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DEFENSE, SPACE & SECURITY

ISIS-SOL mock-up : Key Features Induced by the Adoption of New Standards

Pierre Bornuat (CS Communications & Systems) March 1st, 2011



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Authors : Pierre Bornuat, Pierre-Alban Cros, Christophe Pipo, CS Communications & Systems; Marie-Laure Anadon, Paul Gelie, CNES

Introduction & Context Presentation

CNES plans to develop a new control centre, which should satisfy several main objectives

- Be compliant with international space standards (such as CCSDS: Mission Operations, Space Packet Protocol, SLE - or ECSS: PUS, etc.)
- Reduce possession costs and secure development of CNES projects
- Define an evolutive and re-usable platform product line for control centers
- Perform a first implementation to be operational in 2016
- As a preparation of future developments, CNES has delegated to CS Communications & Systems the development of a mock-up (ISIS-SOL)
 - Evaluate service-oriented architecture (SOA), based on the CCSDS MO standard
 - Evaluate possible technologies, check real-time performances on critical subsystems
- This presentation gives an introduction to the main characteristics of this mock-up, in terms of
 - Service orientation (MO standard)
 - Module orientation (OSGi technology)



ISIS-SOL mock-up Service Oriented Architecture **CCSDS MO standard main concepts**

- Service Oriented Architecture: definition of architectural layers, use of modular components, communication through service interfaces
- Framework of standard services: components assembled as « plug-ins »



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ISIS-SOL mock-up Service Oriented Architecture MO services implemented in the mock-up

7 CORE Services

- **Parameter Service**: manage Parameter status information
 - ISIS-SOL mock-up specificity: receive / distribute raw TM packets
- **Action Service**: invoke actions (i.e. remote commands)
- **Aggregation Service**: group several Parameters in a single request
- Not used: Alert Service (raise and receive alerts), Check Service (check Parameters against monitoring rules), Statistic Service (statistical evaluation of parameters), Conversion Service (engineering unit conversion), Argument Service (access to Actions / Alerts arguments definitions)

Common Services

- Directory Service: providers publish services / consumers discover available services
- **Retrieval Service**: retrieve blocks of historical data
- **Replay Service**: replay session (used in case of investigations)
- Not used: Login Service (authentication), Configuration Service (configuration delegation to a service), Interaction Service (request input from operator)



ISIS-SOL mock-up Service Oriented Architecture

ISIS-SOL mock-up Architecture



ISIS-SOL mock-up Service Oriented Architecture Focus on Command Control – Scalability and telemetry processing

- Modularity of telemetry acquisition chain results in a very adaptable system
- Changing On-Board telemetry format may impact a limited number of components: Demultiplexing Daemon and removal of service provider for Large Data Transfer Daemon
- Adding a new specific processing for a type of telemetry packet can be achieved by adding a new Daemon which is a consumer of a Parameter Service provided by Demultiplexing Daemon
- Using specific packet processing for each type of packets (or group of type) can be done by only changing system configuration and launching as many Telemetry daemons as necessary (for example, one per packet provider)



ISIS-SOL mock-up Service Oriented Architecture Focus on Command Control - Commands

- Command Action is also encoded in compliance with ECSS PUS standard
- Actions states: published by the Command Control subsystem, archived by the Datastore subsystem
 - Allows to follow action uploading in real-time or to replay sending command stacks
- Examples of possible adaptations to specific behaviors with a low impact on existing components, due to ISIS-SOL mock-up service oriented architecture:
 - PUS Large Commands handled by a specific component which splits them into smaller actions, and requests Commanding Daemon to take them into account (transparent to the user)
 - Handling telemetry reports for actions processing: this could be achieved by simply modifying the Commanding Daemon and register it as consumer of a Telemetry Aggregation Provider





ISIS-SOL mock-up Service Oriented Architecture MAL Joram - Quality of Service (QoS)

One of the main benefits of using a MOM system for all exchanges in the system is that it provides several possible levels of Quality of Service (as required by CCSDS MO standard)

BEST EFFORT

- Messages are not persistent
- Sending order is FIFO
- Fault tolerant to network errors: message re-emitted until sending is successful

ASSURED

- Messages are persistent: a consumer will receive messages later if not present when the message was emitted
- Fault tolerant to both network and MAL (Joram) server errors. Possibly some messages loss if an error occurs on client reception

- Same as ASSURED but all messages are acknowledged on the client-side
- Ensures that client has received a message

• Not supported by Joram transport layer



ISIS-SOL mock-up Module Oriented Architecture OSGi concepts and used technologies – Commanding Daemon

- OSGi: Java-based services framework, providing APIs and services
- Applications / components, organized as « bundles » (i.e. plug-ins)



Equinox OSGi implementation



- Expected benefit: reduce complexity in most aspects of development
- ISIS-SOL mock-up Commanding Daemon = ISIS-SOL mock-up Daemon = OSGi application



- P2 Agent = OSGi application responsible for installations / updates
- Commanding Daemon composed of
 - Command control OSGi bundles
 - Common OSGi bundles
- Commanding Daemon uses
 - Declarative Service
 - Extension Point
- → OSGi Container / JVM / OS



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ISIS-SOL mock-up Module Oriented Architecture OSGi bundles as major software structure elements – Eclipse features

- ISIS-SOL mock-up uses Eclipse notion of features
- Feature = group of bundles, which defines the deployment strategy using P2 Repository mechanisms
- Separates logical software unit
- Guarantees that a group of bundles are coherent (software dependencies, prerequisite specifications)



ISIS-SOL mock-up Module Oriented Architecture

Deployment characteristics and Eclipse Equinox P2 repository

- Deployment based on P2 Repository (Web server – HTTP Protocol)
 - All features are uploaded on this repository by an administrator
- After installation, every data exchanges go through the MAL (JORAM)
- オ High level of modularity
 - P2 repository allows easy upgrades on several machines, independently
 - Every component can be installed on any server
 - Scalability can be implemented easily (JORAM on a dedicated server for example)



Conclusions and first lessons learnt

- Although ISIS-SOL mock-up project is not finalized yet, some first lessons might be drawn from this mock-up.
- **7** Integration of CCSDS MO standard and PUS standard : works pretty well !
- Our understanding and implementation of CCSDS MO Services corresponds precisely to how we imagined it worked !
- ISIS-SOL mock-up Architecture (owing to SOA) enforces inter-operability and saves cost and time during software integration.
- Notion of bundles and use of OSGi technology : interesting to implement and to guarantee modularity of software components. Only negative point : PDE Build (Eclipse build tool) is not very efficient to use when building large projects.
- Starting from a service-oriented description of the main control center functionalities, we have designed an architecture fully compliant with initial requirements.







ISIS-SOL mock-up : Key Features Induced by the Adoption of New Standards

Annexes

1 - Documents and other references

2 - MO services : focus on the Command Control subsystem (external & internal interfaces)



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Annex Documents and other references

CCSDS standards

- CCSDS 521.0 : Mission Operations Message Abstraction Layer
- CCSDS 521.1 : Spacecraft Monitor and Control Common Services
- CCSDS 522.0 : Spacecraft Monitor and Control Core Services
- CCSDS 133.0B1 : Space Packet Protocol
- CCSDS 910.3-G-3 : Cross-support concept part I Space Link Extension Services
- ECSS standards
 - ECSS-E-70-41A : Telemetry and Telecommand Packet Utilization
 - **CCSS-E-ST-70-31C** : Monitoring and Control Data Definition

OSGi standards

- Sweb Site : <u>www.osgi.org</u>
- ⇒ OSGi Service Platform Release 4



Annex – ISIS-SOL mock-up Service Oriented Architecture MO services : focus on the Command Control subsystem (external interfaces)



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Annex – ISIS-SOL mock-up Service Oriented Architecture MO services : focus on the Command Control subsystem (internal interfaces)



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