YAMCS Suite

Yamcs Applications

Overview

Yamcs server main purpose is an efficient and effective processing of telemetry and commands.

The server can be connected to a TM/TC frontend (interface to Ground Station or EGSE equipment) or to a simulator used for development and test of the ground software or for training purposes. The data acquired from the TM/TC frontend is interpreted based on the Mission Database.

The Yamcs server provides the Archive, a powerful storing system with functionality to inspect and retrieve data and to assess the archive completeness. It employs a graphical user interface.

Connected to Yamcs server are a number of workstations which run end-user applications such as displays or commanding tools. Yamcs server uses an embedded key-value database for storing all the received TM and sent TC. This helps to both keep the deployment dependencies at a minimum and to provide high performances.

Communications between several Yamcs servers is performed using a hot replication mechanism. This allows complex deployments to handle use cases like mirror of archives, cascading of data to a DMZ network, forwarding data from remote sites, etc.

YAMCS

Yamcs Applications is an extended set of existing tools to augment the Yamcs server functionalities, and it is further extensible to fulfil all kind of mission needs. In fact, the practical limit of out-of-the-box, legacy software for Mission

Yamcs Applications is a super-module of Yamcs Suite whose intent is to lower the dependence on COTS software and facilitating the tailoring of a generic MCS to specific mission needs, decreasing the risk and ultimately improve mission success and economy with no compromises in terms of performance and reliability.

One important application among the currently available products is Yamcs Studio, a rich desktop client for use with Yamcs Server. In its default configuration, it includes support for authoring and running operator displays, and comes bundled with various built-in displays that highlight different aspects of Yamcs (Alarms, Events, Commanding, Archive playbacks, etc.). See below for details.

Another in-house application is TYNA, which is a web-based frontend for remote notifications. See below for details.

Timeline is also developed in house and it provides the basic and convenient functionality of monitoring the mission activities and improve situational awareness.

The integration of third party tools is fostered by the very philosophy of Yamcs Applications modules. A few examples:

- SPELL, a well-known standard for flight control procedures and test scripts
- OPEN-MCT, a web based mission data visualisation framework by NASA
- Grafana, an analysis and monitoring tool for time-series data.

TECHNOLOGIES
- XTCE standard for Mission Data Base definition
- Open Source Software

COMMUNICATION PROTOCOLS
- Raw packets over UDP unicast or multicast
- Raw packets over TCP
- CCSDS SLE, Space Link Extension

CCSDS Frames protocols:
- TM Space Data Link Protocol, CCSDS 132.0-B-3
- AOS Space Data Link Protocol, CCSDS 732.0-B-4
- TC Space Data Link Protocol, CCSDS 232.0-B-4
- Unified Space Data Link Protocol, CCSDS 732.1-B-2
- TC Synchronization and Channel Coding, CCSDS 231.0-B-4
- TM Synchronization and Channel Coding, CCSDS 131.0-B-3
- Communications Operation Procedure, (COP-1) CCSDS 232.1-B-2
- Space Packet Protocol, CCSDS 133.0-B-2
- Encapsulation Service, CCSDS 133.1-B-3

FLEXIBILITY
- Custom protocols can be easily added
- Telemetry replay, scientific data extraction, profiling, and offline analysis
- Detailed packet and parameter inspection
- Remote and cascaded connectivity from external science users or other centres
- Authorisation at parameter, packet, and command level. Furthermore the authorisation data is stored in an LDAP database

INTERFACES and INTEGRATION
- API: Rest, Websocket, Python Client
- Security: LDAP, Kerberos, OpenID Connect
- Server OS: Linux, Windows
- Client interfaces: Yamcs Studio, Open MCT, Grafana

SERVICES AVAILABLE

For more information please visit:
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We offer YAMCS training courses to kick-start your team and your mission.
More information here: YAMCS Training

Yamcs Studio

Editor and Runtime IDE

Yamcs Studio is Yamcs' graphical user interface framework. It is built upon Control System Studio, which is a set of tools to monitor and control large scale control systems. The key attraction of Yamcs Studio is a full-feature runtime application for execution of User Interface displays and a corresponding design application for their authoring. It allows Yamcs users to build and subsequently execute displays required to operate part or whole of the mission.

In execution mode, Yamcs Studio connects to Yamcs real-time processor for TM and commanding acquisition and sending. In editor mode, a large set of widget for display authoring is available. Yamcs Studio is an Eclipse RCP application, and builds upon Open Source software libraries. The main programming language is Java 8. In addition of being a display solution, Yamcs Studio includes a variety of custom views for complimentary operations in one integrated environment.

These views can be rearranged across the window layout according to the operator's needs. Major ones are the Archive Browser, the Event Viewer, the Command Stack, the Command History, the Command Queue, and the Data Link.

SPELL

Procedure Authoring and Execution Environment

Satellite Procedure Execution Language and Library (SPELL) is an open source framework for procedure-based

automation of mission operations, developed by SES (satellite operator) and GMV. SPELL includes several components which are fully integrated with Yamcs and provide an integrated and collaborative environment for the development, testing, validation and execution of operational procedures as well as to automate other elements in mission operations.

TYNA

Automated Notification Tool for Control Centres

TYNA is an alarm safety and event response solution specifically developed for off-site operators. It is a web client application allowing an off-site operator to be notified of an event and to access its details.

TYNA will send alarm notifications to off-site operators by any of phone, email, pager message or SMS-text. Off-site operators will see or hear the details of active alarms and may acknowledge those alarms using the same format with which the alarm was sent.

TYNA is highly configurable and fully operative.

Timeline

Mission Activity Monitoring

Timeline is a tailorable web-based solution for positioning time-tagged data along a navigable time axis. Default features include panning, scaling, zooming and partial reloading. The technology allows for real-time updates of the timeline without browser refreshes.

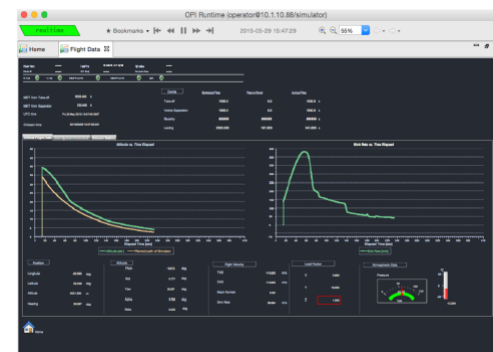Figure 1 **Yamcs Web Interface**, Telemetry and Telecommands, embedded with Yamcs server.

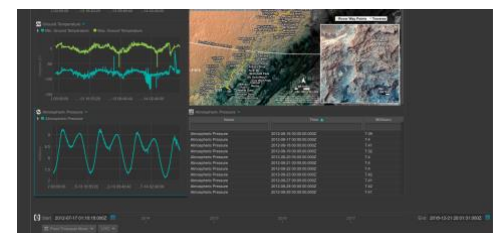Figure 2 **Yamcs Studio**, Telemetry and Telecommands. Provides extensive capabilities for building synoptic displays.

Figure 3 **Open MCT**, Telemetry only, Integrated by NASA Ames with Yamcs.

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It can be employed for multiple objectives like mission planning or GANTT-like resource planning. Timeline is continuously extended with major functionalities. Current ones are: support for multiple timescales in different time zones,

custom lanes for indicating when passing through the SAA, general TDRS Ku- and S-band availability, orbit numbers, day/night differences and attitude changes, a 'now'-locator showing the current simulation time as provided by Yamcs.

Frequently Asked Questions

- ### Why should I use Yamcs?

Customers usually select Yamcs because it is lightweight, easily configurable, and not hardware dependent. Yamcs is flexible and open source. Yamcs has the ability to easily interface with existing systems. Yamcs has a heritage of use in a range of applications, especially ISS.

- ### What can be said about Yamcs Reliability?

It is crucial that the monitoring and control system performs flawlessly during operations.

The Yamcs deployment at Belgian User Operations and Support Centre typically provide over 4,320 hours of mission-critical period (manoeuvres, science) each year, with a better than 99.9% service availability rate. During non-critical mission periods, payloads are monitored 24/7 with a service availability of more than 99.7 %.

- ### What user interfaces are available in Yamcs?

Yamcs comes with:

- The built-in Web Interface. It allows operator to quickly access all Yamcs data and functionalities.
- Yamcs Studio: desktop client Providing extensive capabilities for building synoptic displays, monitoring and commanding.

Third party integrated user interfaces:

- Open MCT: a next-generation mission operations data visualization framework maintained by JPL and NASA AMES.
- Grafana: an analysis and monitoring tool for time-series data

Yamcs provides an API and a python client to develop further customised User Interfaces.

- ### What can be said about software quality?

Quality of Yamcs developed software is the result of a long heritage of SpaceApps with ESA program requiring high-quality results and enforcing strong process orientation (ECSS standards). A certification plan is in place for delivery of safety-critical configuration of the Yamcs Server.

- ### Who is the ideal customer of Yamcs?

Any individual or organisation keen to rely on a proven and growing framework for his/her/its Mission Control System; looking for a solution that would be cost-effective in addressing risks but with no compromises on performance and functionalities and, in particular, with plenty of growing capabilities
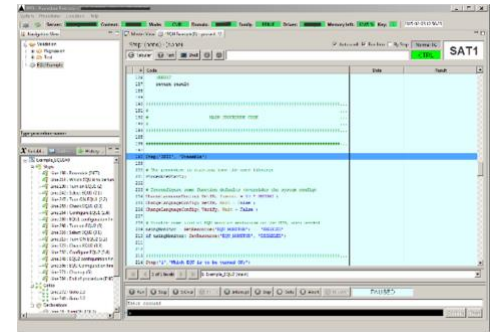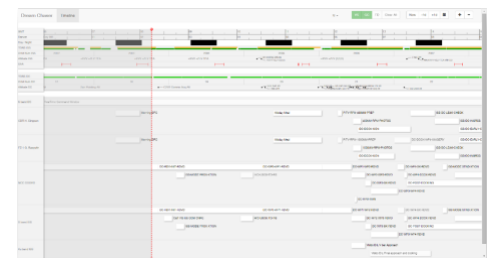

Figure 4 SPELL Execution Window

Figure 5 Example of timeline configuration for monitoring ISS planning

ABOUT SPACE APPLICATIONS SERVICES
Space Applications Services NV/SA is an independent Belgian company founded in 1987, with a subsidiary in Houston, USA.
Our aim is to research and develop innovative systems, solutions and products and provide services to the aerospace and security markets and related industries.
Our activities cover manned and unmanned spacecraft, launch/re-entry vehicles, control centres, robotics and a wide range of information systems.

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- ### What is the licensing policy?

Yamcs Suite and its constituent parts come under different licences due to the technologies used within.

Yamcs server software comes under AGPL licence (Affero General Public License) with components released under a LGPL licence (Lesser General Public License).

From Yamcs Applications standpoint, Yamcs Studio, based on CS-studio, has to be released under an EPL license (Eclipse Public License) which is similar to GPL. TYNA licensing scheme is driven by ESA software license regulations which allows any ESA member state organisation to request a license.

- ### Why is Yamcs (mostly) Open Source?

We believe that having an open-source core, is not only fun and exciting, but also increases the quality of our products and benefits all of our customers equally.

- ### What is the documentation available?

All the information and documentation of Yamcs can be found at www.yamcs.org

- ### What are the up-to-date deployment of Yamcs?

Belgian User Operations and Support Centre (BUSOC), European Robotic Arm Mission Control Centre (ERA-MCC), Atomic Clock Ensemble in Space ground segment (ACES), International Commercial Experiment Cubes Service (ICE Cubes), etc.