TITAN
Turnaround **I**ntegration in **T**rajectory **A**nd **N**etwork

Project Number: 233690

Validation Strategy

CLASSIFICATION: PU **ISSUE:** 1.0 **DATE:** 12/07/2011

DOCUMENT REFERENCE				
Project	**Work Package**	**Partner**	**Nature**	**Number**
TITAN	WP3	ISD	DEL	01

Project co-funded by the European Commission and TITAN consortium.

DOCUMENT CONTROL			
Responsible	**Organisation**	**Name**	**Date**
Author	ISD	Martijn Koolloos / Izaro Etxebarria	14/02/2011
Partners involved	CRI	Eva Puntero / Nicolás Suarez	23/12/2010
Reviewer	ISD, INE, RWT	Vicente Bordón, Laura Serrano, Sebastian Kellner	23/12/2010
Approver	INE	Laura Serrano	16/02/2011

DOCUMENT CHANGE LOG			
Issue	**Date**	**Author**	**Affected Sections / Comments**
v0.1	15/10/2010	ISD	Creation draft document.
v0.2	25/10/2010	ISD/CRI/INE/RWT	Section1.4, 2, 3, 4 and 5.
v0.3	23/12/2010	ISD/CRI	All sections
v0.4	16/02/2011	ISD	All sections after INE / ISD review
V1.0	12/07/2011	INE	All sections

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EXECUTIVE SUMMARY

This document describes the Validation Strategy of the TITAN project. It explains how validation is managed within the TITAN project to provide a consistent validation approach based on the application of the European Operational Concept Validation Methodology (E-OCVM) and aligned with SESAR.

The purpose of this validation strategy is to consider the project objectives, the operational concept, the project timescale and resources and the stakeholders' expectations and to establish from these inputs the validation objectives, the lifecycle maturity of the concept and applicable transition criteria, the validation requirements and a high level exercises planning in terms of the tools and techniques to be used.

The Validation Strategy is completed by a global description of the validation scenarios to be used and the initial assumptions for the validation activities.

1. INTRODUCTION

1.1 Purpose of the document

The TITAN project (Turnaround Integration in Trajectory and Network) is aimed at enhancing the efficiency, predictability, cost efficiency and flexibility of operations by improving the turnaround process [1]. This document describes the development of a validation strategy for the TITAN project, ensuring hence a clear and shared interpretation of the TITAN Concept, a common approach to the process of validation and a common framework of performance and measurement.

Following the European Operational Concept Validation Methodology (E-OCVM [2][1]), the purpose of a validation strategy is to consider the project objectives, the operational concept, the project timescale and resources and the stakeholders' expectations and to establish from these inputs:

- the validation objectives;
- the lifecycle maturity of the concept;
- a high level exercises planning.

1.2 Intended audience

This public document, which may be distributed freely, is intended to explain the basis of the planned validation process in TITAN for all TITAN partners involved in validation activities, and to those outside TITAN who are engaged in validation processes, especially at the airport side.

1.3 Document Structure

Chapter 2 of this document describes the scope of the Validation Approach in terms of the stakeholders' expectations, the TITAN objectives, the operational concept, and the project timescale and resources. Chapter 3 summarizes the TITAN Performance Framework and chapter 4 presents the Validation Objectives, Lifecycle considerations (current maturity and transition criteria) and the identification of the validation exercises and associated tools / techniques.

1.4 References

[1] TITAN Annex 1 Version 0.4, September 2009

[2] The European Operational Concept Validation Methodology (E-OCVM), EUROCONTROL, version 3, February 2010

[3] TITAN D1.1 “Analysis of the current situation”, SLOT Consulting, version 1.0, May 2010

[4] TITAN D1.2 “High Level User Requirements”, SLOT Consulting, version 1.0, October 2010

[5] TITAN D1.3 “Performance Framework”, Isdefe, Version 1.0, October 2010

[6] TITAN D1.4 “Operational Concept Document (Issue 1)”, INECO, Version 1.0, October 2010

[7] TITAN D7.7 “Report on Stakeholder's needs Workshop”, INECO, Version 1.0, May 2010

1.5 Acronyms

AIBT	Actual In-Block Time
ANSP	Air Navigation Service Provider
AOBT	Actual Off-Block Time
APOC	Airport Operations Centre
ASAT	Actual Start-up Approval Time
ATA	Actual Time of Arrival
ATOT	Actual Take-Off Time
ATC	Air Traffic Control
ATM	Air Traffic Management
ATTT	Actual Time To Turnaround
BT	Business Trajectory
CDM	Collaborative Decision Making
CFMU	Central Flow Management Unit
CLM	Concept Lifecycle Model
DPI	Departure Planning Information
EAEA	European ATM Enterprise Architecture
E-OCVM	European Operational Concept Validation Methodology
ETA	Estimated Time of Arrival
ETTT	Estimated Time To Turnaround
FUM	Flight Update Message
GH	Ground Handler
GSE	Ground Service Equipment
HIL	Human-In-the-Loop
IT	Information Technology
LDM	Local Data Manager
PFIS	Passenger Flow Information System
R&D	Research & Development
RBT	Reference Business Trajectory
RFID	Radio Frequency Identification
SOBT	Scheduled Off Block Time
SWIM	System Wide Information Management
TIS	TITAN Information Sharing
TOBT	Target Off-Block Time
TSAT	Target Start-up Approval Time

TSSD	Turnaround Service Sequence Diagram
VTT	Variable Taxi Time

2. SCOPE OF THE VALIDATION

2.1 The turnaround process

The current turnaround process is described in detail in D1.1 [3] and is summarized here in order to set the scope for the validation process. The turnaround of an aircraft comprises the set of services required from the moment the aircraft arrives at its stand (AIBT – Actual In-Block Time) until the time it leaves it (AOBT – Actual Off-Block Time). Many organisations are involved in the turnaround making it a complex operation with a large potential for inefficiencies.

The turnaround time, defined as the difference between AOBT and AIBT (see Figure 1), is also known as gate occupancy time as it directly affects the number of aircraft that can use a gate over the course of the day. It also affects the number of flights that can be performed by an aircraft per day. Typical aircraft turnaround times for passenger carriers range from twenty minutes to three hours.

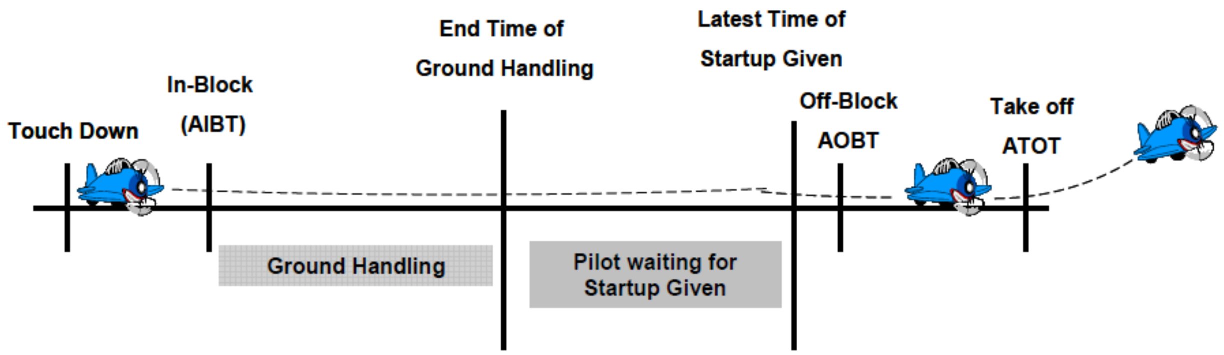

Figure 1: Typical Turnaround times

The turnaround process includes a set of operations that are performed in a sequential way and must be coordinated to optimize the process without affecting negatively the target off-block time. The scheduled turnaround time mainly depends on:

- The size of aircraft: bigger aircraft require longer turnaround times;
- The itinerary of aircraft: (short-haul or long haul). Short-haul flights are operated with higher frequency than long haul; long-haul flights require longer pre-flight servicing time;
- The number of passengers;
- The volume of cargo to be loaded and unloaded;
- Company operating strategy: some airlines plan a greater time buffer for turnaround into their schedule to help manage the effects of delays.

2.2 Current bottlenecks and shortcomings

The origin of airport delays is mainly related to the inefficiency of daily airport operations and the non-availability of reliable information [6]. All airport partners lack current global situational awareness due to inadequate information sharing or fragmented information flows.

Furthermore, according to the SESAR Definition Phase, the main shortcomings of the turnaround process are the lack of integration of turnaround in overall planning process and the deficiencies in passenger and baggage process (check-in, screening, border control, boarding, etc.).

Possible reasons for airport turnaround delays are:

1. Lack of information sharing:

   Currently ANSP's, Airports and Airlines use different planning data, do not share a common view of aircraft evolution and take their decisions based on different performance data, in spite of managing a single, unique set of aircraft. There is no single partner that has the complete picture: the information systems of the various partners have been developed and built independently.

   During the execution phase, overall poor information sharing and management prevents efficient coordination between all stakeholders resulting in a less effective use of available assets and therefore increasing the hidden costs to the airspace users in the form of operational inefficiencies, such as a non-optimised turnaround process.

2. Deviations from the original planning and unexpected events:

   The turnaround is an optimised process by each stakeholder involved. They optimise their resources to perform their tasks in the agreed time. Delays arise when a deviation from the original schedule occurs, mainly because of the unavailability of required equipment of staff which may lead to a chain reaction of delays. Deviations refer not only to delays, but also to early arrivals. Early arrival is not always desirable as it could cause blockage or contention for resources.

   The turnaround process can be considered as a dense network of direct and indirect related activities. A conflict in one of these activities (see D1.1 [3] for a detailed list of possible conflicts that can occur during the turnaround) can therefore readily result in a general turnaround delay.

   Passengers' behaviour could also be considered within the category of unexpected events as their behaviour cannot be predicted either inside or outside the aircraft. Their late arrival to the boarding gate could cause delays due to the short reactionary time and could be caused by different external factors, such as late arrival to the airport, long queues in the security processes or misreading of the boarding time.

2.3 The TITAN Vision

TITAN ConOps [6] is an advanced operational concept for the turnaround as an integral part of the aircraft trajectory, taking into account also the relevant landside processes and based on the principles of Collaborative Decision Making and System Wide Information Management. The concept aims to increase the predictability of the turnaround and enhance the situational awareness of the stakeholders involved. As a direct consequence of the increase in predictability and the situational awareness enhancement, both the efficiency and the cost effectiveness of the operations performed by all actors involved will also be improved.

More specifically, the following **performance targets** were defined for the TITAN concept [1]:

- Increase of **predictability**: reduction of the standard deviation of the turnaround process time to 3 minutes;
- Increase of **efficiency** of airline operations (punctuality): reduction of the total number of delayed flights by 9%;
- Increase of **cost effectiveness**: reduction of operational costs during the turnaround process by 20%.

2.4 Stakeholders identification and their needs

The principal stakeholder groups involved in the current turnaround process are the following:

- Airline;
- Ground handler (GH);
- Air Navigation Service Provider (ANSP);
- Airport operator.

In addition, there are a number of indirect stakeholder groups such as the authorities that regulate certain aspects of the airports, the Central Flow Management Unit (CFMU), security and immigration staff, fuel companies and meteorological services. The performance of those stakeholders has a direct impact on the turnaround process execution so they should be also considered when assessing stakeholders' needs.

The stakeholders' needs were collected through a workshop in Brussels (on the 17th of March 2010, [7]) and several questionnaires and personnel interviews. The information was analysed and reported in a "Users Requirements" document [4], which served as an input for the definition of the TITAN Operational Concept [6][6].

It was concluded that there is an urgent need for turnaround related Information Sharing. Accordingly, the main outcome of the above mentioned workshop was the future information needs of the stakeholders. Table 1[4] summarizes these needs.

Stakeholder	Future information needs
Airline	Accurate Target Off-Block Time (TOBT) Arrival time and stand of arriving transfer passengers Passenger movement
ANSP	Modification of flight plan Resource allocation Target Start-up Approval Time (TSAT) Actual Start-up Approval Time (ASAT) Target Off-Block Time and its updates Variable Taxi Time (VTT) Holdover time
Ground Handler	Passenger movement improvement of the process of monitoring ground handling resources and activities
Airport Operator	Location of passengers (RFID information)
CFMU	Flight Update Messages (FUM)
Immigration	Information on restrictions
Fuel Company	Availability of trucks/staff Quantity of fuel in each truck; Location of trucks
Meteorological Service	
Other	More information on the moduling: connection of the services, interrelation between the services

Table 1: Stakeholder's future information needs

In addition, the stakeholders expressed their ideas regarding the changes that would improve the efficiency of the turnaround process:

- Better information exchange required to be reached by:
  - Application of CDM mentality;
  - Encouraging different actors involved to collaborate and to share information;
  - Sharing of the actual information in an integrated central database;
  - Increase communication between ANSP and Handling Agent during arrival and departure;
  - More up-to-date information about gate allocation:
- Development of the information systems is needed:
  - Unification of mandatory shared information;
  - Automated decision making in some of the services;
  - Common interfaces for each stakeholder;
  - Standardization of different information systems;
  - Easier access to the information (hand held) for the actors;
- Use of GPS systems to monitor resources, such as passengers buses or containers (ULDs);
- More accurate and updated information regarding passenger monitoring including information about disabled passengers.

2.5 Alignment with SESAR

The TITAN concept can be seen as enablers for and facilitators of the achievement of the SESAR Airport CDM objectives by building on a net-centric design principle, using trajectory based operations as the means to integrate airports into the ATM network, defining services that act on the processes that are the subject of analysis and making use of CDM and SWIM principles. This approach is aligned to that used in SESAR, but limited to turnaround operations.

Furthermore, the TITAN performance targets (see section 2.3) contribute to the SESAR key performance target of cutting the ATM unit costs by 50% per flight.

Finally, an important feature of Airport CDM as defined by SESAR are the so-called A-CDM Milestones and there associated alert messages [6]. This concept element is incorporated in the TITAN concept.

2.6 TITAN solution

The proposed TITAN solution is described in the ConOps document [6] which develops the new advanced operational concept for the turnaround process aimed to improve predictability, flexibility, efficiency, cost effectiveness and to provide a common situational awareness to those actors involved in the process. The scope is limited to the sequence of ground operations required to service the aircraft in the turnaround from the in-block to the off-block time as well as those external services which have a direct influence on it.

The Concept of Operations is expressed in a process-based, service-oriented way based on principles like net-centricity, information management or collaborative decision making. It describes how the turnaround process will be performed from different perspectives by identifying functions and processes, and their corresponding interactions and information flows; concerned actors, their roles and responsibilities.

Regarding processes, main focus is on landside processes and their link with airside ones, a description of how to track passenger and baggage flow is addressed among others. Also common and off-airport processes are considered to ensure an extended handling view by including processes hitherto not, or not fully, considered in the Collaborative Decision Making view.

In order to be executed, those processes require various services which, in turn, support end-user applications that are the operational interface to the outside world (for humans) or to external environments without human intervention. Services in the TITAN concept of operation context include both operational and supporting services but exclude technical/IT services. As an application of those services, TITAN collects technical performance data as well as data on planned and actually performed trajectories, warnings (time issued and time in advance), actions, etc. The aim is to provide sufficient data to end-user applications that generate performance information for the different partners, including trends and problem source analyses.

TITAN is aligned with and complements A-CDM through a better management of the turnaround. To this aim, TITAN will use the procedures and rules established for A-CDM supplemented by those developed for the turnaround. Besides A-CDM milestones, a set of specific turnaround milestones have been defined to support the monitoring of the turnaround process progress. Milestones are significant events that occur during the planning or progress of the aircraft trajectory and may have an impact on coming events aimed to link the air and landside, improve current information flows and predict forthcoming events.

3. PERFORMANCE FRAMEWORK

3.1 Background

The Performance Framework details what should be measured during the validation exercises and how these measurements are related to the project objectives. It is composed of different layers with increasing level of granularity.

- **Key Performance Area (KPA)** provides a way to categorise performances related to high level ambitions and expectations. The KPAs will be identified from the KPAs defined by SESAR Safety, Capacity, Efficiency, Flexibility, Security, Environmental Sustainability, Cost Effectiveness, Predictability, Access / Equity, Participation and Interoperability.
- **Focus Area** identifies within each KPA a number of more specific areas in which there are potential intentions to establish performance management. For example, within the Capacity KPA one can identify airport capacity, airspace capacity and network capacity as Focus Areas. Within each Main Focus Area, a number of Lower Level Focus Areas may also be defined.
- **Performance Driver** describes how the objective can be achieved within each focus area corresponding to a specific Key Performance Area.
- **Key Performance Indicators** identifies what information must be obtained to reach the performance objectives previously defined. These indicators quantitatively describe the performance of the turnaround process to address a specific performance driver within a focus area related to a Key Performance Area. KPIs are also defined according to the performance objectives defined within the project. Normally, KPIs are not directly measured but calculated from supporting performance measurements according to clearly defined formulas. They will be defined at the end of the performance framework definition.
- **Performance Measurement** identifies how the measurement of each KPI is performed. In other words, they describe how the KPIs are calculated/obtained

Based on the project performance targets, the Performance Framework [5] has identified the following KPAs that are addressed by the TITAN concept:

- Predictability
- Efficiency
- Cost-effectiveness
- Flexibility

Validation of the TITAN concept is about demonstrating that incorporating the user requirements and SESAR alignment mentioned in chapter 2 in the concept will contribute to a performance improvement in these key areas.

3.2 Assessment related KPAs

For each KPA, the Performance Framework has identified the sub-layers mentioned above. The following tables show the KPIs and corresponding performance measurements which will be used to assess the concept performance targets and therefore validate the concept. The Performance Framework has defined more KPIs but these will be used to monitor and evaluate the turnaround process in order to provide feedback (recommendations for improvement) to the concept development team (WP1.4).

Before the conduction of any validation exercise in WP3.2, it will be necessary to indicate exactly which indicators will be used as evaluators and how the exercise objective contribute to the validation objectives and hence to the project objectives.

KPA	**Predictability**	
High level objective	Increase predictability of the turnaround process	
Focus Area	Turnaround operations variability	
Performance Driver	**Performance Indicator**	**Performance measurement**
Reduce the variability of the turnaround time duration	Variability of the ETTT	Measure the standard deviation of the difference between the ATTT and ETTT.

Table 2: KPIs for the KPA Predictability

KPA	**Efficiency**	
High level objective	Increase efficiency of airlines operations	
Focus Area	Temporal efficiency	
Performance Driver	**Performance Indicator**	**Performance measurement**
Increase of departure punctuality	Off-Block Punctuality	% of flights compliant with AOBT- SOBT <15 minutes. This indicator can be measured in terms of Number of delayed flights and Total delay (in minutes).
	Number of flights	Total Number of departure flights per day in the airport.
Reduce the delays due to turnaround process	Total Delay	Delay time in minutes per flight (AOBT-SOBT).

Table 3: KPIs for the KPA Efficiency

KPA	**Cost effectiveness**	
High level objective	Reduction of the operating costs	
Focus Area	Turnaround processes	
Performance Driver	**Performance Indicator**	**Performance measurement**
Optimization of resources utilization in economic terms	Cost reductions	Costs related to turnaround

Table 4: KPIs for the KPA Cost Effectiveness

Flexibility assessment will be addressed through the evaluation of predictability and efficiency KPIs taking into account several unexpected events which may arise during the airport operation or changes in the initial scenario baseline (e.g. flight increment). Typical flexibility indicators are:

- Number of changes incorporated to schedule without increasing delays;
- Capability of recovery from delays.

4. VALIDATION WORK PLAN

Validation is a transversal activity and as such, it will be active during almost the entire project. Figure 2 shows the position of validation within the TITAN project logic.

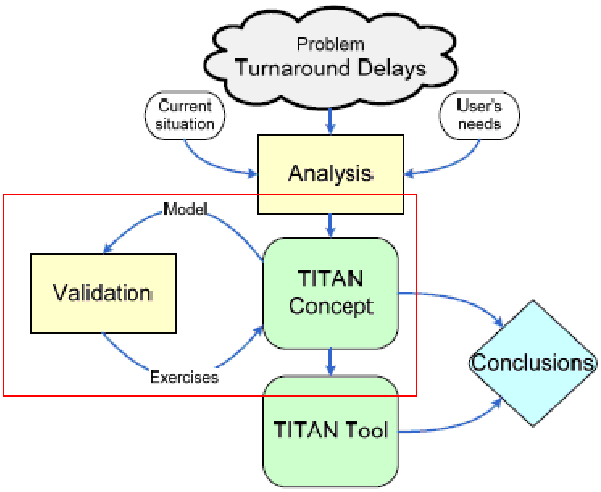

Figure 2: Validation iterative process

As can be seen, validation is an iterative process that will take place in parallel with the concept development. This chapter defines the validation plan for TITAN.

4.1 Maturity assessment

The Technical Annex of TITAN [1] described on a high level the problem, the key issues and the performance targets of the Turnaround process. Furthermore, a draft concept was drawn-up and a high level validation strategy was defined. After being approved the first major activity of TITAN was to analyse thoroughly the current situation and to identify the stakeholder's problems and needs, which is described in D1.1 [3] and D1.2 [4] respectively. These deliverables indicated also potential future solutions / situations and closed consequently the V0 phase of the Concept Lifecycle. That left the project in V1 (halfway the first year), where typical validation activities involve:

1. Initial definition of the operational concept;
2. Initial definition of the logical system architecture;
3. Identification and description of the benefit mechanisms;
4. Identification of the R&D needs (high level validation objectives);
5. Definition of the Validation Strategy

The first two activities are covered in D1.4 "Initial TITAN Operational Concept" [6], although further detailing is necessary to fully complete V1. Activity 3 resulted in the Performance Framework [5]. Activities 4 (partially) and 5 are captured in the present document.

This means that by publishing this validation strategy, the development of an improved turnaround concept, as envisaged by TITAN can be considered almost at the end of V1. Some work has to be done in a first feasibility assessment resulting in a further detailing of the concept and the definition of the R&D needs for V2 and V3. After completing V1, the TITAN concept will be further assessed on feasibility and further elaborated in V2.

4.2 Validation objectives

4.2.1 Global

Based on the stakeholders' requirements, including the SJU expectations, and given the current maturity of the TITAN concept (see section 4.1), the following validation objectives for TITAN can be defined:

- Assess the operational feasibility of TITAN concept;
- Assess the predictability, efficiency, flexibility and cost efficiency of the TITAN concept;
- Provide feedback (enhancements and corrections) for the refinement of the operational concept in WP1;
- Ensure the TITAN concept coherence with SESAR concept of operations.

4.2.2 Validation objectives during each V-phase

The global validation objectives can be further detailed and sub-divided in Lifecycle phase specific objectives:

V1 validation objectives

- Assess that the overall turnaround time performance is improved by the implementation of TITAN concept;
- Assess that the proposed TITAN concept improve the predictability, efficiency, flexibility and cost efficiency of the turnaround process;
- Assess the feasibility and usability of the information exchange in the TITAN concept;
- Assess compliance with SESAR;
- Identify the R&D needs. During this project, the TITAN concept will be mainly validated on its feasibility by means of a model to be developed within the project. Once feasibility is shown, a decision support tool will be developed, complemented with the analysis of how this concept could be integrated in the Air Transport System. The major R&D needs for the next two phases (V2 and V3) in which this among other things is done will be defined during V1;
- Refine the TITAN Operational Concept and the present Validation Strategy (if necessary) based on the results of the V1 activities.

V2 validation objectives

- Assess whether the TITAN concept meets the targeted performances levels for predictability, efficiency, flexibility and cost efficiency;
- Assess the effect of disruptions and unexpected events on the performances of the TITAN concept;

- Assess the influence of passenger and baggage processes, especially under several unexpected situations (e.g. late passenger arrival or lost baggage);
- Validate the application of the TITAN services described in the Operational Concept (BFIS, PFIS, CMFIS, AIRS, ASRS);
- Refine the TITAN Operational Concept based on the results of the V2 activities.

The objectives above are high level objectives. In each validation exercise lower level validation objectives will be defined. Each exercise type will be oriented to one or several validation objectives, and each specific objective will be linked to several indicators which will serve to assess the specific objective fulfilment.

4.3 Transition Criteria

During the TITAN project execution, the maturity of the concept will increase and it is expected that a transition from V1 to V2 will take place. It is important to know when this occurs. Globally – and as already introduced in section 4.1 – the assessment will examine whether the proposed operational concept and supporting technical enablers are defined at the level of detail required for the development of benefit mechanisms and for the identification of major feasibility and performance related R&D needs.

More specifically the following transition criteria [2] may help to analyse whether V1 is completed (mind that many criteria are already fulfilled):

Operational concept:

- Is the operational concept defined at the level of detail required for the development of the benefit mechanisms and for the identification of major R&D needs?
- Are different concept options (variants) defined, if any?

In case of a supporting technical enabler:

- Have the relationship and interaction between human and machine been defined for all concept options, at the level of detail required for the development of the benefit mechanisms and for the identification of major R&D needs (related to socio-technical issues)?
- Are the supporting technical enablers defined at the level of detail required for the development of the benefit mechanisms and for the identification of major R&D needs?

Context of use:

- Is the potential context of application (e.g. airport, TMA, en-route, traffic density, airspace structure, etc.) defined and adequate?
- Is the potential deployment context (local/regional/pan European use) defined and are they adequate?

Problem/Solution link:

- Are the potential benefits identified for representative stakeholder groups and intended context(s) of use as well as adequate (benefit mechanisms/relevant KPAs/contribution to performance targets/rationale)?

Alternative solutions:

- Are the alternative concepts and supporting enablers adequately identified for each context of application?
- Is the need to validate the subject concept instead of (or in addition to) these alternative concepts justified?

Integration

- Is the potential impact of the concept on the target system identified? Have all related concepts been identified and are the relationships adequately defined?

Assessments

- Are the major performance related issues (R&D needs) identified based on high level benefits, risks and impact assessments covering all relevant KPAs?
- Are the major operational, technical, socio-technical, and transition related feasibility issues (R&D needs) and standardisation/regulation needs and issues adequately identified? Are the need to assess these feasibility issues justified (i.e. there are not any know results showing non feasibility)?

Development and validation plan (planning level)

- Does the development and validation plan adequately cover all major performance, feasibility and standardisation/regulation related R&D needs/issues?

4.4 Cases Identification

The objective of using a 'case' is to group information into a clear structure in order to describe the potential of the concept under evaluation and thereby provide pertinent feedback to the concept developers and support the key stakeholders by providing evidence as they make the investment and implementation decisions.

The Case Based approach starts as early as V0 with the identification of case specific performance needs. The main establishment of the cases is done in V1 with the scoping and planning of the case's work based on the stakeholders' needs and always with the objective of supporting the stakeholder decisions through the lifecycle of the programme/project. It also establishes the case baseline relevant to the validation activity and the case reports being targeted for development.

Typical cases for which the E-OCVM V3 gives guidelines are Safety, Human Factors, Environment and Business. As explained in the Operational Concept description [6], safety is outside the direct scope of the TITAN Turnaround concept and the turnaround does not require any special environmental considerations.

The human will (continue to) play an important role in the TITAN concept; The ConOps proposes the use of applications and interfaces with the human operators, which provide the end users with more accurate and comprehensive information that reduces the workload, promotes active use and supports decision making. These aspects will however not be assessed in a specific Human Factor case, but rather be integrated in the technical feasibility assessment.

The Business Case can be summarized as being a support management tool which provides a substantiated argument to decision makers for investment decisions. A full Business Case addresses many types of issues associated with the analysis of investment and therefore it cannot and will not be performed during TITAN. However, one of the most typical activities of a business case within V1 and V2 of the concept lifecycle is to present a first sketch of benefit and cost mechanisms as well as a rough assessment in terms of return on investments metrics. Within the

TITAN project, these activities will be carried out in WP5 on the TITAN tool, thereby estimating the operational costs and benefits by means of expert judgement, historical data, simulations and economic studies.

4.5 Validation Requirements

To achieve the validation objectives given in section 4.2, validation requirements can be defined by answering questions regarding *what*, *where* and *how* to validate. The answers to these questions will reveal what things need to be set up, known, modelled, or taken (or not) into account before starting the validation exercises.

- ***What* to validate:**

  It will be validated that the performance targets are met by the TITAN concept, that the proposed services can be delivered and that the involved actors experience a better situational awareness and accept the processes and information provision.

- ***Where to validate***

  The concept feasibility will be assessed within the current airport context, taking into account the currently used methodologies, performances, airport configurations, air traffic and involved actors. Future scenarios will also be created by modelling SESAR mode of operations, CDM processes, and the turnaround process integration within the business trajectory. Weakness and strengths of the TITAN concept application and their feasibility under both scenarios contexts will be assessed.

- ***How to validate:***

  The TITAN concept will be validated by modelling the TITAN processes to:

  - allow the technicians and users to visualize and refine the TITAN concept of operations;
  - provide evidence that the TITAN objectives are achieved and that the TITAN concept is feasible.

  It is foreseen that these requirements can be fulfilled by a model that simulates the processes and a gaming session. This will be further explained in section 4.6.

Additionally, the following validation requirements are identified:

Processes: The turnaround is composed by several processes that are highly interdependent. It is important to correctly select and model those processes that best represent the TITAN concept and its singularities (in contrast with the current Turnaround Concept), thus providing a potential source of evidence regarding the achievement of the validation objectives.

In order to select the processes that will be modelled, the following **general criteria** are proposed:

- Processes related to the Concept Solution Evaluation and understanding, for example:
  - Access to the airport;
  - Passenger/baggage progress from arrival at the airport to the security control;
  - Passenger/baggage progress from security control to boarding gate;
  - Passenger Boarding/deboarding and baggage loading/unloading;
  - Passenger check-in at home;

  - Aircraft turnaround.

- Critical processes: processes whose lack of performance implies a cancellation of the turnaround. Any process impacting on a critical process will be considered “critical” as well.
- Potential Delay processes: process whose performance impacts directly on the “current bottlenecks and shortcomings” identified in Ref [3], namely:
  - Information sharing;
  - Planning (with respect to reaction to the deviations from the original plan and unexpected events);
  - Increasingly demanding security processes.
- Added Value Processes: processes that are considered as relevant for achieving the TITAN objectives, but have no direct impact on its performance. These processes will be initially identified by evaluating the relevance of the TITAN turnaround services or by their relationship to the TITAN KPIs [5].

Resources: TITAN intends to improve resource management via an efficient use and monitoring of resources and their availability. Resources to be modelled will be selected using a rationale similar to the process selection criteria. Since each selected process will have related resources, these will constitute the basis for the resource selection. Resources will also be taken into account for the validation exercises using the different viewpoints i.e. availability, time of availability, etc.

Main resources will be sorted by type:

- Airport resources: stand/gate availability, fingers…
- Airline resources: Cockpit crew, boarding personnel, catering services, UM assistants, wheel chairs…
- Ground handling facilities: fuel, maintenance, stairs…

Actors: Some of the main actors involved in turnaround (Airline, Ground Handler, ANSP and airport operator, see section 2.4) will be simulated within the model to demonstrate the feasibility of the concept. It is necessary to clearly understand and identify the actions that each individual actor carries out within each process.

Actors’ behaviours will be modelled by defining possible decision rules (according to the TITAN concept and based on the turnaround status in the concerned exercise). Some examples of actors[1] are cockpit crew, Passenger agent, baggage handler, fuel provider, or security personnel.

4.6 Validation tools / techniques

Based on the validation requirements given in section 4.5 the following techniques are selected for validating the TITAN concept:

- Fast Time Simulation;
- Gaming sessions.

[1] It must be noted that some entities such as “cockpit crew” can be considered as a resource or as an actor. An entity will be considered as a resource when its availability/unavailability will result on the start/stop of a service; it will be considered as an actor when it can impact the process by changing the course of the simulation through his/her behaviour modelling.

4.6.1 Fast Time Simulation

The selected simulation technique proposed to validate the TITAN concept is the Outcome Driven Distinctive Simulation (ODDS). Through this technique, a turnaround model will be used to conduct a set of exercises aimed to evaluate the degree of achievement of the validation objectives through the use of scenarios that engage the user in an "evaluate-by-doing" approach (using scenarios that reflect day-to-day operations or problems related to the turnaround). The simulations will be focused on a single set of expected results. In the course of the execution of the exercises, data are recorded to identify the performance parameters and drivers and thus to validate the TITAN concept.

Since there are currently no adequate turnaround models available, it is decided to develop this model within the TITAN project (WP2). The model design and development will take place in coordination with the validation process in order to ensure that the model meets the validation requirements.

There will be two models; both of them will comply with the validation requirements:

- Single Aircraft Model
- TITAN Model.

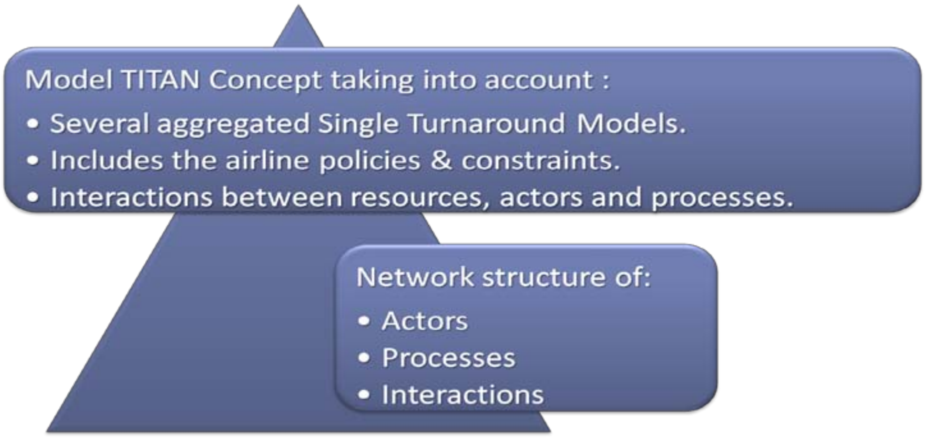

Figure 3: TITAN Model

The Single Aircraft Model will model the turnaround process of an isolated aircraft describing the TITAN turnaround operations, their processes, resources and involved actors and providing the KPIs information for individual processes. The Single Aircraft Model will serve as:

- a first approach to the TITAN model that will be an aggregation of several Single Aircraft Models correctly characterized and interconnected according to the exercises type or used scenarios;
- a validation tool which provides the technicians a complete understanding of the TITAN concept and a first approach of the optimal turnaround time without taking into account the network effect.

The TITAN Model (or *aggregated model*) will model the overall turnaround process in a generic Airport (some parameters identifying several airport or aircraft configurations could be included if it is considered necessary) including the concerned sub-processes, associated resources, and related actors and their roles. Network effect, TIS, and CDM process will also be modelled in order to validate their benefits. A basic interim structure definition of the processes according to TITAN model will compose TITAN model.

The scenarios necessary to validate the concept should represent:

- present and future situations;
- different traffic samples with several traffic densities;
- different situations, disruptions (e.g. delays) and events;
- different airport/airlines/ground handling policies.

4.6.2 Gaming

Human-In-the-Loop (HIL) Gaming technique allows the definition and exploration of roles and their responsibilities and the interaction of these roles within an automated environment. The technique is well-suited to assess the feasibility of the information exchange in the TITAN concept:

- detection of bottlenecks and shortcomings;
- clarification on roles and responsibilities (e.g. gaps and overlaps).

The use of gaming in TITAN will be focussed on the exploration of the situation awareness and the human-human and human-machine interactions. This technique facilitates the analysis and refinement of operational concepts because it allows learning about no-developed systems yet, studying the behaviour of the people and/or machines' interactions with lower and controlled cost (comparing with prototypes). Besides, gaming stimulates players to be open-minded and to obtain results from another point of view.

Games are played with air transport operational experts acting as actors on specific roles and interacting through specific processes in a structured way, focusing the players' attention on the information flow and responsibilities associated to the processes. Different gaming techniques are available, but taking into account the maturity level of the TITAN concept, **paper-based gaming technique** is the most appropriate in comparison with (more costly) other techniques as platform-based gaming or prototypes.

Paper-based games are performed using basic office material. They are basically board games where the rules are designed according to the processes and roles interactions to be studied/ clarified.

The main elements to take into account in the design of the gaming session are the following:

- Scenarios defining the context of a gaming exercise. They include the specific objectives to address, the initial expectations and hypothesis and the operational and temporal context, as well as the storyboard or main line of action of the game, in order to focus the players on the specific interactions to be explored;
- Selection of player. This is one of the main success factors of a gaming session. The human elements should be selected to play according to different factors such as the role, the objective of the gaming session and the personality of the player. It is important that the same players participate in all games of the session to maintain the built-up knowledge transfer from one game to the other;
- Rules to be applied define how each game should be undertaken in terms of actions allowed/ nor allowed for the players, definition of the human-human and human-machine interactions, etc;
- Tools to collect the outcomes. These elements are important to establish the methods to compile the results. Some examples are questionnaires, comment sheets and debriefing

techniques (techniques to obtain conclusions from the participants at the end of each game or gaming session).

4.7 Validation Scenarios

The scenarios will have to be defined in such a way that the simulation exercises during which the scenarios will be used will provide evidence on meeting the validation objectives during the following situations:

- normal airport operation, using scenarios with different traffic samples, aircraft configurations, defined resources availability times;
- disruption (unexpected situations) such as bad weather conditions, traffic arriving out of schedule or incidents. Those situations may reduce the predictability and efficiency.

To that end the high level operational scenario [6] will be detailed into several validation scenarios, see Table 5. There will be two generic scenarios and four specific ones where during the course of the turnaround process an event occurs. These events are selected based on the specific user needs or on issues related to coherence with SESAR. Each of those scenarios will have two sub-scenarios: one representing the current situation (which will be used as baseline) and one representing the TITAN concept. The same set of scenarios is repeated but now with a disruption (unexpected situation) as a starting point, which is modelled by introducing a “forced” delay in the turnaround process.

		Generic Scenario	Specific Validation Scenarios			
			Late Passenger	Increasing demand	Late arrival	Lack of resources
Normal Airport Operation	Current situation	GEN-1a	SPEC-1a	SPEC-2a	SPEC-3a	SPEC-4a
	TITAN concept	GEN-1b	SPEC-1b	SPEC-2b	SPEC-3b	SPEC-4b
Disruption	Current situation	GEN-2a	SPEC-1c	SPEC-2c	SPEC-3c	SPEC-4c
	TITAN concept	GEN-2b	SPEC-1d	SPEC-2d	SPEC-3d	SPEC-4d

Table 5: Scenario identification

A short description of the main scenarios (GEN1-2, SPEC1-4) is given below:

- Scenario-GEN-1: This scenario represents the normal situation without any unexpected event. It provides relevant KPIs for each KPA and allows a performance comparison between the current turnaround process and the TITAN concept. This scenario serves as a baseline for comparison of the results coming from the specific scenarios;
- Scenario-GEN-2: This scenario is the same as GEN-1, but focused on analysing the “knock-on” effect caused by an unexpected situation that results in a delay in the turnaround process.
- Scenario-SPEC-1: This scenario evaluates the impact of passenger behaviour on the turnaround process. Most of stakeholders have identified landside processes as a main issue affecting to their slot adherence;
- Scenario-SPEC-2: This scenario evaluates the impact of increasing the number of flights on the turnaround process. One of SESAR objectives is to accommodate an important increase in air traffic;

- Scenario-SPEC-3: This scenario evaluates the impact of late flights on the turnaround process;
- Scenario-SPEC-4: This scenario evaluates the impact of a lack of resources on the turnaround process. Most stakeholders have identified the lack of resources as a main issue hampering the turnaround.

This list is not exhaustive and may be modified during the complete definition of the scenarios and simulation exercises in WP3.2.

4.8 Warnings

A warning is the information generated automatically or manually in case of the existence of defined situations, events, trends or forecasts, with the purpose of enabling the actors concerned to become aware of the situation, event, trend or forecast which has caused the warning. Warnings will be used to monitor the turnaround process as they rise when there is an unacceptable discrepancy between any planned and actual event during the turnaround.

As explained in section 2.5 the so-called A-CDM Milestones are an important feature of Airport CDM as defined by SESAR. Validation scenarios will include the TITAN milestones defined for the turnaround. When milestones do not occur as planned and no re-planning has taken place, a prompting mechanism will raise a warning. It is noted here that all TITAN milestones have a warning associated but not all warnings are necessarily linked to milestones.

The warning messages are not yet defined in the concept description. During the validation exercise planning a preliminary list will be defined (and reported in a separate technical document) and the feasibility and usability of those warnings will be validated during the exercises. The validated list of warnings will then be incorporated in the second version of the TITAN concept description.

4.9 Validation Assumptions

As part of the validation requirement identification and according to the previous considerations some assumptions will have to be taken into account during the validation of the TITAN concept:

- Current airport traffic will be used in the validation activities, for this reason, the required airport traffic data and the proper data format to feed the built network of process, resources and actors will be identified. Several samples may be required according to several scenarios and exercises types;
- The current airport configuration will be used in the validation activities, such a configuration must be reflected in the model by means of time of resource availability, current sequencing of the activities, actors responsible for the airport activities/services…
- Turnaround will be considered as a part of the business Trajectory, and therefore it will require synchronisation points with the business trajectory, mechanisms to update the business trajectory or to define external impacts of events out of the turnaround process. All outside of the TITAN validation scope;
- A-CDM will be considered fully implemented; it implies the introduction in the model the possibility of processes monitoring, collaborative actor decisions-making, and resources sharing. This is assumed to happen through the exchange of information at the TITAN milestones;