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D 8.5 - Modelled and Model-based Analysis of the Control Room AdCoS and HF-RTP Requirements Definition Update (Feedback)

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Compiled by:	Robert Sharples- Airbus DS
Authors:	Robert Sharples - Airbus DS Elisa Landini - REL Martin Boecker - Airbus DS Ian Giblett - Airbus Group Innovations Caterina Calefato - IRN
Reviewers:	Mathieu Maqnaudet - ENAC Frank Jonat – Airbus DS
Technical Approval:	Jens Gärtner, Airbus Group Innovations
Issue Authorisation:	Sebastian Feuerstack, OFF

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3 Glossary

AdCoS	Adaptive Cooperative Human-Machine System
C2	Command and Control
C4ISR	Command, Control, Communication, Computer, Intelligence, Surveillance and Reconnaissance
C#	is an Object-oriented programming language from Microsoft that aims to combine the computing power of C++ with the programming ease of Visual Basic
COP	Common Operational Picture
COTS	Common Off The Shelf
Dect	Digital Enhanced Cordless Telephone
DNG	DOORS Next Generation
DPCD	Direct, Collect, Process and Disseminate
DoDAF	Department of Defence Architecture Framework
DOORS	Dynamic Object Oriented Requirements System
DS	Defence and Space
EA	Enterprise Architect
EO	Electro Optic
EO/IR	Electro Optic Infrared Sensor
HF	Human Factors
HF-RTP	Human Factor Reference Technology Platform
HR	Human Resources
LEA	Learning Classifier System
LED	Light Emitting Diode
HSI	Human System Integration
GMTI	Ground Moving Target Indicator
GSM	Global System for Mobile Communications
HEE	Human Efficiency Evaluator
HQ	Head Quarters
HV	Human View
ID	Identification
IO	Input Output
IR	Infrared
IRN	IREN EMILIA
ISR	Intelligence Surveillance Reconnaissance
ITP	Integration and Test Plan
IVQ	Integration Verification and Qualification

NAF	NATO Architecture Framework
NATO	North Atlantic Treaty Organisation
MBSE	Model Based System Engineering
MODAF	Ministry Of Defence Architecture Framework
MTT	Methods and Techniques
OSLC	Open Services for Lifecycle Collaboration
REL	RE:LAB
PC	Personnel Computer
RPAS	Remotely Piloted Vehicle
RTP	Reference Technology Platform
SA	System Architect
SAR	Synthetic Aperture Radar
SATCOM	Satellite Communications
SDK	Software Development Kit
SE	System Engineering
SEMP	System Engineering Management Plan
SNV	Universita Delgi studi Suor Orsola Benincasa
SMS	Short Message Service
SOA	Software Oriented Architecture
SoS	System of System
SME	Subject Matter Expert
SW	Software
SysML	Systems Modelling Language
TLC	Telecommunications Operator
UML	Unified Modelling Language
WLAN	Wireless Area Network
WP	Work Package

4 Introduction

4.1 Objective of the document

The objective of this document is to provide a common template that will be used by all four AdCoS deliverables D6.5 Health, D7.5 Aeronautics, D8.5 Control Rooms and D9.5 Automotive.

This common template will provide each deliverable with a very similar definition for each AdCoS. Each AdCoS will have a Description, followed by an Operational Overview of the 'real world', it then defines the three common elements of the AdCoS environment, the Controlled Entity, Operators of the AdCoS and the External Environment of the AdCoS. The Use Case models are then defined with their interaction with the Modelling Techniques employed, then an initial definition of the WP 8 Demonstration (D8.7) and finally the Models that have produced for each Control Room AdCoS.

4.2 Relationship with other domain in HoliDes

The Control Room AdCoS that has been developed by Airbus DS and IRN/REL are in nature very different from the other three work packages, in terms of modelling the AdCoS, as both are using a 'real system' or a 'derivative real system' which acts as the Controlled Entity. Therefore WP8 is not producing development software, development model or prototypes etc. and therefore commonality will be restricted, as defined below.

The following can be considered as common relationships with the other Work Packages:

- Use Case Modelling is being used by all the work packages.
- Task Modelling is being used by all the work packages.
- Human Interaction Modelling is being used by all work packages.
- Common Methods and Techniques (MTTs) are being used within the Control Room AdCoS as defined in section 6.
- Common model analysis should be performed in conjunction with the each WP DX.7 as this will provide a detailed view of the actual models produced for each demonstration

A more detailed account of the common models can be found in associated Dx.5 HoliDes document D6.5-7.5-8.5-9.5 – Common Annex.

5 AdCoS Modelling

Section 5 contains the two Control Room AdCoS developed within Work Package 8: the first is the Airbus AdCoS which defines a Control Room environment within a generic Command and Control (C2) System, the second from IRN which defines an Emergency Control Room.

5.1 AdCoS Airbus (Control Room AdCoS)

5.1.1 Description of the AdCoS

The Command and Control Room AdCoS provided by Airbus DS is broken down into the following major components, Figure 1 describes the high level view of the AdCoS, and Figure 2 defines in detail the relationships within the AdCoS.

- Operational Definition - This section defines the high level operational concept of the Command and Control system in its entirety. It defines all the operational elements that provide data into the system and all elements that control the system in terms of resources; these can include hardware, communications, sensors, vehicles, humans etc.

- Use Cases / Scenarios – This section defines the six Use Cases that have been derived for the Airbus AdCoS which are detailed in the Architectural Models, implemented in the demonstration model which is derived from the Operational Concept Model.

- The Environment of the AdCoS – This section defines the common structure for each Dx.5 AdCoS, as it defines the integration of the common elements – the Controlled Entity, Operators of the AdCoS and External Environment.

- Modelling Techniques – This section briefly defines the techniques used within Airbus DS and the use of the HoliDes research.

- Architecture Models – These three sections define the Airbus DS architecture model and process that is used on the majority of its projects. It is broken down in four main sub-sections, the first briefly defines Airbus DS Model Based System Engineering, the second Task

Modelling, the third the Architecture Framework product sub-set derived from the Department of Defence Architecture Framework (DODAF) and finally the internally developed Airbus DS Human Viewpoints Architecture framework additions.

- Initial Demonstration Model – Two defines the initial demonstrator components, the full demonstrator will be defined in D8.7. The initial Test Scripts that will be derived from the Use Cases and the Architectural models, these scripts will be used as an input to WP8 deliverable D8.7.

- Connection to other Work Packages – This section defines the inputs from other HoliDes work packages and deliverables and the outputs to the next set of deliverables.

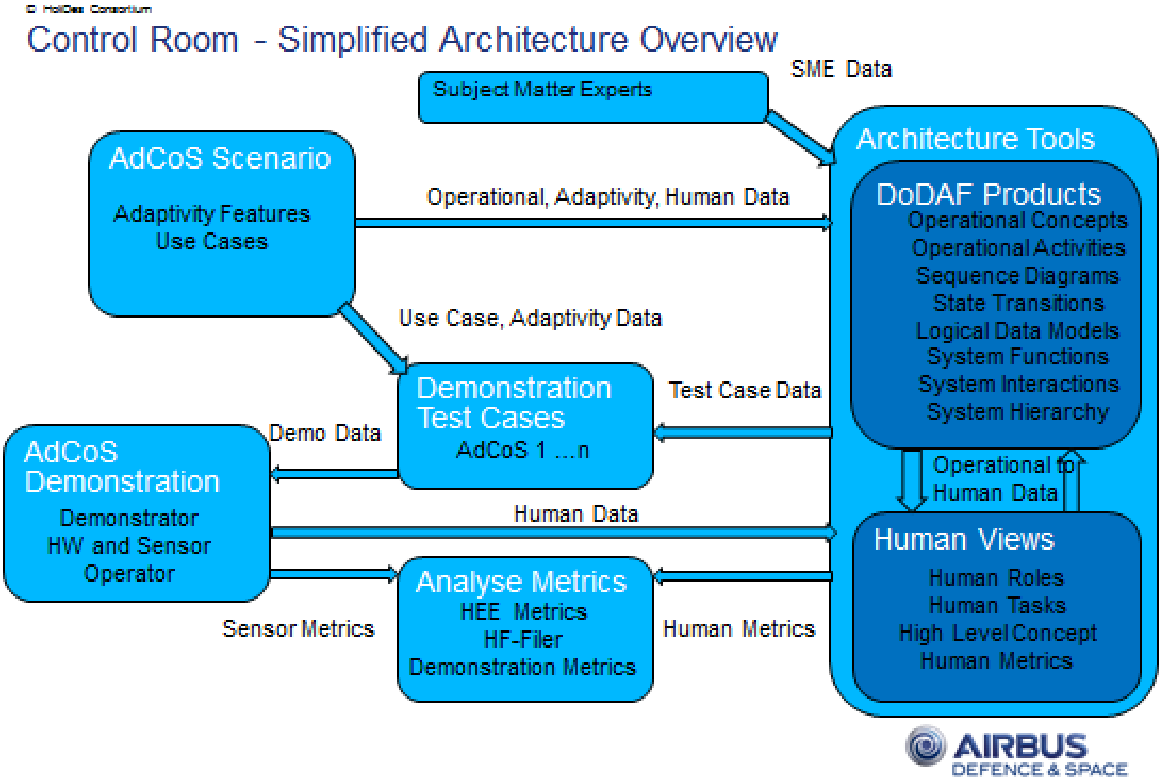


Figure 1 High Level Interaction Diagram (SV-1) Simplified Architecture Overview for the Airbus DS Command and Control AdCoS

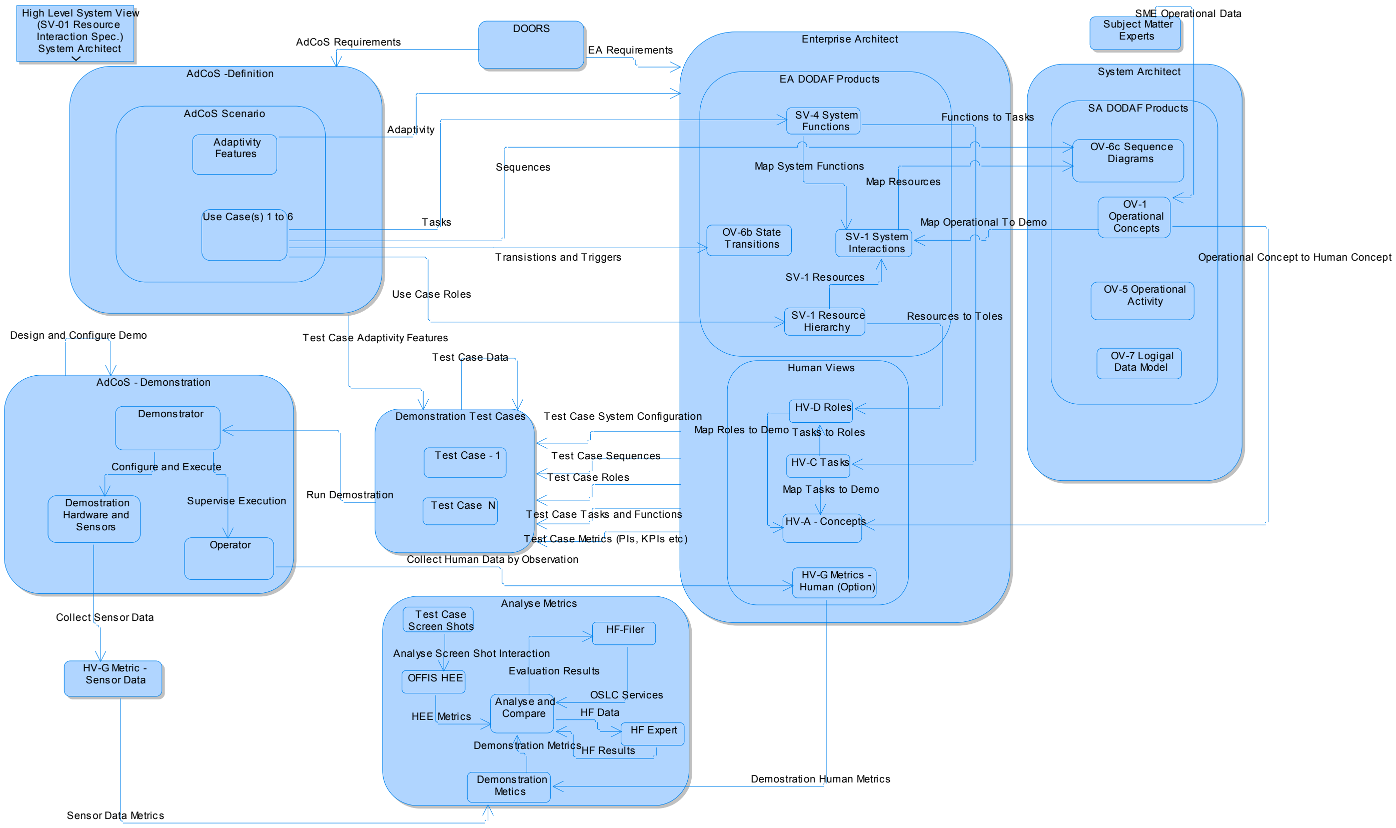


Figure 2 Detailed Interaction Definition Diagram (SV-1) for the Airbus Command and Control AdCoS

5.1.1.1 Operational Definition

To put the Airbus DS AdCoS definition into perspective it is imperative that this document defines the Operational Concepts of a generic Command and Control System that will be defined as the Controlled Entity for the Airbus DS AdCoS.

5.1.1.1.1 Operational Concepts

Figure 3 defines the high level operational concepts for a generic Command and Control, brief descriptions of the entities are defined in section 5.1.1.1.2 together with the main functions of the Controlled Entity in section 5.1.1.2.1.

The Airbus DS demonstration to be defined in D8.7 will concentrate on the Response Operators, located at various sites, defined in Figure 3 Generic Command and Control Operational Concept, whose primary role is to 'monitor' the data supplied to them via the Intelligence and Surveillance Systems.

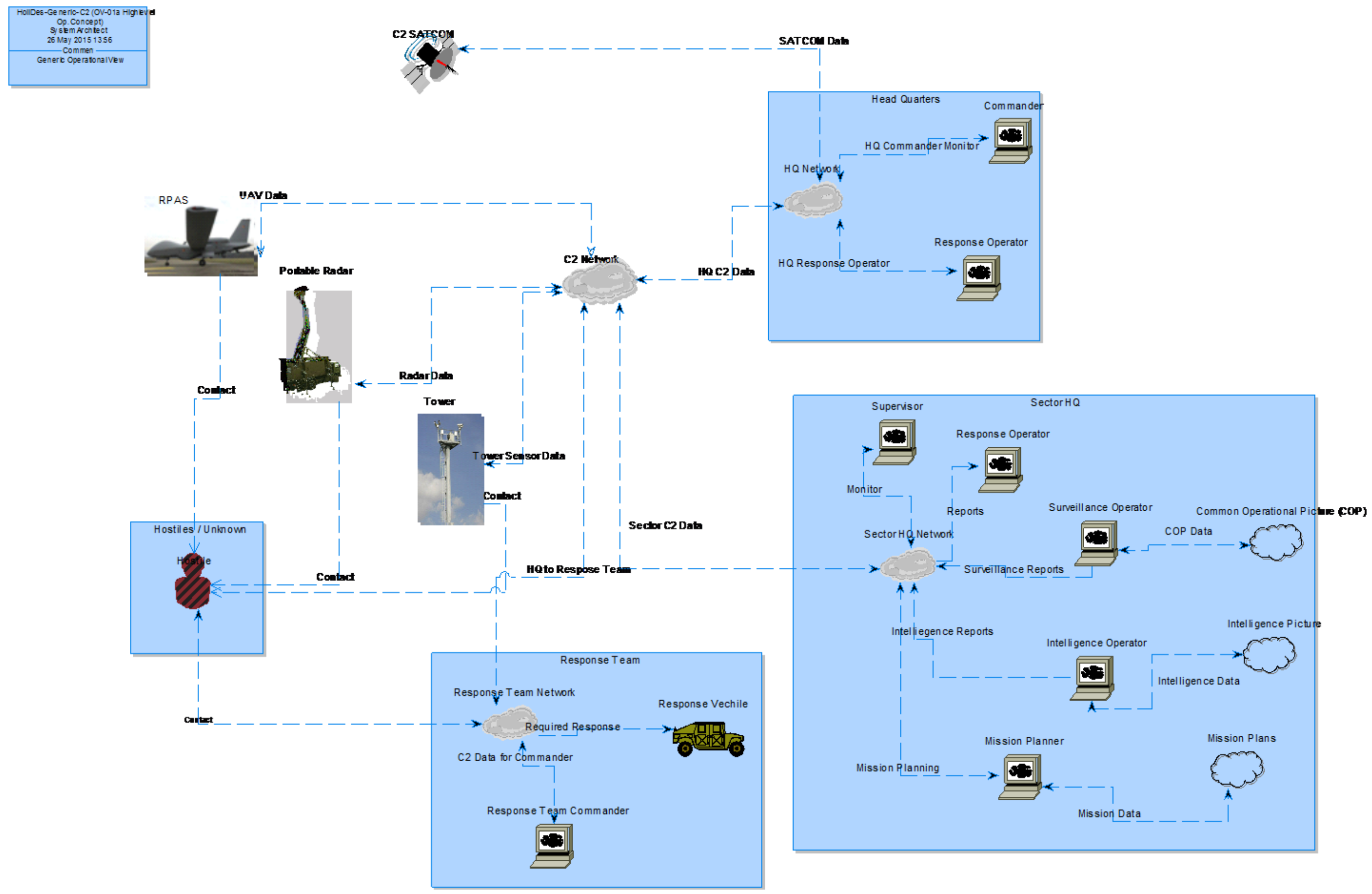


Figure 3 Generic Command and Control Operational Concept

5.1.1.1.2 Brief descriptions of the Operational Concepts for a Generic C2 System

- A generic organisational structure for the operational concepts is define in Figure 28.

- Remotely Piloted Air Vehicles (RPAS) – These air vehicles are used to collect data on ground movements within the area of operational responsibility. Dependant on the air vehicle sensor fit the data that can be downloaded to the available ground station or mobile device will be full motion video, still imagery, infrared imagery, ground moving target indicator or synthetic radar data.

- Mobile Sensors – mobile sensors can be used to collect and download the following full motion video, still imagery, infrared imagery, ground moving target indicator or synthetic radar data.

- Sensor Towers – the sensors will download data dependant on the tower fit - full motion video, still imagery, infrared imagery and radar data. They can also collect acoustic data if the appropriate sensors are deployed.

- Ground Patrols – these patrols will consist of armed or non-armed personnel dependant on the country and type of personnel deployed. They will be tasked with investigating any type of incursion in to the Area of Operational Responsibility or any task requiring a physical response. They will be in communication with any appropriate Head Quarters (HQ) and ground patrols.

- C2 Communications Network – the C2 communications network will connect the C2 system to all elements in the network. This will involve voice and data connections, via land lines, radio links and SATCOM.

Figure 4 defines a high level generic Operational Environment diagram for a generic C4ISR System; it details the three levels of Operators of the defined location; main HQ, the Local HQ and the C2 Operators in the control room.

To reduce complexity the activity diagram only defines surveillance and intelligence operators at the local level, it highlights the types of sensor data that is collected by the C2 system and the ground patrol teams that investigate any incident.

The main purpose of the diagram is to highlight the 24/7 monitoring of the system as defined via the Airbus DS Use Cases and to define the operational concepts that map to the Controlled Entity, Local Operators and the External Environment modelled in the AdCoS demonstration defined in section 5.1.1.2.

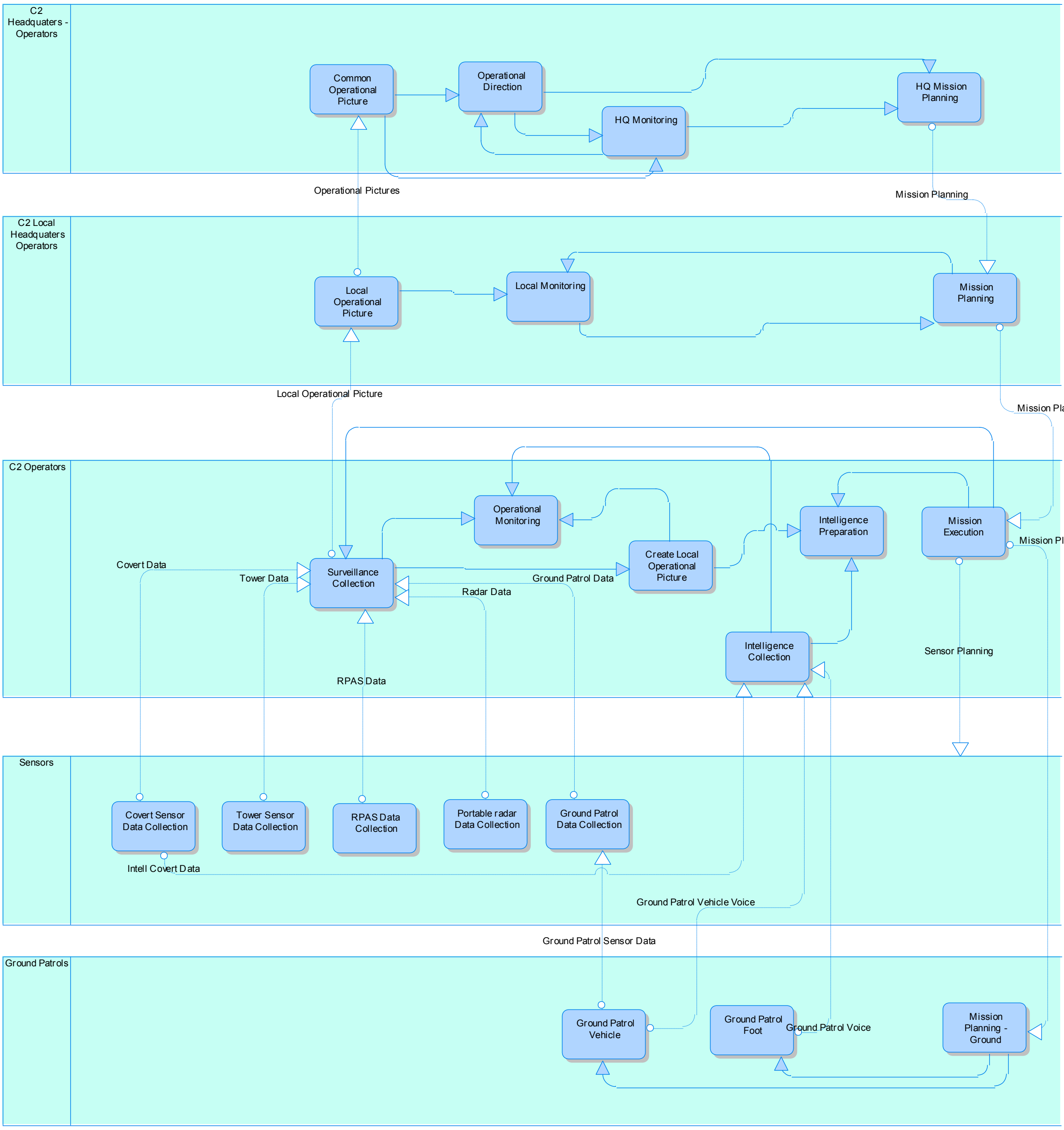


Figure 4 Generic C2 Operational Environment

5.1.1.2 The Environment of the AdCoS

The Airbus AdCoS environment will consist of the standard three Dx.5 sections, the first a detailed description of the AdCoS Controlled Entity, the second Operators of the AdCoS and finally the External Environment. The environment will then detail the six Airbus Uses Cases Airbus for the initial demonstration; these will be completed for the full demonstration and defined in D8.7.

5.1.1.2.1 Controlled Entity

The Controlled Entity will act as the 'complete system', the following is a high level overview of the main functions and elements together with a definition of the classic Direct, Collect, Process and Disseminate intelligence cycle that is used by most if not all C2 type organisations, as defined in Figure 5.

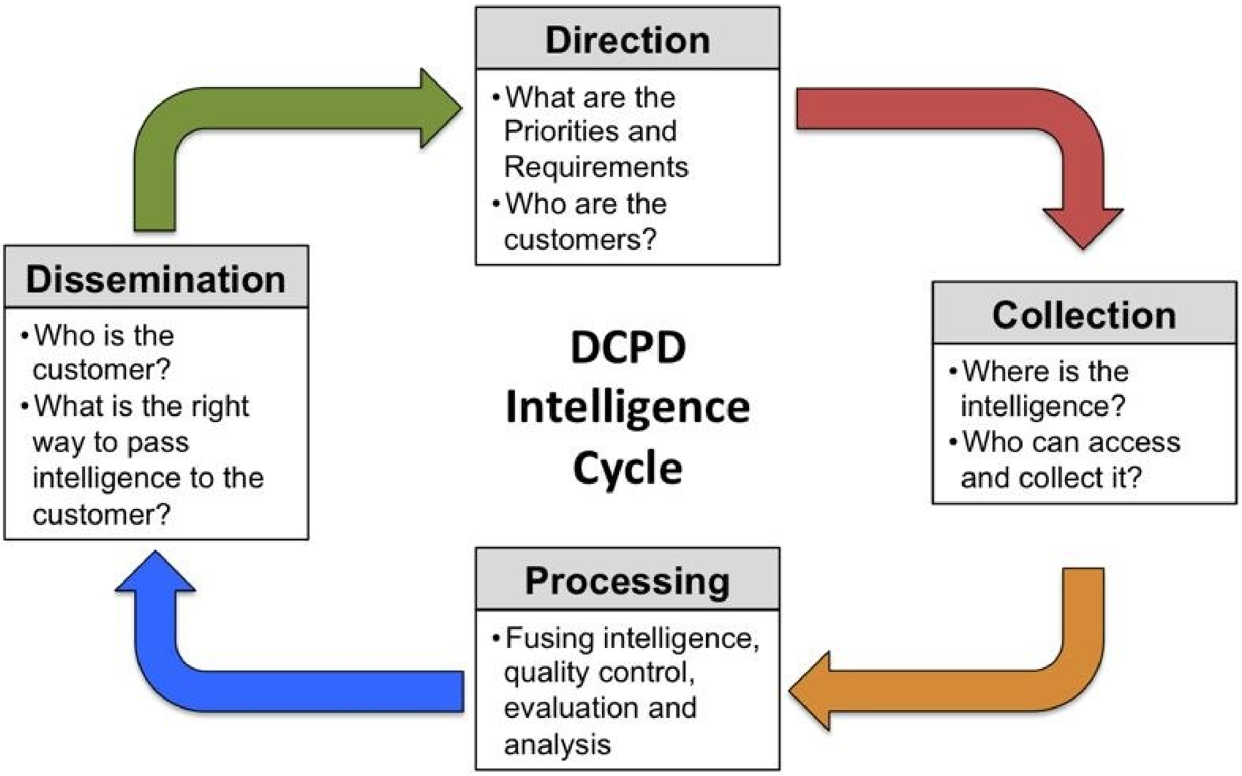


Figure 5 Classic DCPD Cycle

The main functions of the Controlled Entity are defined as follows –

- Command and Control (C2) – it will follow the classic mission cycle direction, collection, processing and dissemination or detect, decide, act and monitor (as defined in Figure 5 Classic DCPD Cycle).

- Intelligence, Surveillance and Reconnaissance (ISR) – the ISR operators perform the detect part of the cycle:

    - Intelligence – the prime aim of the intelligence operators is to turn the large amounts of information collected from all resources (sensors, people etc.) into useable intelligence. The intelligence operators will have a direct input into the dissemination function.

    - Surveillance – the prime aim of the surveillance operators is to assimilate the various sensor feeds and produce a local common operating picture (COP) that can be used by the HQ commanders, HQ staff and the intelligence staff. They will also provide alerts and alarms on direct threats to their Area of Operational Responsibility.

    - Reconnaissance – the reconnaissance operator's prime function is to ensure that the mission plan can be accomplished with the current assets and sensors available. They will work closely with the mission planning staff.

- Situation Awareness – one of the prime goals of any C2 system is to supply the chain of command with timely information on the evolving environment to allow the commanders to make an informed decision within the course of actions defined in the mission plan.

- Mission Planning and Reporting – Mission planning is performed at each level of the command chain and provides each level with a plan of action for a pre-determined time frame. It must be flexible enough to allow for immediate response to take place.

- Communications – the communication systems are key to the operation of any Command and Control System. These systems consist of the following as a minimum:

    - Head Quarters infrastructure – this will provide the backbone for the Head Quarters to operate and will include all the required hardware and software for the severs and operator console and all internal and external communications

    - Voice Communications – this will include land line phone connection, Mobile phone connection, local radio connection and satellite connection

  - Data Communications – this will include bandwidth for all the sensor data required and all other data requirements local intranet and external internet etc. to all data sources that are required

  - Satellite Communications – this will include all the necessary hardware and software to operate at the required location.

- Sensors – the sensors available depend on the type of system, its location (fixed or mobile) and type of deployment. The generic system defined for the Airbus AdCoS with contain the following:

  - Portable Radar – a radar system fitted to a ground vehicle.

  - Fixed Radar – a radar system fitted to a fixed location e.g. a surveillance tower. They will therefore have a fixed field of view.

  - Mobile Electro Optical / Infrared (EO/IR) sensor - these will collect normal video or infrared data and will be fitted to a ground or air vehicle.

  - Fixed Electro Optical / Infrared (EO/IR) sensor - these will collect normal video or infrared data and will be in a fixed location e.g. to a surveillance tower. They will therefore have a fixed field of view.

  - Covert Sensors – these sensors are hidden to collect covert intelligence, they will collect Voice, Video data etc.

  - Remotely Piloted Air Vehicle – these system are generally fitted with an EO/IR and GMTI/SAR sensors, so they have the ability to stream data direct to any appropriately equipped ground station or remote video terminal.

5.1.1.2.2 Operators of the AdCoS

The C2 Supervisor and Operator will interact directly with the Controlled Entity, the demonstrator role will be to guide the audience through each operational Use Case.

- Demonstrator – the demonstrator’s sole function is to guide the audience through each Use Case.

- C2 Supervisor – the supervisor will acts as the supervisor of the C2 Operators, the Local HQ Commander or the HQ Commander, dependant on the Use Case Definition.

- C2 Operator (s) – the C2 operators for the purpose of the AdCoS demonstration will perform the monitoring functions defined for a Response Operator as defined in Figure 34 Response Operator Function (SV-4) detailing the Operator Tasks (HV-C)

5.1.1.2.3 External Environment

The operational environment of the C2 system is detailed in section 5.1.1.1.1, this section will detail how we are going to represent the external environment within the Airbus demonstration.

The Controlled Entity will define the Operational functions of the Command and Control System

- Intelligence Surveillance and Reconnaissance (ISR) Functions – these functions will be defined within the Controlled Entity and are collated, processed and disseminated as intelligence and surveillance data to the Response Operators

- Communications – only the equipment usually available in the control room is used (in addition to the AdCoS specifics, i.e. sensors etc.).

- Sensors – The sensor data will be part of the ISR function and be defined within the Controlled Entity

- Patrols – The Response Operators will pass voice and data commands to the Controlled Entity.

5.1.1.3 Initial AdCos Demonstration Components

Eye Tracker – Remote eye-tracking sensor and SW: Remote eye-tracking systems are usually employed in order to analyse a user's eye movements (e.g. with the aim of studying his strategy of searching a website). Remote systems capture the viewer's eye movements without the need of him wearing any special equipment such as glasses (see Figure 6). In the context of the load balancing Use Case, the system can be used to assess whether the operator is tired by monitoring the behaviour of his eyes (lengthy periods of eye lids closed or half closed). The algorithms of identifying fatigue may not be part of the standard SW provided with the eye-tracking system and may have to be developed.

Figure 6 Eye Tracker

Actuator - The actuator sends a tactile signal and can be worn e.g. in the form of a wrist-band (as defined in Figure 7).

Figure 7 Actuator

The purpose of the signal is to

(a) remind the operator to return to his workstation if he has stayed away from it for longer than an accepted time or if new events have been assigned to him during his absence;
(b) wake up the operator if he has fallen asleep.

The form factor of the actuator is yet to be decided, as is the data network through which it is communicated with (e.g. Bluetooth, WLAN, GSM). An alternative to a wrist-band is using the operator's own smart phone, sending messages to him via messaging services or text.

Sensor Device – Microsoft Kinect for Windows sensor and Microsoft Kinect SDK-
Microsoft Kinect is a sensor device (Figure 8) originally designed as input source for applications running on the Xbox. It can be used by applications developed with the Microsoft Kinect SDK for a range of purposes:

- Capturing and processing the colour image data stream;
- Processing the depth image data stream;
- Capturing the infrared stream;
- Tracking human skeleton and joint movements;
- Human gesture recognition;
- Capturing the audio stream;
- Enabling speech recognition;
- Adjusting the Kinect sensor angle;
- Getting data from the accelerometer;
- Controlling the infrared emitter

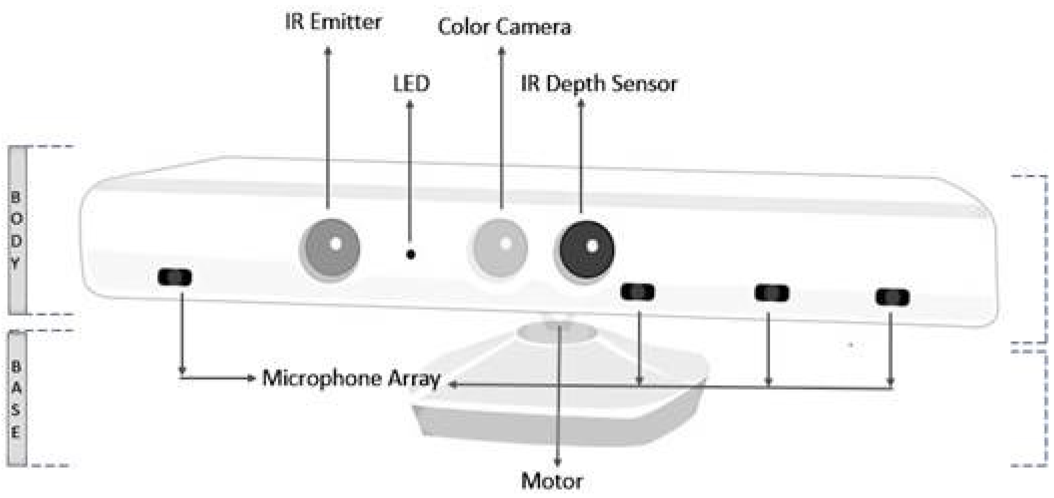


Figure 8 Sensor Device – Kinect Box

Operator PC – The Operator PC are COTS products and are similar to high-performance workstations for office work. They are equipped with standard PC-Mouse and keyboard and two large 16:9 monitors.

Controlled Entity – In the context of the HoliDes demonstrator, the Server providing the control room functionality is a high-performance desktop PC. The connection to the operator workstations is maintained (a) through a company network in lab mode, and (b) through a portable switch in demonstration mode (as defined in Figure 9)

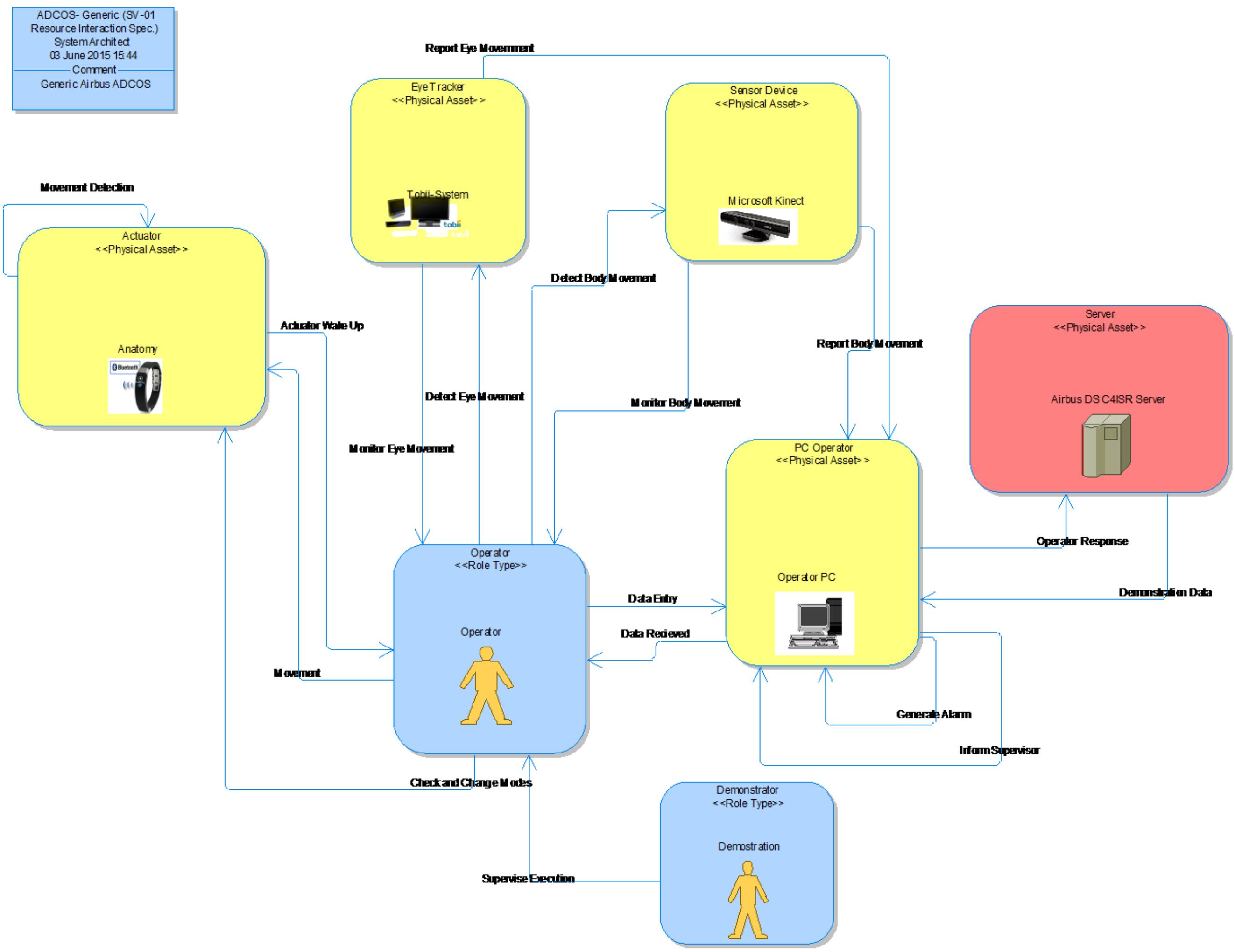


Figure 9 Generic Airbus C2 AdCoS

In Figure 9, the red box maps onto the Controlled Entity, the yellow boxes map to the External Environment and the blue boxes map to the Operators of the AdCoS.

5.1.1.4 Use Cases

5.1.1.4.1 Generic Sequence Diagram for Use Case 1 to 4

The following diagram (Figure 10) has been developed to allow only one sequence diagram to be used for the first four Use Cases, as the flow between the operator the controlled entity and the supervisor is basically the same.

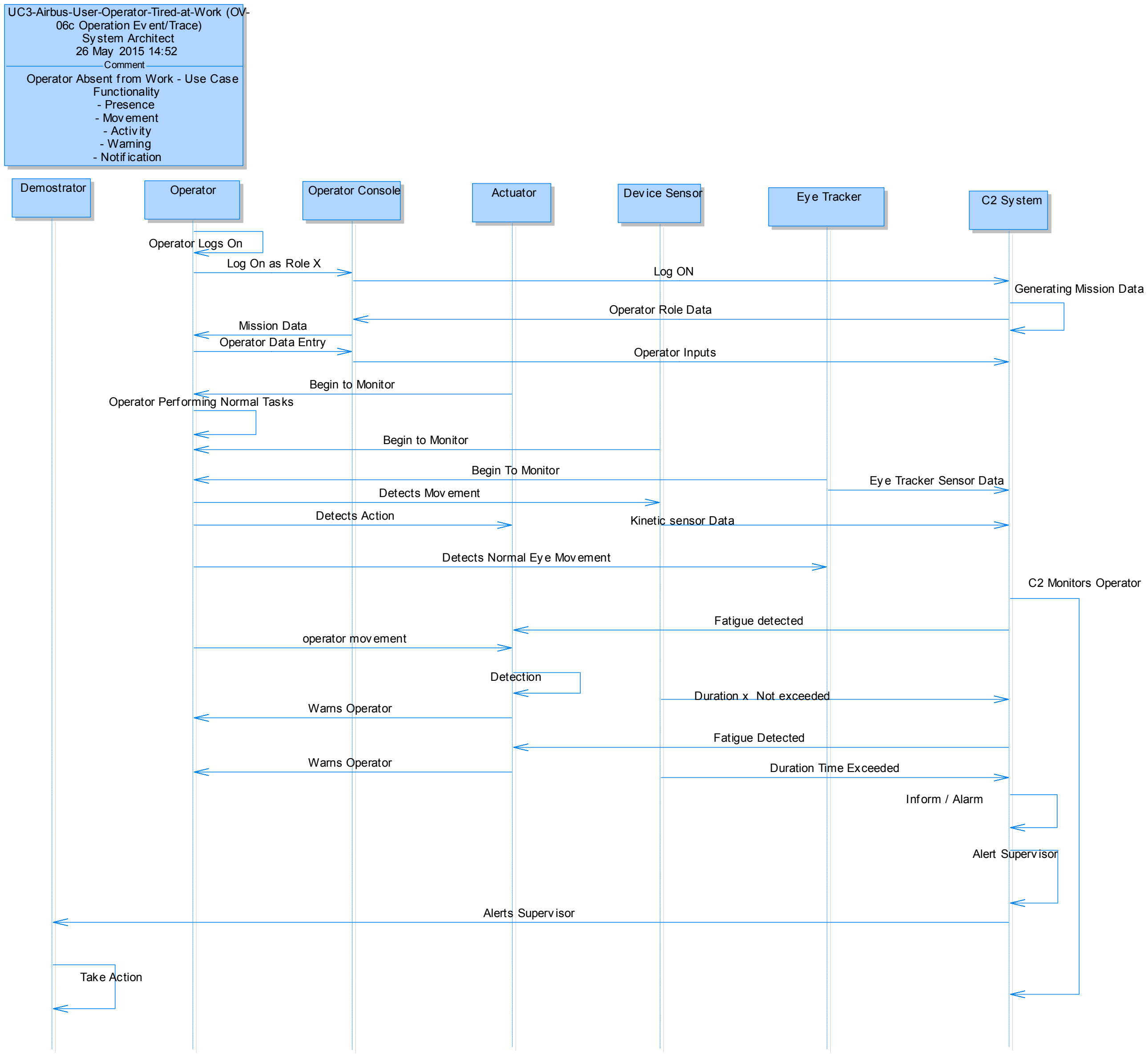


Figure 10 Generic Sequence Diagram for Use Cases 1 to 4

5.1.1.4.2 Prime Goals and Adaptation for Use Case 1 to 4

Description of the adaption

The system is able to detect the absence as well as the mental and physical state of the operator (this includes operator awareness and the possible lack of sleep/rest). It furthermore detects unusual behaviour patterns of operators that could be exploited by perpetrators.

Why to adapt?
The system can increase the effectiveness of the control room operation if operators are in a state that allows them to effectively and efficiency respond to events. If operators are in a sub-optimum state (e.g. absent from workplace, tired or asleep), the supervisors can take measures to guarantee the effectiveness of the station.

What to adapt?
The system is able to recognize the state of individual operators and initiates a response if a measured state is outside of the allowed range. The physical and mental states covered by the system are:

- Presence/absence of the operator from his workplace at a given point in time or for a given period of time;
- Lack of movement for a given time of an operator present at his workplace, suggesting that he is asleep;
- Particular behaviours that suggest tiredness and/or lack of concentration.

All the results of the above methods (some of them might not be necessary or not be allowed in some case) must be surveyed by the system constantly. If any change of state takes place and is noticed by the system (operator becomes sleepy), the system takes one of the following actions:

- Motivate the operator to remedy the situation (return to his desk or take measures to overcome his fatigue)
- Notify the supervisor about an operator status that could interfere with proper system operation
- Suggest measures (replace sleepy operator, transfer tasks away from him to resolve overload) or initiate a workflow (e.g. process transfer) to resolve situation (see functional area Load Balancing).

The decision on how to handle such a situation must be taken by the superior officer. The system can only provide hints or workflows to assist in the solution.

In addition the system logs all instances of absence / tiredness in an anonymised way in a database that is analysed in regular intervals for unusual patterns that could be exploited by perpetrators monitoring those behaviours.

How to adapt?

The system monitors the operator's behaviour in a non-obtrusive way and in one that does not violate local ethical standards and maintains the individual's dignity.

Upon detecting a specific operator state, the system responds accordingly:

- If the absence of an operator is detected for an unacceptably long time (e.g. breaks of up to ten minutes are considered acceptable), the system motivates the operator to return to his workplace or informs the supervisor if the operator doesn't respond.
- If the presence of an operator is detected, but no body movements for a pre-defined time (e.g. ten minutes), the system responds by ensuring that the operator is awake (e.g. by actuating a tactile wake-up stimulus that can be perceived only by the operator in question and/or by asking him to acknowledge his presence by responding to a system message, comparable to the dead-man switch functionality in trains). A lack of response leads to the supervisor being informed.
- Indications of the operator getting drowsy (e.g. by monitoring the operator's face looking for typical symptoms of fatigue such as half-closed eyelids) initiate an acoustic or tactile wake-up stimulus.
- Indicators monitoring the operator's actual performance (input into the system and the speed and accuracy of these user interactions) can determine the degree of awareness and stress of the operator, responded to by the system through appropriate measures such as suggesting to re-assign part of the workload to other operators or to request assistance by calling the supervisor (see functional area Load Balancing).

5.1.1.4.3 Use Case 1 Operator Absent from Work Place

5.1.1.4.3.1 Description

An operator is absent from his workplace for a longer than accepted period of time. The system calls the operator back to his workplace. If he doesn't return to this workplace after a defined length of time, his supervisor is informed.

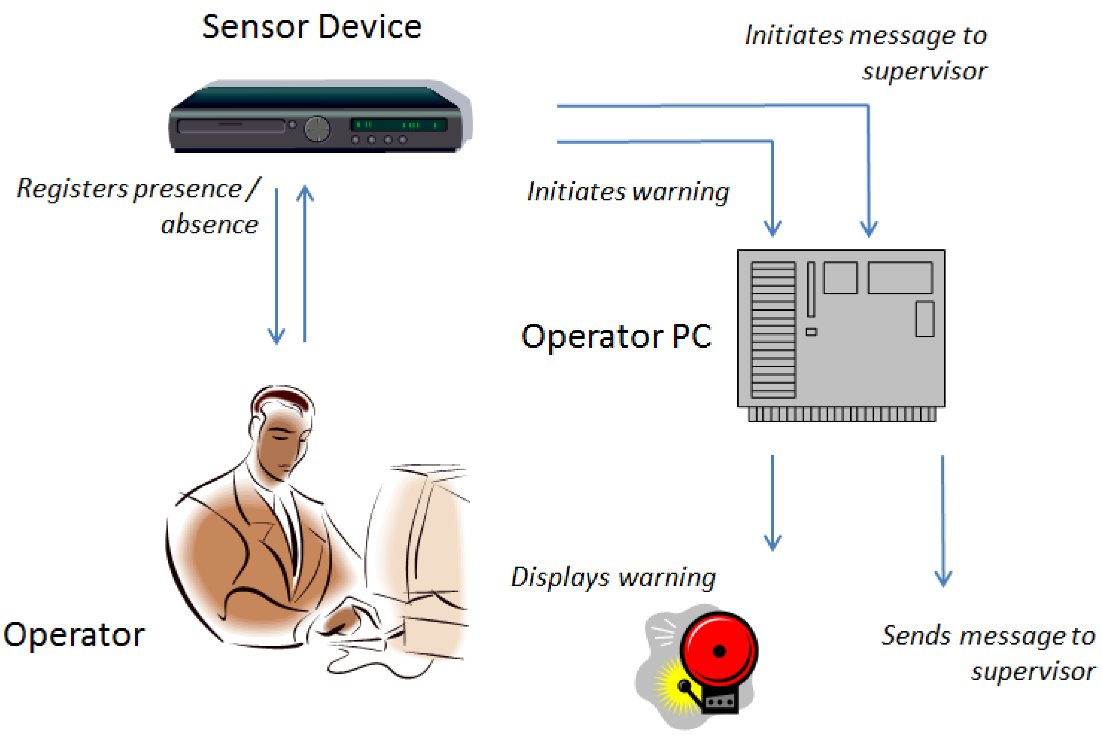


Figure 11 High Level Interaction Diagram for Use Case 1

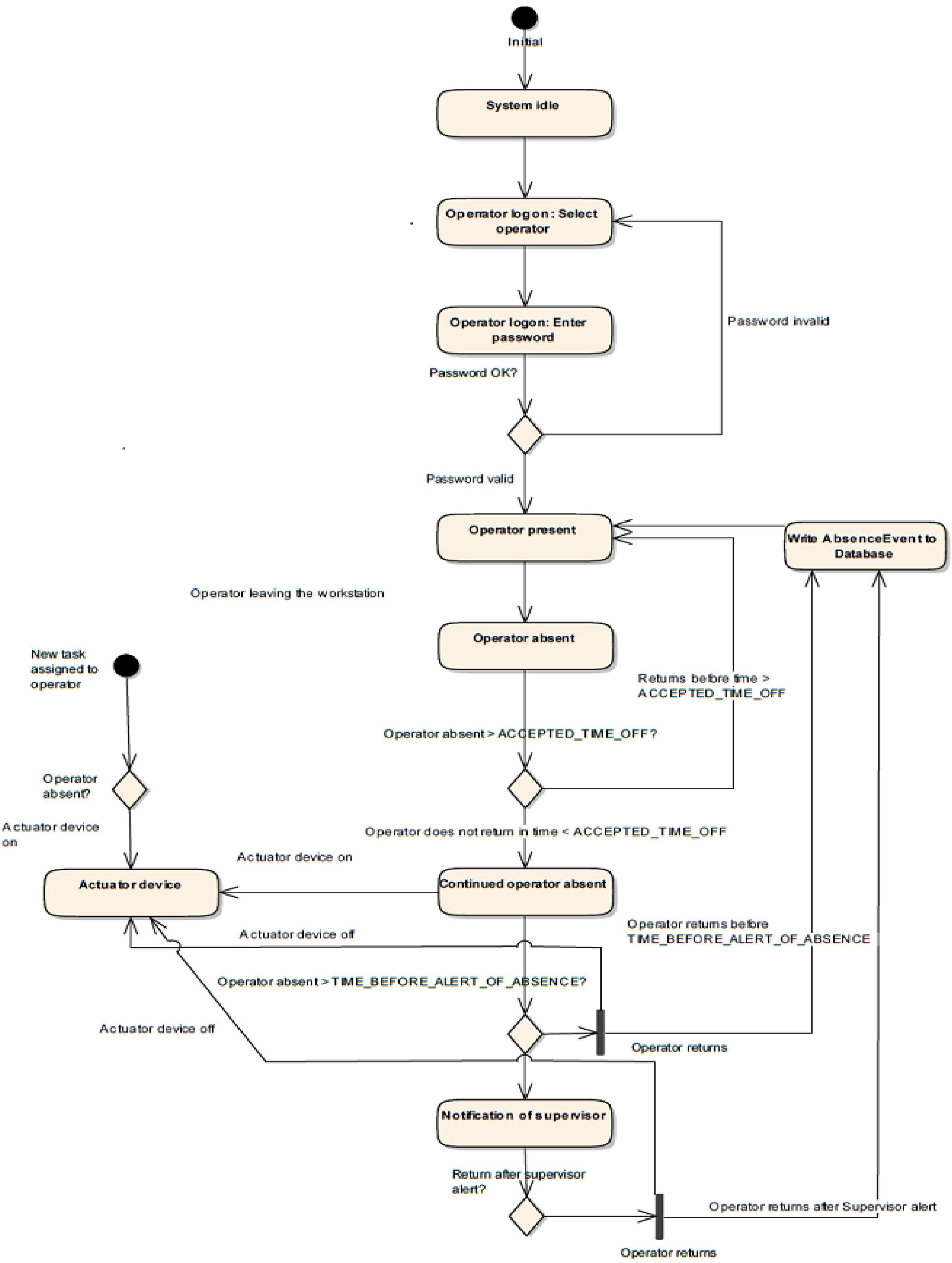


Figure 12 State Transition Diagram for Use Case 1

5.1.1.4.4 Use Case 2 Operator Idle at Work Place

5.1.1.4.4.1 Description

An operator is present at his workplace but idle for a longer than accepted period of time (idle is defined as motionless suggesting that the operator is asleep). The system contacts the operator. If he doesn't display any activity after a defined length of time, his supervisor is informed.

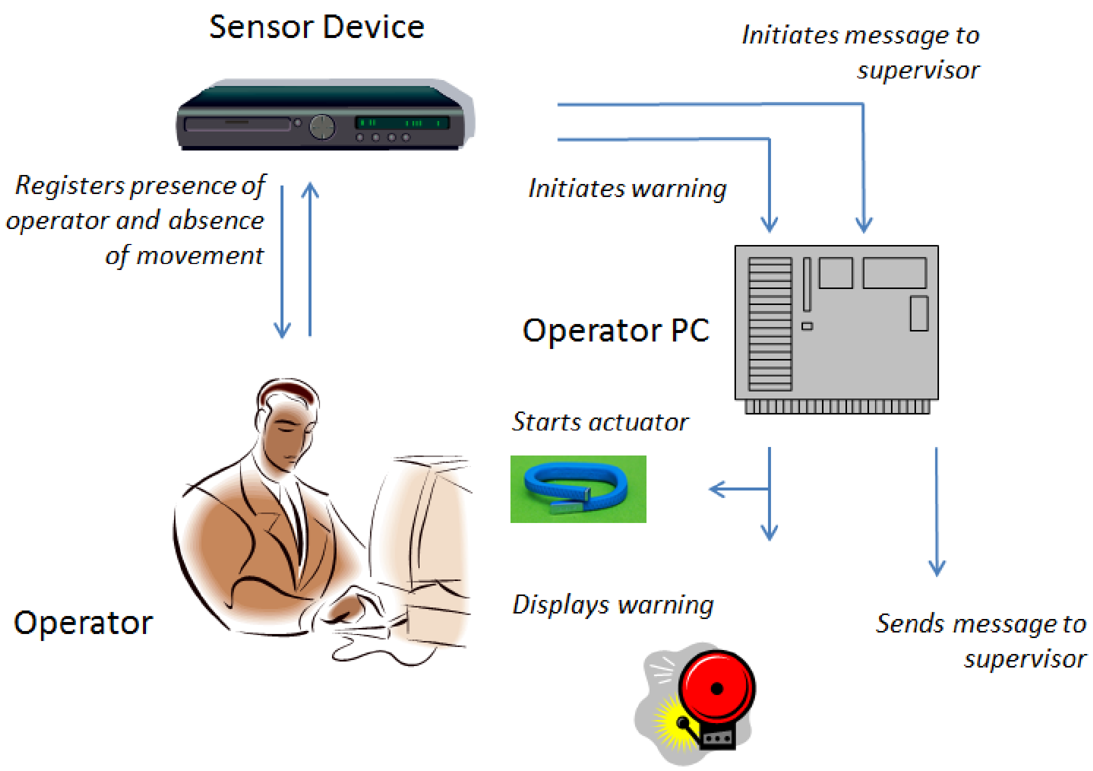


Figure 13 High Level Interaction Diagram for Use Case 2

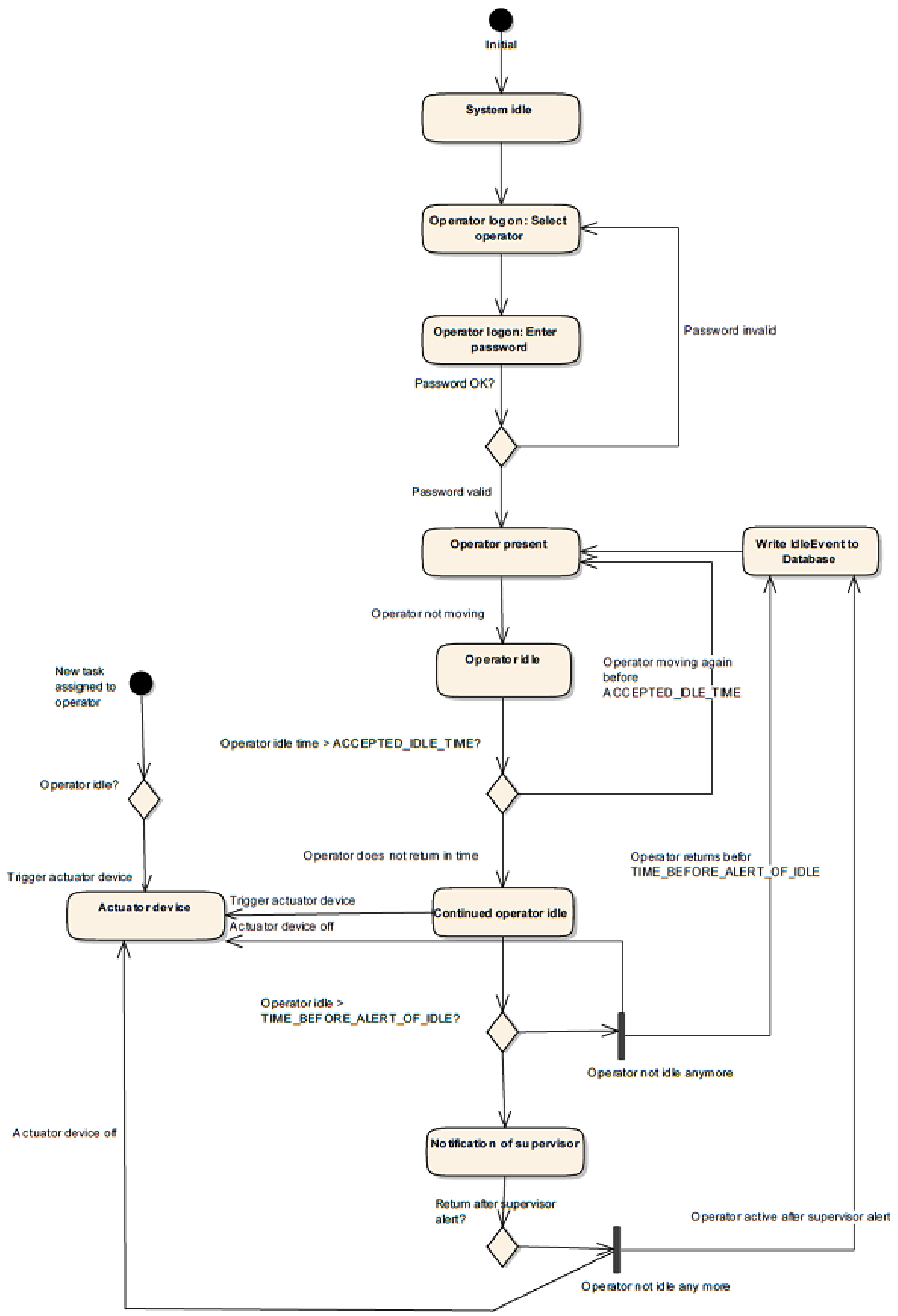


Figure 14 State Transition Diagram for Use Case 2

5.1.1.4.5 Use Case 3 Operator Tired in Work Place

5.1.1.4.5.1 Description

An operator is present at his workplace but displays signs of fatigue. The system contacts the operator with a warning. If he doesn't acknowledge the warning after a defined length of time, his supervisor is informed.

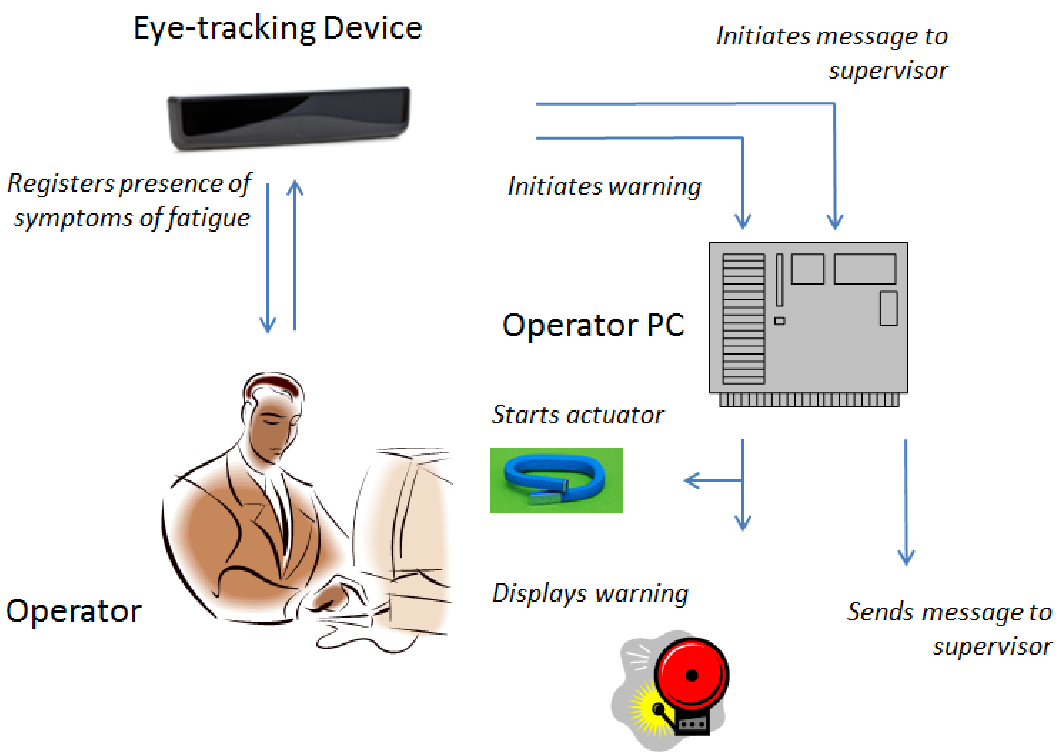


Figure 15 High Level Interaction Diagram for Use Case 3

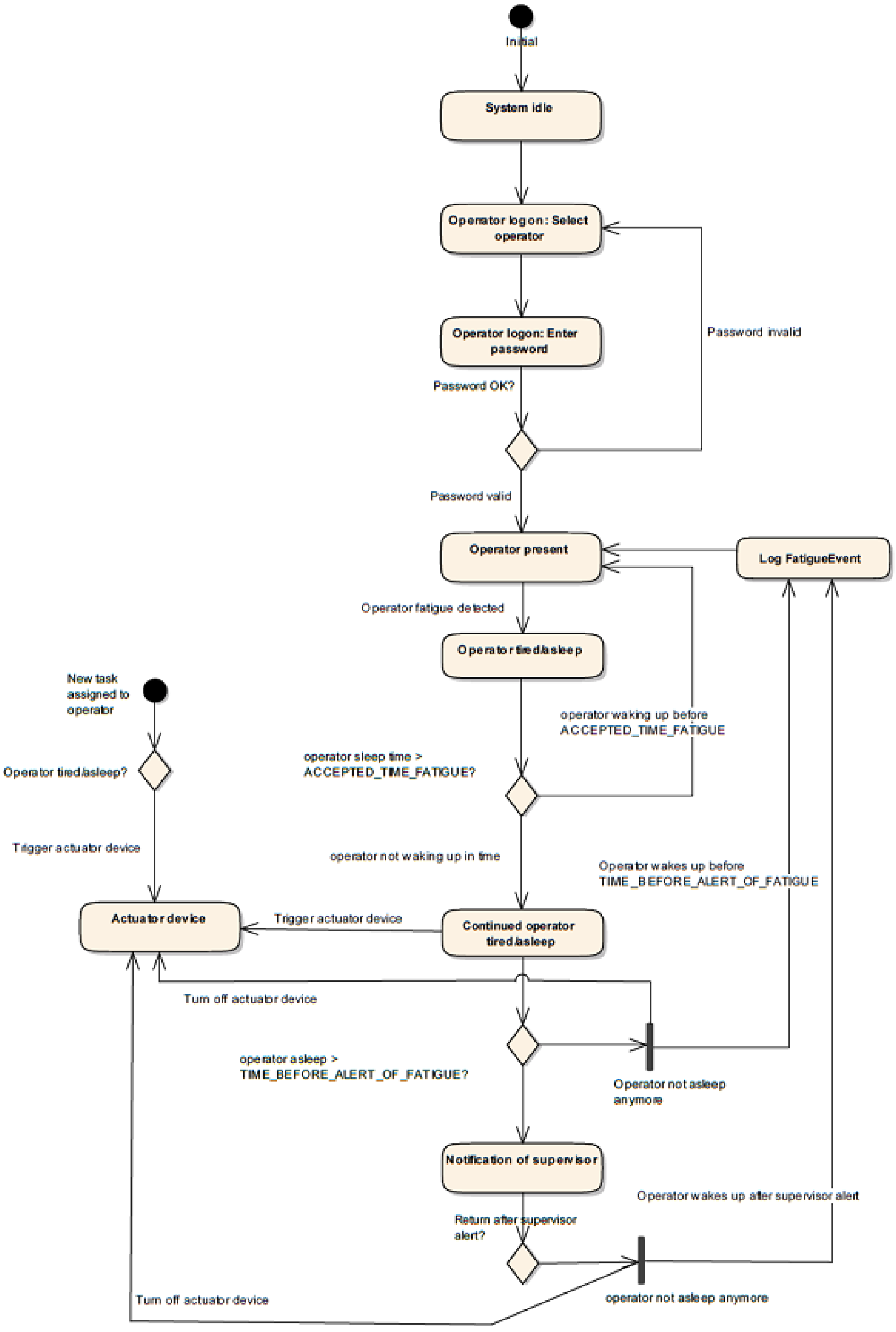


Figure 16 State Transition Diagram for Use Case 3

5.1.1.4.6 Use Case 4 Registration of Unusual Operator Behaviour Patterns

5.1.1.4.6.1 Description

Individual and cumulative instances of operator absence can be plotted with the aim of allowing the border security management to identify behaviour patterns of the crew that can be exploited by third parties in order to compromise a station's security.

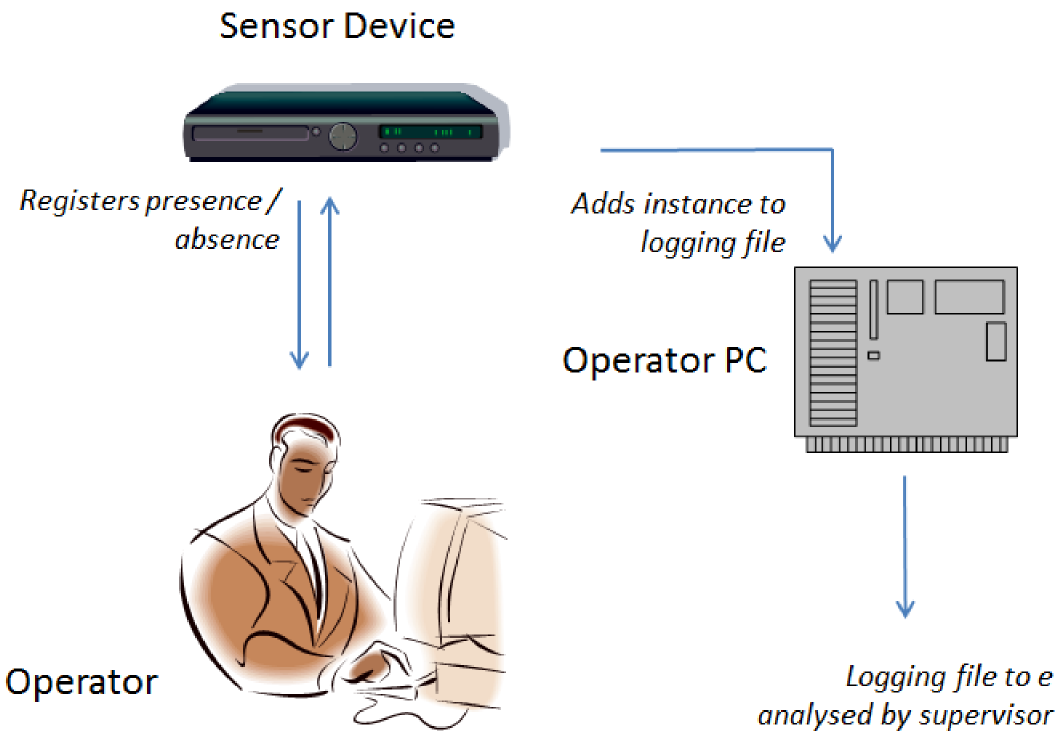


Figure 17 High Level Interaction Diagram for Use Case 4

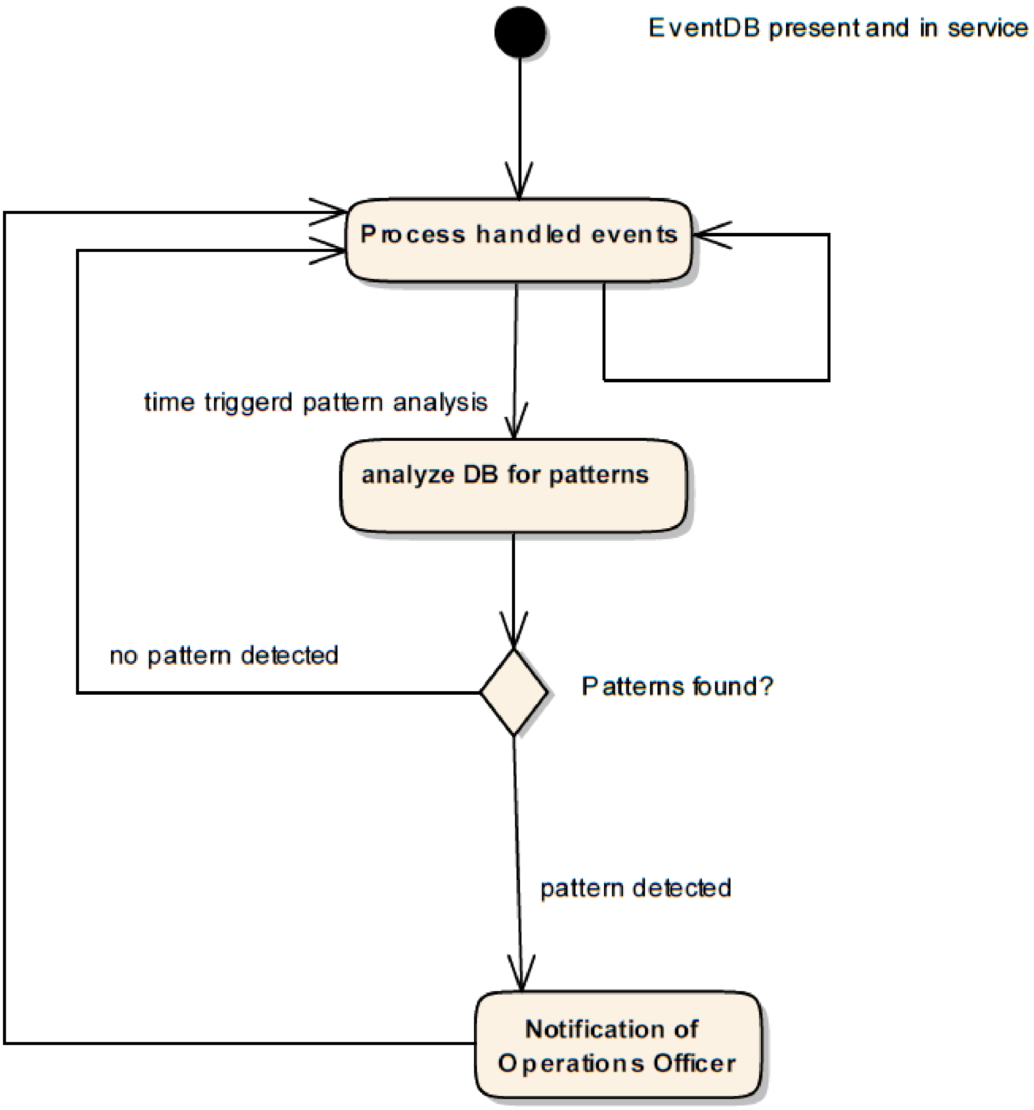


Figure 18 State Transition Diagram for Use Case 4

5.1.1.4.7 Use Case 5 Load Balancing on Operator Level

5.1.1.4.7.1 Description

The system is able to recognize the load of a single operator compared to the overall load of all operators in one headquarters. To avoid overloading an individual operator, the system shall distribute incoming events to operators with a lower current workload and offer the redistribution of events from operators who are dealing with a number of events above a critical threshold.

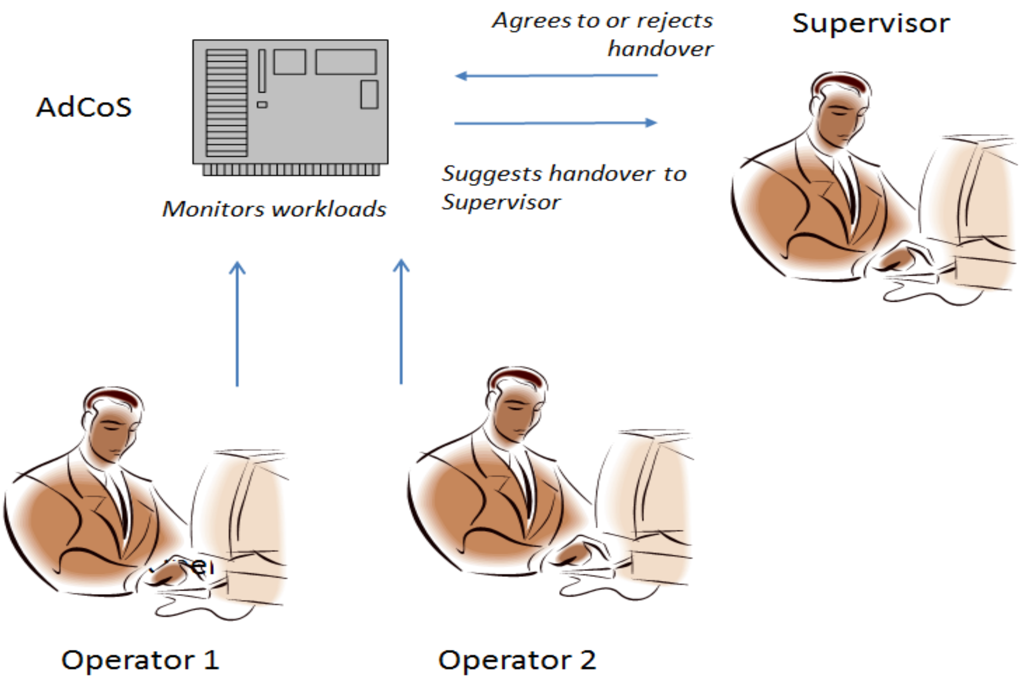


Figure 19 High Level Interaction Diagram for Use Case 5

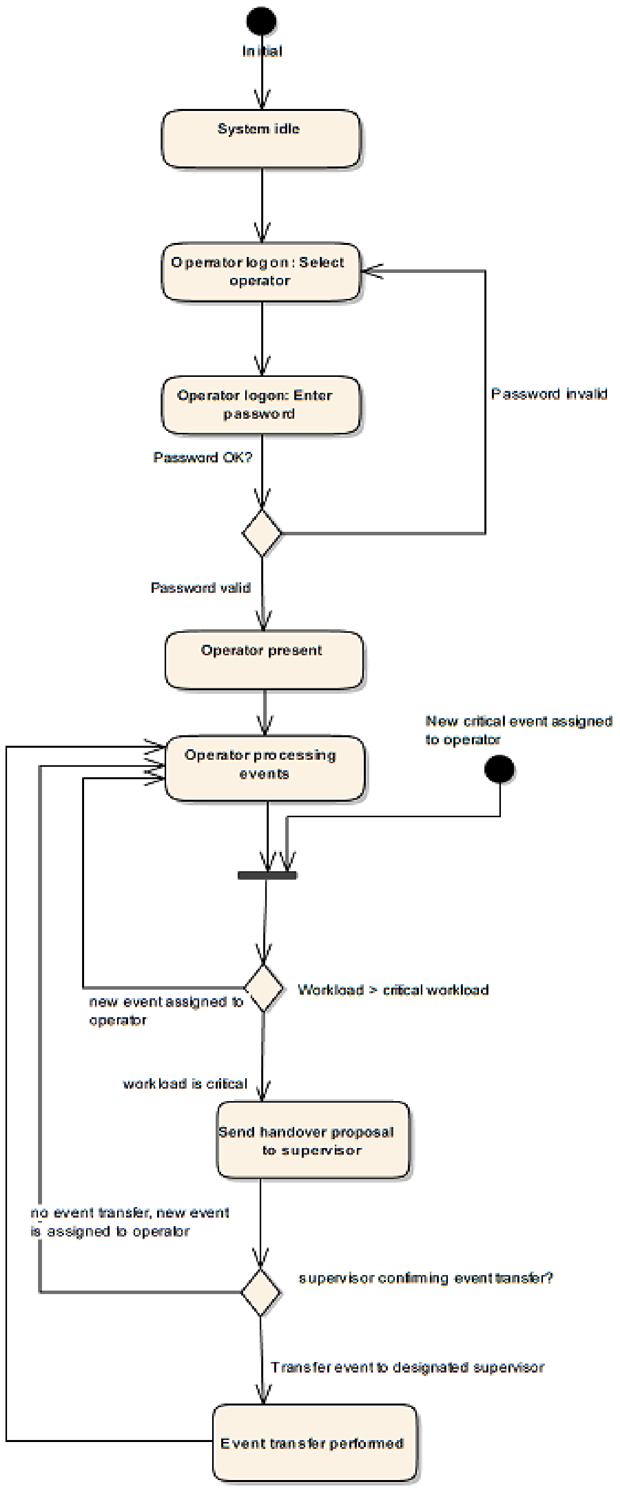


Figure 20 State Transition Diagram for Use Case 5

5.1.1.4.8 Use Case 6 Monitor and Update the Status of Employees

5.1.1.4.8.1 Description

Based on a set of parameters, the system can support the border security centre management in categorising their staff into meaningful categories such as 'basic experience', 'advanced experience', and 'expert experience'. These categories can be used for selecting appropriate functional, help and training levels.

Variable	Basic Level	Advanced Level	Expert Level	Comment
Employee	n/a	n/a	n/a	Employee number as maintained in C2ISR SW
Status	1 'basic'	2 'advanced'	3 'expert'	0 'undefined'; 4 'other'
Time in position	0 – 6 months	7 – 18 months	> 18 months	Time in months
Training levels	1	2 – 3	4 – 5	Fictitious training levels
Regular instances	< 100	101 – 500	> 500	Number of regular instances successfully dealt with (see table Event Type Classification below)
Critical instances	< 50	51 – 100	> 100	Number of critical instances successfully dealt with (see table Event Type Classification below)
Faulty decisions	< 10 %	< 5 %	< 1 %	Number of percentage of faulty decision (critical instances not successfully dealt with).These are not yet systematically collected by the system
Performance assessment	1 'basic'	2 'advanced'	3 'expert'	This is the recommendation of the supervisor 0 'undefined'; 4 'other'

Figure 21 Experience Level Indication for Use Case 6

5.1.1.4.8.2 Use Case Goals and Adaptation

Description of the adaption

Based on a set of parameters, the system can support the control room management in categorising their staff into meaningful categories such as 'basic experience', 'advanced experience', and 'expert experience'. These categories can be used for selecting appropriate functional, help and training levels.

Why to adapt?

The system currently does not differentiate between operators with different degrees of experience. A mechanism for supporting the control room management in assigning levels of expertise to individual operators can help increasing the operators' effectiveness and thereby the effectiveness of the entire C2 operation. The levels of expertise are:

— 'basic experience': These are entry-level operators with little training and little first-hand experience on the job and who still require supervision when performing their tasks.

— 'advanced experience': These are operators with solid training and experience who can be trusted to perform reliably in everyday situations.

— 'expert experience': These are operators with the highest degree of expertise who can be relied upon to correctly assess and respond to critical and/or unusual situations and circumstances and who are qualified for the supervision of operators with 'basic experience'. An expert-level Response Operator may be a candidate for becoming a Response Supervisor.

What to adapt?

The system uses a number of parameters to propose to the control room management the initial level-of-expertise category or a category change for each member of staff. The level-of-expertise categories can be used to:

— Automatically adapt the layered help function
— Propose a training measure (recurring training or next-level training)
— Propose a personal fresh-up training session with a supervisor

How to adapt?

The system uses the following parameters (and others to be specified) to propose to the control room management the initial category or a category change for each member of staff:

— Time spent in current position
— Training levels achieved
— Number of regular instances mastered
— Number of critical instances mastered
— Number of faulty decision over a defined period of time

Performance assessment by supervisor

5.1.1.5 Modelling Techniques Employed

Airbus DS has research tasks running in parallel with the HoliDes project, the first is Human System Integration (HSI), which include Human Viewpoints, the second is the introduction of Model Based System Engineering (MBSE) into several pilot projects. Airbus DS will use the research from the HoliDes project within its MBSE pilot's projects and disseminate the data throughout the company, it is also using the Human View research within the Airbus DS AdCoS.

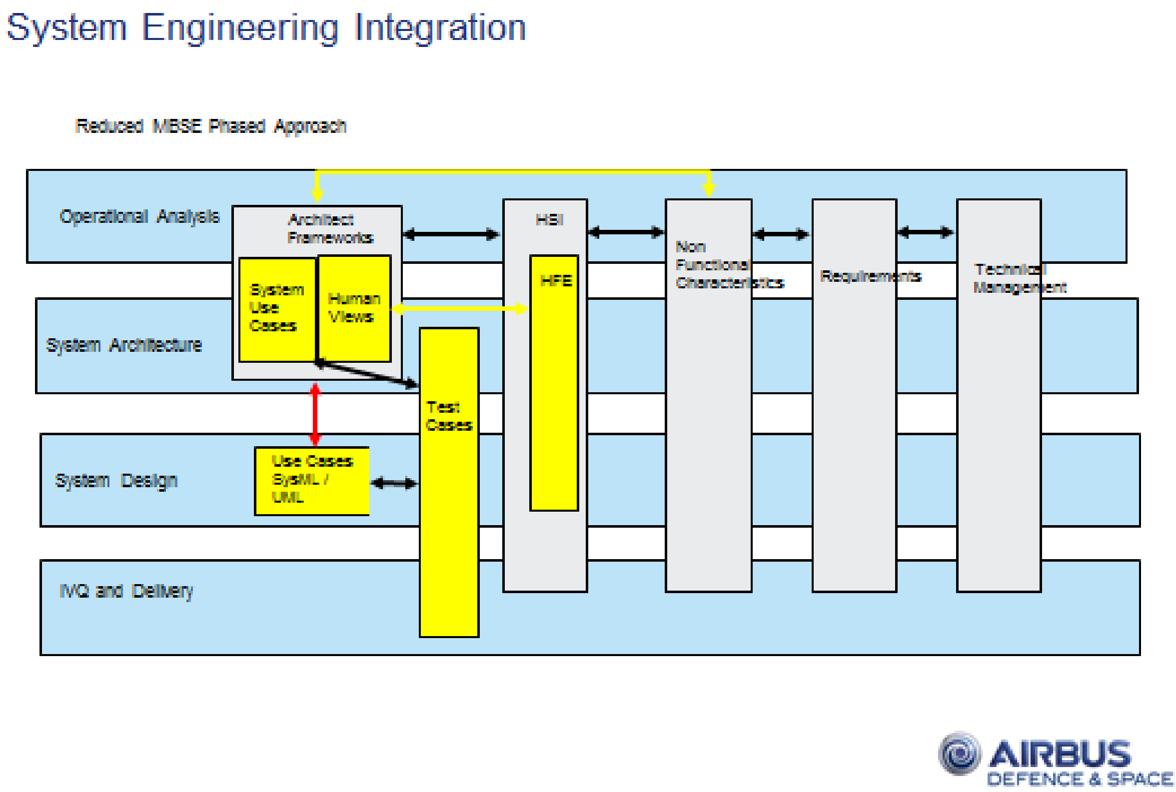


Figure 22 Simplified Airbus MBSE Phased Integration Approach

The modelling techniques for the Airbus AdCoS are based on the following two specific Airbus DS on going developments

- Airbus Model Based System Engineering (MBSE) – Figure 22 Simplified Airbus MBSE Phased Integration Approach is a simplified diagram for our MBSE approach. The grey boxes define our process that is well defined. The yellow boxes indicate the current on-going research into

Human System Integration. Our next development step is defined by the red arrow, this will provide a process that links the Architecture Frameworks development onto our SysML development, which we use for detailed design.

- Airbus System of System Framework (SoS) Approach – Figure 23 defines the complete Airbus approach, but as defined in section 5.1.1.6 we have tailored the Framework to use only the Operational and System Viewpoints from the standard DODAF set, together with the Airbus derived System and Test Case and Human Viewpoints.

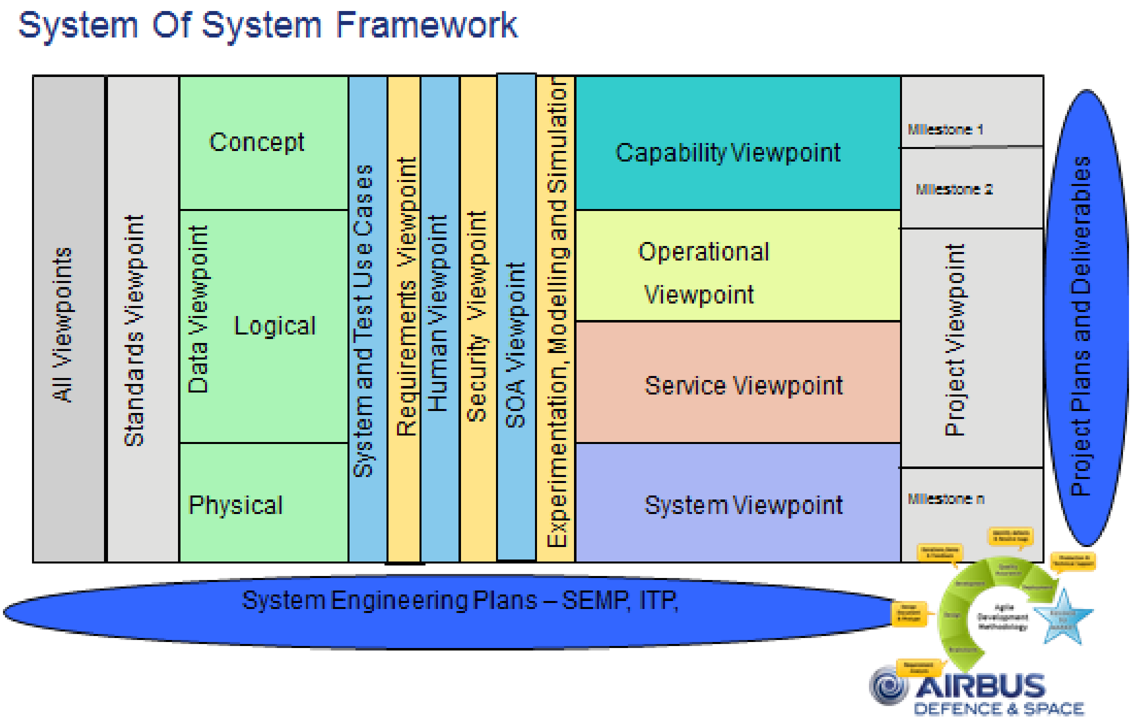


Figure 23 Airbus System of System Framework

The Operational, System and Human Viewpoints are defined in detailed in Section 5.1.1.7 and 5.1.1.8, with the Task modelling defined in section 5.1.1.6.

The System Test and System Use Cases Viewpoint production are define as follows:

- Use Cases have been produced in line with the HoliDes template and are defined in section 5.1.1.4.
- The Initial Demonstration system is defined in section 5.1.1.9.
- Test Case / Scripts will be defined in D8.7.

5.1.1.6 Task Modelling

The Airbus DS task modelling is based on the company's Model Based System Engineering (MBSE) approach, using an Architectural Framework, together with an appropriate tool set for the Operational and System Modelling, Task Modelling is intrinsic to this overall approach.

Figure 24 defines the Task Modelling in more detail, however it does not include the Operational Concept models as these are used to model the external environment defined within the Controlled Entity. The Task Model defines how the Airbus DS model is structured and how it maps onto the Controlled Entity, Operators of the AdCoS and External Environment defined in section 5.1.1.2.

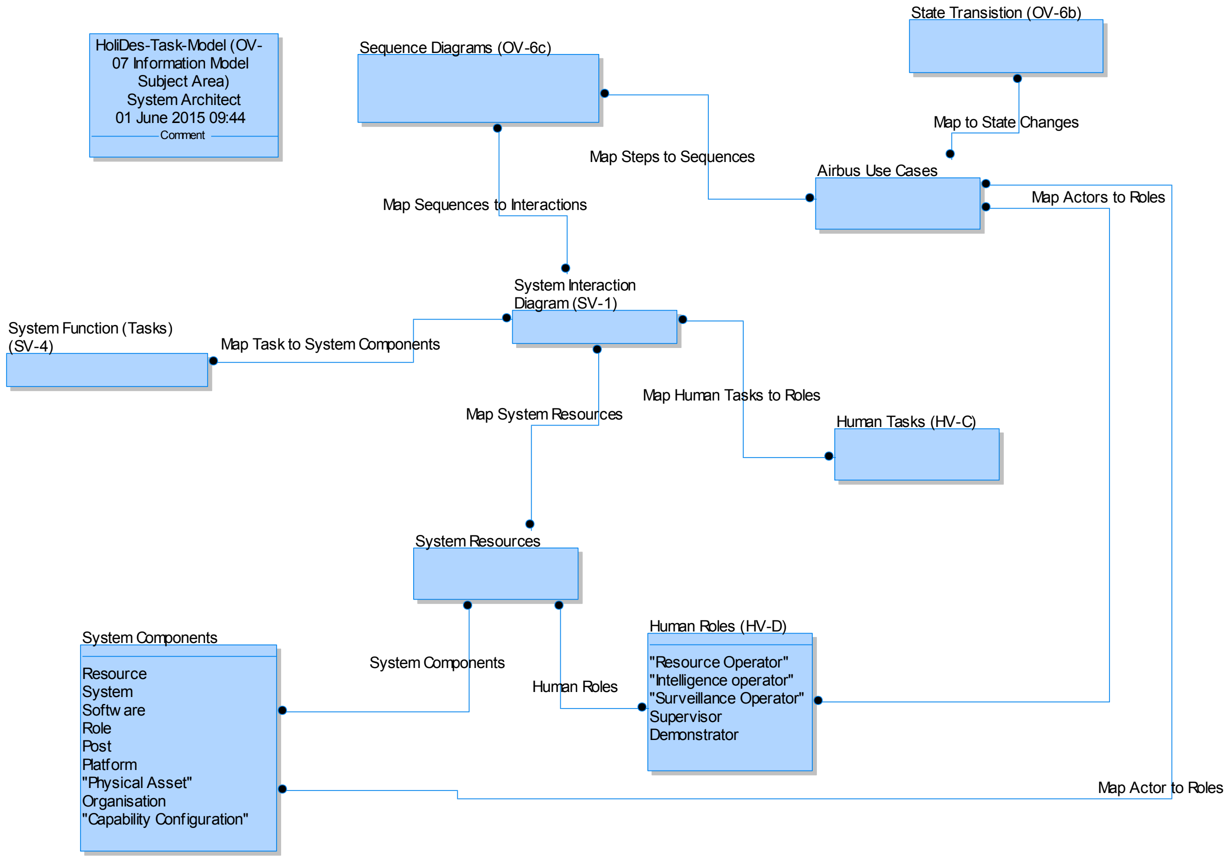


Figure 24 Airbus Task Modelling Model Product Interaction

The Task Model has been broken down into two distinct parts, the first being System Task / Functions and the second Human Tasks.

The System Tasks/Functions are created within an Architecture Framework Tool as a System Function Diagram (SV-4 as defined in section 5.1.1.7). The first part details the System Tasks / Function allocation to System Resources, which are defined in a System Interaction Diagram (SV-1 as defined in section 5.1.1.7). The System Interactions are then allocated between System Components; these interactions are derived from the Use Cases, Operational Sequence Diagrams (OV-6c), Subject Matter Expert advice and Command and Control Operational experience.

The second part defines the Airbus Architectural Human Viewpoint addition to any standard Framework, Airbus DS has spent the last two years developing this Architectural Framework addition and was the prime reason for Airbus DS UK joining the HoliDes consortium, the Human Viewpoint included in the Airbus DS AdCoS are defined in section 5.1.1.8. The Human Tasks defined in (Human Tasks HV-C) are allocated to the Human Roles defined in Human Roles (HV-D) and the Actors defined in the Airbus DS Use Case descriptions. These Human Roles are defined as System Resources and allocated to System Components in the System Interaction Diagrams (SV-1), just in the same way as System Tasks/Functions are allocated. The System Interactions are then allocated between System Components; these interactions are derived from the Use Cases, Operational Sequence Diagrams (OV-6c), Subject Matter Expert Advice and Command and Control Operational experience.

The System Interaction Diagrams represent the detailed interaction of the Airbus DS AdCoS in terms the Controlled Entity, Operators of the AdCoS and the External Environment that will form the initial demonstration capability and will be an input to the detailed demonstration that will be defined in D8.7.

5.1.1.7 DoDAF Products

The Airbus DS Model Base System Engineer (MBSE) process mandates the use of an Architectural Framework for all of its projects. Therefore for the HoliDes C2 Architecture, Airbus DS has defined a tailored/reduced set of Department of Defence Architectural Framework (DoDAF) products that fits to the scale of the project. Of the 52 available DoDAF products we will define the following 8, from the System and Operational Viewpoint. The Service, Capability, Data, Standards and Project Viewpoints will not be utilised. The following is a brief description of the products used for the Airbus DS HoliDes AdCoS:

- High Level Operational Concept - The OV-1 describes a mission, class of mission, or scenario. It shows the main operational concepts and interesting or unique aspects of operations. It describes the interactions between the subject architecture and its environment, and between the architecture and external systems.

- Organisational Diagram - The OV-2 applies the context of the operational capability to a community of anticipated users. The primary purpose of the OV-2 is to define capability requirements within an operational context. The OV-2 may also be used to express a capability boundary.

- Organisation Relationships - The OV-4 shows organizational structures and interactions. The organizations shown may be civil or military. The OV-4 exists in two forms; role-based (e.g., a typical brigade command structure) and actual (e.g., an organization chart for a department or agency). A role-based OV-4 shows the possible relationships between organizational resources. The key relationship is composition, i.e., one organizational resource being part of a parent organization. In addition to this, the architect may show the roles each organizational resource has, and the interactions between those roles, i.e., the roles represent the functional aspects of organizational resources.

- Operational Activity - The OV-5a and the OV-5b describe the operations that are normally conducted in the course of achieving a mission or a business goal. It describes operational activities (or tasks); Input / Output flows between activities, and to/from activities that are outside the scope of the Architectural Description.

- Sequence Diagram - The OV-6c provides a time-ordered examination of the Resource Flows as a result of a particular scenario. Each event-trace diagram should have an accompanying description that defines the particular scenario or situation. Operational Event/Trace Descriptions, sometimes called sequence diagrams, event scenarios, or timing diagrams, allow the tracing of actions in a scenario or critical sequence of events

- State Transition Diagrams - The OV-6b is a graphical method of describing how an Operational Activity responds to various events by changing its state. The diagram represents the sets of events to which the Activities respond (by taking an action to move to a new state) as a function of its current state. Each transition specifies an event and an action.

- The Logical Data Model – The OV-7 the data model including its data entity definitions, is a key element in supporting interoperability between architectures, since architecture data definitions may be used by other organizations to determine data compatibility. Often, different organizations may use the same name to mean very different kinds of data, with different internal structure.

- System Interaction Diagram - The SV-1 links together the operational and systems architecture models by depicting how Resources are structured and interact to realize the logical architecture specified in an OV-2 Operational Resource Flow Description

- System Functions - The SV-4 address human and system functionality, the intended usage includes description of task work flow, identification of functional requirements, functional decomposition of the system and to relate human and system functions.

5.1.1.8 Human View Products

We have also included an additional Airbus DS architectural viewpoint specifically designed for Human System Integration. These views are based on the views defined in the NATO Human View Handbook and will be defined and integrated into Architecture Framework defined within Sparx's Enterprise Architect and defined in section 5.1.2.4.

- Human Concepts HV-A – The Concept view (HV-A) is a high-level representation of the human component of the enterprise architecture framework. Its purpose is to facilitate understanding of the human dimension in relation to operational demands and system components. It serves as a single point of reference and departure to depict how the human impacts performance (mission success, survivability, supportability, and cost) and how the human is impacted by system design and operational context (e.g., personnel availability, skill demands, training requirements, workload. wellbeing).

- Human Tasks HV-C – The Tasks view (HV-C) describes human-specific activities (i.e., functions assigned to humans over a system's entire life cycle). It also captures how functions are decomposed into tasks. (The term *task* in this product refers to a piece of work that can be assigned).

- Human Roles HV-D – The Roles view (HV-D) describes the job functions that have been defined for humans interacting with the system. A role therefore represents a job function defining specific behaviour within the context of an organization, including the authority and responsibility conferred to the role, and competencies required to do the job. The role structure can be mapped to the HV C task decomposition to define organizational responsibilities, and relationships between roles can be defined to provide the basis of the organizational structure.

- Human Metrics HV-G - The Metrics view (HV-G) is an optional product since it can be incorporated into other architecture products. HV-G provides a repository for human-related values, priorities and performance criteria, and maps measures to other HV elements. It maps high-level (qualitative) values to quantifiable performance metrics and assessment targets and maps measurable metrics to human functions. It provides the basis for human factors assessment that underpins enterprise performance assessments, or for requirements tracking and certification

5.1.1.9 Initial Demonstration Model of the AdCoS

The Airbus Control Room AdCoS shall be demonstrated in the form of a demonstrator system and posters.

The aim of the demonstration is to document and visualise the principles of the AdCoS solution. For this reason, the AdCoS use cases will, wherever possible, fully implemented into the existing control room demonstration system.

At this stage of the planning, it is foreseen that the demonstrator system will consist of several independent technical units, partly or totally integrated into the border control room software, conveying an impression of a fully integrated system.

The aim is to develop a demonstrator system with the following characteristics:

- Reproducible: the system can be built in more than one instantiation;
- Mobile: the system can be transported to venues outside of the manufacturer's premises for the purpose of demonstrating the AdCoS;
- Modular: the system consists of several sub-systems that act independently while creating the impression of an interacting whole;
- Economical: the system realises the most economical solution, minimising developers' efforts wherever possible;
- Conservative: the system will minimise the number of changes required to the main control room software;
- Innovative: the system will make use of new technologies in order to demonstrate the potential of new I/O peripherals.

The demonstrator system will consist of the following sub-systems:

- Control Room Demonstrator, implemented on three PCs (see Figure 25):
    - Server PC (Tower) acting as server for the control room SW and AdCoS modifications;
    - Operator PC 1 (Laptop PC) acting as Response Operator workstation or Response Supervisor workstation;
    - Operator PC 1 (Laptop PC) acting as Response Operator workstation or Response Supervisor workstation.
- AdCoS I/O system with the following functionalities:
    - Interaction with the Kinect device (on Operator PC 1 and 2):
        - Receive input from the Kinect device;
        - Monitor the input from the Kinect device (e.g. counter n minutes no presence of skeletal shape within range of Kinect);
        - Act on the input from the Kinect device (send message to actuator or initiate a Windows message window).
    - Interaction with the Tobii Eye Tracker device (on Operator PC 1):
        - Receive input from the Tobii Eye Tracker device;
        - Monitor the input from the Tobii Eye Tracker device (register only when Kinect device reports presence of a human; monitor behaviour of the operator's eyes in order to infer states such as 'tired' or 'asleep');
        - Act on the input from the Tobii Eye Tracker device (send message to actuator or initiate a Windows message window).
    - Interaction with output devices:

  - Send output to a sensory actuator (e.g. Bluetooth wristband initiate vibration or vibration alert or SMS to a handset connected to mobile network or local network).
- Interaction with Control Room SW System:
  - Send output message to the Response Office workstation via Microsoft message window;
  - Receive messages from the Response Office workstation via Microsoft message window;
  - Send output message to the Supervisor workstation via Microsoft message window;
  - Receive messages from the Supervisor workstation via Microsoft message window;
  - Re-assign events on the Response Operator workstations during the workload balancing use case and visualise the changes.

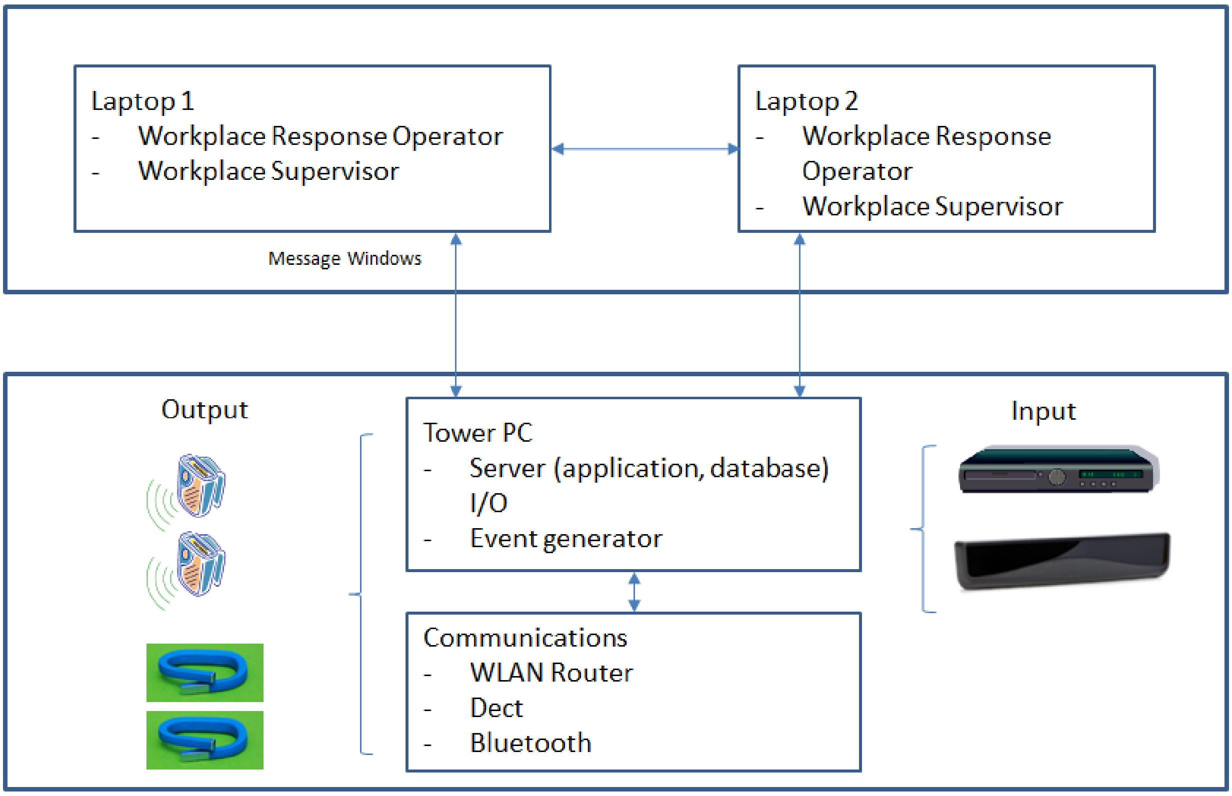


Figure 25 High Level View of Airbus AdCoS Demonstration System

In the laboratory set up, the PC are connected via a company network. In the mobile demonstration set up, the various components will be connected via a mobile switching unit. The details of this set up are yet to be defined.

The final set up of the demonstrator will be described in detail in Deliverable 8.7.

The demonstration scenario

At the current stage of the planning, the following demonstration scenario is foreseen.

a) General introduction to the C2 AdCoS, background to the operational context of the work in the control room (verbal, posters)

b) Use cases 1-4 Operator State Assessment

Set up

- The demonstration system is running.
- The peripherals (sensor device, remote eye-tracking sensor and actuator device) are connected and the respective application is running.
- If possible, an additional window illustrates the operation of the data capturing of the sensor device (body shape or skeletal representation) and/or of the eye-tracking device.
- For demonstration purposes, the variables are set to low values: TIME_BEFORE_ALERT_OF_ABSENCE, TIME_BEFORE_ALERT_OF_IDLE, TIME_BEFORE_ALERT_OF_FATIGUE all set to one minute.

Demonstration

- The underlying problem is explained: patterns in the behaviour of crew members (e.g. regular absences at night of one or several crew members) can be interpreted by enemies planning an assault on the border.
- The principle of the adaptation is explained: registering operator absent or idle, logging the data and presenting them in a graphical form.
- A practical demonstration is given:
  a) demonstration of operator absent
  b) demonstration of individual instances logged
  c) demonstration of overall crew data with unusual patterns

c) Use case 5 Load Balancing on Operator Level

Set up

- The demonstration system is running.
- For demonstration purposes, the variables are set as follows: CURRENT_WORKLOAD: track list filled, work load just below

CRITICAL_WORKLOAD. A control (additional button) leads to some more tracks being added to the track list so that CURRENT_WORKLOAD > CRITICAL_WORKLOAD

Demonstration

- The underlying problem is explained: an emergency-response service or an air traffic control agency fails to perform optimally because the workload is not distributed optimally across operators. Situations with an overload of individual operators can have critical consequences.
- The regular operation (i.e. without adaptation) is explained.
- The principle of the adaptation is explained: monitoring the workload of all operators, initiating a handover proposal wherever necessary and possible.
- A practical demonstration is given:
  a) displaying the already busy track list of the operator
  b) adding additional tracks
  c) demonstrating the case of accepting the handover proposal
  d) demonstrating the case of rejecting the handover proposal
  e) demonstrating the event from the perspective of the "incoming" operator

d) Use case 6 Assisted Operator Categorisation

Set up

- The demonstration system is running.
- If possible, an additional window illustrates the operation of the data table in the background).
  For demonstration purposes, the traffic of tracks must be simulated with new tacks coming in and being dealt with which in turn affects the data table in the background.
- Alternatively, the principle may be illustrated with the help of posters.

Demonstration

- The underlying problem is explained: the C2 software so far does not support the customer's HR or higher ranks with an overview of the employees' experience and maturity for taking over new responsibilities.
- The regular operation (i.e. without adaptation) is explained.
- The principle of the adaptation is explained: a live table watches the progress of each employee and recommends changes if certain maturity levels are reached.
- A practical demonstration is given:
  a) the current practice of logging skills is presented

b) the data table and its parameters is introduced
c) the event of reaching a next level with the automatic notification of the supervisor is presented
d) the supervisor accepts the change and the change can be verified in the table

5.1.1.10 Interactions to the Modelling Process from other Work Packages

Figure 26 defines a high level activity diagram for the interactions and dependencies for HoliDes deliverable D8.5, with other Work Package 8 deliverables and Work Packages 1, 2 3 4 and 5.

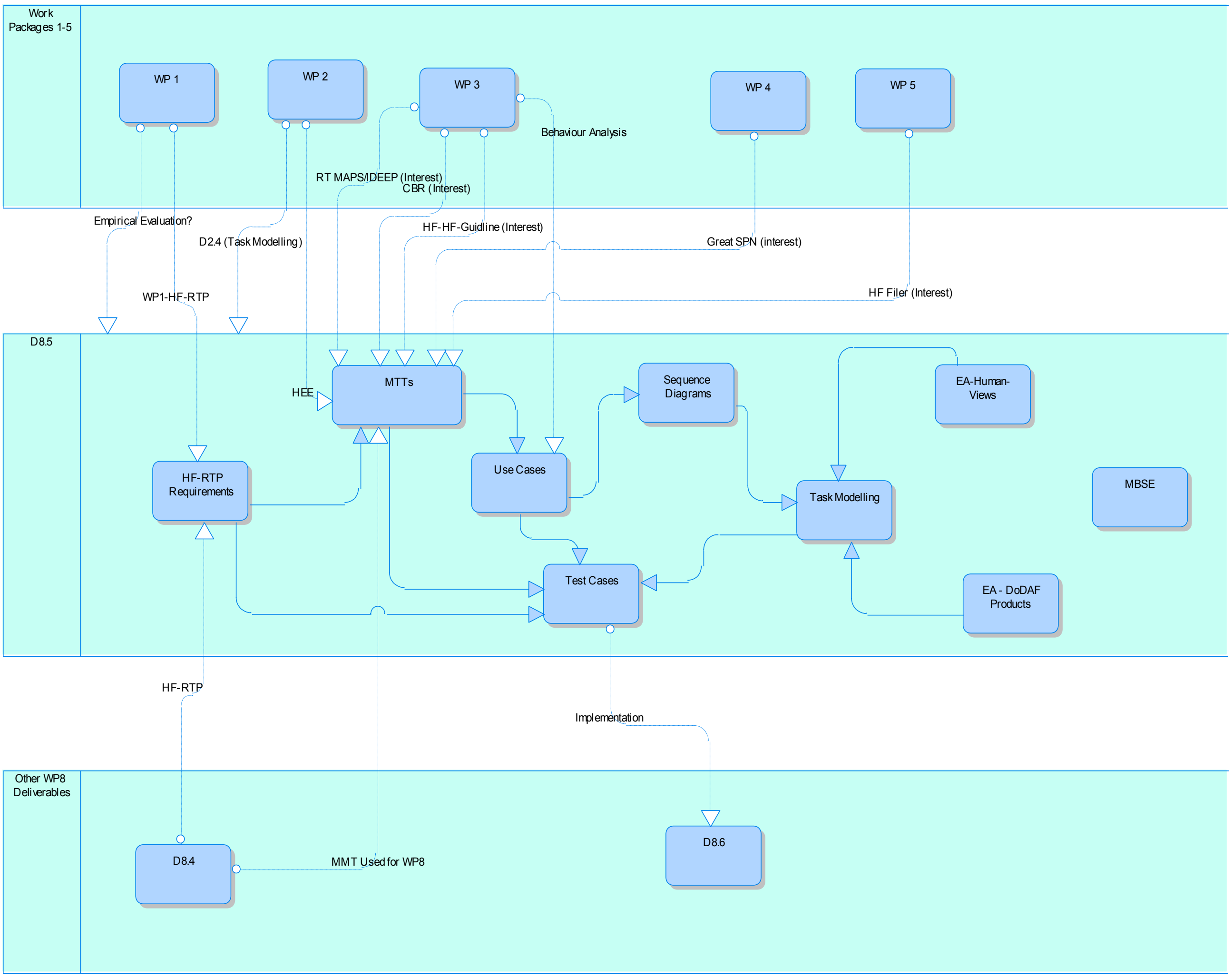


Figure 26 Airbus D8.5 Work Package Interactions and Dependencies

The interactions / dependencies are defined as follows

- Work Package 1 – will supply the HF-RTP and may supply Empirical Evaluation
- Work package 2 – will supply Task Modelling references and the OFFIS HEE analysis tool as defined in section 6.1.7
- Work Package 3 – after detailed investigation none of the MTTs defined in WP3 were suitable for use within the Airbus DS AdCoS. Two MTTs LEA and CBR were investigated and the results of these investigations are defined in Section 6.1.8 and 6.1.9 respectively
-
- Work Package 4 – after detailed investigation none of the MTTs defined in WP4 were suitable for use within the Airbus DS AdCoS. RT-Maps was investigated and the results are defined in section 6.1.6. Great SPN is still under investigation as defined in 6.1.5
- Work Package 5 - will provide HF-Filer as defined in section 6.1.4
- Work Package 8
  - Work Package 8 D8.4 – will provide details of the initial definition of the HF-RTP and MMTs to be used within WP8.
  - Work Package 8 D8.7 – D8.5 will provide as output, the Architecture models, the Use Case definitions and the initial demonstration capability to D8.7.
  - HF-RTP Requirements – as supplied by WP1 and D8.4
  - MTTs – the initial MTTs have been detailed in D2.5 and D8.4. D8.5 will define the complete and final list of the MTTs to be used with the Airbus DS AdCoS.
  - Use Cases – as defined in section 5.1.
  - Test Cases / Scripts will be detailed in D8.7.
  - Sequence / State Transition Diagrams – as defined for each use case defined in 5.1.1.4.
  - Task Modelling – as defined in section 5.1.1.6.
  - Human Views products – as defined in section 5.1.1.8 and instantiated in section 5.1.2.4
  - DODAF products as defined in section 5.1.1.7 and instantiated in section 5.1.2.4.
  - Model Base System Engineering (MBSE) and SoS Approach are as defined in section 5.1.1.5.

5.1.2 The Model

5.1.2.1 Model Based System Engineering (MBSE)

One of the aims and objectives of the Airbus involvement in the HoliDes consortium was to use and disseminate the research into its ongoing MBSE objectives and activities.

The overall objective is to identify an MBSE process to support Airbus Defence and Space portfolio of products, to provide the engineering process and governance to implement, maintain and provide the solution for use within our portfolio.

A definition of Model Based System Engineering (MBSE) - is a model-centric approach to support specific System Engineering (SE) activities. Models allow to manage the architecture complexity, share and build a common representation among SE specialties, reduce inconsistencies and check for completeness, produce consistent architecture based documents/reports and deduce information and so, support SE decision making process.

The aim of this process is to

- Define correct project and engineering governance
- Ensure customer confidence throughout the lifecycle
- Reduce re-work
- 'Get it right' before we define a solution
- Reduce paper documentation
- Reduce cost in terms of manpower, tools, duration of reviews etc.
- Remove Non-Quality Issues
- Remove integration risk in our projects
- Drive innovation with the ongoing Model Based System engineering

5.1.2.2 The Airbus DS AdCoS Model

This section will details the

5.1.2.2.1 Architectural Frameworks

To make maximum reuse of modelling resources Airbus DS has used two Architecture tools to provide the complete HoliDes model as defined in

Figure 27. IBMs System Architect (Yellow boxes) has been used to produce the operational architecture, this includes the Operational Concept diagram (OV-1) and the Sequence Diagrams (OV-6c) used in conjunction with the Uses Case. It has also been used to produce logical data model (OV-7) to provide a graphical representation of task and process interactions and finally Operational Activity diagrams (OV-5) to produce a graphical representation of process flows, both these diagrams have been produced to assist in the understanding of overall modelling tasks.

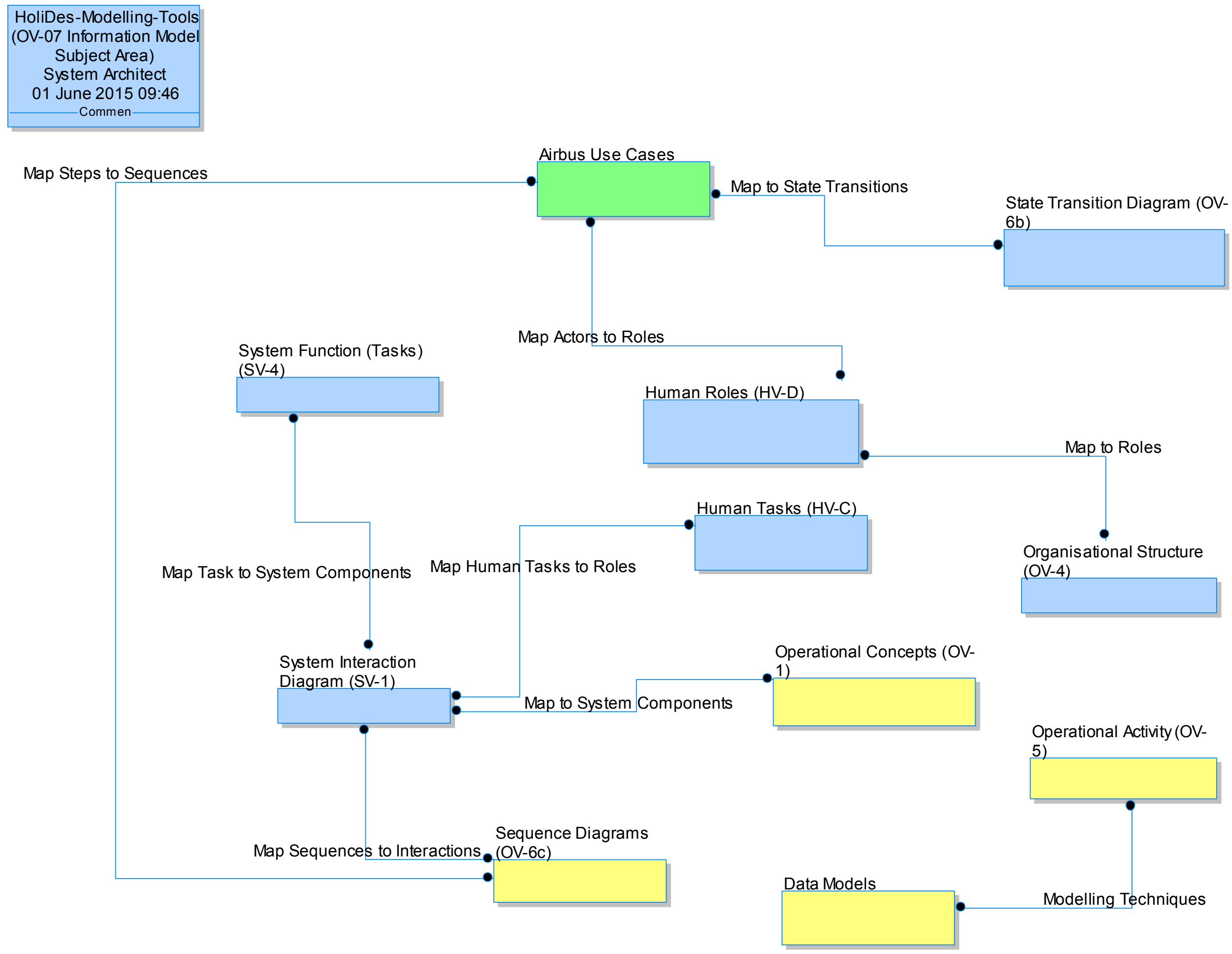


Figure 27 Airbus Modelling Product Breakdown

Sparx's Enterprise Architect (EA) (Blue boxes) has been used to define the Airbus DS AdCoS, principally to integrate the Human Viewpoints into the tool. EA has modelled the Organisation structures (OV-4) derived from the operational models, the System Tasks/Functions (SV-4) derived for the Controlled Entity, the Human View definitions for Roles (HV-D) and Tasks (HV-C) derived from the Use Cases and Operational Concepts and finally the

System Interactions Diagrams (SV-1) that detail the functionality for the Airbus DS AdCoS.

5.1.2.2.2 Requirements Management

Requirements Management is a continuing process of requirements extraction, refinement and allocation throughout the Airbus DS HoliDes lifecycle. It is envisaged that this process will be complete and documented in D8.7. The high process is defined as follows:

- Requirements extraction from all HoliDes sources, primarily Word document and Excel spreadsheets
- Requirements defined in DOORS
- Manual mapping of requirements to the Airbus DS Use Cases
- Manual mapping of the Airbus DS Use Cases to Enterprise Architect and/or DOORS
- Requirements refinement and mapping to Test Scripts (to be defined in D8.7)
- Standard DOORS to EA linkage
- EA linked to DOORS via an OSLC interface

5.1.2.2.3 Metrics and Analysis

HE-Filer will be used to collect the results of analysis carried out on the AdCoS. One way to validate the AdCoS is with the use of surveys and questionnaires on participants in trials and experiments.

There are many templates for surveys and questionnaires which can gather human factors information, but they are generally paper and text based and not explicitly linked into the engineering lifecycle. These results would typically be used to modify the system to make improvements. Such improvements would likely involve modifications to the modelling which defines the system. Good systems engineering practice dictates that traceability should be preserved and this is not often the case with human factors.

With the HF Filer tool, any human factors analysis results captured during validation would be stored digitally in an open format using linked data. i.e. OSLC.

This approach would allow the results to be linked directly to the modelling tool which understood human factors analysis results using linked data. In

WP8, EA will be modified to consume human factors analysis data from the HF Filer tool

5.1.2.3 Modelling Techniques

The Airbus DS modelling techniques have been defined in the previous sections

- The Airbus Modelling Techniques – section 5.1.1.5
- Task Modelling section- section 5.1.1.6
- Architecture Frameworks DODAF – section 5.1.1.7
- Airbus addition HV – section 5.1.1.8
- The AdCoS modelling section defines the instantiation of the models/ products defined in sections 5.1.1.5 through 5.1.1.8.

5.1.2.4 AdCoS Modelling

5.1.2.4.1 Enterprise Architect Modelling

The Human Viewpoints modelled for the WP8 AdCoS comprised the Human Roles and Tasks. The roles and tasks were modelled in Enterprise Architect using an Organisational Relationships diagram OV-4.

Figure 28 shows the roles in the Airbus control room in a hierarchical format.

Figure 29, shows the system interaction diagram for the Airbus Use Cases 1 to 4. The purpose of this SV-1 diagram is to show the systems which are necessary for fulfilling the control room Use Cases 1-4 and the interactions which take place between those system components.

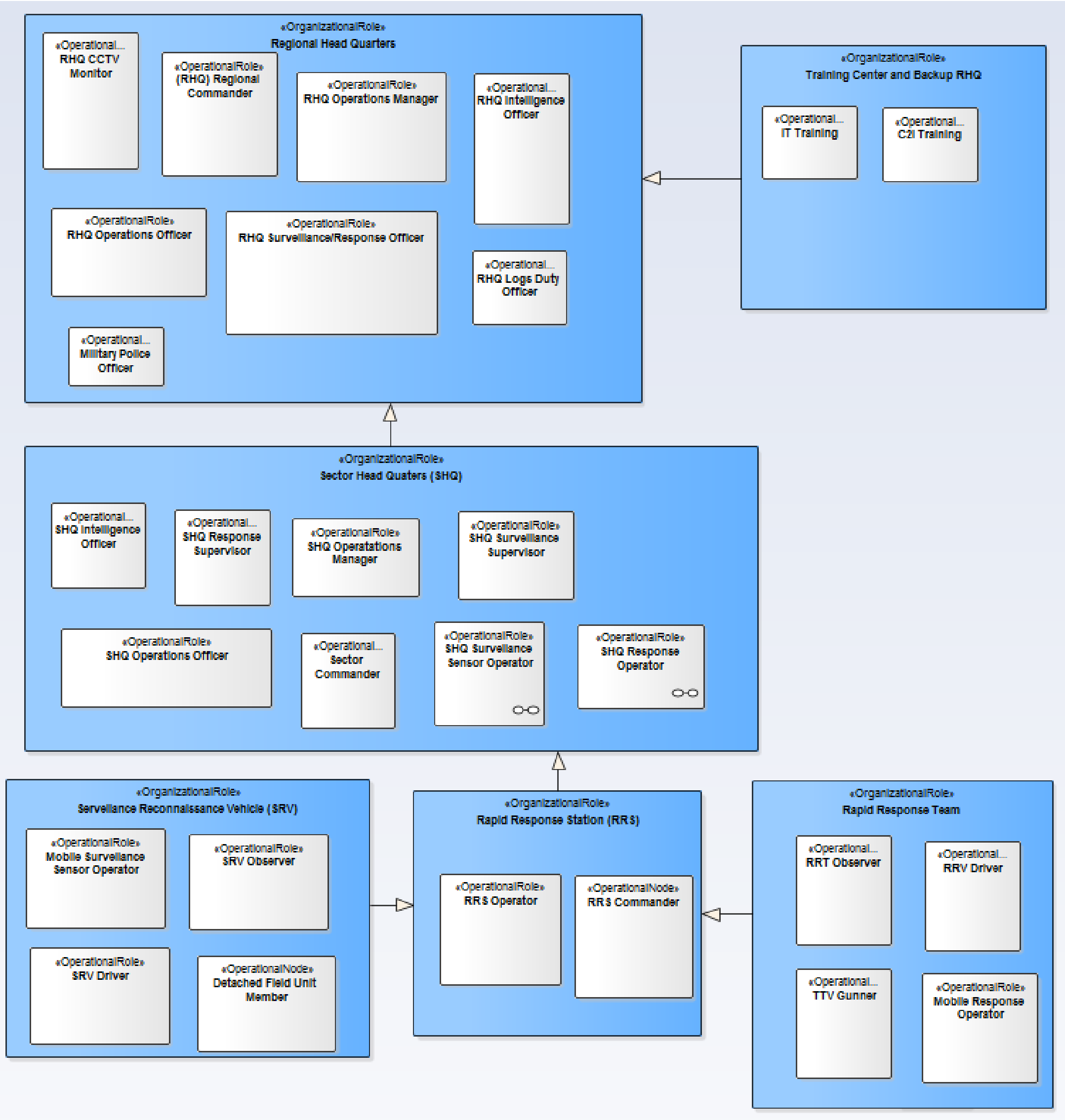


Figure 28 Organisation Relationship (OV-4) detailing Human Roles (HV-D)

Use Cases 1 to 4 comprise of 4 systems, the system sensor feeds, The C2 software system, the AdCoS demonstrator and the operators with their terminals. The AdCoS part of the system provides adaptivity in the shape of the Kinect and a Bluetooth actuator. When the Kinect hardware detects an absent or fatigued individual, the Bluetooth actuator transmits a discrete warning to the operator. If the discrete warning fails to have an effect after an arbitrary amount of time, a notification is transmitted to the operator's supervisor to prompt an investigation.

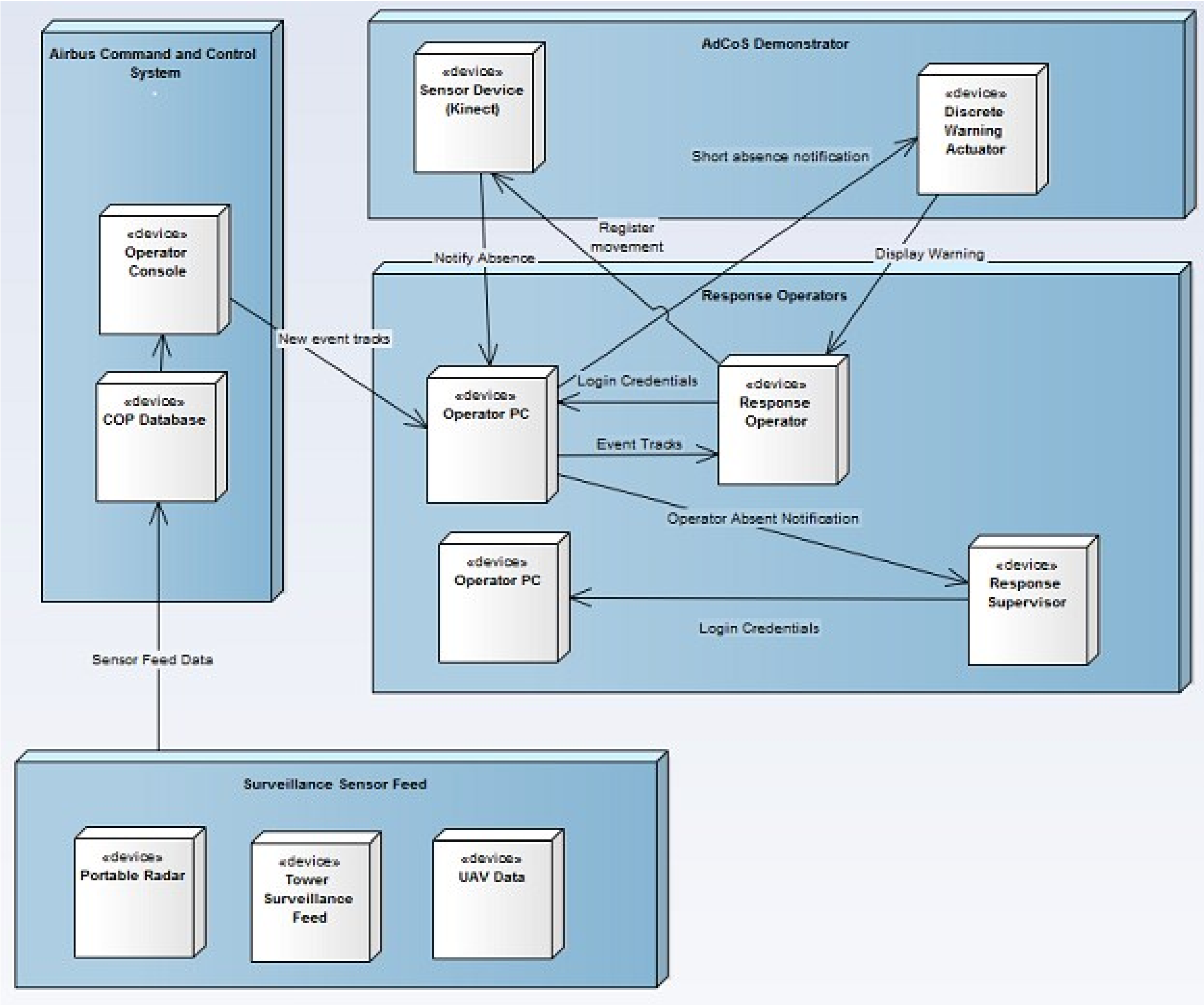


Figure 29 System Interaction Diagram (SV-1) for Use Cases 1 to 4

Figure 30 shows the interaction diagram for the system components which need to be in place to satisfy Use Case 5.

In Use Case 5 the operator is overloaded and might require assistance to deal with the quantity of new event tracks coming in. When the number of events being dealt with by an individual exceeds an arbitrary amount, the supervisor is informed through their terminal where they can assess details of the tracks that are being worked on by the response operators. If the response supervisor decides that the workload needs to be redistributed, they can accept a recommendation to pass the workload to another response operator.

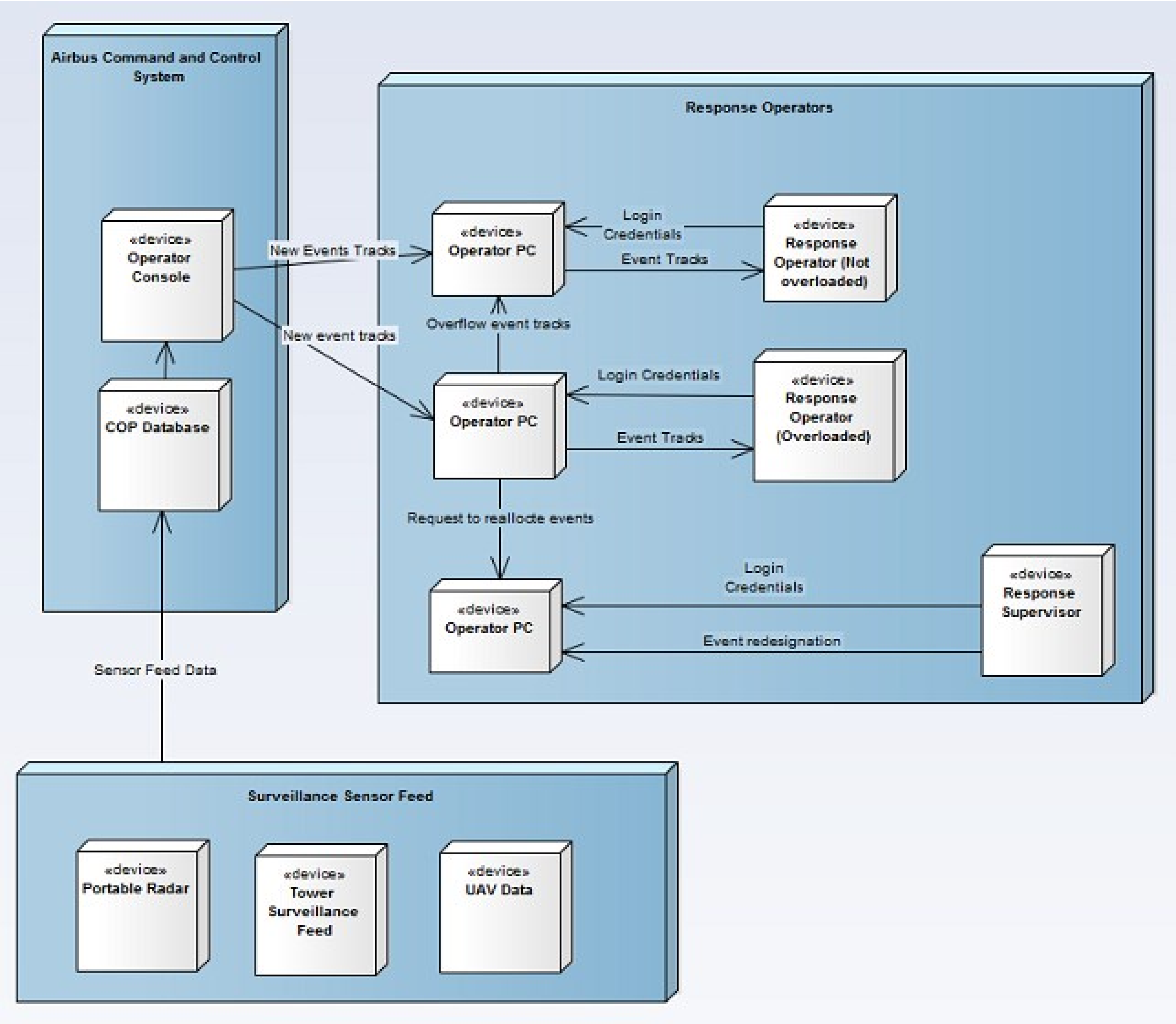


Figure 30 System Interaction Diagram (SV-1) for Use Case 5

The roles shown here pertain to all of the Use Cases listed in this document.

The Regional Headquarters sit at the top with information flowing upwards. The regional commander sits here along with the regional operations manager, regional surveillance and regional operational managers.

Under the Regional Head Quarters sits the Sector Head Quarters. The final system would have multiple Sector Head Quarters for each sector being monitored and controlled but only one is modelled here. At sector level sit the surveillance and response operator

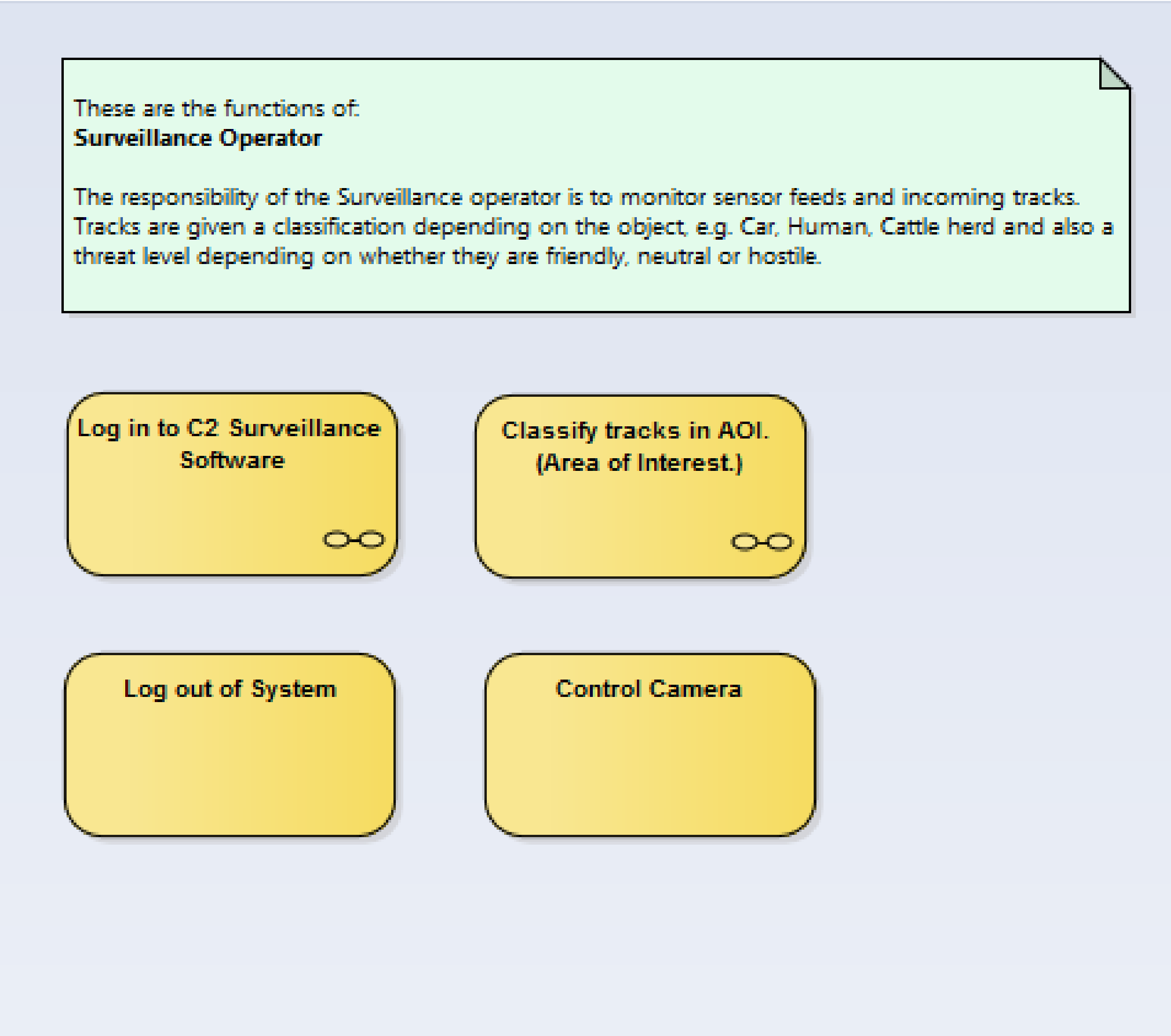


Figure 31 Surveillance Operator Function (SV-4) detailing the Operator Tasks (HV-C)

Figure 31 shows the functions of the surveillance operator role. The functions represent interactions between the surveillance operator and the Airbus Command and Control Software. Functions are broken down in to the Human View Task model.

Figure 32 shows the task involved when the operator logs in. Note that, the C2 software is the same for each role. Each role type is given an interface which is specific to the functions that they are required to perform. For this reason the task model for logging in is the same for both surveillance and response operator

Figure 32 shows the tasks taken by the surveillance operator in classifying tracks which are picked up by the radio and video sensor feeds. Classified sensors feeds are known as tracked entities or simple 'tracks', are used to update the Common Operational Picture. The COP screen is used by every role in the Airbus Command and Control centre for a clear view of situational awareness.

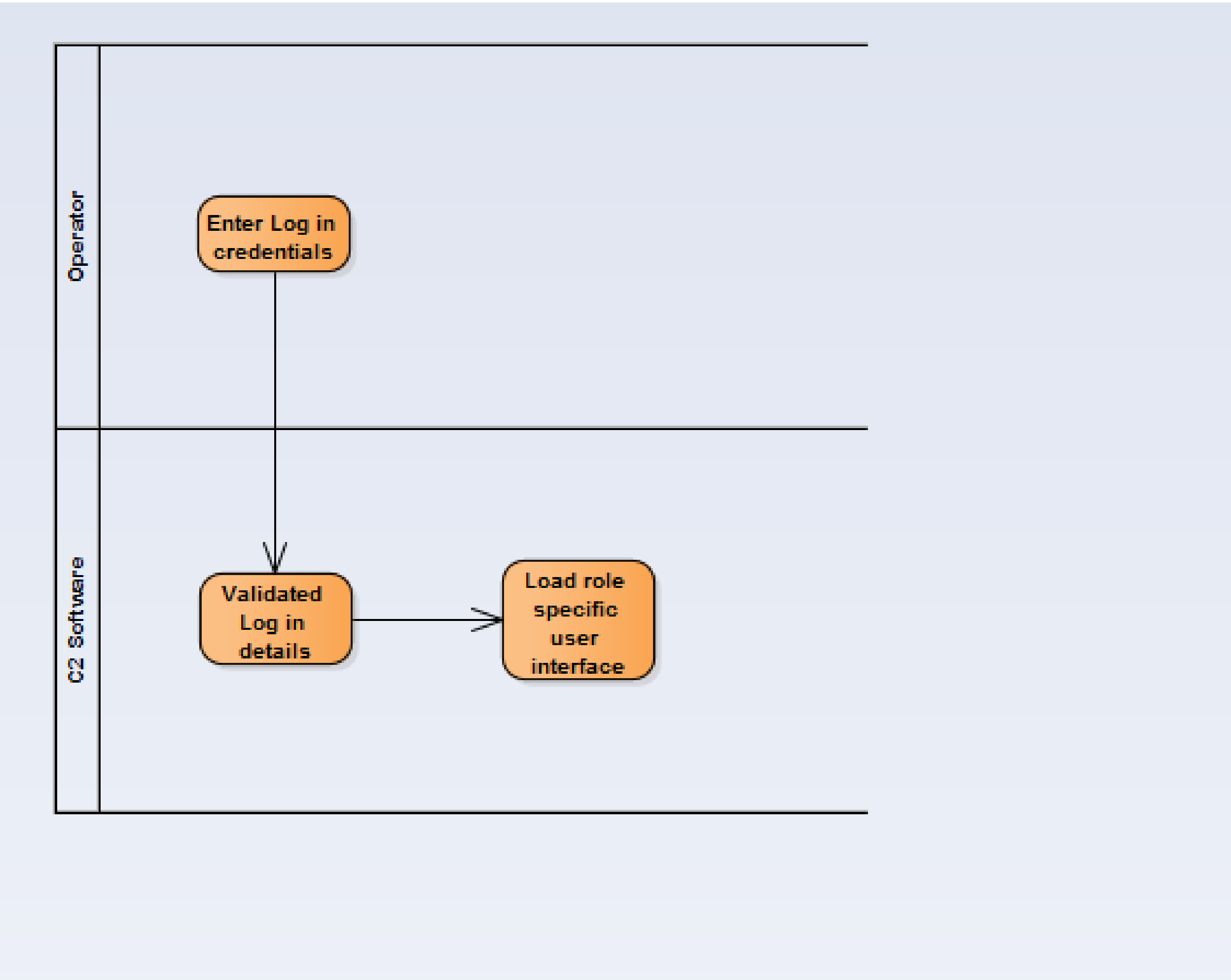


Figure 32 Task Model (HV-C) for User System Logon

After the classification of tracks, they need an appropriate response. This response is decided and monitored by the Response Operator. The functions of the Response Operator can be seen in Figure 34.

The two main functions of the response operator are to allocate events a response team if needed and to close the event following a completion of the mission.

The allocation of the response resources can be seen in Figure 35 which is Human View task model for the response operator.

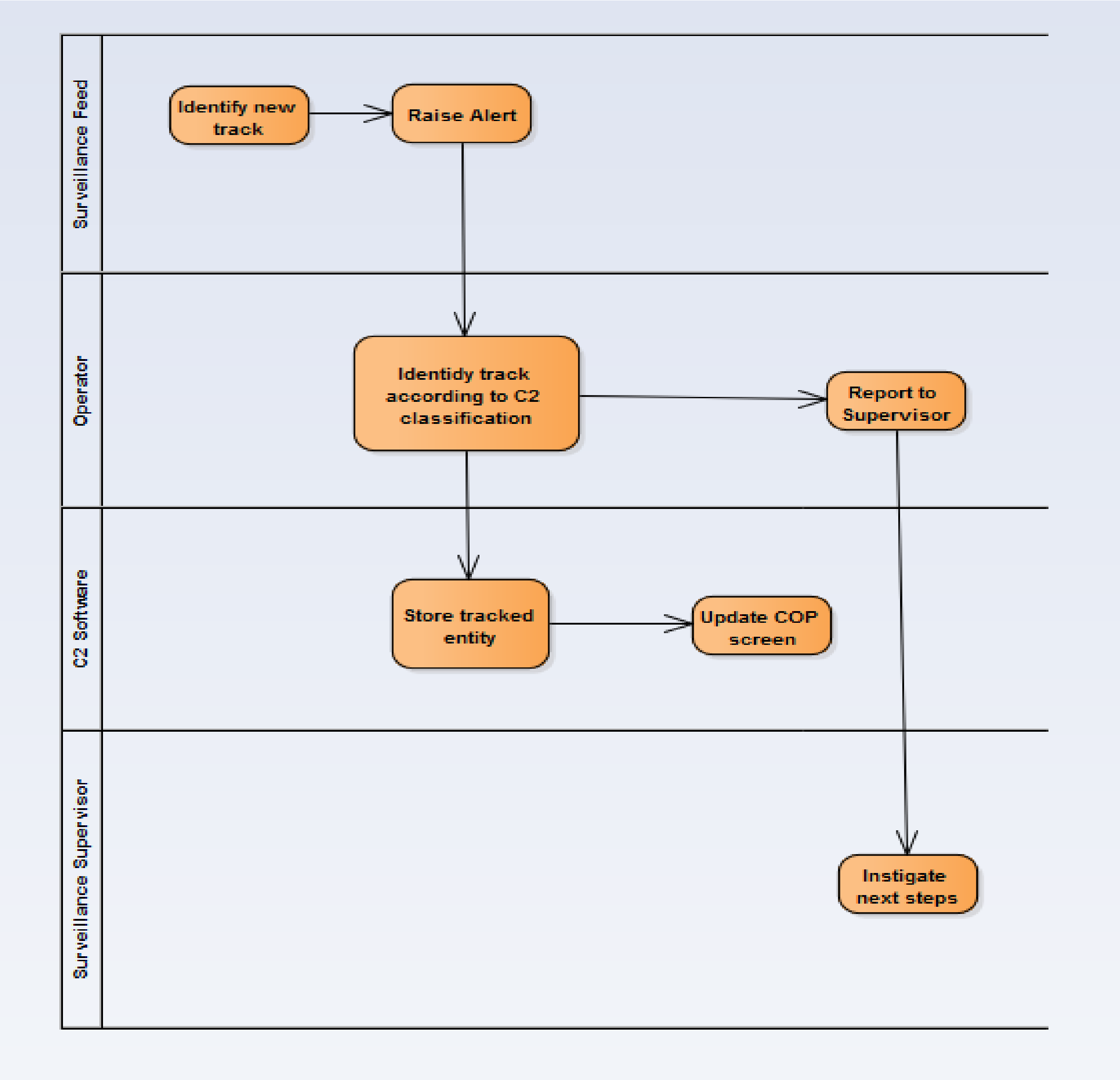


Figure 33 Task Model (HV-C) for the Surveillance Operator

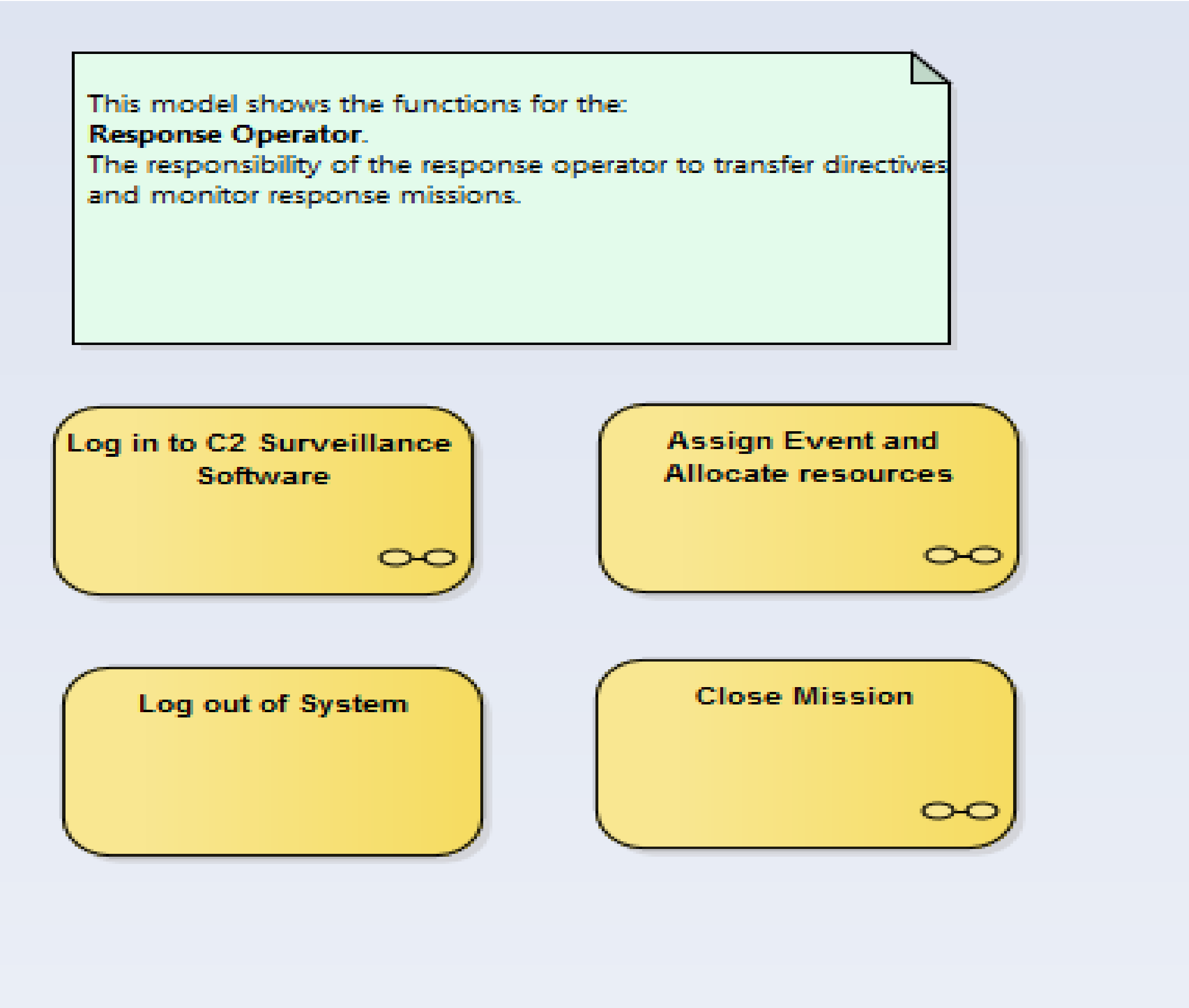


Figure 34 Response Operator Function (SV-4) detailing the Operator Tasks (HV-C)

Before a response can be determined, the event must be allocated to a response operator. This is done by the response operator themselves. Through the Airbus Command and Control software, they can view a list of unallocated events and attach their name to it. This blocks other response operators from also assigning a response and thus sending multiple response units to investigate the same event.

Following allocation, the response operator must determine which response team is best placed to conduct the investigation based on their proximity to the event and their current status. (Should they be investigating another event, their status will be listed as unavailable.)

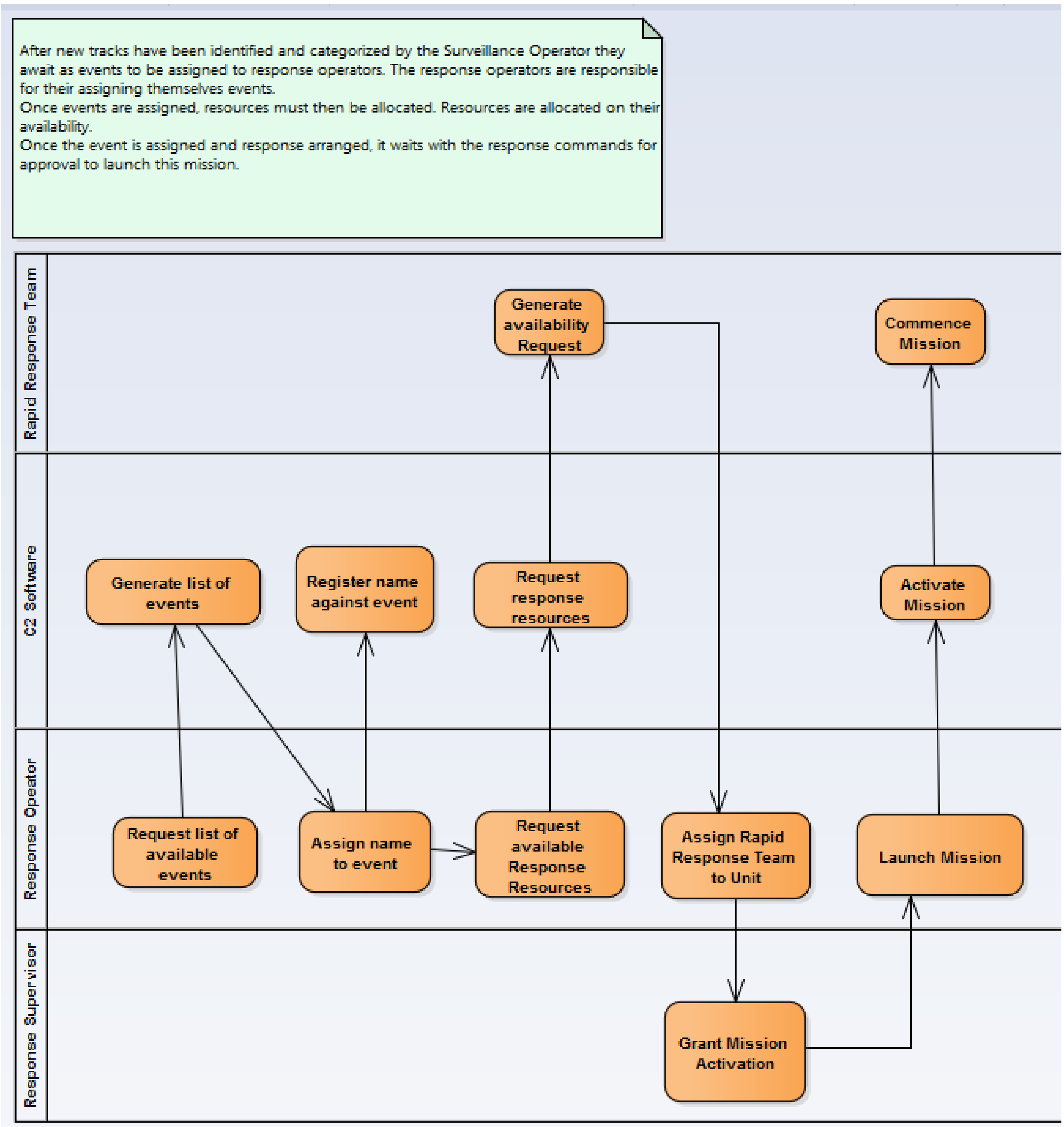


Figure 35 Task Model (HV-C) for the Response Operator responding to an event

When a response team is allocated, the response supervisor must look over the case before the mission can start. When the response supervisor is happy with the mission, the response operator gives the go ahead on the command and control software which activates the mission and releases the response team for investigation.

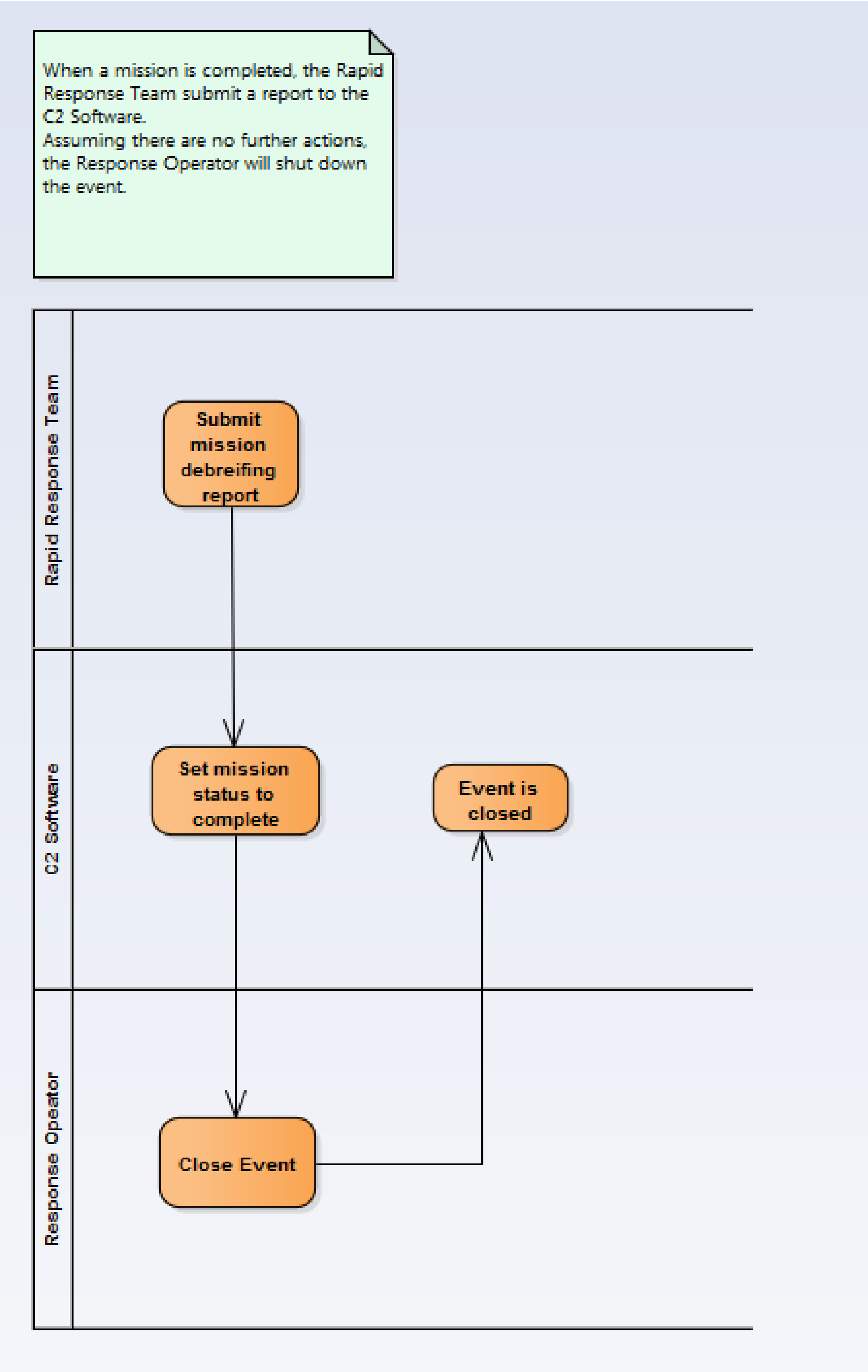


Figure 36 Task Model (HV-C) for the Response Operator completing an event

Whilst the mission is underway, the response operator follows the status on the command and control software. Following a completion, a debriefing report is sent from the Rapid Response Team. This can be seen in the Human View Task model of Figure 36.

All that remains after the report has been received is for the Response Operator to set the mission to 'complete' and close the event.

5.1.2.5 Outputs from D8.5 to D8.7 AdCoS Implementation

Section 5.1.1.10 defines the interactions and dependencies with the next WP8 delivery D8.7.

The outputs to D8.7 are defined as follows

- Initial Demonstration definition
- Use Case Models
- Architecture Framework models – the DODAF and Human Views

5.1.3 Feedback on MTTs and HF-RTP regarding AdCoS X (CO part)

Section 6.1 defines in detail the Feedback on the MTTs that are included or have been investigated for inclusion in the Airbus DS AdCoS.

5.2 IRN AdCoS (Emergency Control Room)

5.2.1 Description of the AdCoS

The energy network surveillance AdCoS consists of an Emergency Management System for the maintenance of energy distribution networks. The Call Centre receives either calls from customers who report network failures or signals from the controlled network segments which are displayed on a big screen on the Control Room wall.

As highlighted Figure 37,
the Energy Network Control AdCoS will focus on the communication between operators in the control room and Operative teams on the field (Use case no. 4) without neglecting to make reference to the collection of historical records of each emergency (Use case no. 6).

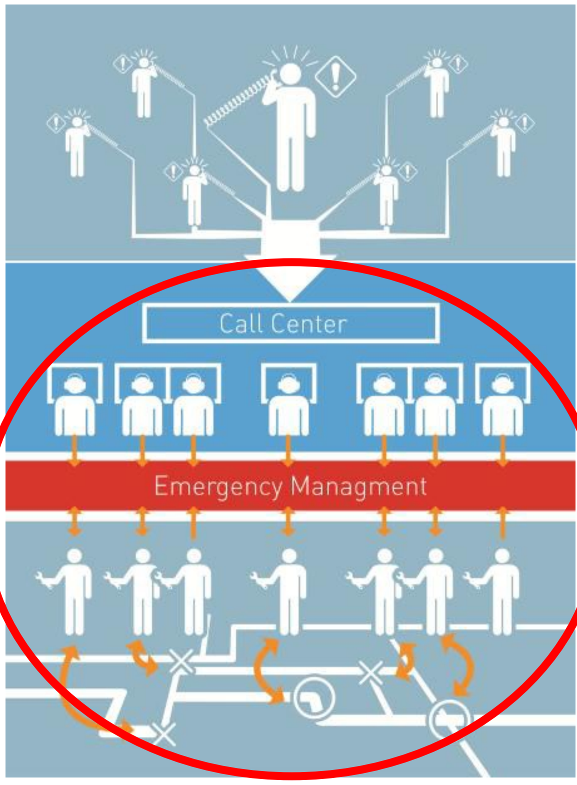


Figure 37 Energy Control Room Scenario

These use cases are summarised below.

Use Case #4: Communication between the operator and the operational teams in the field

This use case addresses a clear human factor in the Control Room. In fact, at present, the communications between the operators in the Control Room and the technicians on the field rely on phone calls and prints on remote servers to their offices (to send the key data of the intervention, such as the address and the problem on the energy network). Even though several systems have been internally developed to address this problem and try to substitute the phone calls, they have always been rejected because not considered as flexible and reliable as the phone calls.

However, this very flexible approach is extremely time consuming for the operators because it requires the engagement of the operators for the assignment of each activity and to assess it has been actually taken in charge. Moreover, the information used by the operators to identify the correct technician according to the shifts and the areas of responsibility is distributed over several documents, according to the energy service (water, electricity, gas), the zone of the intervention, the shifts (working hours, night, weekends, etc..).Therefore the allocation of tasks and responsibilities is based onto the senior experience of Control Room operators.

Use Case #6: Collection of historical information about intervention of each installation for future events

Operators must have access to historical and geographical data concerning the local area where the emergency has been signalled, in order to better understand the nature of the malfunction and to inform the technicians to be sent in place in a more effective and efficient way.

This is a crucial use case in terms of the enhancement of performance of the system as a whole. The aim is to share qualitative and quantitative information with the technicians without extending the average time of phone conversations (with the technicians in the field), to avoid the engagement of the operator for a long time. Today the Control Room is not provided with any adaptive system capable to automatically share and collect the relevant information concerning the life cycle of the emergency (if the problem was previously reported, how the problem was addressed in the past and when it was solved), in order to create a database of previous interventions and do not rely only on the know-how of each technician.

5.2.1.1 Operational definition

The aim of the AdCoS is to automatically collect and use the (so far distributed) information for the allocation of the resources (technicians) to adapt the distribution of tasks according to a set of (configurable) criteria, and automatically send this information via mobile phone by using an app to make the data available to the technicians even in mobile conditions.

Moreover, it aims to provide both the operators and the technicians in the field with historical records concerning the relevant infrastructure by automatically querying the databases once the emergency is localised. The availability of relevant and historical information (in mobility conditions) is fundamental to enable an optimal and timely understanding of the nature of the malfunction thus allowing better deployment and allocation of teams and resources on the field.

The overall goal of the AdCos is reducing the number of phone calls and the time spent by the operators on the phone with the technicians.

In particular, 2 metrics have been identified in order to evaluate the performances of the AdCos and lead the evaluation activities that will be conducted in task 8.5:

1. The AdCos shall reduce by 70% the number of phone calls made by the operators (by considering a phone call for each assignment, even though sometimes the operators makes several phone calls before assigning an activity)
2. The AdCos shall reduce by 70% the time spent by the operator on the phone with the technicians (by considering the average time of a call between the operator and the technician saved for each intervention automatically sent to the app).

5.2.1.2 The environment of the AdCoS

The environment of the overall system is graphically represented Figure 38 Environment of the Energy Network Control AdCoS

Actors:

- **Human agents:** Telecommunication (TLC) Operator, Dialer, on-field Team
- **Machine agents:** Software Genesis (to switch and store the emergency calls), software CCE (to manage the emergency calls data)

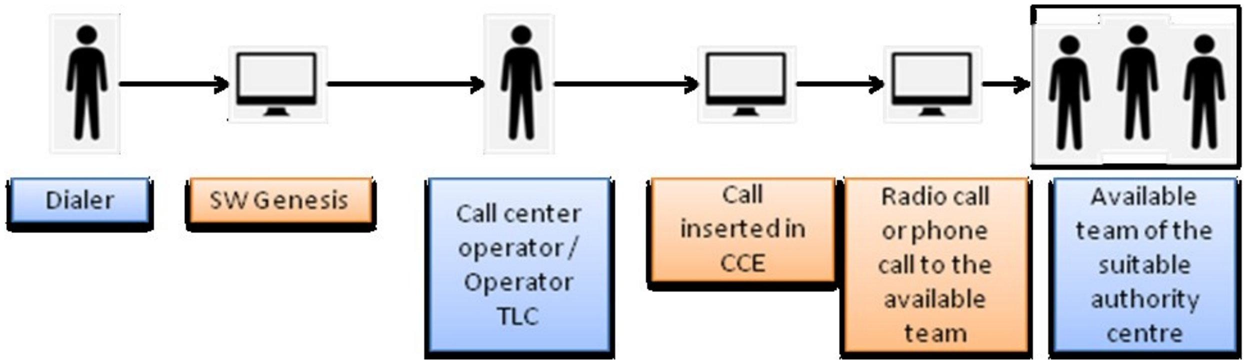
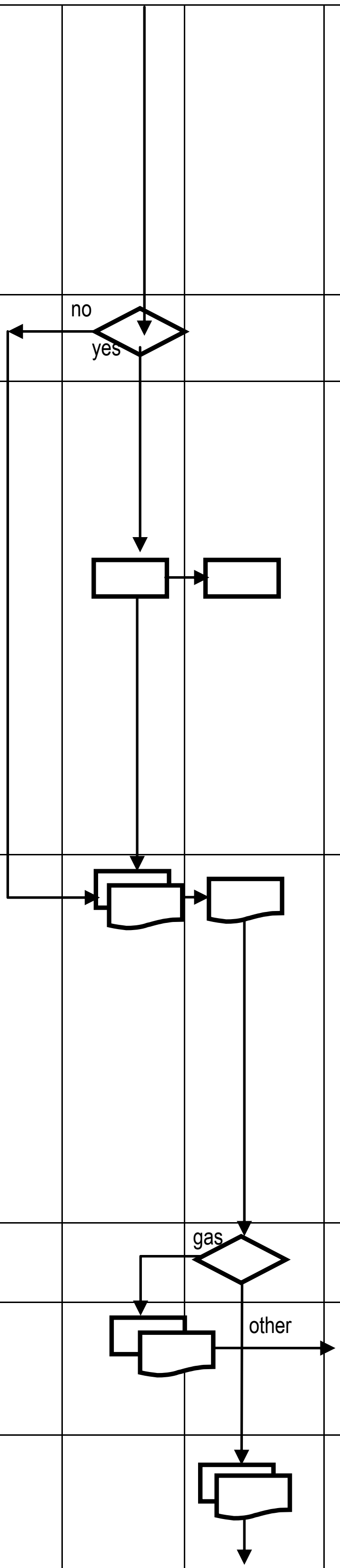


Figure 38 Environment of the Energy Network Control AdCoS

In Figure 39 the operative complete flow for the emergency calls management has been modelled.

Responsibilities / Activities	Responsible of the authority centre of electricity	Responsible of remote control and emergency call centre	Operator of tele operative room	Authority centre	Enia specialists	Users / others
1. Detection of a malfunction by one or more users (gas, water, electricity, etc.)						
2. The user calls the call-center (the "green line")						
3. The intervention request is opened and its scheduling starts						
4. The user (the dialer) gets voice-recorder instructions, in order to select the interested service/item						
5. The intervention request is received and it is queued up in the list of pending intervention for the control room						
6. Information gathering for user identification and malfunction evaluation, instruction given to the dialer to keep a safe behaviour.						
7. Does it concern IRN?			no / yes	**END**		
8. Does it concern the Emergency Call Center?			no / yes			
9. Intervention request directed to the proper authority centre.						
10. Launch of the intervention management by receiving of user ID data; malfunction description (i.e.						

call type, criticality level, etc.) timestamp (date and hour) of the referral. Automatic launch of the current commitment on database by CCE.NET.						
11. Is it critical?						
12. Launch of the emergency team of the suitable authority centre or of the attending available team, providing information got by the user. The team/ coordinator/ technical chief of the authority centre is called by mobile or radio.						
13. The contacted specialist refers about his/her own skills in solving the current problem and about the transmission time. The datasheet is printed in the authority centre.						
14. Intervention on gas network						
15. The time of the intervention on the gas network is recorded.						
16. The intervention is deleted from the pending list. Data about the						



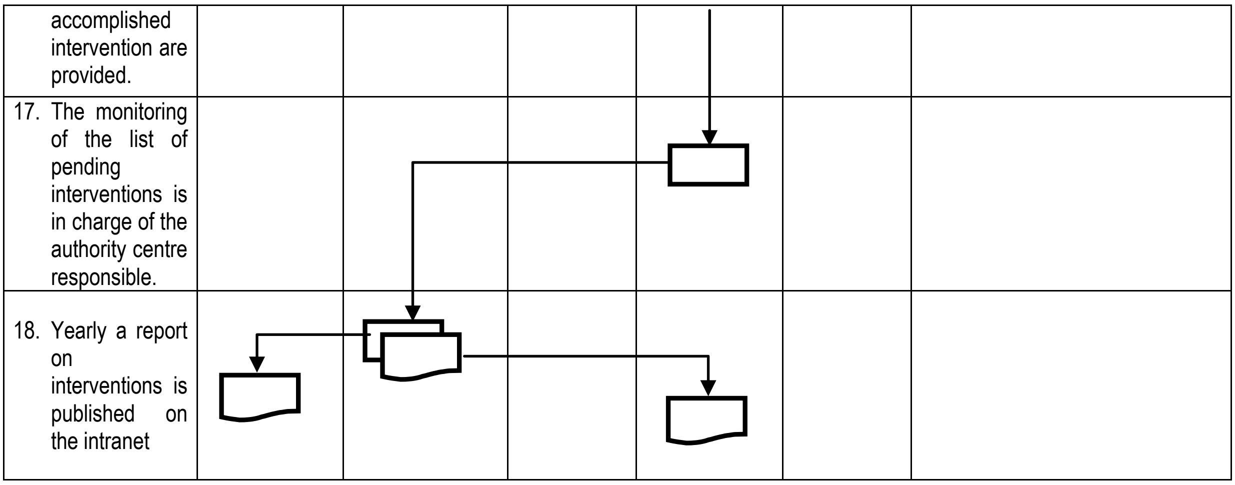


Figure 39 Modelling of the flow of the Energy Network Control AdCoS

Since the AdCoS will focus on the communication between operators in the control room and Operative teams on the field, only activities from the 9th on (i.e. from "Intervention request directed to the proper authority centre.") are considered for the app.

Controlled entity

The controlled entity of such a system is the traffic of emergency calls and the most critical passages it has to cope with are located between the Control Room Call Centre and the Operative teams on the field.

Operator of the AdCoS

The app (i.e. the AdCoS) is controlled both by the operators in the Control room and the technicians in the field, because both of them can provide inputs to the system to modify its behaviour.

Control Room provides inputs through the CCE (about the emergency, the address of the intervention and, once a new technician is operative, about his role, name and zone of intervention).

On the other way, the technicians in the field interact with the mobile app by accepting the interventions and including basic information about its status (e.g. closed).

Most of the information used by the AdCos (i.e. the app) are automatically extracted by the system from third parties software (e.g. on the on-call duty portal for the shifts of the technicians) or directly from the app (e.g.

when a technician has taken in charge an intervention, he is considered "not available" and no other intervention will be send to him until he is in that state).

External environment

The external environment is the real conditions the technicians work in: in fact, the number of emergency can suddenly increase in a specific zone, or a technician can be involved in an extremely time-consuming intervention that makes him unavailable for the whole day.
These conditions already affect the performance of the overall system, and must be taken into consideration when developing the app.

5.2.1.3 Modelling techniques employed

Two techniques will be used to model different parts of the Energy Control Room AdCos: the task modelling and the Petri Nets.

The task modelling will be used to define the interactions between the operators in the control room and the technicians in the field, in order to understand the critical issues that may affect the communication as well as the performance of the overall system.

A Petri Net is a directed bipartite graph, in which the nodes represent transitions (i.e. events that may occur, signified by bars) and places (i.e. conditions, signified by circles). The directed arcs describe which places are pre- and/or post conditions for which transitions (signified by arrows).

The Petri Net technique has been selected because its execution is nondeterministic: when multiple transitions are enabled at the same time, any one of them may fire. Since firing is nondeterministic, and multiple tokens may be present anywhere in the net (even in the same place), Petri nets are well suited for modelling the concurrent behaviour of distributed systems.

The Petri Nets will be employed to model the distributed yet finite state machine that compose the AdCoS and in particular the transitions between a state and the others. Once the model will be completed, it will be used to fire all transitions and simulate the behaviour of the AdCoS in critical in normal and critical conditions (e.g. when the number of emergency calls increases) to define the operability conditions of the app, and assess its reliability in those conditions.

5.2.1.4 Input to the modelling process from other work packages

Figure 40 shows all MTTs selected for the development of the AdCoS.

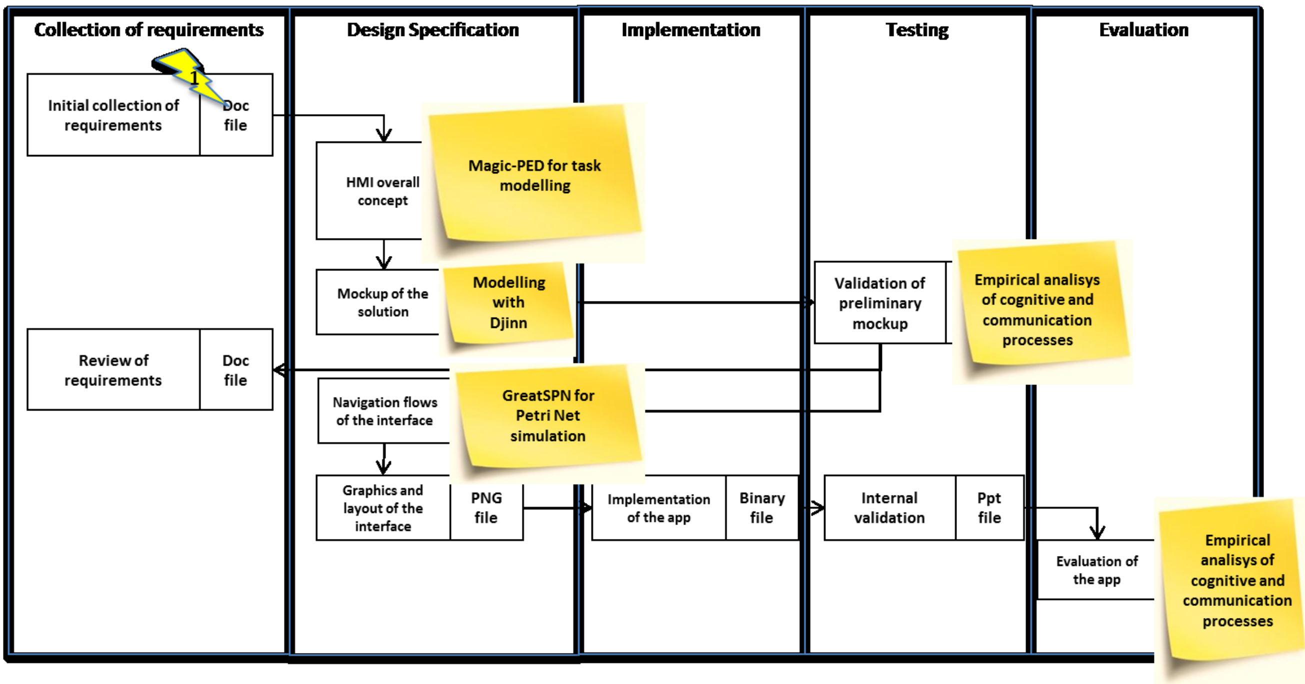


Figure 40 Selection of MTTs to improve the development process of the HMI

According to the development process described in Figure 40 Selection of MTTs to improve the development process of the HMI, two MTTs will be employed for the modelling of the AdCoS: the Magic-PED (OFF) and the GreatSPN.

The Magic-PED will be used to perform the task modelling of the interactions between the operators in the control room and the technicians in the field.

The GreatSPN will be employed to check if it can effectively simulate the navigation flows and evaluate the performance of the app when the number of requests from the operators suddenly increases (to simulate an emergency with a great number of interventions to be assigned to the technicians). The GreatSPN is based on the Petri Nets techniques.

Figure 41 shows the interactions with the other scientific WPs for the modelling of the AdCoS.

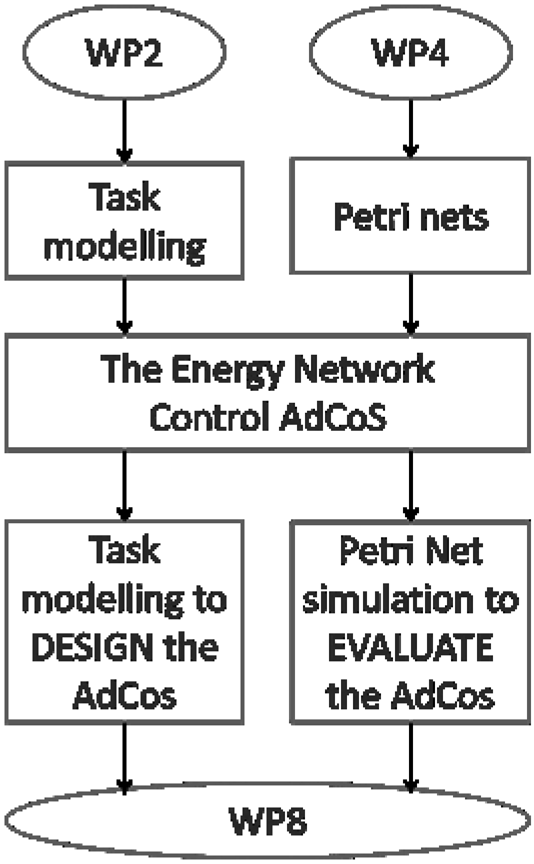


Figure 41 Flow of modelling MTTs related to the Energy Network Control AdCoS

5.2.2 The model

In order to start modelling the AdCoS with the techniques provided by WP2 (Magic-PED) and WP4 (GreatSPN), a preliminary model has been defined, in order to turn this information into the suitable models.

Figure 42 Model of the interaction between the Operators, the actual system and technicians in the field and Figure 43 Model of the interaction between the Operators, the app (AdCoS) and technicians in the field then represent respectively the model of the interaction between the operators, the actual system and technicians in the field and the interactions when the app will be introduced.

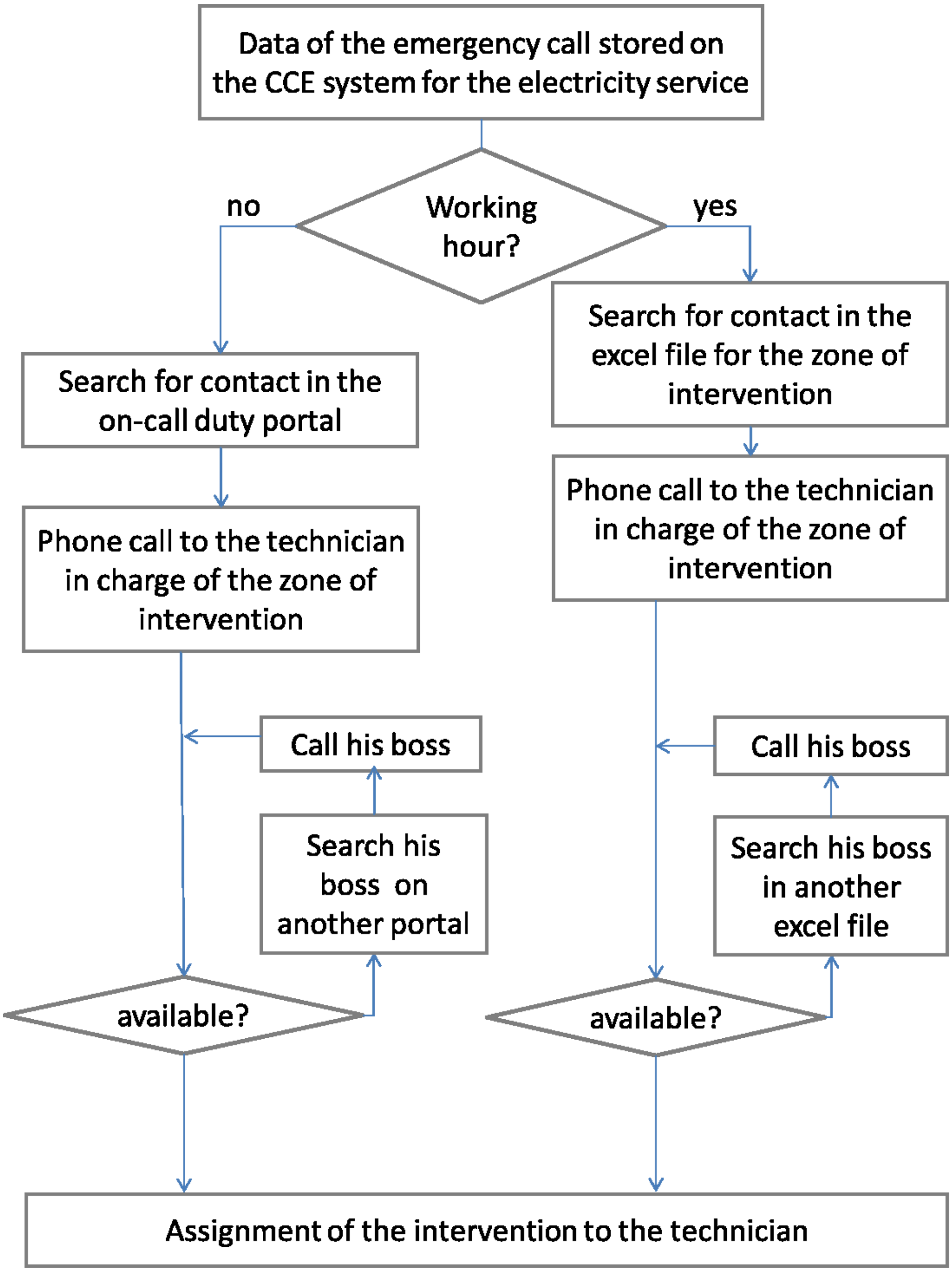


Figure 42 Model of the interaction between the Operators, the actual system and technicians in the field

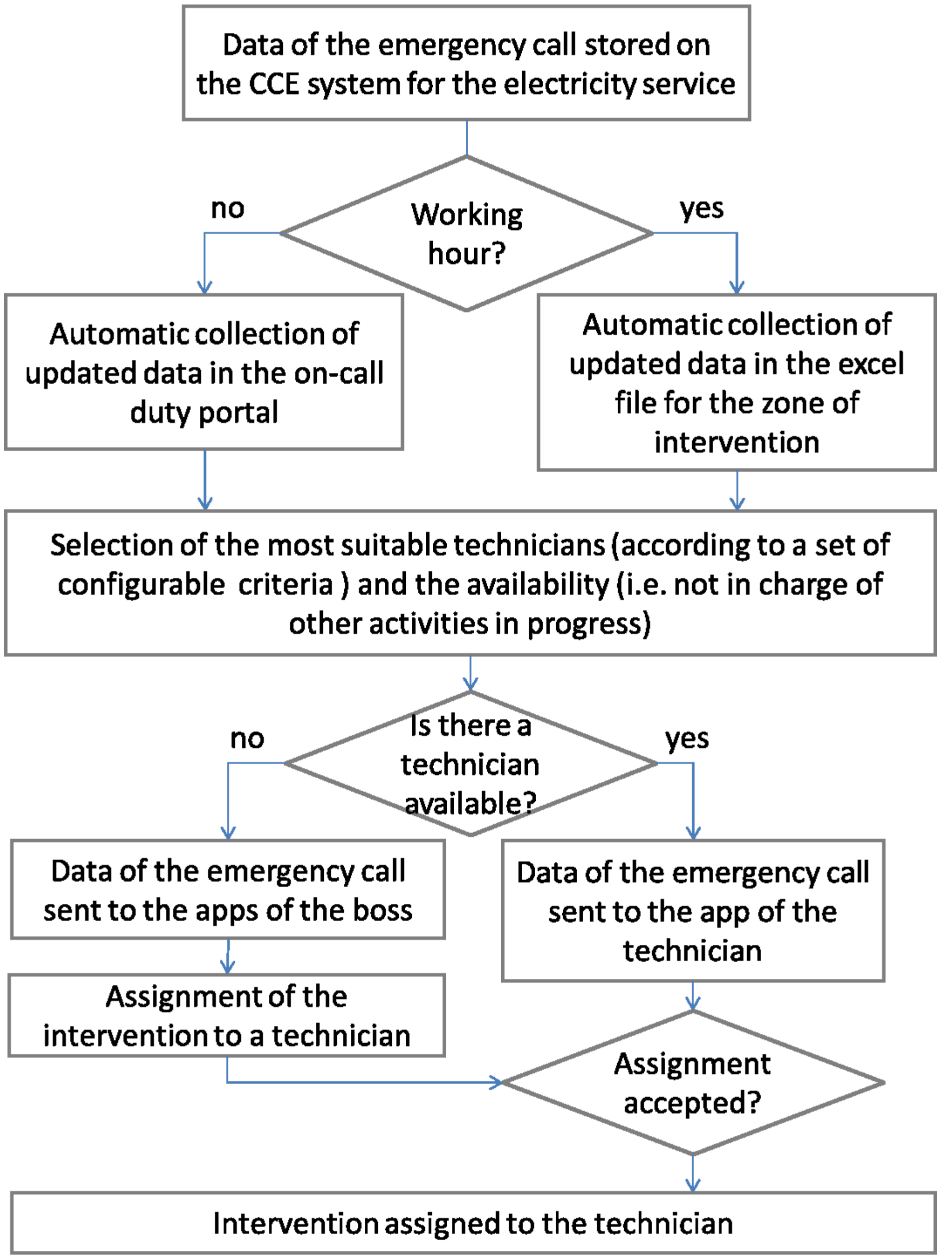


Figure 43 Model of the interaction between the Operators, the app (AdCoS) and technicians in the field

5.2.3 Feedback on MTTs and HF-RTP regarding the Energy Network Control AdCoS (CO part)

As regards the Magic-PED, it should provide a flexible and intuitive environment to define the tasks of the operators and the technicians and specific fields to (manually) assign an average duration of each task in order to automatically identify the most critical tasks (in terms of time) to be addressed to improve the performance of the overall system.

As regards the GreatSPN, it should allow the evaluation of the AdCoS by simulating normal as well as extreme conditions that could not be tested in the real environment (e.g. more than 100 intervention in 1 hour).

6 General feedback on MTTs and the HF-RTP regarding modelling of AdCoS in the Control Room domain (CO part)

The feedback on the Control Room MTTs can be found in the separate document - confidential Annex I.

7 Conclusions

As stated in the previous sections the model based approaches used by Airbus and IRN/REL, while dis-similar in nature, have come to common conclusions in terms of how we have modelled the AdCoS: the models have given us a good insight into the behaviour of the each AdCoS.

We have used different MTTs but we have achieved the same objective in applying a model-based approach for the representation of the each AdCoS

This information for the further development of each AdCoS will continue in D8.6 which is an update to the HF-RTP and deliverable D8.7 which will define each AdCoS demonstration. However the models developed for this deliverable will be used to provide input for the initial AdCoS demonstration that is planned to take place in conjunction with the next HoliDes Technical Meeting in November at Philips in the Netherlands.

Common conclusions can be found in the DX.5 Annex and the Cross domain commonalities and commonalities in the use of models and design and the development process can be found in document 6.6-7.5-8.5-9.5-Common Annex.