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The Benefits of a Service Oriented Architecture for Flight Dynamics Systems

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Agenda

- Introduction to the Problem and Solution
- Example SOA Systems Implemented
  - Goddard Trajectory Determination Software
  - Risk Reduction/FreeFlyer Demonstration
  - LandSat Data Continuity Mission Flight Dynamics System
- Summary

Current Spacecraft Ground System Problems

- Spacecraft operational life is usually extended well beyond the primary mission
  - In the operations environment there is a heavy opposition to change
    - If it isn't broken don't fix it
  - Results in aging or unsupported software
    - Required upgrades introduce risk
- Ground Systems are built on many different components
  - Each component must speak to the others
  - Requires significant effort to develop and maintain interface control documents as well as each components software interface

Solution

- Service Oriented Architecture
  - Specifically utilizing the plug-and-play features
    - Interfaces can be made “generic” – no need for “component” specific interfaces
  - Provides a robust capability to update system capabilities as mission requirements change or evolve
  - Eliminates risk associated with the use of non-configuration controlled off-line tools
  - Addresses the issue of maintaining unsupported software
  - Provides effective two-way communications between system processes
  - Greatly decreases the development and maintenance burden of ICDs.

Examples

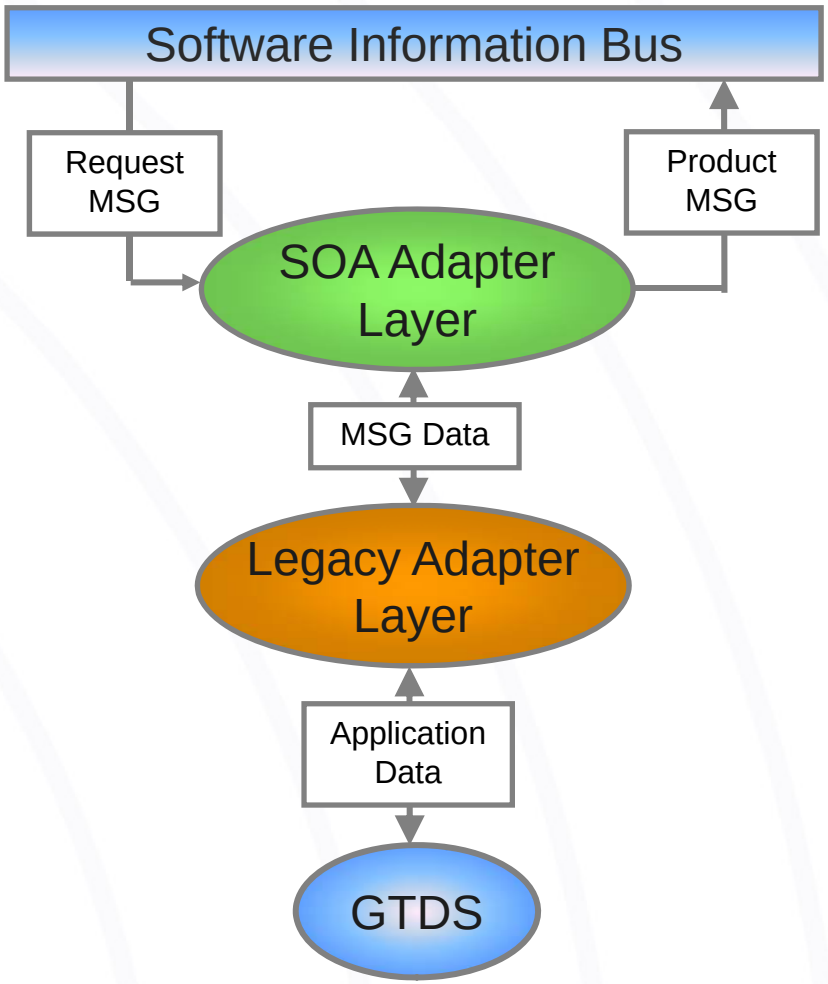
- Interface Goddard Trajectory Determination System (GTDS) with the Goddard Mission Services Evolution Center (GMSEC) Message Bus as a demonstration of the ability to rejuvenate legacy applications
- Extend capabilities of the COTS FreeFlyer to support GMSEC and the Oracle Service Bus (OSB) in a demonstration of ground system design in the dark
- Design the LandSat Data Continuity Mission (LDCM) Flight Dynamics System to support SOA features

Goddard Trajectory Determination Software

- GTDS is a critical component to the Flight Dynamics Facility (FDF) at NASA Goddard
- The software is 30+ years old and is expected to be used for the foreseeable future
- The FDF is re-engineering to a SOA system utilizing GMSEC
- Current automation processes for GTDS and other legacy applications will not be effective in the new environment

Goddard Trajectory Determination Software

- Two modules were created as part of a demonstration to integrate legacy applications with the GMSEC system
  - A generic module which will be used by any and all FD applications
    - Supplies the connection to the GMSEC Message Bus
    - Standardized interface for any flight dynamics software
  - An application-specific module ties the GTDS software to the generic module to complete the interface
    - Translates to native input/output format
    - Starts the GTDS application
    - Supplies information to be sent back to the GMSEC bus

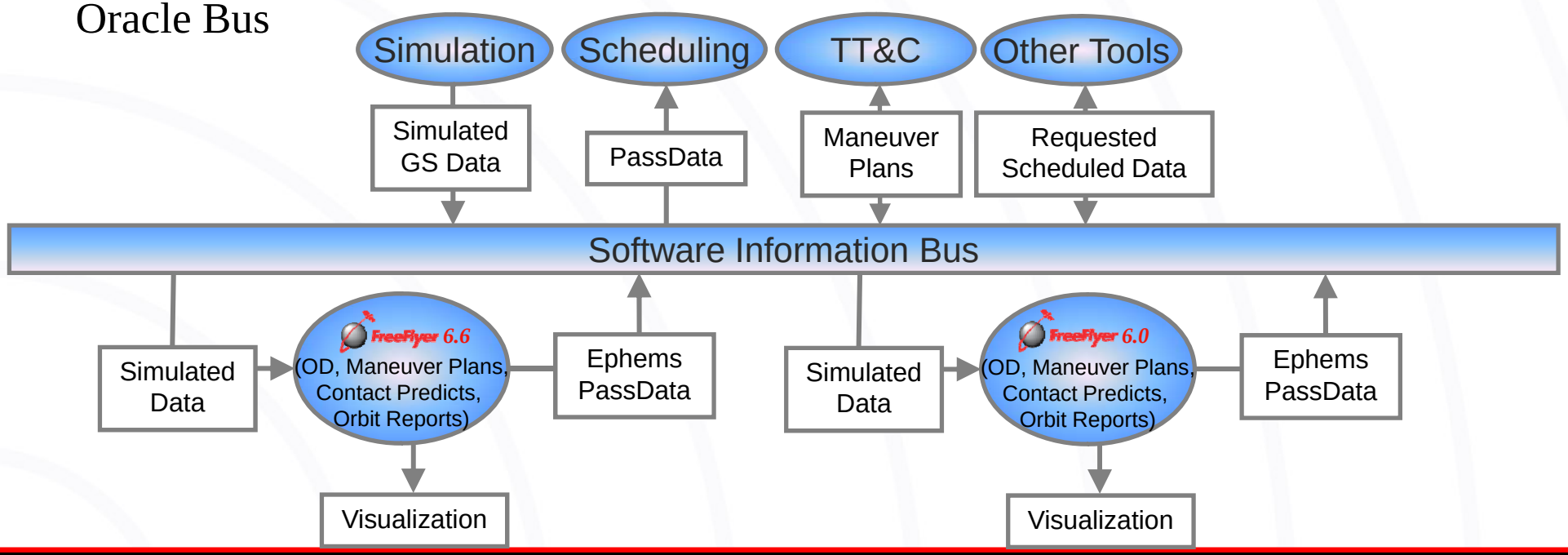


Lessons Learned

- Legacy applications can be integrated with SOA systems to meet evolving ground system requirements
- It is a large effort to interface complex and legacy software like GTDS with SOA systems
  - There are hundreds of keyword cards and thousands of options that must be accounted for in order to effectively integrate the software.
  - Required information in messages may create an application specific message

FreeFlyer Demonstration

- FreeFlyer provides the user the ability to extend its capabilities via custom DLLs.
- Extensions to the FreeFlyer base code (DLLs) were created to support interfaces with both GMSEC and Oracle Message Buses
- The GMSEC extension was used in a demonstration that showed that the different ground system components could be designed in a near vacuum and integrated using the message bus.
- The Oracle extension was used in a risk reduction effort to show that the different subsystems (FDS, TT&C, and Mission Planning) could be integrated with the Oracle Bus

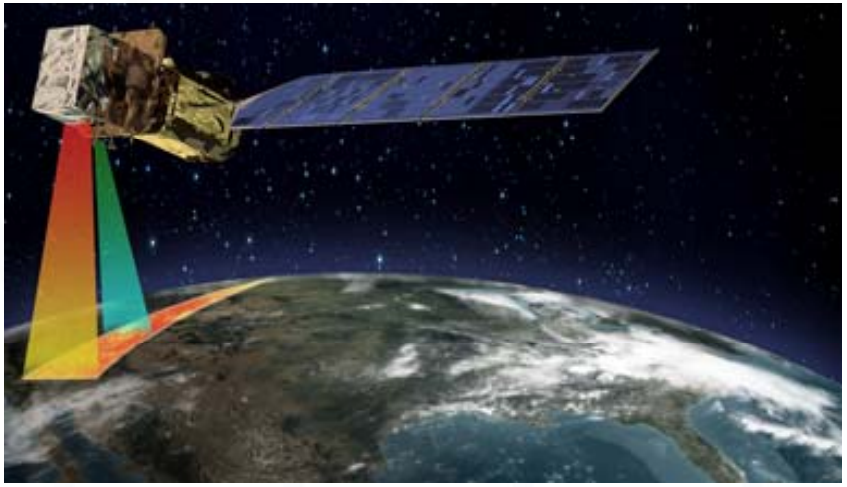


Lessons Learned

- The capabilities of FreeFlyer can easily be extended to support SOA systems such as the GMSEC and Oracle Services Message Busses
- It is possible to develop a ground system component in a near vacuum, but some insight into the other systems is still necessary
- There should be a significant reduction in development of interface controls and documentation

LandSat Data Continuity Mission

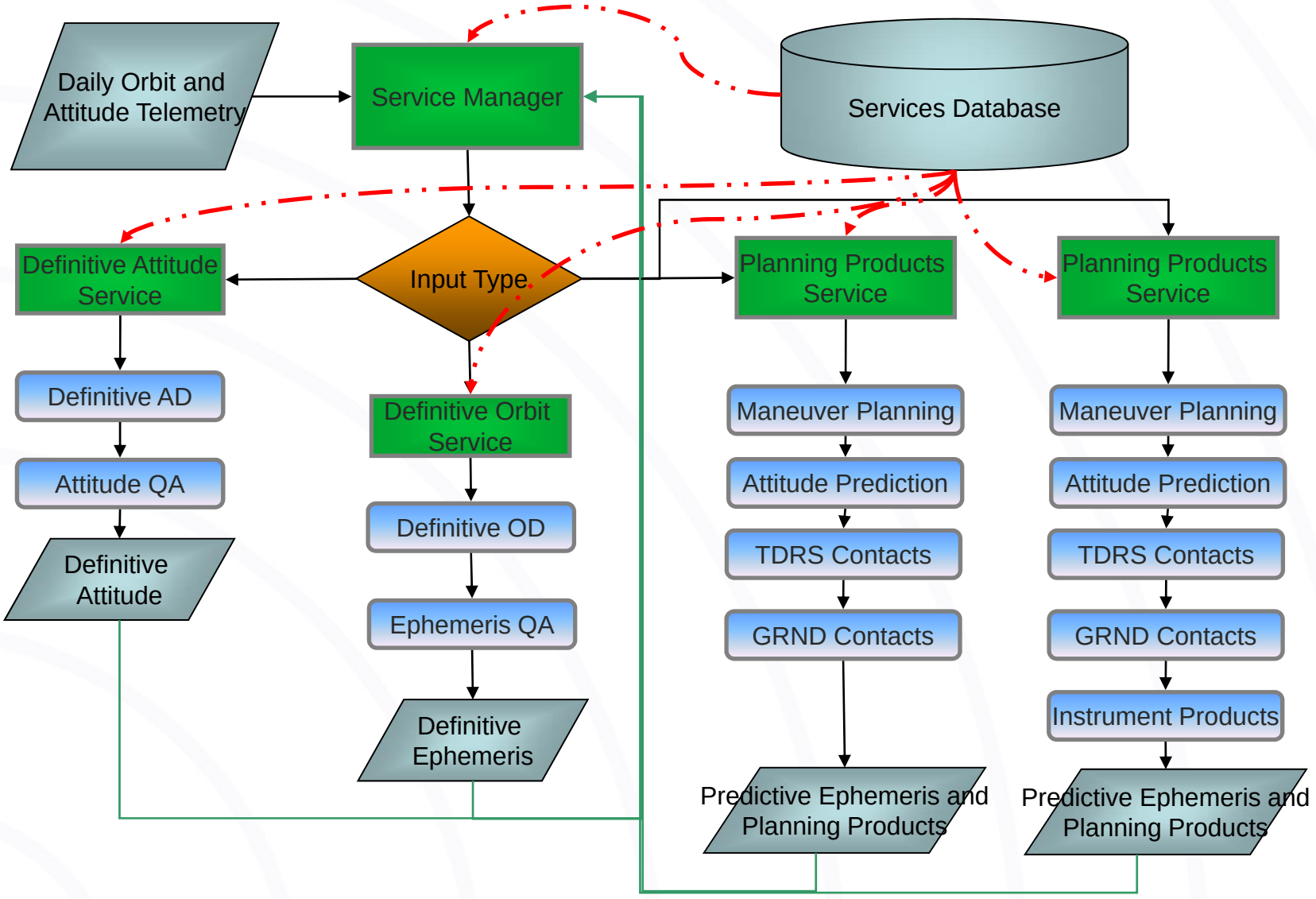
- The LDCM Mission Operations Center (MOC) is being developed around a SOA-like system.
  - All information (Heartbeats, Statuses, and Data) is transferred via files using a common bus
- The FDS system supports the MOC SOA system
  - Receives and reacts to incoming files
  - Creates files that initiate activities in other sub-systems
- The FDS is a SOA within a SOA



LandSat Data Continuity Mission

- A central system, the Service Manager, manages receipt of new files
- Based on the type of file the system executes a sub-process and continues to wait for new files
- The Service Manager also reports the status of the files and the sub-processes
  - Log files and heartbeats are created
  - Event messages are created at each level

LDCM FDS Flow



Lessons Learned

- While the MOC is not employing a SOA system in a strict sense, there is advantage in maintaining a SOA model
- The plug-and-play functionality built into the FDS system provide superior flexibility to standard FDS systems
  - Flight Ops Team can add or remove actions as needed
  - New software and updates to existing software can be tested without disrupting operations

Summary

- SOA systems can be integrated with legacy software to enhance their usefulness
- SOA systems can reduce cost associated with developing a ground system
- SOA systems enable software testing and integration to occur in a much less invasive manner