



JPL

Proposed Fully Automated Multi-
Mission Uplink Sequence Generation
Tool Suite

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What Is The Problem To Be Solved?

- Current and future missions are requiring very rapid turnaround for commanding and sequence generation.
- Project budgets for above tasks have progressively dwindled to, in many cases, less than one person per year of support.
- Multi-mission ground system must provide tools capable of supporting operations as described above.



The Automated Sequence Processor (ASP)

- Fully automated command and sequence processor.
 - Operates unattended 24/7.
 - Used primarily for real-time commanding but can be used for stored sequences.
 - Receives inputs from remote users to process commands destined for various spacecraft.
 - Enforces security and sequence integrity.
- Dramatically increased efficiency of uplink process.
 - Reduced workforce required for real-time command processing from two people to zero.
 - Reduced turn-around time for command processing from two hours per file to less than one minute.



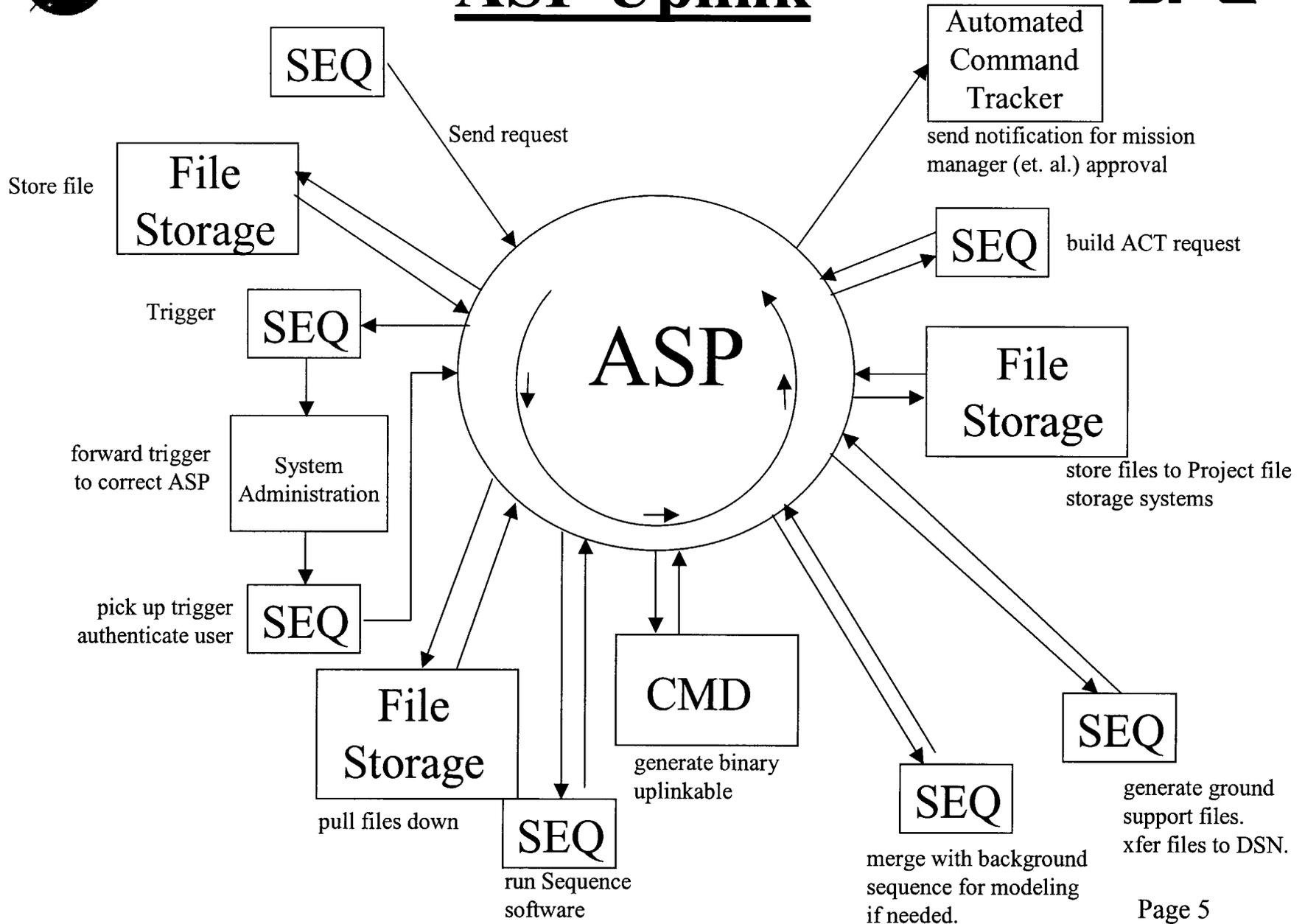
The Automated Sequence Processor

(ASP) (continued)

- Is an automation of the well understood and “debugged” standard manual processes used for uplink.
- Consists of a large set of scripts that perform all tasks formerly done by Sequence Engineers.
- Has been in use for more than eight years in flight operations.
- Originally developed by Mars Surveyor Operations Project (MSOP) Sequence Team.
- Was adopted as a multi-mission tool by JPL’s Deep Space Mission Systems Organization (DSMS).
- Used by several projects that are currently in-flight.



ASP Uplink





Autogen

- Autogen is both a process and a set of scripts that perform the following tasks.
 - Scheduling of command sequences for certain mission phases that follow regular patterns.
 - Creating output files for these command sequences that conform to existing SEQ system interface formats.
 - Automatically invokes downstream software tools that complete processing these command sequences for uplink to a spacecraft.
- Autogen is the next logical step in automating the entire uplink process at JPL.
- Autogen uses the JPL sequence planning software APGEN as the basis of its planning capabilities.



Autogen (continued)

- Originally developed for Odyssey mission flight operations.
- Leveraged off of the following Odyssey characteristics.
 - Onboard Blocks made it possible to create standardized, reusable sequencing and commanding components that could be stored onboard and modeled in the ground software.
 - Virtual Engines made it possible to have multiple sequences executing simultaneously onboard.
- Scheduling algorithms needed for APGEN were developed under the auspices of JPL's Mission Management Organization (MMO) by the MMO Mission Planning and Sequencing Team (MPST).

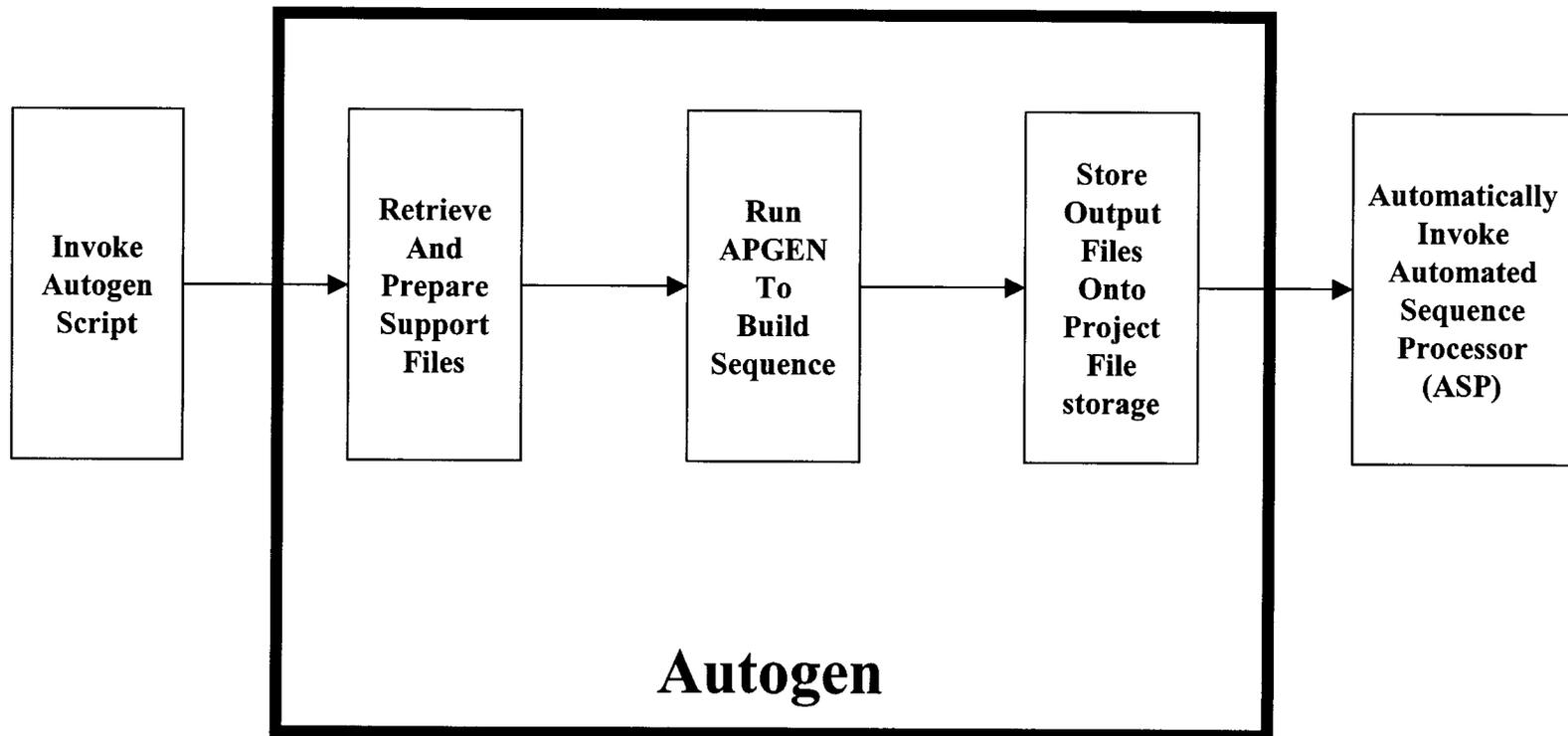


Autogen (continued)

- Autogen is currently being used to build “background sequences” for the mapping phase of the Mars Odyssey mission.
- Autogen was used to build cruise and aerobraking sequences during these phases of Odyssey’s flight.
- Use of Autogen for more than onboard sequence building has permitted enhancements to its capabilities, making it more multi-mission.
 - Read data sets for multiple spacecraft.
 - Write out multiple sequence files.
- The Autogen tool and process have been used since early 2001 to build 7 cruise sequences, more than 200 aerobraking sequences, 6 transition-to-mapping sequences, and more than 13 mapping sequences without any major failures.



Autogen (continued)





Multi-Mission Architecture

- Mission Definition must be done early during project development phase to support software adaptation.
 - Mission Rules
 - Flight Rules
 - Flight Operations Strategies
 - Command Definition
 - Block Definition
- Adaptation of Multi-Mission Software
 - APGEN
 - SEQGEN
 - SLINC
- Implementation is as a GROUND based capability, not onboard.



Multi-Mission Architecture (continued)

- ASP is already a multi-mission capability.
 - Originated in the MSOP Sequence Team.
 - Has been in use by several projects for approximately eight years.
 - Requires only minimal adaptation for a specific mission.
 - Uses standard multi-mission tools offered by DSMS.
- Autogen is currently in use by the MMO Mission Planning and Sequence Team (MPST).
 - Has been used for Odyssey very effectively.
 - Was written by MMO MPST member based on established operational procedures.
 - Was written in such a fashion so as to not preclude use in a multi-mission environment.
 - Uses standard multi-mission tools offered by DSMS.
 - Very dependent on flight operations strategies and block definitions.



Multi-Mission Architecture (continued)

- DSMS (Mission Services and Applications Office) must:
 - Obtain Autogen script code from MPST and take ownership of Autogen.
 - System engineer the Autogen process and scripts to provide functionality in a multi-mission environment.
 - Make necessary modifications to code and process.
 - Document entire Autogen/ASP uplink toolkit for user community.
- Individual Projects must:
 - Develop processes early enough in the development phase to provide sequencing strategies to the ASP and Autogen adapters.
 - Test standard sequencing and commanding strategies prior to launch.
 - Enforce standardized sequencing and commanding strategies on the flight team.
 - Provide flight software/hardware that is compatible with above referenced standardization.



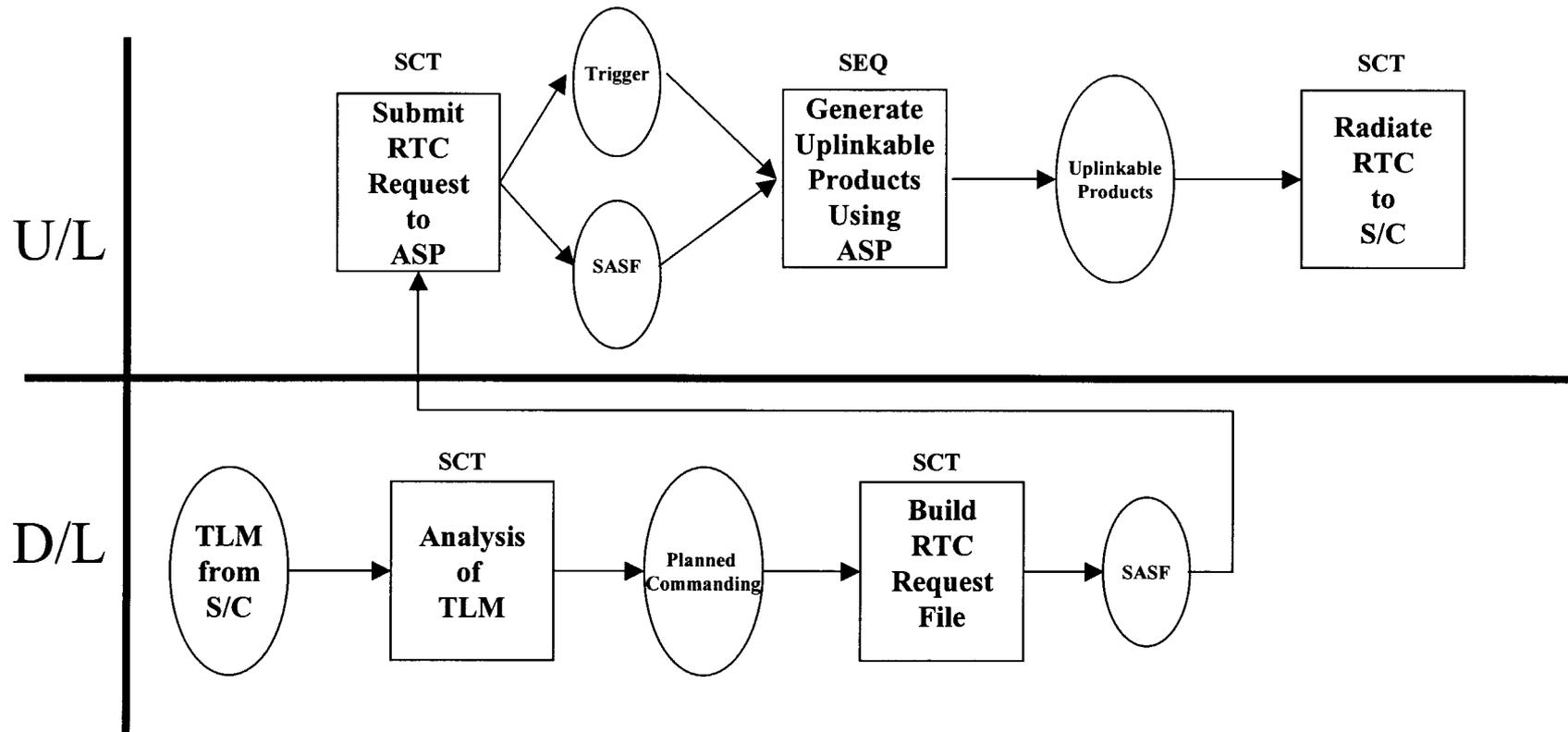
Future Improvements

- Build Interface with Automated Command Tracker (ACT)
 - Exists to a large degree today.
 - Needs refinement to make it more useful.
- Build Interface with DOWNLINK Software
 - Analyze downlink data
 - Use to modify existing or create new operational plans
 - Implement above plan automatically



Future Improvements (continued)

Fully Automated RTC Process





Conclusions

- DSMS and MMO have worked together to build a high level of synergy with respect to development of new and highly efficient operations tools and techniques.
- DSMS is planning to adopt and support the Autogen system into its multi-mission uplink system.
 - Adoption will be analogous to how DSMS adopted the ASP.
 - Timeframe as yet uncertain.
- Fully automated uplink system will be available to all future projects that choose to use it.
 - Will increase efficiency of a project's uplink system.
 - Will decrease costs associated with maintaining a flight team.
 - Will decrease risks of commanding errors because all “templates” will be tested and approved prior to implementation in the automated uplink system.