Research Fellowship on Model-Driven Avionics

Directorate of Technical and Management Support

European Space Agency, ESTEC, Noordwijk, The Netherlands

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Overview of the Division's mission

The Software Systems Engineering team addresses a number of domains, the most relevant for this position being system-*software co-engineering.* Reviewing several software projects has shown the need to create a link between the work of the system team and the software team. The goal of this line of activities is to offer, to system and software teams, the same set of methods and tools, unified within a common process. This allows them to outline the architecture of the system and its properties, and to verify - as early as possible - the system properties (simulation, object-oriented models, data models, behavioural models, state machines, message sequence charts, proof-based design, and so on).

This applies in particular to the Avionics discipline, where Software, Data Handling and Control join forces to produce the avionics system of the spacecraft. In order to streamline the production of avionic systems, a joint initiative between ESA and industry has been started, called SAVOIR (http://savoir.estec.esa.int)

More generally, the Software Systems Division also addresses the following topics:

- requirements engineering and modelling
- model-based software engineering
- software architectures
- automatic code and test generation
- cross-development environments
- schedulability analysis
- software engineering environments
- standardisation.

Overview of the field of activity proposed

The present Research Fellowship is at the core of **Model Based - System Engineering** and **- Software Engineering**.

The model-based approach is the trend in embedded systems. Although it is challenging to demonstrate its return on investment, there is the shared perception that it is the solution to the complexification of embedded systems.

The industrial needs in space avionics are **FASTER, LATER, SOFTER**:
- because of the schedule decrease, the embedded systems must be developed **faster**
- due to the system increasing complexity, system issues needs to be solved and implemented **later** and later in the avionics life cycle
- the particular space industrial policy establishes a variety of customer/supplier relationships in a multivendor context creating the need for a "**softer**" interoperability of avionics elements.

The model based approach is one of the best candidates to implement these needs. It is relatively well established in software, but it only starts emerging in system and in particular in avionics hardware. Major avionics stakeholders start to communicate on model based avionics:

- Boeing: http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1420953,
- JPL: http://trs-new.jpl.nasa.gov/dspace/bitstream/2014/13354/1/01-2187.pdf,
- Thales: http://www.henrymuccini.com/documents/ArchitectingGoodQualitySoftware_slides/FrancescoMonai_An%20overview%20of%20Thales%20methodology%20for%20SW%20Design,%20Development,%20and%20Qualification.pdf and http://space-env.esa.int/indico/getFile.py/access?contribId=31&sessionId=7&resId=0&materialId=1&confId=53)

Still, several issues need to be solved, such as:

- the relationship between several models describing particular views on the system (e.g. data modelling, with a view to creating a database of the avionics configuration parameters, Fault Detection, Isolation, Recovery (FDIR) models, deployment view or hardware physical model, etc)
- verification of the design using the models, potential automatic generation of artefacts
- tooling, architecture of the tools, industrial organisation of investments in tools,
- validation of avionics based on the Savoir concept, i.e. reuse of validation credit of components,
- use of ontologies to organize the avionics knowledge and to define data models or generic requirements
- software/microelectronic co-design (avionics-to-software together with avionics-to-microelectronics - Asic or FPGAs).

Beside these technical issues, the approach is done in the industrial context of the European space industry. This means that the technical decisions are made in view of deploying the technology in the space community. This implies the constant involvement of the industrial stakeholders, as well as a definitive standpoint based on industrial competitiveness and product lines. This is the goal of the SAVOIR initiative.

Introduction to SAVOIR

SAVOIR is intended to produce reference architecture and generic specifications, in order to facilitate the emergence of product lines. For example, the avionics reference architecture identifies the functions related to the on-board computer (OBC) and a generic specification is produced for the OBC that will be attached to space procurements. If suppliers receive similar product specifications, they will be able to establish product lines.

The definition of generic specifications assumes the definition of domains in which the specifications will be reused. Currently, these domains are Earth Observation, Science and Telecommunications. This does not prevent other domains such as Launchers from reusing these specifications.

The definition of generic specifications requires a high level of consensus among the stakeholders. For this purpose, various working groups are investigating the different disciplines involved. The Savoir Advisory Group (SAG) is the steering board of the Initiative, while subgroups are in charge of software, sensor actuators, etc.

The subgroups are supported by industrial activities that investigate technical details and propose solutions, which are then discussed and endorsed by the Advisory Group. Savoir documents are then reviewed by several groups of stakeholders before being published.

SAVOIR has produced several draft documents, in particular OBC and Remote Terminal Unit specifications, some software architecture, specifications and component models, some sensor interfaces and several communication mechanisms.

Proposed activity

The proposed activity is to support the consolidation and the facilitation of this initiative, and to put into practice the theoretical aspects, in order to structure the activities and produce results.

It requires a theoretical (academic) background in order to keep, in the model based approach, the mandatory rigour needed to have a strong semantic suitable for (automated) verification of models and potential automatic generation of artefacts.

It requires a system standpoint necessary to build up a multi-model approach based on particular views of the system (data and spacecraft data base view, real-time and interaction patterns view, dependability view, hardware deployment view, etc.)

It requires a vision on the processes and the tools allowing defining the toolset architecture.

It requires a pragmatic approach derived from the knowledge of the industrial practices that will be acquired during the activity, in order to adapt the theory to the industrial real-life and to the ultimate goal of improving industrial competitiveness.

This position, located at the crossroad of academic approaches and industrial applications, of avionics systems and software engineering, is at the core of the current embedded software challenges. It is also an opportunity to transition gradually from an academic context into an industrial perspective.

The output of the activity includes in particular:

- a multi-model organisation featuring the software models, the system data models, the dependability models, the hardware models, the microelectronics models, etc.,
- a toolset architecture supporting interoperability of the models in an industrial context,
- the associated process,
- the consolidation of the existing demonstrator, that can also be used to prototype new ideas.

For this purpose, the tasks include in particular:

- support to the SAVOIR working groups, in order to learn industrial practices while maintaining an academic rigour in their deliberations,
- interacting with Esa contacts in system, hardware, microelectronics, control, etc. entities, as well as the Esa projects potential users,
- working in the Estec laboratory
- supporting the communication strategy by reflecting internal tasks into papers and presentations.

Keywords include: avionics, model based, product line, domains of reuse, variability within the domains, feature models, domain specific languages, component model, model editors, model transformation, reference architecture, etc.

Who can apply

The programme is open to suitably qualified women and men. Preference will be given to applications submitted by candidates within five years of receiving their PhD.

The Research Fellow Programme is open to nationals of the following states: Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland, and the UK, or Canada as a Cooperating State, Estonia, Hungary, Latvia and Slovenia as European Cooperating States (ECS).

Required qualifications

Applicants should have completed (or be about to complete) a PhD in computer science or informatics; the subject of their thesis should be relevant to the task description provided above (e.g. model based approach, avionics, etc.). A degree at Master level in computer science, informatics, avionics engineering or in a related field would be an asset.

Applicants must be fluent in English and/or French, the working languages of the Agency. A very good proficiency in English is required.

Applicants should have good interpersonal and communication skills in order to interact with the avionics community and should be able to work in a multi-cultural environment, both independently and as part of a team. Good methodological and organisational skills are required. Applicants should demonstrate an interest in space as well as the ability and interest to get actively involved in prospective interdisciplinary research (software - system - avionics - hardware).

How to Apply

Please fill in the online application form attaching to it, **in one document only,** your CV, your motivation letter and your research proposal.

Applicants must also arrange for up to **three letters of reference** to be sent by e-mail, before the deadline, to the **temp.htr@esa.int**. The letters must be sent by the referees themselves. The applicant's name must be mentioned in the subject of the email.

Applications satisfying the general conditions for eligibility, to be submitted by **30 March 2015**, will be evaluated and successful applicants will be invited for an interview.

Interested applicants are highly encouraged to visit the ESA website: www.esa.int.