	HoliDes **Holi**stic Human Factors **Des**ign of Adaptive Cooperative Human-Machine Systems	

D7.4 – Tailored HF-RTP and Methodology Vs1.0 for the Aeronautics Domain

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Compiled by:	Sara Sillaurren, TEC
Authors:	Zdenek Moravek, HON Jesús López, TEC Sonia Bilbao, TEC Sara Sillaurren, TEC Jan-Patrick Osterloh, OFF Frank Rister, TRS
Reviewers:	Ignacio González, ATOS Roberta Presta, SVN
Technical Approval:	Jens Gärtner, Airbus Group Innovations
Issue Authorisation:	Sebastian Feuerstack, OFF

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1 Introduction

1.1 Objective of the document

In deliverable D7.2, which was the initial version of the tailoring process, we defined the RTP and described how the RTP can be applied in the development process of the aeronautics domain. The application or the tailoring process was divided into steps; each step was described and illustrated with an example from aeronautics demonstrators. Based on these steps and similar tailoring processes from other HoliDes domains, four tailoring rules were derived in WP1 (D1.4) and are listed and discussed briefly in section 2.2.

The main objective of this deliverable is to describe the current tailoring process in each of the two AdCoS composing the use case of the aeronautic domain.

The first AdCoS is the DivA (Diversion Assistant), whose intended function is to provide the user with all necessary information in order to choose an appropriate alternate airport. Some degree of automation in the data pre-arranging process will be involved, but the final decision is expected to be made by the crew. The functionality will provide the crew with only relevant data presented in a way that will ease the crew's decision making process.

The second AdCoS is the EATT (Enhanced Adaptive Transition Training), which is an adaptive, model-based transition training tool that accounts for the trainees' previous experience. Based on cognitive task models, learning theory-based models and system comparisons, EATT provides training that emphasizes the differences between two aircraft types (e.g. B737 and A320), identifies areas of higher training requirements (e.g. when procedures significantly differ or only "mask" to be identical), areas of less effort and also allows for an enhanced learning curve by redistributing training tasks to an optimum level.

This tailoring process is referred to the HF-RTP, to the MTTs chosen to improve each AdCoS development and to the interoperability between MTTs.

1.2 Structure of the document

This document goes one step further in the tailoring of the HF-RTP since D7.2. Based on the recently delivered D1.5, the document presents in the first place the *current HF-RTP tailoring methodology*. In this sense, this deliverable updates the status of the tailoring process using a structure implied by the tailoring rules. The following aspects are covered by this status update:

- Step 1, project scope – activities that were just planned are being now executed. Some of the activities brought up more details to the scope definition.
- Step 2, selection of the tools – the selection was refined based on first round of tests and new objectives coming from the scope refinement.
- Step 3, semantics and information mapping between tools – knowledge of interfaces provided by selected tools was used to define a generic way of communication between the tools.
- Step 4, implementation of models and connectors – examples of the implementation that led to the information models are given. This considers mainly types and formats of data to be exchanged especially when the data may be consumed by other than foreseen parties within RTP. The standard protocols to be used and OSLC compliance are also discussed.

The prospects of development in all four aspects are given with respect to RTP (what is expected) and with respect to AdCoS (how it will be implemented). In the same section, this deliverable also analyses the added value that *adaptation* brings to the domain for future systems.

After that, the *deployment of the HF-RTP tailoring rules* is made for each one of the AdCoS of the aeronautic domain.

In the last place, *conclusions and summary* are extracted, and the way forward and upcoming activities for the future are dealt.

1.3 Acronyms

HF: Human Factor
HF-RTP: Human Factors Reference Technology Platform
DivA: Airport Diversion Assistant
EATT: Enhanced Adaptive Transition Training
MTT: Methods, Techniques and Tools
IOS: Interoperability Standard
OSLC: Open Services for Lifecycle Collaboration
EFB: Electronic Flight Bag
ATC: Air Traffic Control
ETA: Experiment tagging and annotating
EEG: electroencephalography data
ECG: electrocardiogram data
MED: Missed Event Detector
DDS: Data Distribution Service
SOP: Standard Operating Procedures
Eclipse Lyo: an SDK to help the Eclipse community adopt OSLC (Open Services for Lifecycle Collaboration) specifications and build OSLC-compliant tools

2 HoliDes Reference technology platform (HF-RTP)

2.1 HF-RTP tailoring methodology

To define a clear methodology for the HF-RTP tailoring we should start from the assumption that an RTP is basically represented by a list of tools and services which are all IOS compliant. In this sense, the basic idea for the tailoring process will be composed by two main steps:

1. Select those tools and services from the RTP to be used in a given development project.
2. Integrate these tools and services by providing a suitable way to exchange data between them.

The result of this tailoring will be a project-specific instance of the RTP. The second point relies on the interoperability specification, applying the principles for linked data based on the OSLC specification.
Human-Factors-related activities in many cases are not clearly formalized and might rely on informal methods with unclear specification of how results should be presented. To be able to integrate informal methods, a library of scripts describing common practices of used methods will be defined. In this methodology for HF-RTP tailoring it will be then needed to append the choice of methods and their documentation in the way of shared descriptors, defined in an HF-ontology.

2.2 Tailoring rules for the aeronautics domain

A first approach to the tailoring process has been sketched in D1.4. According to this approach, tailoring is about:

"*Selecting tools and services for the project at hand and creating an instance of the RTP which should be apt to address the needs of a specific project.*"

The tailoring should address rules described in the following sections.

2.2.1 Tailoring Step 1 – Identification of the purpose of the project and the used tool chain

The first step of the tailoring process is the definition of the overall purpose of the project and the role of the RTP in supporting its. In the aeronautics domain, two projects will be considered:

1. Airport Diversion Assistant AdCoS – DivA: to provide the user with all necessary information in order to choose an appropriate alternate airport.
2. Enhanced Adaptive Transition Training AdCoS – EATT: to provide training that emphasizes the differences between two aircraft types (e.g. B737 and A320), identifies areas of higher training requirements and areas of less effort.

The purposes will be described in terms of the planned workflows; the expected outcomes of each step within the workflows will be given and will include the human-factors and certification criteria. Also the weak points in the development process will be identified, to maximize the profit of using RTP tools over those already in use.

2.2.2 Tailoring Step 2 – Selection of methods and tools

In the second step, related methods and tools are selected to fit the needs of the project purpose. A library of generalized descriptions of methods will support the method selection. A HoliDes tool list will support the tool selection.

2.2.3 Tailoring Step 3 – Definition of semantics and information mapping between methods and tools

The next step is to decide what level of information exchange is needed for the RTP instance. A common semantic approach will be used to generalize the information exchange across several methods and tools. To this end, the common meta-model together with the Human-Factors ontology will be used.

Step 3 should also think ahead: will the meta-model or data format identified when practising Step 3 be sufficient if (some of) the tools are used in different circumstances? The part of work in Step 3 should contain generalization of the data flow.

2.2.4 Tailoring Step 4 – Implementation of information models and connectors.

Once the common semantics and mappings have been decided upon, the information management has to be implemented. This is mainly a technical task. Step 4 should focus on the documentation to describe how RTP tools were inserted in the process and how non-RTP tools were modified to cooperate. Step 4 should provide implications for RTP – update on protocols that govern data exchange and update on tools (i.e. new tools added, new connectors to existing tools created).

2.3 Adaptation in the context of the aeronautics domain

Aeronautics is an industry with strong accent on safety and determinism. Hence, adaptation needs to be well justified. If justified, adaptation needs to be:

- Comprehensive to pilots – they need to understand why adaptation was invoked and what has been adapted
- Consistent – adaptation is realized in the same way in the same or similar situation
- Unobtrusive – as little as possible should be changed

Briefly, confusion and feeling of randomness must be avoided when adaptation is triggered.

The EFB (Electronic Flight Bag) platform is less restricted by regulations; therefore it may be a gate for adaptation in the cockpit. Diversion Assistant (DivA) AdCoS will have to adapt the prioritization in selecting and evaluating available airports. For this adaptation to be performed, the system will have to infer the pilot's mental state, through a tool present in the HF-RTP, called Pilot Pattern Classifier. This tool will use the interoperability provided by WP1 in the form of Human Factors ontology and the OSLC standard to communicate this state to the DivA AdCoS.

In the use case of the Enhanced Adaptive Transition Training (EATT) AdCoS, the adaptation of the system is based on the knowledge, experience and the individual progress of a trainee. In this specific use case, the requirements definition (which will be captured in a traceable format) will be based on the previous knowledge of the trainee. The term knowledge, in this context, refers to tasks that basically remain the same, regardless of the aircraft type flown (i.e. air traffic control, navigation, time planning - as aircraft operate in the same speed regime, or workload management). But also, previous knowledge refers to problematic areas of it, when similar procedures or similar interfaces of different functionalities and/or system architectures require special attention during training. The tool in HF-RTP used to do so will be the commercial UML tool MagicDraw. MagicDraw is a graphical UML modelling tool, which comes with a very sophisticated and customisable User Interface and functionality (e.g. plugin API, Model Versioning, Collaborative development/editing of Models, Validation Suites). It offers also rapid customisation of UML diagrams via UML Profiles, i.e. it allows developing your own graphical languages as extensions of the existing UML diagrams. Therefore we can focus our development effort on the language and the algorithms itself, instead of developing yet another graphical editor. Even taking the effort for tailoring (development of HF-RTP wrapper) into account, this is faster than implementing a graphical editor from scratch, not to mention the amount of features that is already contained in MagicDraw (see examples above). The syllabi, will be adapted to the previous knowledge of the pilots, and will be addressed by the tool Training Manager (D7.3), also present in the RTP.

3 Deployment of the HF-RTP tailoring rules

3.1 Airport Diversion Assistant AdCoS – DivA

Diversion assistant (DivA) was described in D7.2 and other deliverables in detail. Briefly, the application should support pilots when selecting and alternative destination if the original one becomes unavailable. A typical use-case can be read as:

> *"There is a regular airline flight connecting European city pair, particularly Barcelona and Prague. During the scheduled flight, approximately one hour before landing, the crew receives message about destination unavailability due to adverse weather. Further exploration reveals that there is an increasing formation of cumulonimbus clouds heading west that not only does not allows to land at the destination, but also prevents from landing at both alternates (Dresden and Vienna) stated in the flight plan. Pilot monitoring opens the diversion assistant application. After inputting initial information the system displays a list of suitable airports with additional specifications. The airports will be sorted according suitability conditions as evaluated by the system. The user crosschecks*

the information displayed and finds out that the best conditions offers Munich airport, second item on the list. He starts to negotiate with ATC vectoring to Munich."

3.1.1 Status of the AdCoS development and workflow

The effort in the first year was dedicated to the core functions of the system by collecting all necessary pieces of information and to integrate and process them for the pilot. The aspects of evaluation were then identified as the weak point of the development process where application of HoliDes tools can be beneficial (see Figure 1 for details, activities identified as weakest points are highlighted in yellow). After that, a set of tools was selected and described in D7.2.

In the second year, more advanced features were investigated and the scope of RTP instance was extended to cover also newly identified weak points – adaptation and additional aspects of experimenter work.

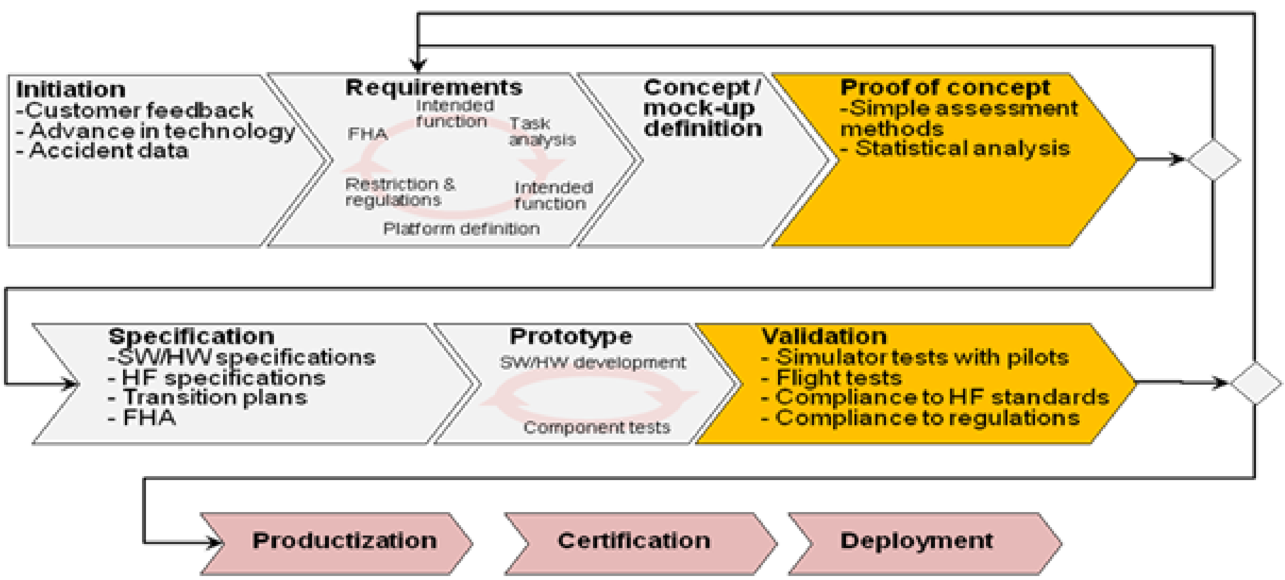


Figure 1: Specific activities in the aeronautics development process. In grey – iterative development, in red – waterfall development and in yellow – activities related to the HoliDes RTP.

3.1.2 Tailoring Step 1 – Identification of the purpose of the project and the used tool chain

On top of project scope described in D7.2, new activities are added.

Adaptation
DivA will implement two modes of adaptation. First, in reaction to the changes in environment (illumination, turbulences etc.) it will adjust display properties to enforce readability in all conditions. Second, in reaction to the state of the pilot, DivA will adjust prioritization in selecting and evaluating available airports. If state of the pilot deteriorates, a more conservative strategy focused on safety rather than economy will be applied.

With respect to adaptation, HoliDes RTP offers methods and tools to cover the following aspects of adaptation in safety critical systems

- how adaption should be done
- how the state of the pilot can be inferred
- how a number of information channels conveying various aspects of the state can be integrated into more robust state classification.

A selection and integration of adaptation related tools is discussed later in the text.

Experiments
In executing the experiments further improvements are proposed. Together with tools already selected from HF-RTP and described in D7.2, a new tool was designed to collect transient information during an experiment – notes or ideas that the experimenter comes across, strange behaviour of the system or pilot, unpredicted events, etc. In current practice, the experimenter reacts by taking his notes, which induces his head-down time and increases likelihood of missing another such event or of losing a context.

3.1.3 Tailoring Step 2 – Selection of methods and tools

In the previous version, D7.2, we selected and described tools that had met some of the requirements for the development of the core functions of DivA.

Here we describe activities that have been practiced in order to connect the tools in the development process.

3.1.3.1 Tools selected in D7.2 – status and prospects

RTMaps

Honeywell team attended a workshop dedicated to usage and development in frame of RTMaps platform. The workshop confirmed the tool fulfilled the requirements for data management in experiments. It also revealed options for connection to the experimenter database tool and identified actions to do in order to apply the tool

- collect hardware devices to be typically connected to RTMaps
- verify applicability of adapters already existing in RTMaps
- specify adapters that will have to be built in order to connect the devices to RTMaps
- implement the adapters for the devices where it is needed (there is no adapter already provided from RTMaps)
- wrap the drivers into RTMaps components
- test the ensemble of components
- apply the tool in validation experiment

Details on the actions are given in section 3.1.5.

Great SPN

Application of the tool for scenario modelling requires two initial steps. First, the proof of the concept needs to be done. Second, knowledge for efficient use of the tool needs to be created.

The attempts to prove the concept have failed so far as a suitable way of using Petri nets has not been found for this type of modelling.

Experiment database

The collection of various type of data used in design and development in aerospace has been done. The results were used to distil a list of requirements that the tool should ideally address. At the same type, a connectivity to RTMaps as a main data feeder was investigated. Results are described in section 3.1.5.

Pilot video surveillance
Requirements and specification for the tool have been collected and the development of algorithms has started. Initial set of training data has been recorded at Honeywell facilities.

Parallel processing tests
Application of the tool is connected to the existence of DivA software, which is to be available later in the project. So far a test case for sensitivity analysis was defined.

3.1.3.2 New tools added to the selection for DivA instance of RTP

Apart from the existing tools, new ones were added to the selection in order to address weak points that arose from the refinement of the project scope.

Experiment tagging and annotating (ETA)
During a course of an experiment, the experimenter has two roles: he supervises the correct course of actions and he monitors and records all relevant aspects of the experiment that cannot be easily recorded by experiment devices.

In doing the latter, the experimenter focuses on unexpected events – malfunctions of equipment, behaviour of subjects, environmental aspects, comments from subjects, etc. He tries to record them and optionally endow them with description. The event should always contain a time reference so that the event can be easily tracked when experimental data are analysed.

As a result valuable data can be collected but at the same time the experimenter's head-down time increases while taking notes. The increase in head-down time may cause missing another event.

Therefore a simple tool is proposed that reduces the head-down time of the experimenter and also attaches reliable time stamp to each event. When the tool is connected to RTMaps, synchronization with other experiment data is assured.

ETA will address two aspects of head-down time. In the first, tagging, the experimenter needs to register quickly an event he detected. The tag event is described by time of occurrence and a type. Types are specific for each experiment; therefore they will be read from a configuration file at a start-up. There should be a reasonably small number of types so that they can be displayed all at once on a device like tablet.

The annotation event extends the tag with a textual description that the experimenter types in a virtual keyboard. A simple HMI that provides the functionality is shown in Figure 2.

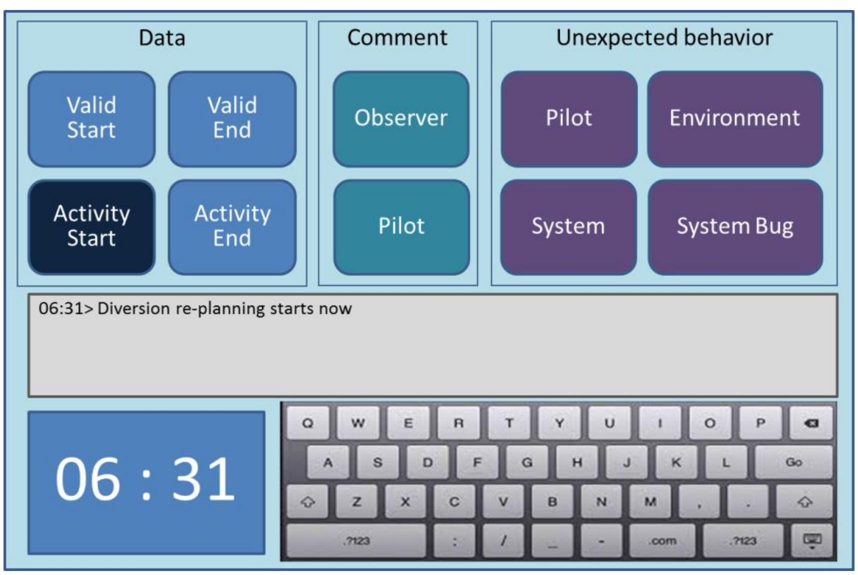


Figure 2: Experiment tagging and annotating - a support tool for quick registration of events during an experiment session.

Time of occurrence of an annotation is defined as the moment of type selection for the event or text input, whichever comes first. Categorization to tags or annotations is done automatically depending on whether there is a text attached to the event.

Fatigue modelling

Fatigue is a complex phenomenon that is not directly detectable. Instead, decomposition in a number of directly measurable fatigue markers will be done and these markers will be assessed and combined to reconstruct the level of fatigue. The identification and relations among the markers will be a subject of modelling, where methods derived in HoliDes will be applied.

Pilot state classification

The objective of this tool is to extract information about the fatigue of the pilot from online recorded data.

Depending on the fatigue makers extracted from **input** data (electroencephalography data (EEG), electrocardiogram data (ECG), gaze tracking), several techniques can be applied to infer the fatigue of the pilot:

- *Feature Extraction*: the technique aims at building relevant features for classification, using the initial set of attributes (all of them) as the basis of the process.
- *Ensembles*: the technique combines several classification algorithms to obtain the best result. Also known as "Bagging" and "Boosting".
- *Feature Selection*: the technique aims at extracting the most relevant features for classification, using a genetic algorithm that boosts the whole process
- *ELM-Extreme Learning Machine*: ELM has already been successfully used in Biometrics, Bioinformatics Signal processing, Human action recognition, etc.

Some of these techniques will be tested on our input data to know which technique fits better and provides the best classification results.

The **output** of the tool will be the fatigue of the pilot (a prediction) and the accuracy of this prediction. For instance:

PILOT STATE: fatigue (87% of accuracy)

3.1.4 Tailoring Step 3 – Definition of semantics and information mapping between methods and tools

Updated tool chain and its interfaces are shown in Figure 3. RTMaps is the central tool to gather data from other tools using its dedicated interface. Each other data consumer/provider needs to develop a connector to read or send data. The experiment database is connected via a bidirectional interface to allow for data storage and data playback. Tools selected for pilot state assessment work on sensor data streamed from sensors to the tools. These tools either write their results back to RTMaps for data storage in the database or publish the data in a standard form for other consumers. The AdCoS can be one of the consumers when being deployed. During the development, however, the AdCoS connects to RTMaps instead.

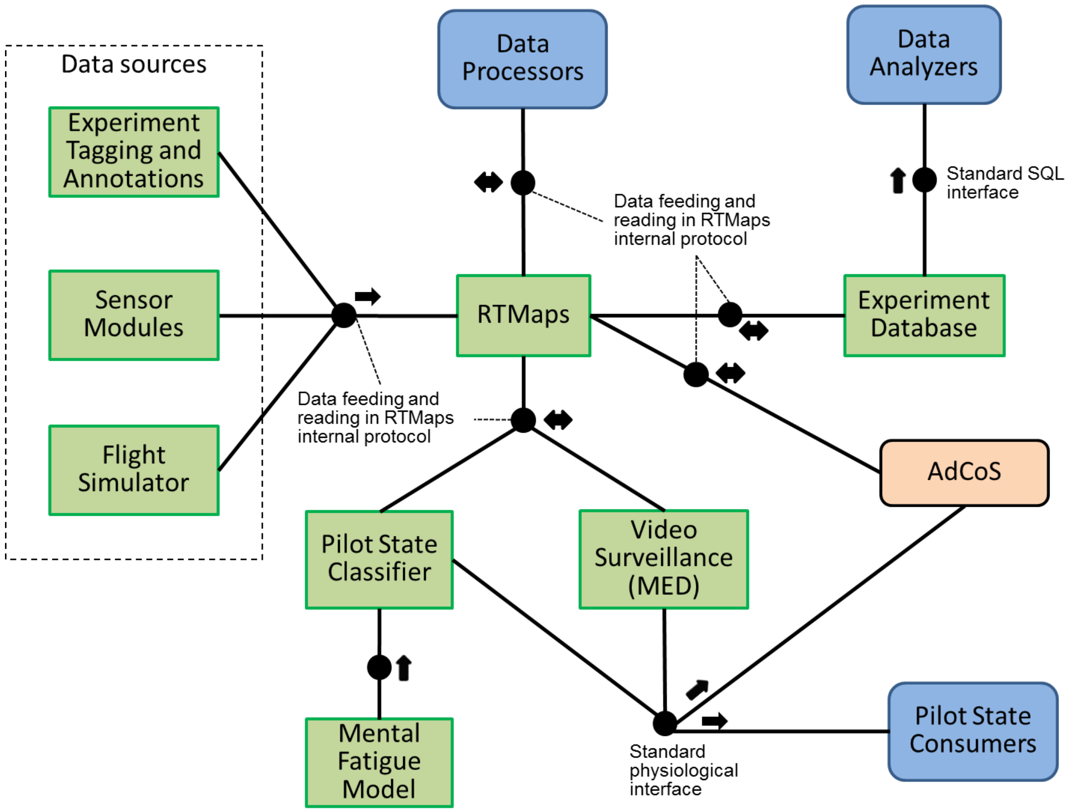


Figure 3: Instance of RTP applied for DivA AdCoS. Selected RTP tools are in green, others in blue. Interfaces (black circles) are described with data transferred through interface and direction (one- or two-way arrows).

Selected tools define two different ways about how they can be connected into the instance of RTP – either as part of RTMaps platform or as OSLC provider/consumer.

3.1.4.1 RTMaps platform

Tools as RTMaps, Video Surveillance-MED (Missed Event Detector), ETA (Experiment Tagging and Annotations) and experiment database are cooperating within the RTMaps platform respecting the interfaces that RTMaps provide. RTMaps expect tools to work as components with defined inputs and outputs and the processing logic being hidden inside the component (see details in section 3.1.5).

Input data are obtained via standard DDS (Data Distribution Service) protocol and the reading component is assumed to understand the protocol and data it transmits. Unlike other tools in HoliDes RTP there is no need to support OSLC when using RTMaps platform.

As there is a number of tools to be connected, see Figure 3, it is necessary to define data structures that flow from the data producers (or the sensors) down to the database.

In DivA case, the data producers are

- flight simulator
- video recorder
- physiological sensors
- event detection in ETA

These sensors produce three different types of data

- time series of real numbers
- video stream
- time localized events

The former two should be stored in dedicated files and only annotated in the database. The last one should be stored directly as records in database. The annotation of files should describe content, and format and location of file, and links to preceding or following files if data is split in more than a single file.

3.1.4.2 OSLC provider/consumer

In addition, tools for the assessment of the mental state of the pilot should be able to communicate the information in a standardized way as there may be a number of various data consumers. As a standard, OSLC (Open Services for Lifecycle Collaboration)[2] can be extended to contain physiological information. The information should be categorized with respect to

- location (where the data was recorded- head, finger etc.)

[2] www.open-services.net

- signal type (e.g. ECG, Electro-dermal activity)
- properties of recording device and its configuration
- interpretation method (e.g. gaze analysis for eye tracker)
- applied Digital Signal Processing (DSP) methods
- data properties

3.1.5 Tailoring Step 4 – Implementation of information models and connectors

As RTMaps are the central tool of the RTP instance for DivA AdCoS, adapters for components shown in Figure 3 need to be developed. An adapter for RTMaps should implement RTMaps component interface, which consists in five steps.

1. Parameters – the adapter defines what parameters it consumes and what parameters it produces
2. Properties – the adapter can provide a number of properties that the user can change in order to control the behavior of the adapter
3. Initialization - the adapter may read configuration file or prepare itself for data processing. The initialization logic is implemented in Birth() function of the component interface.
4. Data processing – all functionality of the adapter is specified in Core() function of the component interface.
5. Finalization – all used resources should be released and running actions terminated programmatically. Death() function cares for that.

In Figure 3 there are six tools that connect to RTMaps, their implementation of RTMaps interface is described in the following paragraphs.

ETA – The RTMaps adapter expects button ID and textual input as input from ETA. It adds simulation time and event label and sends the tag/annotation for consumer (database or logging system).

Sensor modules – Existing modules for video streaming will be used.

Flight simulator – UDP adapter was created to interpret aircraft data (ARINC 429). The adapter will be extended to DDS protocol expected by RTMaps. The flight simulator component can stream incoming messages directly to consumers who can understand them (AdCoS) and it can also log the data content sending the storage information as output for database component.

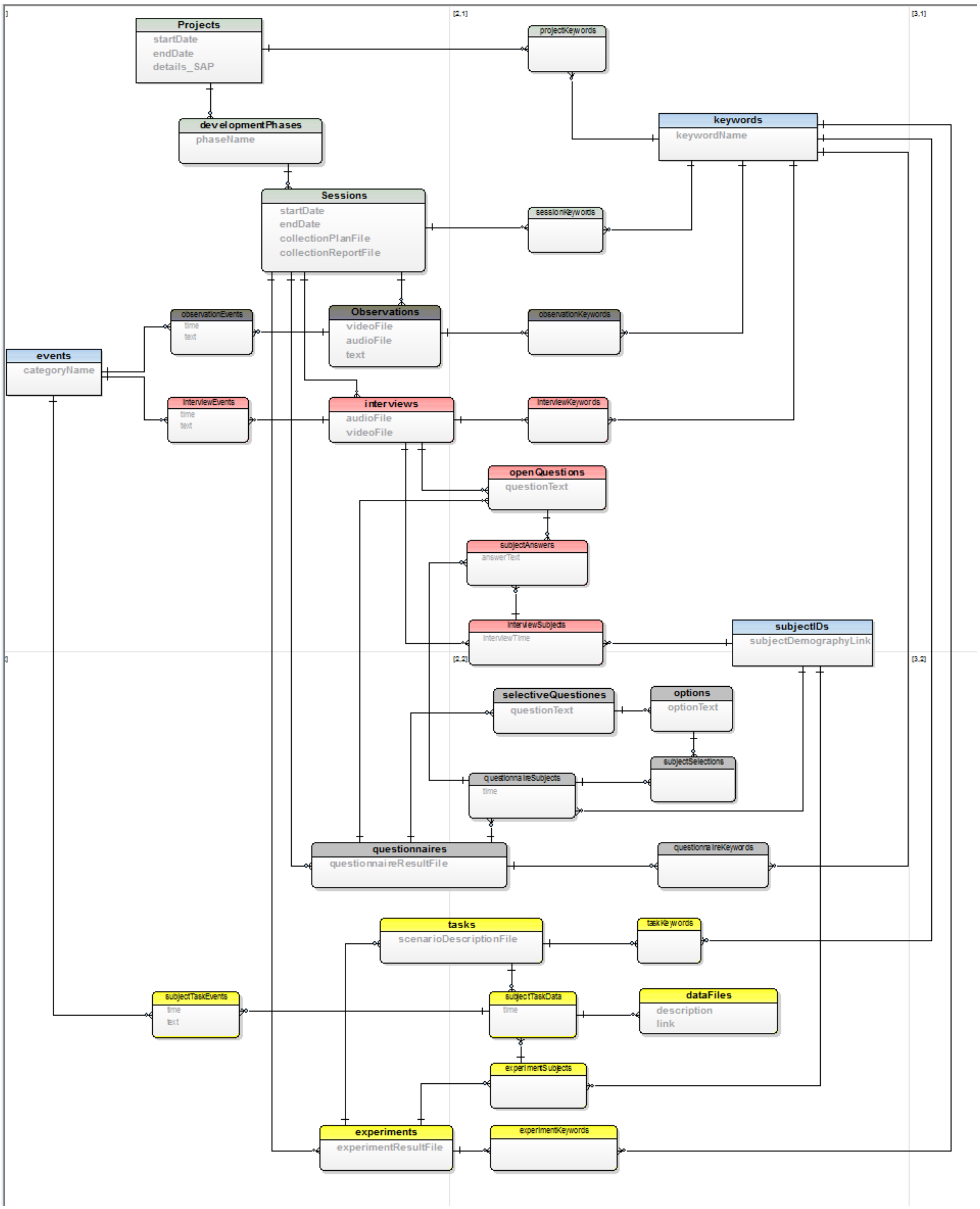
Pilot state classifier – The classifier reads a number of inputs (data from physiologic sensors) in form of unstructured binary stream for sake of data consistency and transfer speed. Each input is interpreted and classified according to the pilot state model (psycho-physiological representation of fatigue). Overall level of fatigue and its components are offered on output. For the implementation of the connector referred to the pilot state model, the HF ontology should be defined beforehand.

MED – MED reads video image recorded by camera and transmitted by RTMaps. Additional video processing methods available in RTMaps can be used. Then algorithms of MED extract head position and direction in context of cockpit geometry and this information is provided on output for database component and for AdCoS.

Experiment database – The database catalogues data. In cases of streamed data (e.g. video, sensor read-outs, flight simulator), the database manages a set of files and stores relevant link information (what and where). Based on its configuration file, it attaches the incoming pieces of information to the appropriate project records.
The implementation of experiment DB started with definition of data collected related to HF design process. Consequently a structure of the database was created, see Figure 4, and a set of low level requirements was compiled, such as

- Meta-information for each data collection session includes keywords describing purpose of the session, time frame and location where data were collected and person responsible for data collection and for data analysis. Data collection session also contains file for collection plan and for report of data analysis.

All listings of results should group the records and show them in their context - project, phase, data collection session, acquisition method.


Projects
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endDate
details_SAP
projectKeywords
developmentPhases
phaseName
keywords
keywordName
Sessions
startDate
endDate
collectionPlanFile
collectionReportFile
sessionKeywords
observationEvents
time
text
Observations
videoFile
audioFile
text
observationKeywords
events
categoryName
interviewEvents
time
text
interviews
audioFile
videoFile
interviewKeywords
openQuestions
questionText
subjectAnswers
answerText
interviewSubjects
interviewTime
subjectIDs
subjectDemographyLink
selectiveQuestiones
questionText
options
optionText
subjectSelections
questionnaireSubjects
time
questionnaires
questionnaireResultFile
questionnaireKeywords
tasks
scenarioDescriptionFile
taskKeywords
subjectTaskEvents
time
text
subjectTaskData
time
dataFiles
description
link
experimentSubjects
experiments
experimentResultFile
experimentKeywords

Figure 4: Preliminary structure of the experiment database showing a generic representation of typical HF data elements in aeronautics surveys and experiments and their relations.

Mental fatigue classifier - It is a tool based on a model describing how individual measured physiological signals combine into the psychological construct of mental fatigue. The model should define what input signals are required and what happens if some of the signals are not available. Based on the model, a mathematical classifier combines the input data into the assessment of the mental fatigue. The interface of the classifier reduces to an RTMaps component. Later a standard protocol for exchange of physiological data can be implemented.

3.1.5.1 OSLC compliance

OSLC describes specifications for easy integration of software tools. The methods and formats defined in OSLC were selected as the basis for HoliDes RTP. As discussed in section 3.1.4, tools selected for DivA AdCoS communicate in two basic ways. The first one is an exchange of episodic events with structured information, such as pilot state information or tags created during an experiment session. This information is low in size and not time critical. Therefore a standard communication protocol is beneficial for creation, transfer and storage. OSLC can support such standardization and some aspects were given in section 3.1.4.

On the other hand, sensor data or video recording is much better handled in native form, as it is optimized for amount of data to be transferred, transfer speed and data consistency (no data loss due to saturation of data throughput). Another aspect is data sensitivity and privacy. Therefore a standard communication protocol such as OSLC is applicable to establish and maintain the communication (who connects to who, what data are transferred, what format is used, what parameters the transfer uses, amount of data, etc.). After the connection is set, both parties need to understand data that are exchanged.

3.2 Enhanced Adaptive Transition Training AdCoS – EATT

To date, the generation of training syllabi is solely based on regulatory requirements and the skill of the respective training organisation to write such a syllabus. The result is a one-size-fits-all training solution, as little to no credit is given for neither the aircraft type, nor the trainees' individual needs. Syllabi in the industry today are often copy-pasted and induce an inefficient and ineffective training effort that bears considerable costs and time without quality improvement. This affects especially the transition training, where pilots already having a type rating retrain to another aircraft type. Therefore, the objective of the Enhanced Adaptive Transition Training AdCoS (EATT-AdCoS) is to provide a training syllabus (e.g. Airbus A320) adapted to the skills and knowledge of pilots, who already have a type rating for another aircraft type (e.g. Boeing 737).

3.2.1 Status of the AdCoS development and workflow

The first year development cycle was dedicated to modelling of the Standard Operating Procedures (SOP) for the A320 and B737. As a first step, the modelling language has been revised (Task Model of WP2), and the editor (MagicDraw) has been selected and customized. MagicDraw is a sophisticated graphical UML modelling tool, as described in section 2.3 After that, most effort has been spent by modelling the procedures of the crew in an A320 and B737 (Normal SOP and abnormal SOPs), as well as the systems to be used in both A/C. The status of both tools has been described in more detail in D2.4.

3.2.2 Tailoring Step 1 - Identification of the purpose of the project and the used tool chain

3.2.2.1 Scope and objectives

Unlike pilots who do not yet have a type rating, pilots who already have a type rating and typically also many flight-hours, are experienced in flying, navigating, communicating, crew coordination, and management. As many of these skills can be re-used on other aircraft types, it is not necessary to train them again, e.g. communication with ATC, planning of the flight, navigation planning, different types of approaches are the same for B737 as for A320, and also all other aircraft. Thus, transition training has to focus on the aircraft specifics, such as system differences, handling qualities and procedures.

The EATT-AdCoS will adapt the existing training syllabi for A320 to transition training from a B737 to A320. This allows shortening the transition training significantly, such that a) the trainee is earlier available for the employee, and b) the training organisation can offer more variable training (better usage rate of simulators) to more attractive conditions for the customers. In addition, the customer satisfaction will rise due to the increase in predictability of the training success.

In order to adapt the training, a model-based process will be used, allowing to detect procedural differences between the aircraft types, and to automatically create a new training syllabus based on latest knowledge on learning strategies of humans.

This model-based approach will also allow, in future versions of the EATT-AdCoS, to dynamically adapt the training online, based on the individual progress and training success of a trainee.

3.2.2.2 Workflow weak points

The standard development workflow is extended by specific activities to assure that the trainee's background, the customer needs and the modularity is properly addressed, combined with automated consideration of regulations and constraints. The main focus in these activities is quality assurance, the enhancement of safety, efficiency and effectiveness of the training.

When analysing the workflow for HoliDes use-case of EATT the adaptation to the above mentioned points was the key aspect not properly covered in the usual development workflow. As a consequence the following two steps were identified as weak points:

- Requirements definition is not based on the previous knowledge of the trainees, nor are they currently captured in a traceable format.
- Syllabus Generation as developed in HoliDes does not exist to date, nor does a model-based approach exist that complies with regulations but also adapts to the individual trainee's background and training needs.

Figure 5 shows the process in detail:

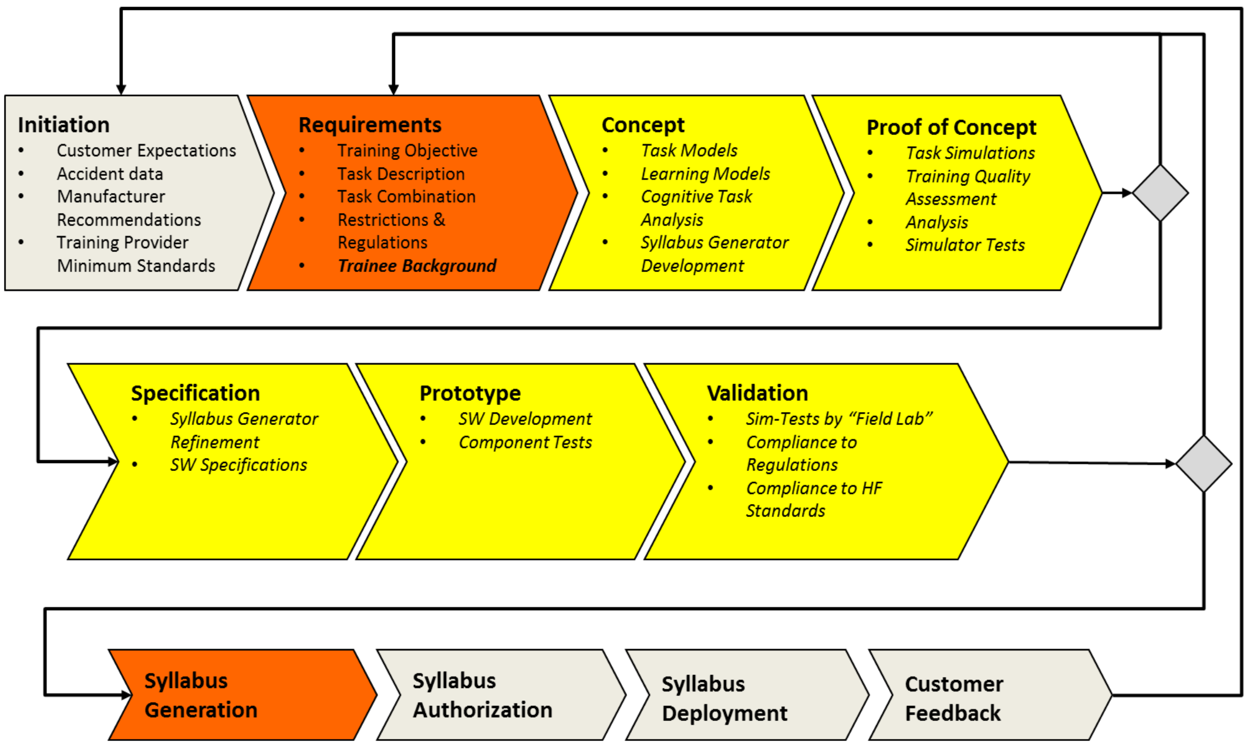

Figure 5: Specific activities in the EATT development process.

The orange activities show weak points and the yellow activities are new activities proposed by HoliDes. The orange and yellow activities are related to the HoliDes RTP, the grey activities will not be touched by HoliDes.

3.2.3 Tailoring Step 2 - Selection of methods and tools

Basis for the development of the adapted syllabi are models of the tasks the crew performs on a flight. Both B737 as source model and A320 as target model will be modelled using the UML COTS tool MagicDraw from NoMagic

Inc. Therefore, a UML profile defining the elements of the task model will be defined. These models will be compared to each other, in order to identify the tasks that are either common or different. The differences will be categorizes and ranked. The categories and ranks are then used by the – to be developed - Syllabi Generator to compute the new syllabus. Thus the selected Tools for EATT are:

- MagicDraw (as provider for the Task Models)
- Training Manager (for specification, generation and management of syllabi)

3.2.4 Tailoring Step 3 - Definition of semantics and information mapping between methods and tools

Figure 6 shows the architecture of EATT, annotated with the data flow from the connected tools. The selected tools will be connected via RTP in an OSLC compliant way.

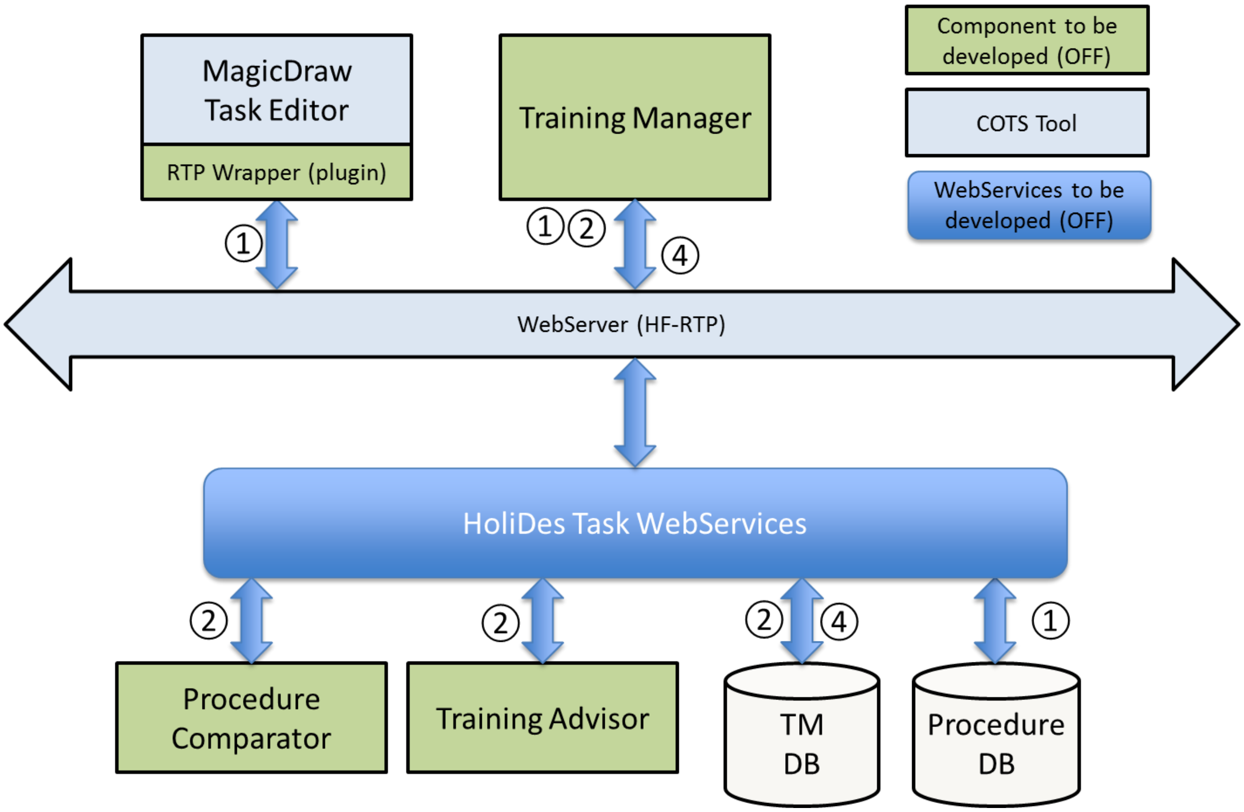

Figure 6: EATT Architecture

Data flows:

① Task Models
② Training Requirement Model
③ Training Advisory
④ Training Syllabus

The data contained in these data flows are described in the next sections.

3.2.4.1 Task Models

The task models are defined using the Task modelling language and tools described in D2.4, section 2.1.1.6. Figure and Figure show an ecore model of the task modelling language.

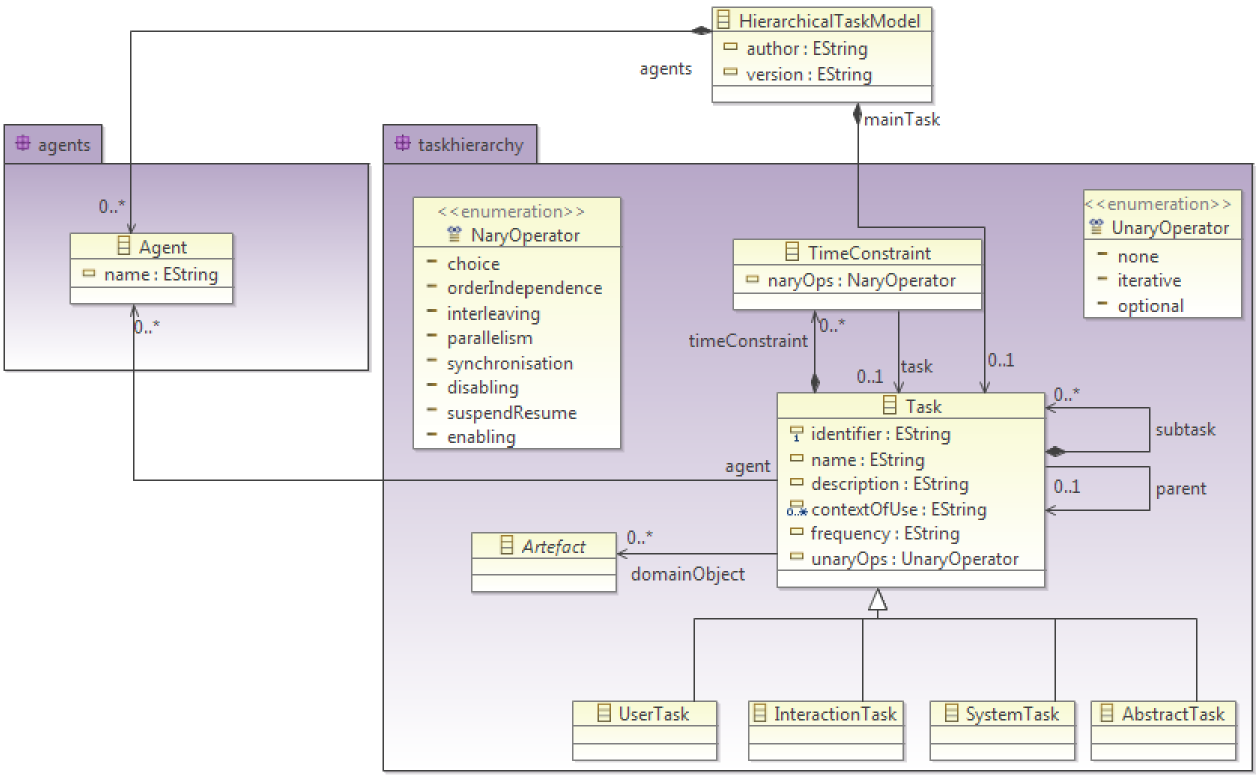

Figure 7: Task Hierarchy Model

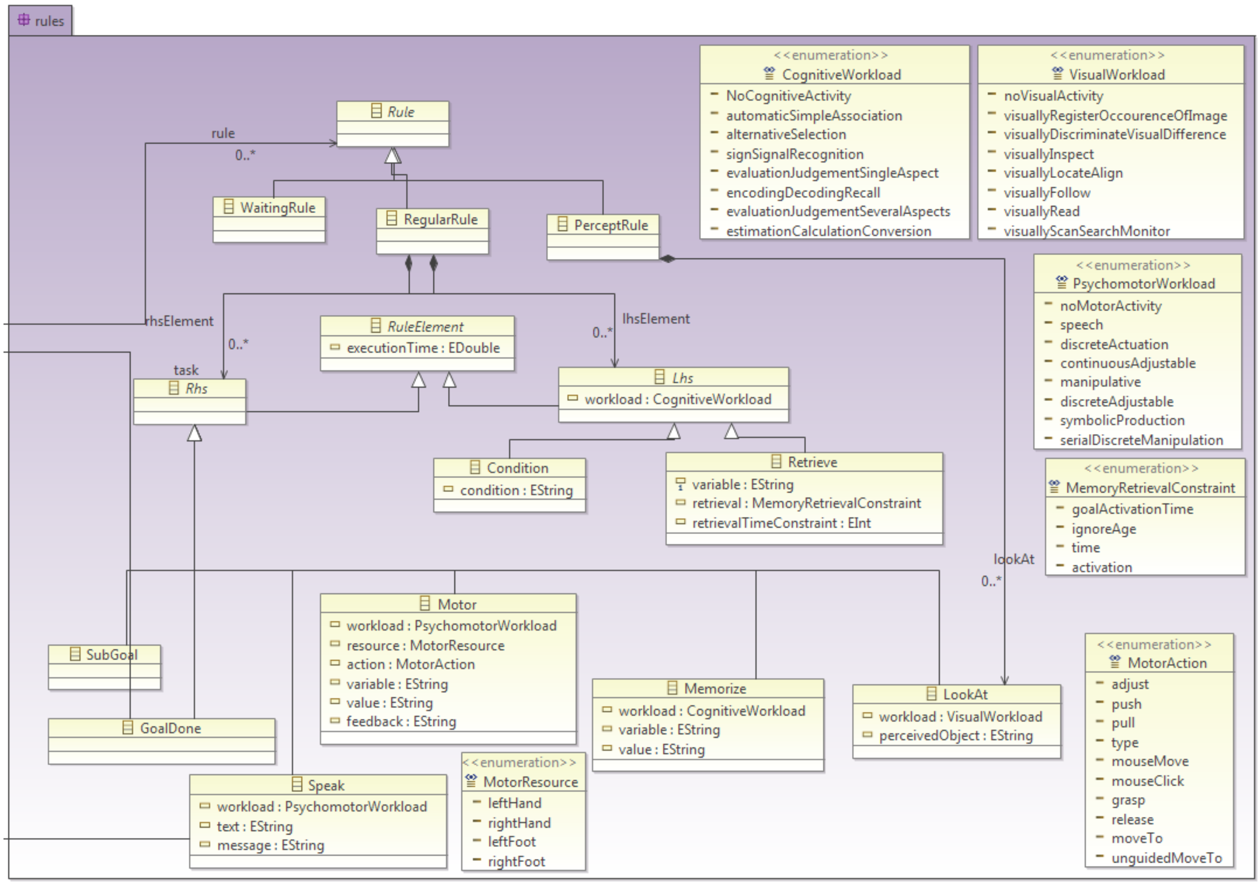

Figure 8: Rule Level Model

3.2.4.2 Training Requirement Model

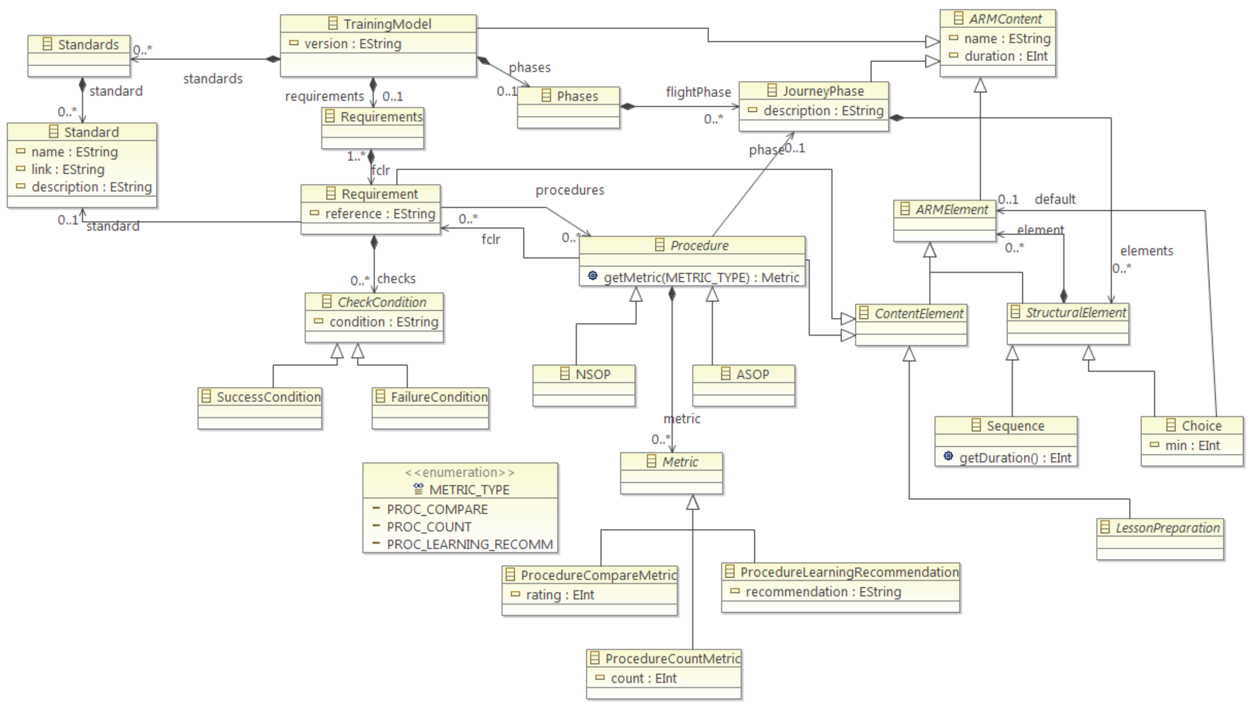

Figure 9: ecore model of Training Requirements

The training requirement model is described in more detail in D2.4, section 2.1.6. Figure 9 shows an ecore model of the training requirement model.

3.2.4.3 Training Advisory

This model has to be defined in next cycle.

3.2.4.4 Training Syllabus

The Training Syllabus is shown as ecore diagram in Figure 10. The current version of the syllabus is domain specific. Each syllabus contains multiple lessons, which refer to an element of the training requirement model (i.e. a requirement which has to be trained) in this lesson. In addition, a syllabus has a link to the task models (source and target aircrafts). The dictionary maps certain resources from resource model from the target aircraft model to resources from the source aircraft model. This is necessary, because systems are often named differently in Airbus and Boeing, while they have the same function; for example the panel where the autopilot can be controlled is the "Flight Control Unit" in an A320, and the "Mode Control Panel" in B737. The dictionary will store this equalities, so that e.g. conditions can be mapped also the naming of the systems is different.

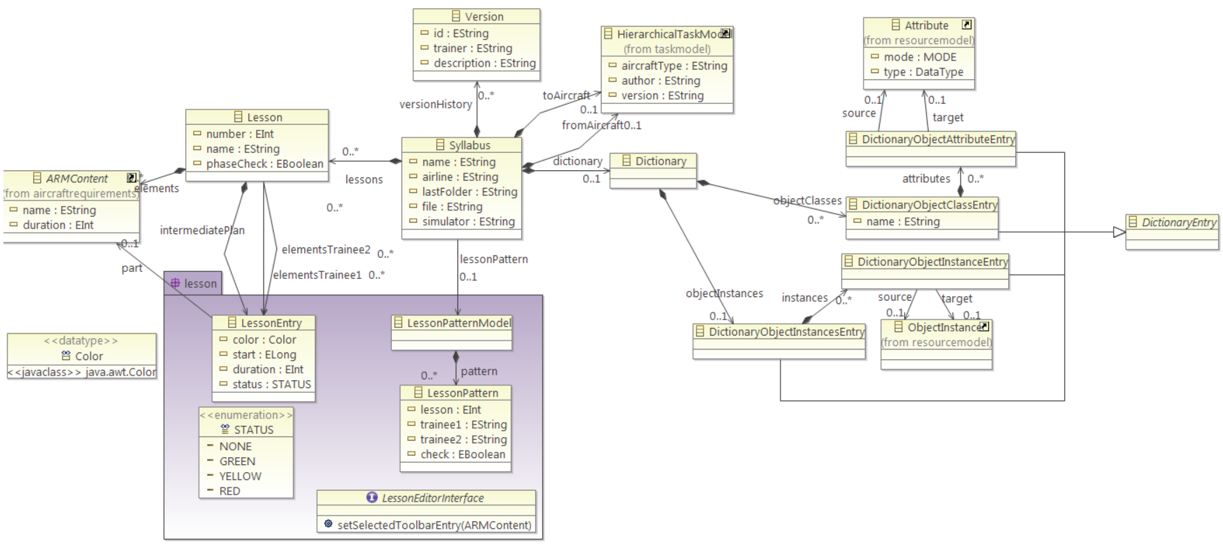

Figure 10: ecore diagram for training syllabus

3.2.5 Tailoring Step 4 - Implementation of information models and connectors

Two RTP connectors have been used from WP2, a) for MagicPED and b) for the Training Manager.

3.2.5.1 MagicPED

For MagicPED, a MagicDraw plugin has been developed, which translates the magic draw internal data structure into the HF-RTP task model and stores this task model into the Procedure DB. The plugin is based on the MagicDraw OpenAPI, and uses the eclipse LYO client implementation for accessing the web service to store the task and resource model into the database.

3.2.5.2 TrainingManager

The Training Manager uses also the eclipse LYO client implementation for accessing the databases. For more information on LYO, please refer to their website: http://eclipse.org/lyo/

4 Conclusion and Summary

In D7.2 were provided examples of different steps for tailoring the HF-RTP in aeronautics domain use cases. Based on that, the deliverable D1.5 defined the four steps for the generic tailoring process to be applied in all the different domains. In this deliverable (D7.4) we have updated the specific tailoring process applied to the two AdCoS in the aeronautics domain.

In this deliverable, it has been also analysed the added value adaptations brings to the aeronautics domain for future systems. We have provided a general description on how adaptation is dealt in each AdCoS and how the HF-RTP can help to do it and also provide a justification on why with the tailoring both system use cases will be better in the future, having into account in one AdCoS the Human Factors in the sense of inferring the pilot's mental state (DivA AdCoS), and in the other AdCoS on the knowledge, experience and individual progress of the trainee (EATT AdCoS).

In this deliverable and for the first part of the second year of the project, the main update has been done in the tailoring step 2, the selection of methods and tools, where more advanced features were investigated and the scope of RTP instance was extended to cover also newly identified weak points. In the case of DivA AdCoS, for example, the new tools added to the tailoring process have been the Experiment Tagging and Annotating (ETA), the fatigue modelling and pilot State Classification. We have also made a good improvement in the definition of semantics and information mapping between methods and tools (work done together with the WP1 partners), in order to analyse and define the Human Factors data flow among the different methods and tools. This work will lead to define the Human Factors ontology to be used in the tailoring steps 3 and 4, so all the tools which are needed will be semantically connected, taking into account the Human Factors data flow.

Plans for this year developments will be focused in both AdCoS on the implementation and refinement of the RTP tools already identified, and will be described in the following section.

5 Way forward and upcoming activities

For both the AdCoS in the aeronautic domain the way forward and estimation of upcoming activities are the following:

5.1 Airport Diversion Assistant AdCoS – DivA

For DivA AdCoS the most significant milestone in the second year of the project is the first evaluation scheduled for November 2015. By that timeframe it is expected that the AdCoS will be implemented in its first version – a functional prototype supporting the most important aspects of the diversion procedure, but with no or very limited capability for adaptation.

At the same time, the new approach for conducting the experiments should be applied in the evaluation. The approach will use RTMaps as the data management tool, experiment database as central data storage, ETA as support for the experimenter. The other tools described in previous sections are not required to mature by the time of the evaluation, but if possible they will be applied as well. Detailed plan of upcoming activities is shown in Figure11.

	March	April	May	June	July	August	September	October	November
Fatigue detection	Fatigue mental model UNISOB, HON	Prioritization of physiological sensors HON	Classifier - method selection TEC						Evaluation WP7
		Test data preparation HON							
MED	Training data collection HON, BUT			Implementation BUT			Cockpit study HON, BUT		
Experiment database	Requirements HON, TEC	Implementation TEC					Test case TEC, HON	RTMaps connector TEC, HON, INT	
Flight simulator adapter	RTMaps connector HON								
ETA	VOC HON	Requirements HON	Implementation HON	RTMaps connector HON					

Figure 11: DivA AdCoS – tailoring plan for 2015.

5.2 Enhanced Adaptive Transition Training AdCoS - EATT

For the EATT AdCoS the most significant milestone in the second year of the project is the first version of the training tool and its implementation into real type rating training in the months May to November 2015. In November, a first evaluation will be made based upon the data received from the simulator training to this date, in order to make further adjustments for the finalization of the AdCoS in the last project year. The AdCoS being implemented in year 2 can be considered a functional prototype supporting the most important features, like offline, automated syllabus planning, and training re-allocation but with a very limited scope of training adaptation.

The uniqueness of the experiments being conducted under field conditions requires a two stage approach. In stage 1, the training will be conducted solely for evaluation reasons and in order to adapt/refine the AdCoS and its used MTTs for stage 2 of the experiments, in which the AdCoS will then be validated. The stage 2 experiments are not necessarily be expected to end by October, as shown in Figure 12, but are planned to be extended into the first 3 months of year 3.

	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
MD B737 models	Finalize Stage 1 TRS		Refinement Stage 2 TRS						Evaluation WP 7
MD A320 Models	Finalize Stage 1 TRS		Refinement Stage 2 TRS						
Model Comparator	Finalize Stage 1 OFF			Refinement Stage 2 OFF, TRS					
Syllabus Generator	Finalize Stage 1 OFF, TRS, LFT			Refinement Stage 2 OFF, TRS, LFT					
Experiments		Preparation Stage 1 TRS, LFT							
			Stage 1 Experiments A320 TRS, LFT		Data Analysis Stage 1 TRS, OFF		Stage 2 Experiments A320 (until Spring 2016) LFT, TRS		
	Questionnaires Control Group (until Spring 2016) TRS, LFT								

Figure 12: EATT AdCoS Tailoring Plan for 2015