OPEN: A community based preparation environment for EGS-CC based systems

François Trifin, Anthony Walsh

European Space Agency
European Space Operations Centre,
Robert Bosch Str 5, 64293 Darmstadt, Germany
Email: francois.trifin@esa.int, anthony.walsh@esa.int

INTRODUCTION

The European Space Agency (ESA) is developing a software framework, named "OPEN Preparation Environment" (OPEN), supporting the preparation of tailoring data for European Ground Systems Common Core (EGS-CC)[1][2] based systems. ESA has the ambition to cfoster a community of contributors from ESA Member States, sharing the benefits generated by the common framework.

Already used across ESA sites (ESTEC, ESOC) on three ESA projects, OPEN is the backbone of a future tailoring environment: for AIT engineers (Mission Model Editor – MME); the preparation environment for all ESOC's Flight Control Teams using the future EGS-CC based Mission Control Systems (OPEN-M); and the preparation environment for ESOC's ground station operators (OPEN-S).

The framework provides generic functions all users and applications should need for tailoring EGS-CC data as well as the basis to develop other additional more specialised functionality. The generic functions include services for data management, such as access control, version control, reporting, consistency checking, scripting, data compare and merging. OPEN also provides MMIs for common user oriented tasks and a variety of editors and browsers for viewing and editing the data definitions, tailored for the EGS-CC monitoring and control models.

OPEN supports generic services and features which can be extended via data type or function specific plug-ins to cover the full scope of data preparation. Being 'open', extensions providing services, data type specific functionalities and the actual 'user front-end' functionality can originate from several sources in terms of funding and organisation. Therefore, proprietary extensions can be used as part of the OPEN-based applications and the whole application can form a proprietary product. At the same time, the framework itself and some related extensions are made available under an ESA community software license.

CONTEXT

The rationales and objectives, context, description and functionalities of OPEN have been clarified in two previous papers [3] and [4].

The Operation Preparation Environment (OPEN) framework is part of an ESA initiative to streamline and harmonise preliminary EGS-CC based preparation environments for spacecraft and ground stations operations teams at ESOC to manage operations data required to tailor and operate the mission data systems.

The extendable frameworks offer the possibility to combine and integrate in a consistent manner specialised tailoring tools from different organisations and develop an eco-system of applications around an a commercially friendly framework system. Beyond operations, OPEN can enable improved coordination and exchange between mission's phases C/D/E tools and organisations.

Along with the deployment of EGS-CC based M&C systems, OPEN is intended to ultimately become the basis of all preparation environments for all ESA monitoring and control systems operated at ESOC.

OPEN –THE FRAMEWORK

OPEN, as a framework, is a software meant to be used as a basis of specialised tailoring tools sharing common basic functionalities. Extensions for dedicated purposes can complement the framework to form a standalone software application.

Should a functionality provided by OPEN requires additions, improvements or simply be complemented, the software architecture and license allows to perform modifications of the framework and redistribute it further as described later in this paper.

The OPEN architecture is modular and as such the final product does not need to include all functions offered by the framework. The 'add-on' concept allows also decoupled inbuilt components of generic services.

The OPEN framework has a layered design with overall two main 'layers'.

The OPEN layer is providing generic functionalities, such as version control, scripting, consistency checking or non-graphical model visualisation. With the exception of the Configuration Item concept, this layer is agnostic to all EGS-CC concepts and is relying on the Eclipse Rich Client Platform and the Eclipse ModelingModelling Framework for its implementation. The OPEN layer has no dependencies on OPEN-CC nor EGS-CC.

The OPEN-CC layer extends the OPEN layer and provides generic functionalities specifically dedicated to support the tailoring of EGS-CC tailoring data. While OPEN-CC is itself a framework based on OPEN with extensions that are EGS-CC 'aware', when referring to 'OPEN', both layers are usually included.

The OPEN and OPEN-CC layers can both be extended by 'extensions' for specific data types or functions but EGS-CC specific extensions can only extend OPEN-CC.

Being a software framework, OPEN is meant to be embedded into a larger software product which is then provided to end users, such as AIT engineers or operators. ESOC is implementing two of those products, one for mission operations preparation (OPEN-M) and the other for ground station operations preparation (OPEN-S), while ESTEC is implementing another (MME).

OPEN –THE TAILORING DATA TOOL

OPEN is not only a framework upon which an application can be built. When used in conjunction with the EGS-CC's Conceptual Data Model (CDM), thanks to its OPEN-CC layer, OPEN itself can be used as a tool to manage EGS-CC Tailoring Data required for the execution of EGS-CC based systems. The functionalities allows to populate, view and edit the data, as modelled by the EGS-CC CDM. Extensions, such as the MME - an OPEN-based application -, can also provide additional higher level of functionalities. The functionalities provided by OPEN are described in [3].

Ground stations, Control Systems and Spacecraft Tailoring Data are all manageable by OPEN natively, with the assumption that the LDM library of EGS-CC, defining the CDM model, is used. Indeed, OPEN's source code does not include this model which is provided with the EGS-CC binaries. With a few assumptions, any EMF-compatible model or extension to the CDM can be loaded in OPEN.

OPEN – THE MODEL VISUALISATION TOOL

When using the CDM Model, OPEN is not only a CDM population tool as it also offers views to navigate and visualise the EGS-CC's CDM itself. Along with the related reference documentation, all properties of all types of CDM elements can be

navigated. Type and sub-type hierarchies can be easily understood via dedicated views. References between elements can be followed.

The non-graphical visualisation of the model provided by OPEN fully replaces, through a dynamic user interface, the HTML EGS-CC Reference Manual for Data Model.

OPEN – THE BASIS FOR A COLLECTION OF HARMONISED TOOLS

All based on OPEN, OPEN-M, OPEN-S, OPEN-D and the MME applications, all share the same set of basic functions and user interfaces to manage the data. Additionally, those tools can easily work simultaneously on the same data repositories, allowing consistent data interconnections, while providing dedicated tools for the different users. For example, the Flight Control Team members do not need to edit the EGS-CC System Configuration but this data still need to be consistency with the Tailoring data of the FCT.

OPEN-M is the preparation environment product of MICONYS-CC, ESOC's Mission Control System software suite, includes EGS-CC based data definitions, editors and browsers to support the needs of the Flight Control Teams.

OPEN-S is the Ground Station Monitoring and Control system (GSMC-CC) preparation environment specific to the Ground Station M&C domain. The primary extensions are additional data definitions and editors required for the tailoring of the GSMC-CC adaption layer which implements the interface between the GSMC-CC and the Ground Station Sub-Systems.

OPEN-M and OPEN-S are described in [3].

MME (Mission Model Editor) has for objective to provide phase C/D's users with a tool allowing them to tailor EGS-CC CDM-based data to the needs of their spacecraft, subsystem, payload and equipment or other elements which is to be monitored and controlled via an EGS-CC system.

OPEN-D will be managing EGS-CC System Configuration Data. OPEN is particularly relevant to this use case as it allows to consistency check the tailoring data with the System Configuration.

OPEN-M – A DATA CONVERTER FROM SCOS-2000 to EGS-CC

OPEN-M includes all the functionalities of OPEN but also a SCOS-2000 MIB 6.9 converter to the EGS-CC Conceptual Data Model. While there are significant changes between the SCOS-2000 and the EGS-CC data models, it is entirely possible to migrate the first into the latter as EGS-CC's model is semantically richer.

Validation of this converter is currently being performed using actual mission data from BepiColombo, ExoMars Trace Gas Orbiter, Gaia, JUICE and the Sentinels spacecraft.

RAISING THE SOFTWARE STACK - A MARKET OPPORTUNITY

Similarly to other well-known open source foundational software, such as the Linux kernel of The Linux Foundation [5], Android of the Open Handset Alliance [6] or the Eclipse Project of the Eclipse Foundation [7], OPEN, while on a much smaller scale, is also an opportunity for a large part of the ESA Members States Industry to (1) quickly offer basic functionalities to EGS-CC based systems which would otherwise require significant prior investment and (2) focus on the specialised added value. Maintenance's cost and evolution of the framework part of the application can be shared.

Like the Eclipse Project's Rick Client Platform (RCP) software which allows to create an application without re-implementing all basic functions, OPEN, sitting on top of RCP, raises the software stack a little bit further.

Implementers of a tailoring data system for EGS-CC should no longer reinvent the wheel. By adopting OPEN, a large set of basic functions are already implemented. If the current software does not fit specific requirements, being involved in the

OPEN community allows to adapt and extend the original project source code. There is also no vendor lock-in due to the very permissive software license terms.

OPEN and its related tools will provide the essential functions to ESA but (1) do not cover all use cases and (2) are relatively basic and limited. Extensions do not need to be shared and can remain fully proprietary.

The benefits to centres, such as ESOC, is the standardised environment for end users, the 'plug ability' of OPEN-based applications to share and exchange the tailoring data and the extended technical know-how shared among a community.

COMMUNITY

As OPEN is distributed under a commercially friendly ESA Community License, proprietary extensions and products can be developed on top and benefit from the framework providing generic functionalities typically required in all preparation environments. Using OPEN avoids the need to reinvent the wheel over and over.

Both OPEN and OPEN-M are licensed under the ESA Community License with Weak Copyleft (https://essr.esa.int/license/european-space-agency-community-license-v2-3-type-3-weak-copyleft). While this license is very similar to the EGS-CC license, it includes a copyleft clause, where copyleft exceptions allow for external modules (such as your new modules which may be implement as a so-called "OPEN Extension") to be distributed under a different license, which may be proprietary.

The license terms allow for direct re-distribution of the software within the ESA Member States. In case of a need to re-distribute the software outside those Member States, an authorisation of the ESA's Technology Transfer Board (ATB) is required. Pre-authorisation for a set of countries is possible.

When distributing the OPEN and OPEN-M software, its source code and modifications must be made available to the provided party under the same ESA Community License with Weak Copyleft. Please note the present paper does not overrule the license terms and conditions.

The governance model of OPEN, by which user contributions can be incorporated into the framework, covering the evolution of the project and the original source code, is in the early specification stage. The future of the governance depends on the stakeholders, namely the organisations participating. Currently the community license is providing the mechanism by which a potential user can evaluation the software.

IMPLEMENTATION STATUS

The implementation phase of the OPEN framework and the OPEN-M and OPEN-S applications started in 2017 with on-site and off-site contractors of multiple companies under the lead of ESA. Using an agile development methodology and the constant involvement of the final users of the applications, the implementation process is ensuring fitness for purpose and the appropriate prioritisation of the added functionalities.

While more than six companies are involved at the time of writing in February 2019, the implementation is happening as a joined effort of one coordinated team composed of task oriented sub-teams having direct technical interactions and support with each other's. Having multiple companies involved allow to spread the technical know-how and benefit from multiple expertise areas sometime particular to a single company.

The first identified users of OPEN-M, Flight Control Engineers of the JUICE and Sentinels missions, are directly involved in the development, use the alpha software on a regular basis with data of flying missions and have direct face to face interactions with the developers on specific topics.

The short-term development objective is having confidence OPEN-M is fit to perform the work in the operational context by 2020, therefore answering all the mandatory use cases, where no alternative exists in the EGS-CC context. Once achieved, the next step is an expansion of the functionalities to increase coverage and efficiency.

The inclusion of User Defined Display editors, management of constellations and the management of the EGS-CC System Configuration are the next extensions foreseen for implementation.

For both, OPEN and OPEN-M, ESA is promoting their use outside the direct missions of the Agency to communalise resources, further spread know how.

CALL FOR INTEREST AND PARTICIPATION

Should you be interested to help define and be part of the OPEN Community, please do not hesitate to contact by e-mail both authors of this paper.

Further information about OPEN will be provided through the ESA portals http://www.esa.int/esaopssoftware and https://essr.esa.int/.

REFERENCES

[1] M. Pecchioli et al., "Objectives and Concepts of the European Ground Systems Common Core (EGS-CC)" SESP 2012, Noordwijk
[2] M. Pecchioli, A. Walsh, "The EGS-CC based Mission Control Infrastructure at ESOC" SESP 2017, Noordwijk
[3] F. Trifin, A. Walsh, "The Next Generation Mission Operations Preparation Environment at ESOC" SESP 2017, Noordwijk
[4] F. Trifin, A. Walsh, "Monitoring and Control Operations Preparation Framework for EGS-CC Based Environments " SpaceOps 2018, Marseille
[5] "About The Linux Foundation", The Linux Foundation, Retrieved 2019-02-01, https://www.linuxfoundation.org/about/
[6] "Industry Leaders Announce Open Platform for Mobile Devices", Open Handset Alliance, 2007-11-05 http://www.openhandsetalliance.com/press_110507.html
[7] "Eclipse Forms Independent Organization". Press Release. Archived from the original on 2004-04-07. Retrieved 2004-02-04, https://www.eclipse.org/org/press-release/feb2004foundationpr.html