IMAGE

Interoperable Management of Aeronautical Generic Executive software

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D 2.1 synthesis: Real Time simulators expressed Needs

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1 Introduction

IMAGE targets at setting up a generic environment facilitating the cooperation between different platforms federated in a same simulation.

The object of this document is to precise a wide range of requirements and needs expressed by real time applications users that the IMAGE API (Application Programmable Interface) should meet. We made an initial consultation by asking these questions:

- What simulators or simulation modules do you use?
- Would you like to make them cooperate with each other(s)?
- What are the cooperative simulation systems you work with?
- What are your own needs concerning the cooperation on heterogeneous simulators (within the above mentioned domains)?

The project's technological objectives raise themes such as:

- Interoperability
- Heterogeneity
- Generic environment
- Optimisation of the data exchange
- Control
- Administration
- Normalisation

We will mainly explore the following axes:

- The distributed architecture of the system that allows to optimise the distribution of all the simulation resources
- The simplification of the communications between the systems and the reuse of the existing modules
- The use of more generic platforms sufficiently fulfilling the users' expressed needs

Having identified "high level" requirements, further "low level" requirements could be specified.

Requirements are summarised here after and named Real Time Requirements **(RTR)**

2 High level requirements

2.1 Interoperability

RTR_1_1 The IMAGE system must allow heterogeneous simulations to cooperate.

Allowing heterogeneous simulations to cooperate will enable, e.g., the splitting of a huge Synthetic Image Generator into several PCs, whatever their hardware and software configurations are.

It will also allow UNIX calculators and PCs to cooperate.

Handling heterogeneity will allow the exploitation of all the computers' resources through a network. This last point is the most often required by users.

RTR_1_2 The IMAGE system must allow distant simulators to cooperate with the illusion of being located in the same place.

In the aeronautical domain, this will allow the different firms to create complex simulations, to gather their knowledge and resources, and simulate whole planes in a realistic way.

In the training domain, a need has been expressed for distant learning, with the trainers and the trainees physically located in distant sites.

For aeronautical training purposes: this would allow trainees to access to training devices through a simple PC or a simplified simulator.

RTR_1_3 The IMAGE system must allow incompatible simulations to cooperate.

“Incompatible” simulations are those that were not meant to cooperate in the first place.

We choose three of them that are illustrative.

- Flight simulator and physical simulation.
- Flight simulator and air traffic control simulator.
- Multi-physical simulations

RTR_1_4 The IMAGE system must allow similar simulators to cooperate.

This will allow training or simulation of group manoeuvring:

- coupling two flight simulators to train/simulate airport approach
- simulating patrols of drones to watch forest fires, detect oil slicks
- simulating planes rolling on taxiways for ATC training
- training on/simulating groups of helicopters for emergency medical units
- making Air Traffic Control simulation sectors to communicate

- gate to gate application in Air Traffic Control simulations involving several simulation units

RTR_1_5 The IMAGE system must manage time constraints for modules handling different times.

To handle real time/non real time constraints; to couple synchronous/asynchronous modules.

RTR_1_6 The IMAGE system must remain coherent: all participants should be aware of each other's action on objects concerning them.

If an object is changed by a simulation, all the participants handling it should know it quickly.

2.2 Heterogeneity

RTR_2_1 The IMAGE system must handle simulators or simulation running on different Operating systems, platforms, network protocols, etc.

RTR_2_2 The IMAGE system must handle simulations with pure simulation modules, real equipment modules, man in the loop (through MHI).

RTR_2_3 The IMAGE system must be able to simply handle simulation modules from various work domains.

RTR_2_4 The IMAGE system must be able to be simply used by "heterogeneous users".

2.3 Generic status

RTR_3_1 The IMAGE system has to be generic with regards to numerous types of applications.

2.3.1 Modularity

RTR_3_1_1 The IMAGE system must allow the use of existing simulators or simulation applications by encapsulating them.

RTR_3_1_2 The IMAGE system must allow the use of simulation modules designed for IMAGE or for other applications.

RTR_3_1_3 The IMAGE system fosters the normalisation and standardisation of the simulation components through development rules and tools.

2.3.2 Flexibility

RTR_3_2_1 The IMAGE system must allow any module matching the IMAGE format (by encapsulation or using the IMAGE API) to join or leave a simulation during the execution and being aware of all the other participants.

RTR_3_2_2 The IMAGE system must allow any module matching the IMAGE format joining a simulation to be able to detect dynamically the available services and participants.

RTR_3_2_3 The IMAGE system must be able to run several simulations.

RTR_3_2_4 The IMAGE system must be able to run a whole simulation on a single platform.

RTR_3_2_5 The IMAGE system must allow the modules to run without being part of a simulation.

RTR_3_2_6 The IMAGE system must allow modules to run independently and exploit each other's data.

RTR_3_2_7 The IMAGE system must allow a simulation to stop/restart.

2.3.3 Compatibility

RTR_3_3_1 The IMAGE system must ensure the compatibility of the various used software (e.g. Data Base Management Systems, etc.).

RTR_3_3_2 The IMAGE system must manage the compatibility of the different users' profiles of a distributed simulation.

2.4 Optimisation of the data exchange

RTR_4_1 The IMAGE system must allow the exchange of data between simulators without common definitions of their objects.

RTR_4_2 The IMAGE system must handle important data flows.

RTR_4_3 The IMAGE system must provide a generic format that all the other users can understand/use and be able to get specific enough to satisfy the user.

RTR_4_4 The IMAGE system must be able to exchange data both on LAN or WAN or through the internet.

RTR_4_5 The IMAGE system supervision module should be able to cast data only to the interested module .

2.5 Supervision

2.5.1 Security

RTR_5_1_1 The IMAGE system must allow a safe run of multi-sites simulations in terms of access to the simulation (unauthorized hosts can not join a simulation).

RTR_5_1_2 The IMAGE system must allow safely the running of multi-sites simulations in terms of access to the simulation information (unauthorized hosts can not access some information).

RTR_5_1_3 The IMAGE system must allow safely the running of multi-sites simulations in terms of data exchange (unauthorized hosts can not spy on the exchanged data).

RTR_5_1_4 The IMAGE system must handle the interaction between secured/unsecured networks.

RTR_5_1_5 The IMAGE system must make sure that the exchanged information are not changed, altered or modified without authorization.

RTR_5_1_6 The IMAGE system must provide multi-users distributed simulation data propriety protection capabilities.

2.5.2 Safety

RTR_5_2_1 The IMAGE system increases the safety of the software and hardware modules by allowing them to be extensively tested from the beginning of the development.

RTR_5_2_2 The IMAGE system must provide testing and controlling tools to test and control the modules and the whole simulation behaviour.

RTR_5_2_3 The interaction between real world and simulation must be particularly safe.

2.5.3 Robustness

RTR_5_3_1 The IMAGE system must detect and handle errors.

RTR_5_3_2 The IMAGE system must keep on running even if a simulation module goes off. Being able to restart a module that went off.

RTR_5_3_3 The IMAGE system must be able to follow part or all the simulation, to access data without perturbing the simulation.

RTR_5_3_4 The IMAGE system must be able to detect if a connecting participant has a sufficient power and so will not degrade the performance of the networked simulation.

2.6 Administration

2.6.1 Learning and Experimentation Support

RTR_6_1_1 The IMAGE system must integrate more efficiently in the simulation the learning supports associated to the different modules.

RTR_6_1_2 The IMAGE system must reinforce the guidelines for the experimentation supports of the simulation.

RTR_6_1_3 The IMAGE system must improve the experimental framework (duration of the experimentation execution, number of replications needed, combination of input factors to be used for specific simulation run, etc.).

RTR_6_1_4 The IMAGE system must provide simulation analysis tools.

RTR_6_1_5 The IMAGE system must provide learning and training support.

2.6.2 Administrative Support

RTR_6_2_1 The IMAGE system must allow simulation services management.

The user must be able to configure, animate and control the simulation through tools provided by the IMAGE system. See also 6.1.2.

RTR_6_2_2 The IMAGE system must provide off-line simulation resource management.

Handling pre-processing data to have an initialisation task as fast as possible.

RTR_6_2_3 The IMAGE system must be easily maintainable.

RTR_6_2_4 The IMAGE system must store relevant data and provide tools to replay (the user can interact) or redisplay (the user is passive) a simulation.

RTR_6_2_5 The IMAGE system should provide debugging facilities.

RTR_6_2_6 The IMAGE system must enable data management in distributed simulation environment.

RTR_6_2_7 The IMAGE system must provide implementation constraints management capabilities.

RTR_6_2_8 The IMAGE system must allow distributed and heterogeneous simulations interfaces management.

RTR_6_2_9 The IMAGE system must provide consolidated statistical facilities.

RTR_6_2_10 The IMAGE system must ensure distributed cross-referencing capabilities.

2.6.3 Configurability

RTR_6_3_1 The IMAGE system must be able to configure the simulation as simply as possible with regard to the user's needs.

RTR_6_3_2 The IMAGE system must be able to record/load a configuration.

RTR_6_3_3 The IMAGE system must build a hosting structure for a distributed simulation from a library of systemic and reusable components.

RTR_6_3_4 The IMAGE system must allow the user to build simulation clusters.

2.7 Norms and standards

RTR_7_1 The IMAGE system must be able to make the system respect a specific norm or standard or to demonstrate that it respects this standard or norm.

- **JAR-STD 2A norm**

  The JAR-STD 2A norm qualifies the flight training devices that respect it. It is based on four main types of rules about: the quality system that the flight training device must have, its updating procedures, installation (environment) and technical requirements.

- **ARINC 610 B standard**

  The ARINC 610 B standard is a guidance for the use of avionics equipment and software in simulators. “When aircraft avionics equipment is used in flight simulators, it is desirable for the equipment to be compatible and identical to the aircraft fleet equipment”.

  It allows all the entities involved in the design and development of avionics equipment (including simulators manufacturers) to coordinate themselves.

- **AICC simulation interoperability guidelines**

  Their purpose is to make these types of integrated training possible. The interoperability guidelines are based on using a virtual interface and set of standard messages for CBT/simulation communication.

2.8 Cost reduction

RTR_8_1 The IMAGE system will allow easy interfacing of components from different simulation systems.

RTR_8_2 The IMAGE system must allow the replacing of real equipment by computerized elements.

RTR_8_3 The IMAGE system will encourage the replacing of expensive dedicated platforms by several cheaper generic platforms (typically PC).

RTR_8_4 The IMAGE system will allow to share computers and network resources on a distributed system.

RTR_8_5 The IMAGE system must keep an acceptable level of quality (performance, speed, precision of the data, …).

This point is the logical conclusion of a list of ways to reduce cost, which must not degrade simulation or simulators beyond an user defined threshold.

3 Conclusion

This document has presented the IMAGE potential users' requirements, which requirements have been established after data collecting.

These requirements have been structured, divided into main themes.

- Interoperability
- Heterogeneity
- Cost reduction
- Modularity
- Flexibility
- Optimisation of the data exchange
- Security
- Safety
- Robustness
- Learning and Experimentation Support
- Administrative Support
- Configurability
- Compatibility

Each theme was detailed and illustrated and covers a broad spectrum.

They have been discussed with clients and partners, potential end users, and so should be representative of their requirements.