISOC Operations Data Products ICD (492-MOC-009)
- LHEA IT Security Plan

- GSSC Operations Manual (GSSC-0008) - to be developed later



GSSC Role in Operations

- Generate science timeline.
- Monitor as-flown timeline.
- Ingest commands sent from Instrument Operations Centers, evaluate any impact on science timeline, pass on to MOC.
- Respond to Target of Opportunity requests from within or outside GLAST team.
- Transfer of Level 0 data and similar is **not** considered part of operations.



GSSC Functional Requirements – Operations (1/3)

- Regular Observations
 - 5.3.2.9 – Scheduling Guest Investigations
 - 5.4.1.1 – Timeline Tools
 - 5.4.1.2 – Planning the Science Timeline
 - 5.4.1.3 – Posting the Timeline
 - 5.4.1.4 – Weekly Science Timeline
 - Interface with the MOC (5.4.1.4.1), ISOC (5.4.1.4.2), & GIOC (5.4.1.4.3)
 - 5.4.1.4.4 – Observational Constraints (Earth avoidance etc.)
 - 5.4.1.4.5 – Revision of Science Timeline in response to TOO/ARs
 - 5.4.1.4.6,.7,.8 – Receipt of Observatory Timeline, Orbit products, As-flown Timeline



GSSC Functional Requirements – Operations (2/3)

- TOO Requests
 - 5.4.1.5.1 – Receive TOO Requests
 - 5.4.1.5.2 – Support Project Scientist TOO Decision
 - 5.4.1.5.3 – Generate TOO Orders
 - 5.4.1.5.4 – Receipt of TOO Status
 - 5.4.1.5.5 – TOO Log
 - 5.4.1.5.6 – Receipt of TOO Execution Notification
 - 5.4.1.5.7 – Notify TOO Requester



GSSC Functional Requirements – Operations (3/3)

- Command Flow
 - 5.4.1.6.1 - Receive commands from IOCs and transfer to MOC
 - 5.4.1.6.2 - Immediate Transmission of High Priority Commands
 - 5.4.1.6.3 - Schedule Normal Priority Commands
 - 5.4.1.6.4 – Maintain Integrity of LAT and GBM Commands
 - 5.4.1.6.5 – Command Logging
 - 5.4.1.6.6 – Autonomous Data Transfers to/from MOC
 - 5.4.1.6.7 – Support Automated MOC



GSSC Ops Functional Requirements – Summary

- No major changes since Design Peer Review...
- ...except, use of Ku-band (TDRSS only) gives significant lead time (~1 month) for preliminary observation scheduling as TDRSS contacts must be scheduled well in advance.
- Top driving requirements are:
 - Delivery of weekly science timelines (5.4.1.4)
 - Generation of TOO orders (5.4.1.5.3)
 - Receipt and transmission of instrument commands (5.4.1.6.1)

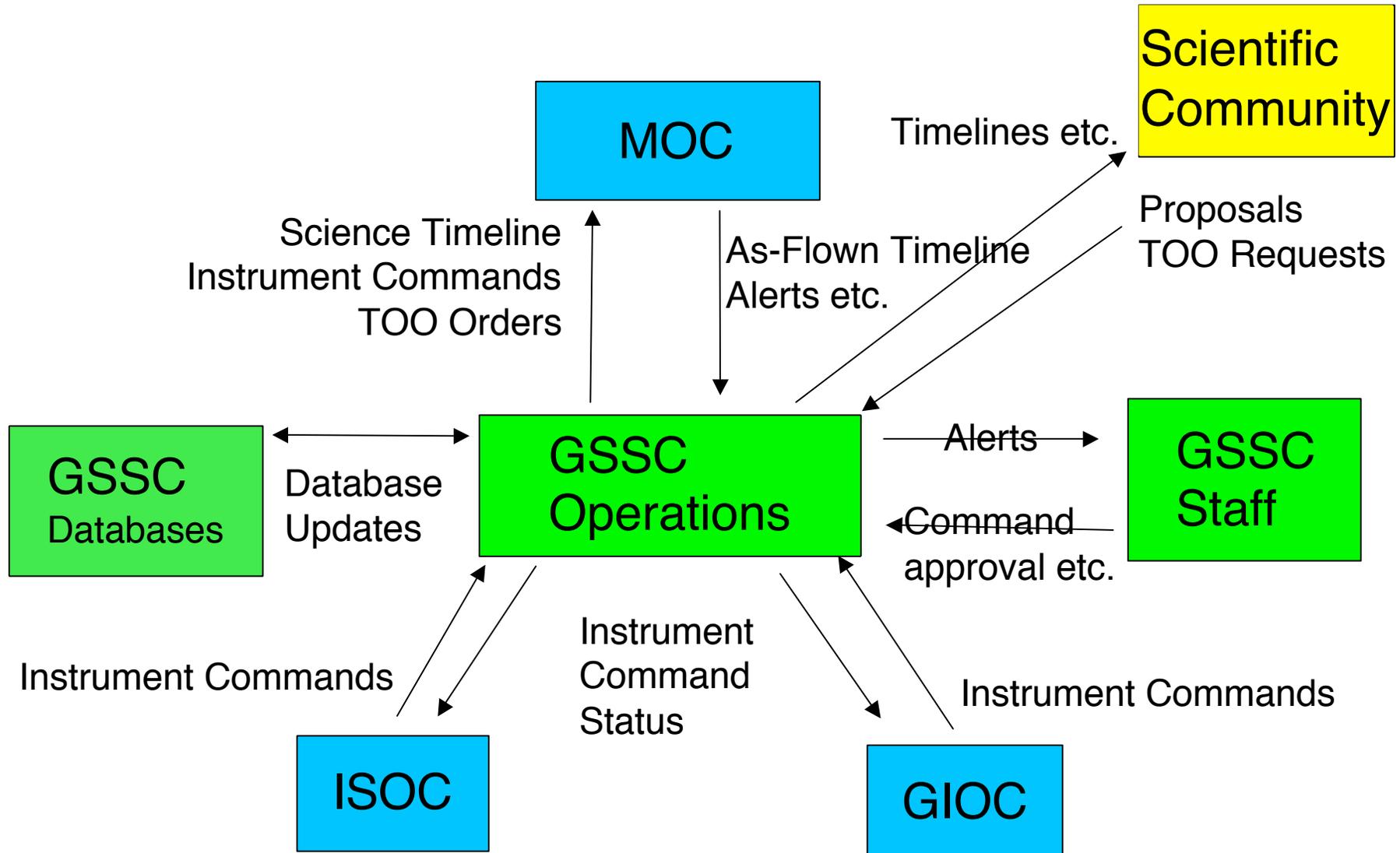


RFAs and Open Issues from Design Peer Review

- RFAs
 - #3. Location of operations computers and BAP
 - #5. DTS security issues
 - #10. Missing trade studies (e.g. Tako or other scheduler)
 - #19. Missing documentation (Concept Document, Operations Manual).
- Open Issues
 - Use of wrappers and their formats for command passing.
 - How long do ops. computers need to run on UPS?
 - Are computer requirements for Tako modest?
 - Will Virtual Private Network (VPN) be used?
 - Will Science Timelines include pointings for TDRSS dumps.
- Responses to these RFAs and Issues are addressed during this presentation and summarized at the end.

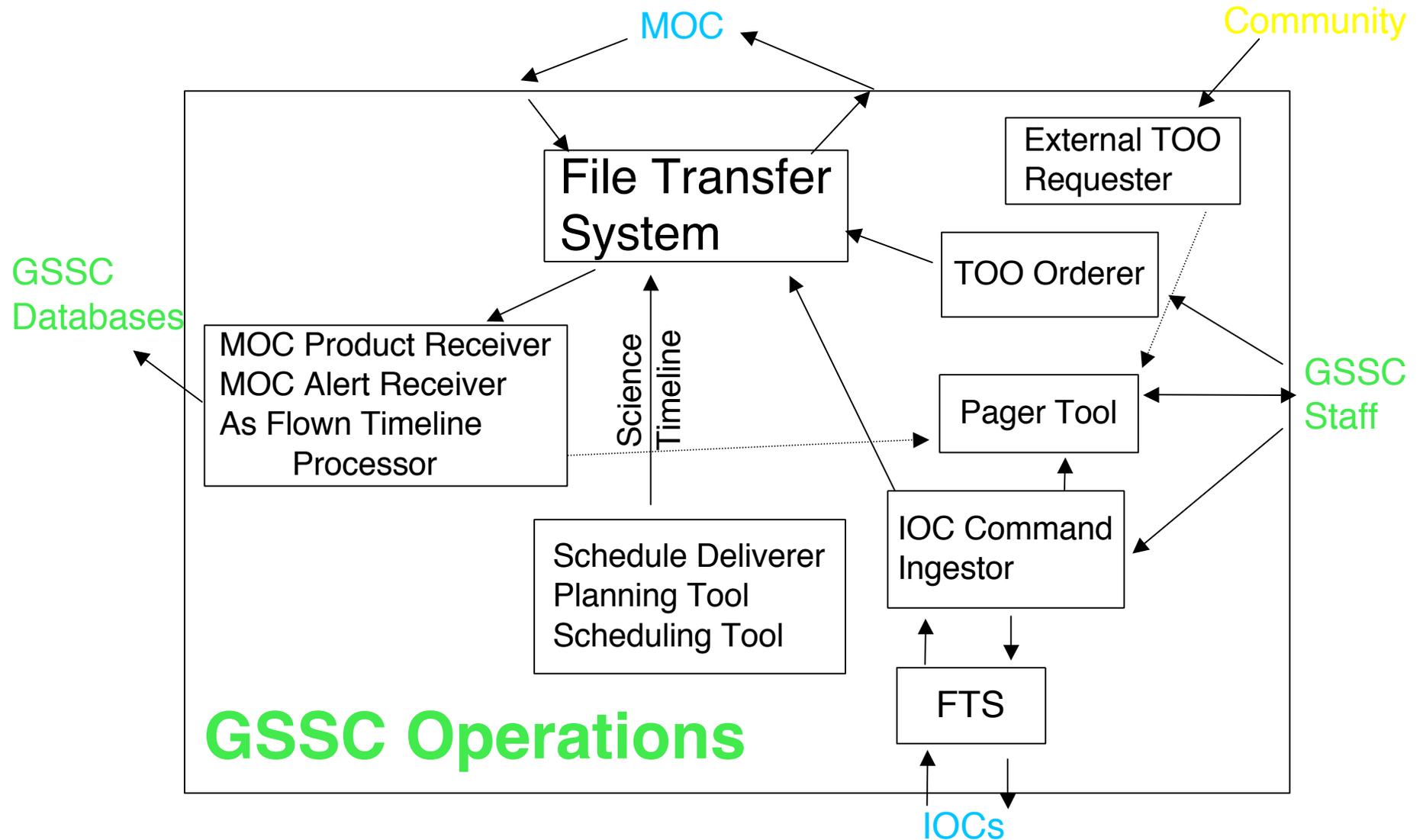


Operations Overview





Operations Overview - Internal Workings





GSSC Operations Software (1/3)

Tool	Purpose	Origin
Op 10. As-Flown Timeline Ingest	Ingests as-flown timeline from the MOC and compares with science-timeline	Custom software + file transfer software (FTS)
Op 20. Integrated Observatory Timeline Ingest	Ingests integrated observatory timeline from the MOC and archives it.	Custom software + FTS.
Op 30. Anomaly Reports Ingest	Ingests MOC anomaly reports and archives them.	Custom software + FTS.
Op 40. GLAST Ephemeris Ingest	Ingests GLAST ephemeris from MOC and makes available to scheduling tool.	Custom software + FTS.
Op 45. TDRSS Ephemeris Ingest	Ingests TDRSS from the MOC and makes available to the scheduling tool.	Custom software + FTS.
Op 50. TDRSS Contact Schedule Ingest	Ingests TDRSS contact schedule from MOC, makes available to scheduling tool.	Custom software + FTS.
Op 60. Observatory Telemetry & Command Database Ingest	Ingests from the MOC T&C databases and archives it.	Custom software + FTS.



GSSC Operations Software (2/3)

Tool	Purpose	Origin
Op 70. Command Ingest	Ingests commands and memory loads from ISOC and GIOC	Custom software + FTS
Op 80. Command Submit	Submits commands to the MOC.	Custom software + FTS
Op 90. Planning Tool	Assists with the design of observing strategies.	Stoneking/Davis simulator with modifications.
Op 100. Scheduling Tool	Generates the science timelines.	Tako
Op 110. Science Timeline Submit	Submits science timelines to the MOC.	Custom scripts + FTS
Op 120. TOO Orderer	Creates and submits TOO orders to the MOC.	Custom software + FTS



GSSC Operations Software (3/3)

Tool	Purpose	Origin
Op 140. Pager Tool	Alerts GSSC if urgent action is required (e.g. TOO request)	Reuse of RXTE system.
Op 150. TOO Evaluator	Assists Duty Scientist in evaluating feasibility of requested TOO observation.	SOT (suitability of target) from RXTE.
Op 160. Proposal Ingestor	Interface between Proposal Submission tools and Scheduling tool.	Custom software.
Op 170. ST2FT2 Reformat	Converts Science Timeline to FT2 format for use in sky coverage monitor	Custom software

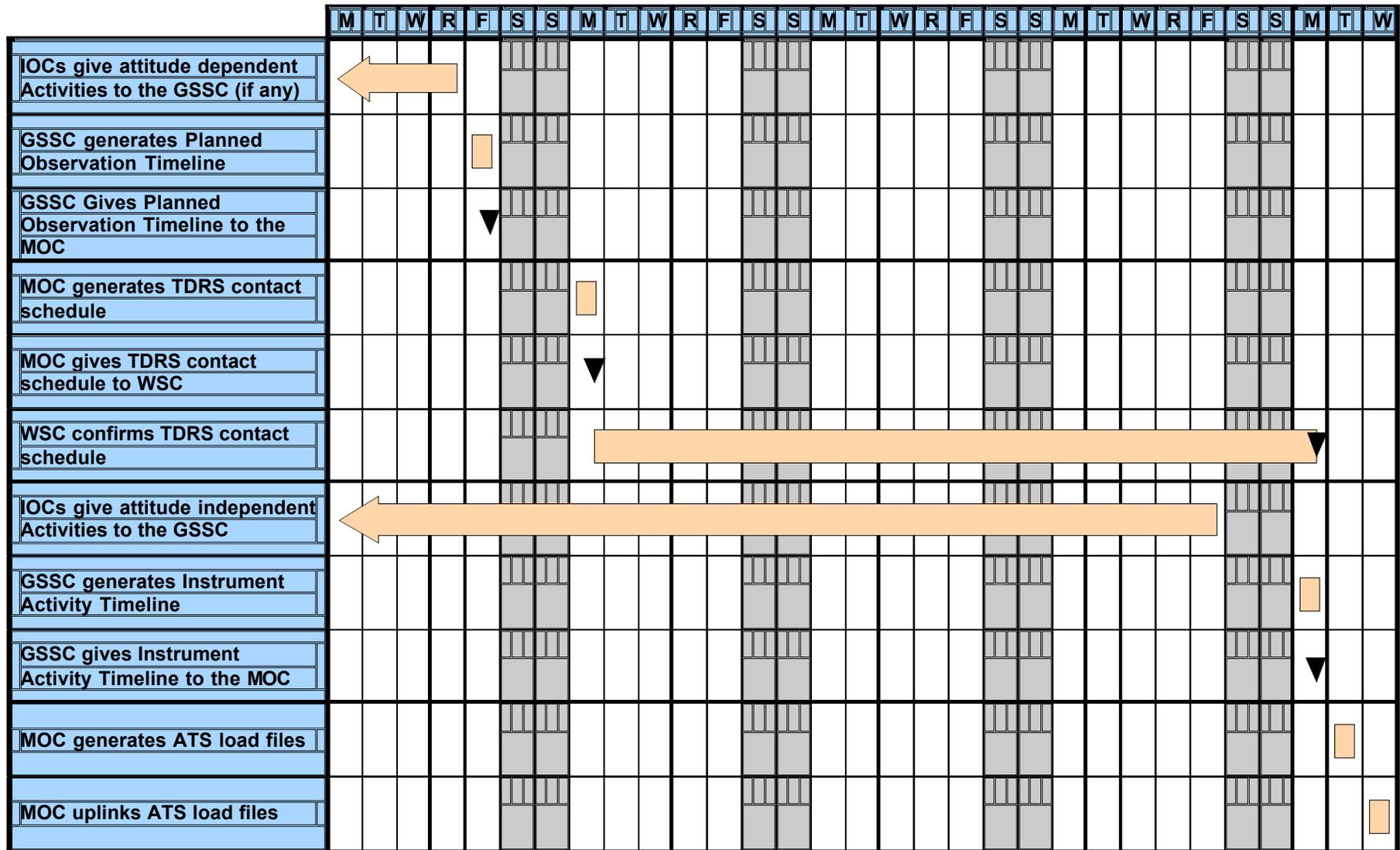


Overview of Basic Scheduling and Planning

- GSSC creates long term schedule (LTS) covering ~1 year based on:
 - Sky survey requirements.
 - Proposed observations.
- LTS assigns targets to one week bins.
- From the LTS the GSSC creates detailed Science Timelines covering week long periods.
- Science Timelines specify:
 - Survey observations.
 - Pointed observations.
 - (If necessary can include pointings to allow high rate TDRSS data dumps but these are not expected to be needed.)
- Science Timelines delivered weekly to MOC with sufficient lead time (~ 1 month) to allow TDRSS scheduling.



Routine Command Timeline





More Complicated Scheduling and Planning

- Planned GLAST Science Timeline can be disturbed by:
 - Auto-repoints caused by gamma-ray bursts.
 - Target of Opportunity observations.
 - Instrument or spacecraft anomalies.
- After receipt of as-flown timeline GSSC automatically evaluates impact on scheduled observations (Op 10).
- Future schedules may be modified to account for effects on survey and pointed observations.
- Long term schedule and future Science Timelines adjusted as needed.



Science Timeline Generation Details (1/2)

- Three primary parts to science timeline generation software:
 - Planning Tool (Op 90).
 - Scheduling Tool (Op 100).
 - Sky Coverage Monitor.
- **Planning Tool** investigates e.g. scan patterns to be used.
 - Davis/Stoneking simulator.
- **Scheduling Tool** (Tako) produces actual science timeline for transmission to MOC. Produce:
 - Long-term (~1 yr) schedule for internal use and made available to the world via the web.
 - Short term (weekly) science timeline transmitted to MOC and made available to the world via the web.
 - Scheduling tool has knowledge of orbital events such as times of SAA passages, Earth occultation of target, times when slews will be made, and can predict approximate slew duration.



Science Timeline Generation Details (2/2)

- **Scheduling Tool** is Tako.
- Tako was initially written for Astro E, it has been modified for use with Swift. It will be used for Astro E2 and now works for short term timeline generation for RXTE.
- A trade study was done comparing Tako to the STK Scheduler.
- List of requirements and desired capabilities for GLAST scheduler generated and comparison made of Tako and STK scheduler to these.
- Trade study discussed in GSSC and copy given to Project Scientist.
- Tako was found to be most suitable.
- **Sky Coverage Monitor** uses D2 (pointing, live time, and mode history) database to e.g. investigate sky coverage uniformity, coverage of Galactic plane and “key sources”.
 - Tool based on utility also used to display information on web (discussed by D. Band).



Target of Opportunity Observations

- TOO requests may come from within or outside GLAST team.
- There is a 2 hour requirement on communicating a TOO order to the MOC.
- Interface for TOO requests is web form. Based on RXTE experience and incorporates RPS. (D. Band presentation).
- GSSC staff and project scientist alerted by pages/email (Op 140) when TOO request made.
- GSSC examines feasibility etc. (Op 150) of TOO request and provides advice to Project Scientist.
- Project Scientist (or designate) determines if TOO is to be done.
- If TOO can be accommodated in regular timeline generation, done that way.
- If TOO decided, TOO Orderer tool (Op 120) sends order to MOC, alerts GSSC staff, and archives request.



Instrument Command Processing

- Instrument commands originate at ISOC and GIOC.
- Transferred to GSSC via “FTS” system (DTS or Fastcopy).
- Commands must have companion “message files” (previously called “wrappers”) to specify:
 - description of contents of file and effect on instrument.
 - urgency of command transmission to MOC.
- FITS and XML were considered as formats for “message files” and FITS chosen (both formats meet needs).
- Initial keyword list now generated.
- Command Ingestor (Op 70) in GSSC logs commands.
 - For standard priority commands, waits for GSSC staff to approve, and approve or assign any desired time for execution before transmission to MOC.
 - High priority instrument commands transmitted to MOC immediately, Relevant GSSC staff alerted (email, pages, text messages). This is for contingency operations only.



General File Transfers

- File transfers between GSSC , MOC, GIOC, & ISOC will either use DTS (LHEA sponsored) or fastcopy (COTS).
- Both DTS and fastcopy meet minimum security requirements.
- DTS can now operate at a higher level of security than initial versions e.g.
 - use fetchmail instead of sendmail
 - Mohan & Preece (MSFC) have studied using DTS via an SSL tunnel.
- DTS has several advantages for GSSC:
 - DTS will be used for data transfers to the HEASARC
 - DTS already has many features that would need to be written if fastcopy was used
- Decision on which file transfer system to use is imminent!



File Transfers and Message File Keywords

- Command files must be accompanied by message files with required information.
- Set of proposed keywords now exists and will be incorporated into the Operations Data Products ICD.
- Example keywords:
 - OBSERVATORY
 - GLAST
 - AUTHOR
 - e.g. “Sean O’Keefe”
 - CREATOR
 - e.g. “Tako”, “Command_Submit”
 - DATE
 - FILENAME
 - FILETYPE
 - e.g. “Science Timeline”, LAT_Instrument_Load



Alert System/Pager Tool (Op 140)

- Some inputs such as high priority commands from IOCs and TOO requests may require urgent notification of GSSC staff.
- Will use method based on sophisticated RXTE system.
- Combination of commercial (TelAlert) plus home-grown system. Alerts appropriate staff by paging, text messages to cell phones, email.
- Has “escalation” system plus methods for putting messages on hold etc.
- Is more than enough to cope with more limited operations role of GSSC!



Development and Release Schedule

- Development and release of software is tied to Ground Readiness Tests (GRTs).
 - Release 1: 11/15/04. Ingest Level 0 data from MOC.
 - Release 2: 2/1/05. Preliminary command and schedule tools.
 - Release 3: 5/1/05. Timeline ingest.
 - Release 4: 8/1/05. Scheduling tools.
 - Release 5: 1/31/06. TOO tools.
 - Release 6: 4/3/06. (Ingest tools, proposal tools.)
 - Release 7: 1/15/07. Cleanup.



Development/Release Schedule Details (1/6)

- Release 1 (11/12/04), tied to GRT1 (2/15/05)-ingest of Level 0 data from MOC:
 - Scripts to move data from MOC to GSSC
 - Creation of GSSC database
 - Scripts to ingest data into GSSC database
 - Tools:
 - No ops tools released for GRT1



Development/Release Schedule Details (2/6)

- Release 2 (2/1/05), tied to GRT2 (4/15/05)-preliminary command and schedule tools:
 - Command passing from IOCs to GSSC, and from GSSC to MOC
 - Timeline creation and passing to MOC
 - Tools:
 - Op 40. GLAST Ephemeris Ingest
 - Op 45. TDRSS Ephemeris Ingest
 - Op 60. Observatory T&C Ingest
 - Op 70. Command Ingest
 - Op 100. Preview of Scheduling Tool
 - Op 110. Science Timeline Submit



Development/Release Schedule Details (3/6)

- Release 3 (5/1/05), tied to GRT3 (6/15/05)-ingest of Level 1 data from IOCs:
 - Scripts to move data from IOCs to GSSC
 - Creation of GSSC databases
 - Software to ingest data into GSSC databases
 - Tools:
 - Op 20. Observatory Timeline Ingest
 - Op 50. TDRSS Contact Ingest



Development/Release Schedule Details (4/6)

- Release 4 (8/1/05), tied to GRT4 (9/1/05) & GRT5 (11/15/05).
 - Completion of command and schedule tools
 - Tools:
 - Op 10. As-Flown Timeline Ingest
 - Op 90. Planning Tool.
 - Op 100. Full-capability Scheduling Tool.
 - Op 160. Proposal Ingest.
 - Op 170. Science Timeline to FT2 converter



Development/Release Schedule Details (5/6)

- Release 5 (1/31/06), tied to GRT6 (3/15/06).
 - Target of Opportunity and alert tools
 - Tools:
 - Op 120. TOO Orderer
 - Op 140. Pager Tool
 - Op 150. TOO Evaluator



Development/Release Schedule Details (6/6)

- Release 6 (4/3/06), tied to GRT7 (5/15/06).
 - Ingest Tools
 - Tools:
 - All Ops. specific tools exist.



Operations Software Development

- Operations Section Staff:
 - Corbet
 - GSSC Operations Lead
 - Marilyn Mix
 - 50% GSSC, 50% MOC
 - Tako development and MOC interfaces
 - Giuseppe Romeo
 - Utilities, Tako, leverage of RXTE experience
 - Sandhia Bansal (also DA/SW Support Section)
 - Data Ingest etc.
 - Tom Stephens (also DA/SW Support Section)
 - Data Ingest etc.



Operations Software Development

- Contributions from other GSSC Sections – given in these presentations :
 - V. Databases (Davis)
 - VI. User Support including Proposal Submission (Band)
 - VII. Overall Software Coordination (Schaefer)
 - VII. C. Software Testing (Stephens)



Operations Software Development Schedule

ID	Task Name	Start	Finish	Duration	2004				2005				2006	
					Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2
1	GSSC PLANNING AND SCHEDULING	Mon 12/22/03	Wed 12/21/05	516 days?										
2	Op 10 As Flown Timeline Ingest	Mon 7/26/04	Mon 6/20/05	231 days										
3	Op 20 Integrated Observatory Timeline	Mon 7/26/04	Fri 3/25/05	170 days										
4	Op 30 Anomaly Reports Ingest	Fri 4/1/05	Wed 12/21/05	189 days										
5	Op 40 GLAST Ephemeris Ingest	Wed 9/8/04	Fri 12/17/04	69.5 days										
6	Op 45 TDRSS Ephemeris Ingest	Wed 9/8/04	Fri 12/17/04	70 days?										
7	Op 50 TDRSS contact Schedule Ingest	Fri 7/30/04	Fri 3/25/05	166 days										
8	Op 60 Observatory Telemetry and Corr	Mon 8/2/04	Tue 12/21/04	98 days										
9	Op 70 Command Ingest	Mon 6/21/04	Tue 12/21/04	127 days										
10	Op 80 Command Submit	Mon 8/23/04	Fri 3/25/05	150 days?										
11	Op 90 Planning Tool	Mon 3/22/04	Mon 6/20/05	319 days										
12	Op 100 Scheduling Tool	Mon 12/22/03	Tue 4/12/05	335 days										
13	Scheduling tool trade study	Mon 12/22/03	Tue 8/31/04	180 days										
14	Scheduling Tool (alpha version)	Mon 5/17/04	Mon 12/20/04	150 days										
15	Scheduling Tool	Tue 12/21/04	Tue 4/12/05	80 days										
16	Op 110 Science Timeline Deliverer	Tue 8/24/04	Fri 12/17/04	80 days										
17	Op 120 TOO Orderer	Wed 12/1/04	Tue 2/1/05	44 days										
18	Op 140 Paging Tool	Tue 5/31/05	Tue 12/20/05	146 days										
19	Op 150 TOO Evaluator	Mon 7/11/05	Tue 12/13/05	112 days?										
20	Op 160 Proposal Ingestor	Mon 1/31/05	Sun 5/1/05	65 days										
21	Op 170 ST2FT2	Mon 8/1/05	Mon 12/12/05	96 days										



Tracking Progress

- In common with other GSSC Sections measuring progress toward final system will track functions achieved rather than e.g. lines of code.
- Some tools have limited functionality (e.g. Op 120 – TOO Orderer) and no intermediate milestones necessary.
- For larger tools such as the Op 100 Scheduling Tool (Tako) determine set of functions, assign target dates for each major aspect of functionality.



Computing Requirements

- Computing requirements are not expected to be large.
- Largest demand for computer power likely to be from Tako.
- Tako designed to handle 400 targets/year for Astro-E.
- In tests find Tako can schedule ~1300 targets in a one year schedule in less than 90 minutes (Apple Macintosh G4).
- For “standard” observations (pointed and sky survey) GLAST demands scheduling easily handled by modern PC running LINUX.
- Nominal Ops computer configuration:
 - Scheduling machine.
 - Data transfer/ingestor/paging machine.
 - “Warm” backup machine in B14.
- Backups maintained of software and scheduling products and will at least daily transfer complete copy to B14 system in case of extensive system problems.
- “Process monitor” from RXTE automatically checks system status.



The BAP

- The Burst Alert Processor (BAP) is provided by the GIOC.
- The BAP sends alerts to GCN (gamma-ray burst coordinates network)
- GSSC provides assistance to GIOC in maintaining BAP.
- Previously planned to put BAP in MOC – but this was questioned in RFA #3.

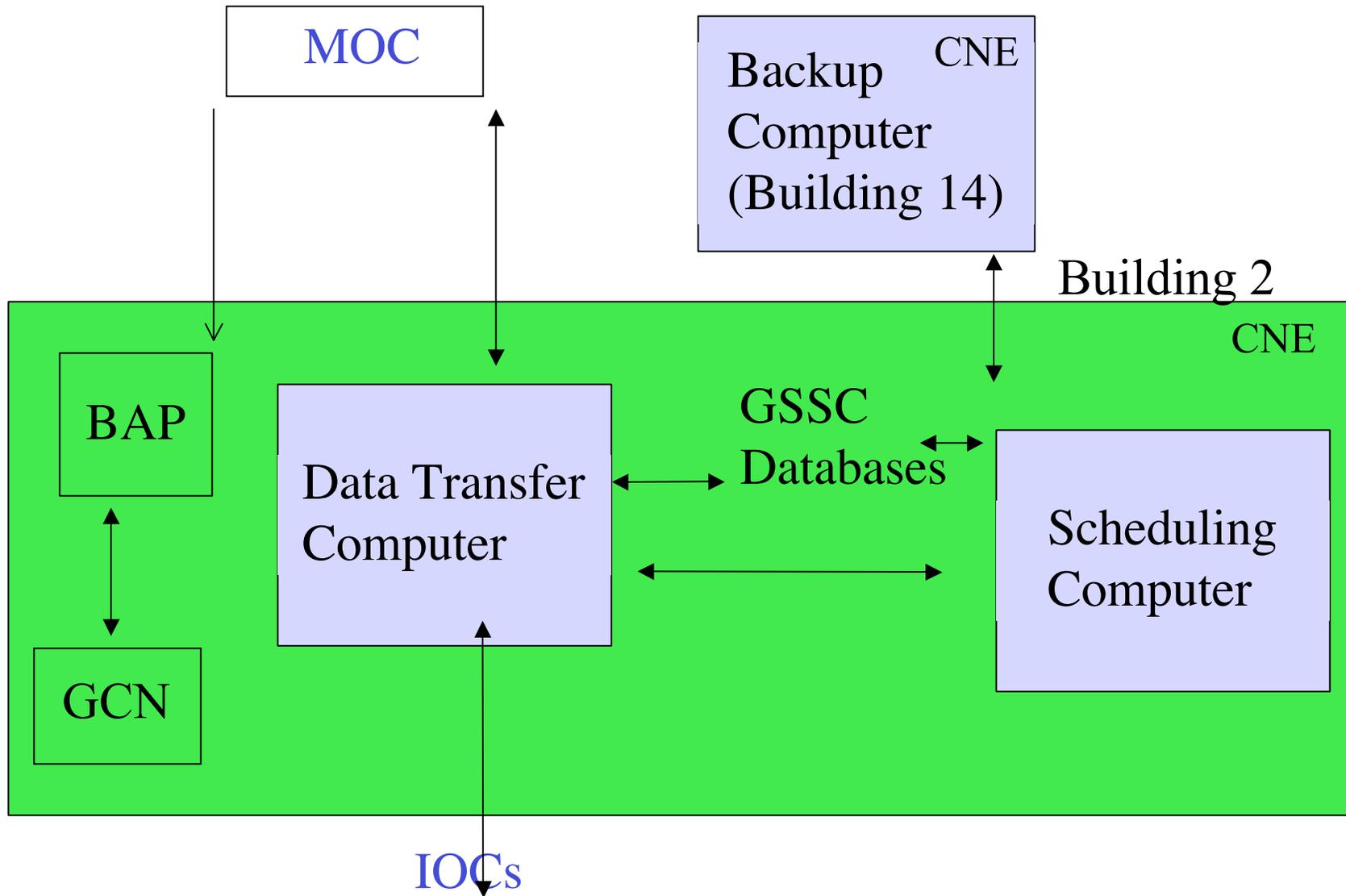


Computing Reliability (RFA #3)

- Main factor in computer reliability for LINUX systems is power supply.
- Building 2 (LHEA location) does not have UPS (uninterruptible power supply).
- If ops. computers are colocated with MOC in Building 14 then would be on building-wide UPS.
- Drawback is reduced accessibility of machines in B14.
- Solution:
 - Main ops. computer system located in Building 2
 - Backup ops. computer located in MOC facility in Building 14
 - Regular (daily) automated backups of B14 computers with planning products and other information required to transparently (to outside world) continue scheduling.
- GSSC also maintains GIOG BAP machine in B2. GCN is also in B2 so has same reliability.



Operations Computer Hardware Overview





IT Security (1/2)

- GSSC will follow accepted NASA procedures as defined in NASA Procedural Requirements (NPR) 2810.1
- GSSC also covered by GLAST project security plan and LHEA security plan.
- Building 2 (LHEA) computer network uses CNE network.
- CNE is used by mission operations systems for administrative information and science data transfer.
- Mission operations use IONet for command and control of the spacecraft.
- The GSSC does not require IONet and will use the CNE network for communication.
- The GSSC machine in B14 will also be on CNE.



IT Security (2/2)

- GSSC will utilize a firewall for protection from outside intrusion.
- Now determined that VPN (Virtual Private Network) tunnelling need not be used for timelines and instrument command uploads.
- Timelines and command uploads will use PGP authentication. (Not encryption).
- Data transfer will use either DTS or fastcopy. Both methods more than meet minimum security requirements.



Operations Phases

- 0. Launch and Early Check Out
 - No GSSC role.
- 1. First Year of Operations (Sky Survey)
 - GSSC will participate to exercise systems (e.g. command file transfer, delivery of Science Timelines) and will assist in any TOO execution.
- 2. Subsequent Years
 - Full GSSC participation.
 - Inclusion of Guest Investigator observations in Science Timelines.



Post-Launch Operations Staffing

- GSSC personnel post-launch operations tasks include:
 - **Run scheduling and planning software.**
 - May be done primarily by BS/MS level person (Timeline Scheduler). Between 0.25 and 1.0 FTE depending on number and complexity of pointed observations.
 - **Monitor as flown timeline.**
 - On-call GSSC Duty Scientist + Timeline Scheduler.
 - **Respond to and evaluate TOO requests.**
 - On-call GSSC Duty Scientist + Timeline Scheduler.
 - **Respond to and evaluate timeline impacts of IOC commands passed through GSSC.**
 - On-call GSSC Duty Scientist + Timeline Scheduler.
- On-call GSSC Duty Scientist role is rotated weekly among the GSSC scientists.



Status of Previously Unresolved Issues and Trades

- Determine whether XML or other wrapper will be used for Instrument Command passing. **Auxiliary “message” files will be used. Set of keywords defined. Wrappers will be in FITS format. (RFA 10)**
- Determine for how long GSSC operations computers should be able to run on an Uninterruptible Power System (UPS). **Resolved. Backup on UPS in B14. (RFA 10)**
- Make decision whether Tako will indeed be used as the Scheduling Tool. **Resolved. It meets our requirements. (RFA 10)**
- Confirm that compute power requirements for science timeline generation (e.g. with Tako) are indeed modest. **Resolved for “normal” observations. Have generated a 1300 targets, one year schedule on a standard system.**
- Determine whether Virtual Private Network (VPN) will be needed. **Resolved. PGP authentication only needed.**
- Will Science Timelines include pointings to allow high rate dumps via TDRSS? **Resolved. Pointings do not need to be included. Tako has the capability, but we do not need to do this.**



Responses to GSSC Design Peer Review RFAs

- RFA #3: Location of GSSC Ops. and BAP computers.
 - Located in B2. Backup Ops computer in B14.
- RFA #5: DTS Security issues.
 - DTS may operate without sendmail, MSFC security study shows highly secure system via SSL. Fastcopy is also an option if necessary.
- RFA #10: Trade studies.
 - Studies done for:
 - Tako vs. STK as scheduler. Tako is preferred solution.
 - Computer locations. (see RFA 3).
 - FITS vs. XML for “wrappers”. FITS will be used.
 - DTS vs. fastcopy. Decision pending.
- RFA #19: Ops Information Missing:
 - GSSC Concept included in Missions Operations Concept.
 - User's Guide is to be written as software tools mature and will be developed in parallel with GRTs