TITAN

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

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EXECUTIVE SUMMARY

The TITAN Air Transport System Integration Documents (TASID) define the details of integrating the output of TITAN into the information stream of the different partners concerned with the turnaround process as well integration with the business trajectory. The TITAN related transition considerations are also described.

The TASID comprises four documents as follows:

- Integration plan Airline Operations Centre (AOC)
- Integration plan airport operations
- Integration plan business trajectory
- Transition considerations

This volume is the integration plan for airport operations.

In view of the large variety of environments in which TITAN will operate, the description is kept at a relatively high level. At the same time, the aspects of integration that are common to all partners and environments (called integration vectors) have been specifically identified and described in more detail. These set the scene for all TITAN integration and transition activities and their thorough understanding is essential in order to plan and execute the integration task.

The way partners at airports will use TITAN is described, followed by a discussion of how TITAN fits in the different airport environments (e.g. airports with or without an Airport Operations Centre (APOC).

Conclusions are provided as guidance for TITAN development and integration.

1. INTRODUCTION

1.1 Purpose of the Document

The purpose of this document is to give a high-level description of how the output of the TITAN may be integrated into the information streams and operations at the airport.

The contents of this document are not prescriptive. This is guidance only, meant to be used with due consideration of the prevailing local circumstances while keeping in mind at all times the need for interoperability between the partners concerned.

1.2 Target Audience

The integration as such is shown in the form of descriptions and suggestions for the way forward, expressed on a relatively high level. This is not an implementation guide. The target audience is therefore experts concerned with improving the turnaround process and considering adding a TITAN tool to their arsenal.

1.3 Structure of the Document

The document has been structured in such a way that it leads the reader through the most important aspects of integration in a logical manner. At the same time, the main chapters have been made into elements that can also stand on their own, supporting both general reading and focused use of the document.

Following this introduction, a chapter is dedicated to describing what TITAN really is and how it will work. This is achieved by a short summary of the TITAN concept of operations (ConOps). The meaning of integration in the TITAN context is also contained in that section.

A large part of the document is devoted to describing the so-called integration vectors. These are in fact areas of activities common to the integration effort of all the partners and which need to be understood and taken into account for successful integration.

The integration plan takes the form of a review of how TITAN may be used in the airport environment followed by a short description of the most important future scenarios to be considered. Finally, conclusions to be taken into account during the integration activities are provided.

It is highly recommended that users consult also Chapter 3 of the other TASID volumes (integration plan airport operations, integration plan shared business trajectory, transition consideration), as those contain information that is of interest for all partners. Chapter 4 is the subject specific chapter in each of the TASID volumes.

1.4 References

When creating this document, the following source material was used as reference:

- TITAN_WP1_INE_DEL_04_v0.2_Operational Concept (Issue 2)
- TITAN_WP4_SLO_DEL_01_v0.7_Turnaround_tool_specification_document
- SESAR “Airport Detailed Operational Description (DOD) Step 1”

- SESAR Factsheet No2/2010: Business Trajectory/4D Trajectory
- SESAR Factsheet No3/2010: System Wide Information Management
- CSIS/World Resources Institute "Managing the Transition to a Secure, Low-Carbon Energy Future" (Ladislaw, S., Zyla, K., and Childs, B. (2008)

1.5 Glosary of Terms

Acronym	Meaning
A-CDM	Airport Collaborative Decision Making
ADL	Additions and Deletions List
AIP	Aeronautical information publication
AIRS	Airport Information Report Service
ANSP	Air navigation service provider
AOC	Airline Operations Center
AOP	Airport Operations Plan
APOC	Airport Operations Centre
ASRS	Aircraft Status Report Service
ATM	Air traffic management
ATS	Air traffic services
BFIS	Baggage Flow Information Service
BRS	Baggage Reconciliation System
CDM	Collaborative Decision Making
CMFIS	Cargo and Mail Flow Information Servie
CPDLC	Controller/Pilot Data Link Communications
CUTE	Common Use Terminal Equipment
DCS	Departure Control System
DPI	Departure Planning Information (message)
EC	European Commission
ECAC	European Civil Aviation Conference
EUROCAE	European Organization for Civil Aviation Equipment
EUROCONTROL	European Organization for the Safety of Air Navigation
FAA	Federal Aviation Administration
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisations

LDM	Load Message
MVT	Movement Message
N/A	Not applicable
NOP	Network Operations Plan
PFIS	Passenger Flow Information Service
PNL	Passenger Name List
PNR	Passenger Name Record
RBT	Reference Business Trajectory
SBT	Shared Business Trajectory
SITA	Société Internationale de Télécommunications Aéronautiques
SOA	Service Oriented Architecture
SWIM	System Wide Information Management
TIS	TITAN Information Sharing
TOBT	Target Off-Block Time
TTOT	Target Take-Off Time

2. UNDERSTANDING TITAN AND ITS INTEGRATION

2.1 Understanding TITAN

2.1.1 The purpose of TITAN

From the integration perspective TITAN should be seen as a decision making support system that receives information from its environment, processes it and then generates decision-making support for its users (airlines, airports, air traffic management, etc.) with the aim of making the turnaround process more predictable, efficient, flexible and cost-effective while also increasing the overall situational awareness of partners who make use of TITAN.

2.1.2 The TITAN Operational Context

TITAN is meant to add value to the existing environment and hence its chief operational context should be seen as an airport where airport collaborative decision making (A-CDM) has been fully implemented.

2.1.3 The TITAN Concept of Operations

The most important feature of the TITAN concept of operations is the embracing of trajectory-based operations that include also the ground part of the aircraft trajectory. When the aircraft is stationary, its trajectory continues to evolve but only in the time dimension. This means that the turnaround itself can be seen as a period during which the trajectory needs to be managed and during which the trajectory is subject to various influences exerted by the turnaround activities. By making these influences visible in more detail, e.g. by including landside influences too, TITAN enables a much finer management of the trajectory (via the time dimension) during the turnaround.

By introducing the trajectory view into the turnaround, TITAN also helps in building a more consistent overall view of an aircraft's movements within the air traffic management environment.

2.1.4 Net-Centricity and Service Orientation in TITAN

Net-centricity can be summarized as an arrangement of information exchange interconnections where each information generator and information consumer is a node on the global network, sharing a virtual information space. This is in contrast with the traditional, point-to-point connection paradigm which is a very rigid arrangement where adding new partners is cumbersome and expensive. Net-centricity also implies that information is properly managed both on the level of the network and on the level of the information providers and users. TITAN relies on the System Wide Information Management (SWIM) concept and principles to ensure proper information management. This is achieved by using standard information exchange models in TITAN, making it suitable for operation in environments where SWIM has already been implemented as well as legacy environments with the addition of standard translation facilities.

To have a better understanding of the turnaround process on both the business/operational and the IT levels, TITAN is using a service-oriented approach to describing the turnaround, however, IT services are out of scope in TITAN. A service in TITAN is understood to be something you need for the processes that make up the turnaround to be executed. Services typically deliver information about aspects of the turnaround that are essential for its successful completion. The initial set of services defined for TITAN are the following:

- Passenger Flow Information Service (PFIS)
- Baggage Flow Information Service (BFIS)
- Cargo/Mail Flow Information Service (CMFIS)
- Aircraft Status Report Service (ASRS)
- Airport Information Report Service (AIRS)

Service orientation means that it is always possible to define additional services and implement them in the TITAN environment with minimum effort. In any case, the services that have been defined cover most foreseeable requirements so that all information about aspects of the turnaround that are essential for its successful completion is delivered.

For instance, the Passenger Flow Information Service will monitor the passenger flow and react to any observed or likely disturbance. Such reactions may be the publishing of information about congestion for example. These services provide a much more refined, real time picture of the evolution of certain critical aspects of the turnaround than milestones on their own can.

2.1.5 The TITAN Model and the TITAN Tool

An important output of the TITAN project is the TITAN Tool, which is in fact a decision-support tool that enables the turnaround partners using it to exploit the information rich environment created by the fine granularity of TITAN through its additional milestones (compated to A-CDM). Interpretation of the information is undertaken by the logic embedded in the TITAN model, which is also a product of the project.

2.1.6 The End Users of TITAN

The information delivered by the TITAN services is processed and an appropriate output is generated. This output is made available by being published in the shared information space. The output is always relevant to the turnaround of a particular flight but TITAN as such does not determine how the information is to be used.

Accordingly, the end user may be a human or another application in a CDM environment.

2.2 Understanding Integration

2.2.1 What is the meaning of integration?

To understand the meaning of the word “integration” in the context of TITAN, we must keep in mind that TITAN is primarily meant to add value in environments where A-CDM is already fully operational. This also means that the CDM related procedures and institutional arrangements are presumably in place. So integration involves creating of additional inputs (e.g. from the landside) required by TITAN and building the additional “intelligence” into the existing applications to enable them to use the output of TITAN.

The concept of publishing TITAN output into the shared information space as defined in SWIM results in a very flexible integration concept, since users are free to utilize TITAN output as and when it best fits their needs.

In legacy environments the need to create direct interfaces with TITAN increases the costs and results in a less flexible arrangement, even if the functional utility and benefits of TITAN are not adversely affected.

It is important to note that at its simplest, the integration of TITAN into the air transport system means creating the ability to use TITAN in terms of feeding it with the required input information (including new elements) and enabling end-user applications to make use of the processed information published by TITAN. Where an instance of TITAN is actually running is of secondary importance.

2.2.2 Legacy ATC Environment considerations

Today's ATC environment supports the operations of the airport, but it does not integrate it into the regular ATC operations. This situation results in separate planning processes for both ATC and the airports that generate unwanted inefficiencies in terms of time and cost efficiency. TITAN will address these issues from the turnaround point of view.

Instead of providing a full list and description of all the elements that are part of the airport, the following text highlights those areas that are required for the implementation and operation of TITAN. The reader is referred to the TITAN document D1.1 for a complete description of the current turnaround concept and its associated environment.

- The Tower Runway Controller is the authority for assuring safe operations on the runway.
- Surface movement operations rely on the "see and avoid" principle as the primary mean to ensure the safety of surface movements.
- Controllers are responsible for issuing information and instructions to aircraft under control in order to assist pilots to navigate safely and timely on the airport surface.
- Controller/pilot digital link communications (CPDLC) will increasingly be used for routine communications.

Voice communications are used for time critical and tactical clearances.

2.2.3 Network management considerations

With the progressive implementation of the Functional Airspace Blocks (FAB), air traffic flow management is undergoing a fundamental change. Tactical ATFM will be more and more performed on the FAB level while the ATFM network as such will be managed by EUROCONTROL. These changes will impact A-CDM in time since the Departure Planning Information (DPI) message exchange with the CFMU as originally defined may undergo certain changes as the overall ATFM arrangement evolves.

Since the TITAN generated output is meant to be used only after proper interpretation by an end-user application or human being and because the output is not meant to be sent directly in messages to any flow management unit or position, changes in the overall network management setup are of no concern to TITAN.

Conversely, the enhanced performance of CDM made possible by TITAN will mean a better network operation and hence TITAN must be seen as an important enabler of improved overall air traffic network management.

2.2.4 SESAR environment considerations

Even though the Operational Concept presented in TITAN could be implemented in part at this moment, its full advantages will become available once Step 1 from SESAR becomes operational. At that moment, it is expected that airports will be fully integrated into the ATM Network, becoming a system node whose integration will be the key to accommodate the linking of multiple business trajectories executed by a single aircraft in order to prevent knock-on effects caused by delays early in the execution phase.

The trajectory provided by the aircraft system will be "take off to landing" (e.g. Flight Management System (FMS) output) and will not include ground segments or turnaround times. However the airport will not be considered as a start or end, but as part of a continuum. Monitoring of aircraft movement and handling on the ground will be part of the Airport Business Trajectory linking two flight segments of two different trajectories as a single continuous trajectory.

The airport will be required to accommodate the forecast traffic increases, in a safe manner, eliminating or recovering system delay, while providing levels of safety above today's standards and respecting the agreed flight schedules.

The main change to current surface movement operations is the transition from the "first come – first served" principle to an increased adherence to a predefined schedule of surface movement (Reference Business Trajectory) for the planning and execution of departure movements ("on time first served").

More information will be available to the pilots on-board to ensure a safe, expeditious and efficient movement on the ground. A-SMGCS will allow accurate surveillance and precise control of traffic on the surface. System features will include traffic advisories and alarms (safety nets) to reduce the risk of runway incursions and ground collisions, while providing guidance and situational awareness to pilots and vehicle drivers. Associated HMI will improve controller situational awareness, assisting in planning and routing of ground movements and allowing enhanced control of traffic in Low Visibility Conditions (head down).

A range of technical and procedural solutions, both ground and airborne, will support the safe and efficient management of the runway, taxiways and apron/stand areas in all weather conditions, achieving throughput rates, equal to or close to the best throughput rates achievable in good weather conditions and with a homogeneous aircraft traffic sequence.

2.2.5 External Partner considerations

Most of the passengers using air transport utilize other transport means such as train, private car, taxi or, underground to access the airport facilities. Some of the passengers arrive at the airport using public transport, shuttle buses from hotels, and some others using their own vehicles. Transport connections with the airport can have a direct impact on turnaround predictability. If real-time information regarding the status of those connections is available, appropriate decisions can be taken in advance to mitigate their impact on the turnaround. Public transport is normally subject to close supervision by dispatch services of the companies themselves or national organizations established for this purpose and these have information about the status of the road and railway network such as traffic jams, road conditions, etc., and this information can be used to predict more precisely when passengers will arrive at the airport for check-in, or go directly to security if they had checked-in at home.

The most useful information a passenger can offer for TITAN purposes is *where* the passenger is coming from, *when* the passenger will start the trip to the airport, by *which* means of transport will he or she arrive there, whether he/she has performed the check-in on-line and if so, whether he/she plans to deliver luggage in the fast-drop lane. Once the origin and destination (airport terminal) are known, the estimated time of arrival can be calculated using the public information mentioned above. Delivered to the partners involved in the turnaround in raw form or processed into deduced information, such external intelligence can provide important additional support to the turnaround decision making. After arrival at the terminal, the passenger interacts with a number of processes, each of which is time critical from the turnaround's point of view. This is why the passenger arrival time at the terminal bears such importance and why it is worth monitoring.

The collaboration of passengers in providing the required data is essential, although some information could be provided also by a common system used by the different means of transport and hotels already before leaving the starting point of their journey to the airport. Conversely, passengers could also be informed of some unexpected events regarding their flights or any other constraints that could be significant for them when getting to the airport. If a flight is two hours late for example, passengers could be notified and they may consider going to the airport later.
Currently, very few external partners are involved in providing information for aeronautical purposes. When they are signed on, the timeliness and accuracy of their information will need to be validated and its quality constantly supervised. Such information is not safety critical, however, it is critical from an economic point of view and the potential for avoidable costs (as a result of wrong decisions) must be minimized.

2.2.6 Non-ECAC environment considerations

Since TITAN is meant as a tool for, among others, airlines, it must be assumed that at least in some cases it will be used by companies whose AOC is not located in the ECAC area and which are operating flights into and out of that area. The turnaround process of such flights at an ECAC airport is of course a legitimate target for such a TITAN instance, however, the data concerned may potentially be subject to EU information privacy rules. This needs to be taken into account as part of the information management arrangements.

2.2.7 Transition considerations

In a true SWIM environment information sources, including new landside sources, publish their data into the shared information space as does TITAN its own output. TITAN will, if a certain item of information is not (yet) available, compensate in some acceptable way (determined locally for the particular implementation or built into the tool in the case of an off-the-shelf version) and so a TITAN tool can be implemented even if not all the input information is available. Once all sources are operational, TITAN will be able to gather all the information it needs and itself become fully operational. Until such time it may signal that its outputs are not yet fully in line with the specifications.

On the output side, again in a true SWIM environment, the TITAN generated output will be published into the shared information space without any need for TITAN to be aware of who will be using the output, which also translates to a very smooth transition procedure.

Making the legacy environment capable of working with the shared information space is one of the hurdles to overcome. Similarly, if TITAN's output is used in a legacy system, modifications will need to be made in that system which impacts the overall planning.

The nature of TITAN is such that while it can potentially improve the situational awareness of the partner using it as compared to those who are not, any operational conflict can be easily overcome during the transition phase via good agreements between the partners which are also followed up vigorously.

In fact such mismatches between partner awareness and the corresponding higher quality of information will probably be one of the automatic marketing features of TITAN once it is out in the field.

2.2.8 The integration vectors

Integration vectors are in fact specific areas for which the integration considerations and integration activities must be defined. They are called vectors because they indicate the direction of the activities and also their timeframe. In this document we have specified the most important vectors which will generally be required. However, each implementation is unique in as much as some vectors may not be applicable at all and some new ones may need to be defined.

The integration vectors are common to each and every partner in as much as they will all have to consider at least the vectors contained in this document when planning their specific integration activities on the understanding that some vectors may not be applicable in a given situation while in others, additional vectors may need to be defined to satisfy the prevailing requirements.

In the following we will touch upon the most important vectors, explaining their significance and providing some guidance on how to approach them during the integration activities.

2.2.8.1 Operational Procedures

Current operational procedures are set up within a framework of a relatively imprecise turnaround operation and even with A-CDM, the granularity is refined only with the milestones. The various services introduced by TITAN will refine the picture much further, among others affording visibility of selected aspects of the turnaround also between the milestones, not to mention the capturing of the influence of factors totally ignored previously.

In an environment served by TITAN developing problems will be recognizable much earlier on the one hand and also much more frequently on the other. To make use of this enhanced granularity, a more instant and flexible reaction is needed. Operational procedures developed for the previous, less precise environment may not always be sufficiently speedy and flexible in which case the usefulness of better information is negated by the inadequacy of the procedures.

It is therefore essential that in parallel with the introduction of TITAN a thorough analysis of the existing operational procedures is also undertaken and changes made as necessary to make them suitable for working with TITAN.

2.2.8.2 Human machine interface

As a general rule, partners do not like to add new displays to what already exists on their desks or is built into their consoles. It is therefore a strongly recommended general principle that the introduction of TITAN be considered without creating a need for an additional physical display. If at all possible, any new information that becomes available as the result of TITAN's implementation should be made available/displayed in windows on already existing physical displays.

2.2.8.3 Training and reform thinking

The introduction of TITAN does not entail specific training for the end-users and only minimal training (probably in the form of web-based self study) for the IT personnel. On the other hand, TITAN introduces new concepts and approaches to collaborative decision-making, including the integration in trajectory-based operations, extended scope of services, etc. It is important that users on all levels become fully familiar with the essence and significance of these new features to enable them to make maximum use of the benefits they provide.

It is probably not necessary to arrange specific training for the personnel but a well-constructed, comprehensive brochure would appear to be required and will probably be sufficient.

2.2.8.4 Institutional

Institutional considerations will arise in particular due to the new information sources (e.g. on the landside) and the eventual involvement of new partners, some of whom may not have been part of the A-CDM environment in the past. To take an example: information on the transportation means serving an aerodrome, including the state of traffic on the motorways concerned, is probably available already but it may be under the purview of different organizations, state or local authorities etc. who may or may not be ready to share this information or demand payment and so on. It is important that timely and effective arrangements are made between all partners concerned to ensure the availability and use of information required and provided by TITAN.

2.2.8.5 Marketing

Experience with the introduction of the A-CDM concept has shown the importance of proper marketing. Although the benefits were not disputed (indeed, they have been demonstrated over and over again), the sheer inertia of the partners concerned was in most cases a major obstacle to be overcome and this was possible only with excellent marketing and the finding of an effective local leader (usually the airport or an airline) to provide the initial motivation and funding.

The benefits of TITAN can be demonstrated equally easily and the business case is clear. However, those benefits are only incremental above what A-CDM has already provided and so the importance of proper marketing and convincing of the partners is as important, if not even more important, than was in the case of A-CDM.

A credible, impartial agent is best employed to deliver the marketing activity and having early reference sites is probably a good idea as these can demonstrate the real capabilities of TITAN while also providing a ready comparison with A-CDM on its own.

2.2.8.6 ATC Systems

From an ATC point of view, the TITAN Concept may improve turnaround process predictability helping airlines and ground handlers to enhance their activities in order to ensure accurate target times. TITAN results are seen as applicable in the long-term complementing the SESAR concept with the aim of integrating the turnaround process into the business trajectory.

TITAN services are seen as a powerful tool that provides information that can be customized enabling each stakeholder to receive the most appropriate data to share common situational awareness at the airport. Tower controllers consider that TITAN results will have an indirect impact on their operations; however TITAN is not enhancing controllers' way of working, as the only trigger required by the controller comes from the pilot.

ATC performs a tactical task whose trigger is the aircraft situation acknowledgement, known through the first flight crew communication. Tower controllers are interested in Target Off-Block Time (TOBT) and Target Take-Off Time (TTOT) that will be directly communicated by the flight crew. The final responsibility over aircraft status belongs to the pilot, so until the pilot requests a clearance for start-up, the controller will not perform any action over that aircraft and will not monitor aircraft status during the turnaround. For planning proposes, ATC works under the hypothesis that the flight will be on time, unless the pilot announces a delay in the first communication. Consequently, the inclusion of TITAN feedback in the tower – e.g. through HMI-may cause excess information for the controller working position leading to a higher workload without adding extra value.

The following diagram shows the communication process between the pilot and the controller summarizing what is explained above.

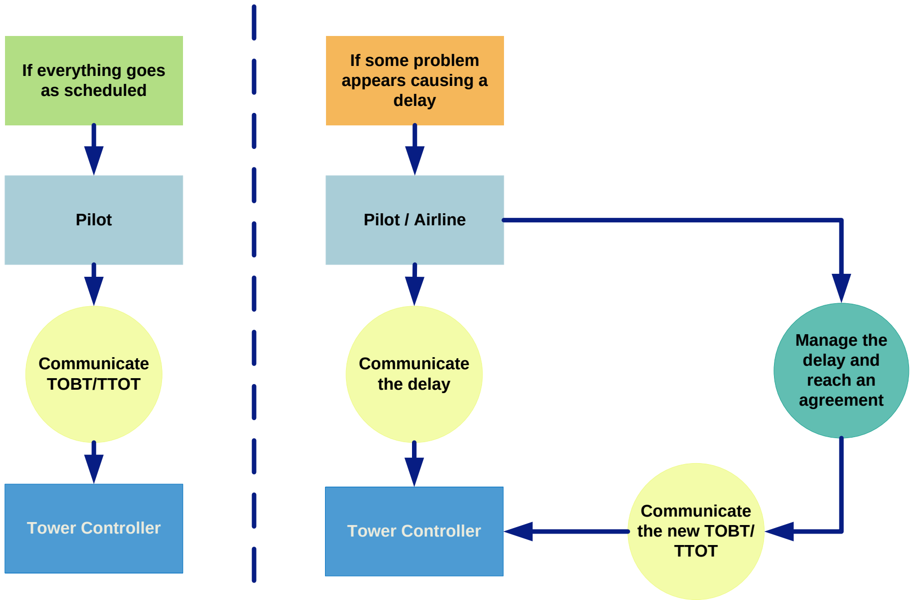

Figure 1: Communication process between the pilot and the controller

From the above it is clear that TITAN integration into the ATC system makes sense only if a specific requirement for information TITAN provides can be identified. On the other hand, air traffic control always benefits indirectly from more predictable turnarounds and early announcement of possible delays, since this enables better planning for ATC also.

2.2.8.7 Airport CDM Systems

As a result of the way Airport CDM was initially implemented, there is little commonality between the various solutions. Their ability to exchange DPI messages with the central unit for air traffic flow management is standardized but they are not as a rule built along the SWIM principles. It is therefore likely that most legacy A-CDM environment will require some kind of dedicated interface to enable them to use TITAN output. It is strongly recommended, however, that updates to the environment are made in a direction that would bring them closer to the SWIM principles rather than perpetuating the legacy solutions.

2.2.8.8 Airport Operations Systems

Airport operational systems in the current airport environment can be logically grouped into three sectors of operations:

- **Terminal**
  - Systems involved in the departure and arrival processes of the passenger.
- **Baggage Handling Systems**
  - Concerned with the handling of baggage.
- **Apron**
  - Systems concerned with all ramp services as well as taxiing of aircraft.

The systems can be described as segmented – that is personnel operating in each area of the airport work with their own local systems. The application of trans-sectoral systems (as depicted in Figure 2) allows limited access to share and access information that may be relevant to other sectors.

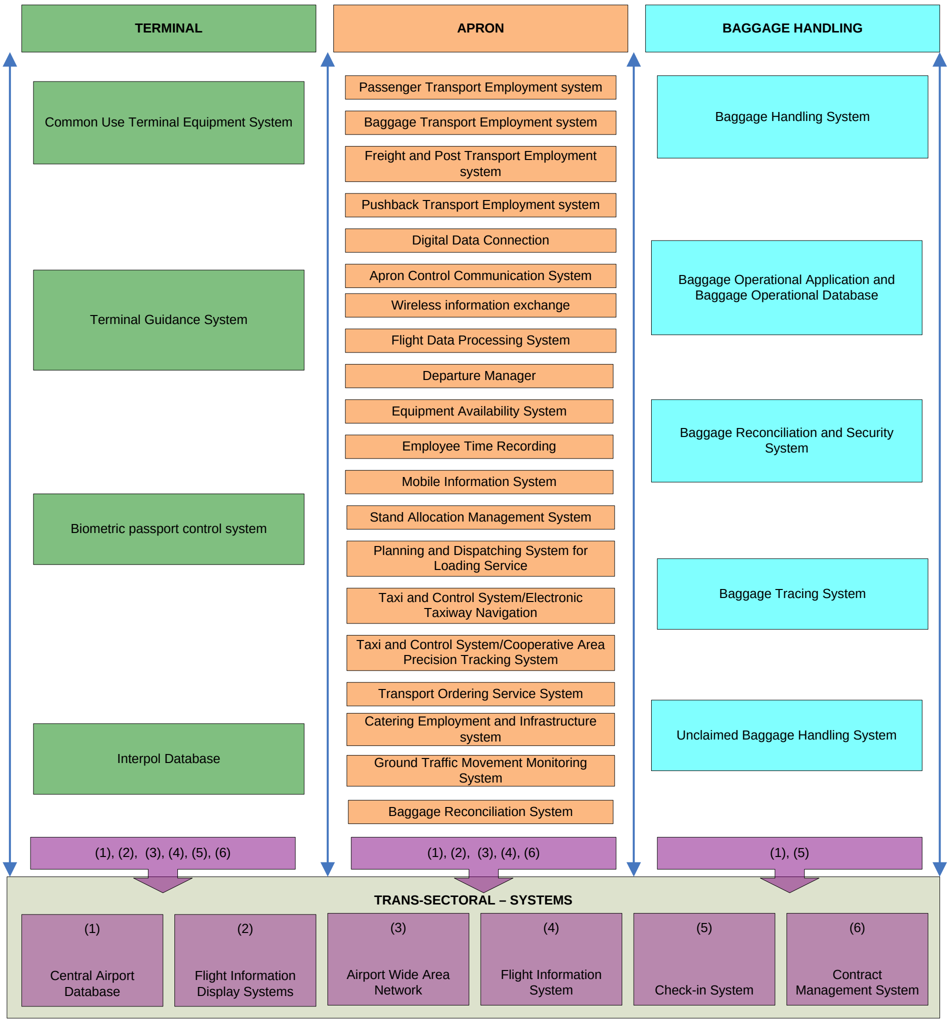

Figure 2: Overview of Airport Information Systems

Within each one of the sectors and their systems, the implementation and infrastructure available can differ based on the technology and operational processes. Computers, telephones and handheld devices can be technical equipment used to access the airport systems, and the data communication protocols and methods can range between voice communications, VOIP, Telex, SITA messages, IP etc. The conceptual maturity in the airport environment also influences the infrastructure needed and the information exchanged/managed. For example, airports which implement A-CDM may have systems allowing for more effective data exchange and system-wide information management between all the relevant parties in the airport environment, therefore bypassing the need for cumbersome trans-sectoral systems.

Regarding integration of the TITAN ConOps within the current airport environment, TITAN's intention is to be an information broker residing between the originators and the users of information, with respect to the turnaround process. Ideally this means the elimination of "trans-sectoral systems" for those involved in the turnaround process, and replacing the trans-sectoral systems with the TITAN ConOps Titan Information Sharing (TIS). The information required for TIS would need to be extracted from the existing systems for use in TIS, and any updates from TIS to other information systems may also require update access. The additional target milestones specific for the turnaround are isolated locally to the TIS, removing any coupling between additional systems milestone requirements and those which are local to the TITAN ConOps. Allowing subscription to TIS data for the main actors (those operating within the Terminal, Apron and Baggage Handling) means that actors across sectors can have updated information from each sector, based on their data access subscription. This premise applies whether trans-sectoral systems are in use at an airport, or whether a more sophisticated system-wide information management approach is taken.

TITAN will not need a full integration of SWIM to implement the ConOps, as the data required for the TIS can be taken from the current information pool and picked to fulfil the TIS data requirements. However, the ability for data from each one of the available airport systems to be brought into the TIS is critical for the TITAN ConOps to be successfully integrated in the airport environment. The principle of information handling in TITAN is predicated on all critical information of concern to the turnaround being shared on a system-wide basis in accordance with the agreed rules and security provisions in the airport environment. The totality of the shared information in TIS is made available to authorised users without them having to know where the information is actually located. The TITAN information environment is globally interoperable with other similar information environments, especially those at the airport, as well as legacy aeronautical information services via the use of appropriate data exchange models and common services.

2.2.8.9 AOC Systems

Airline Operational Control Centres are used by airlines as a means to regulate customer and disruption management as part of their airline operations. The AOC also has functions and divisions for long-term, midterm planning and execution on the day of operation which includes flight following and flight planning, maintenance control, crew and fleet planning. Irrespective of whether an airline operates as a non-scheduled or scheduled carrier, an international, domestic, regional or private operator, success depends upon having complete, positive operational control over their flight operations. The AOC task is to execute the scheduled plan to the best of its availability; however, the AOC also extends much further from sole "day of operations" management to plan and assist in all relevant activities to satisfy the business needs of the airline.

Within the AOC, functional groups exist with varying responsibilities and activities to assist aircraft processes. Table 1 provides an overview of the groups and activities within the AOC:

Functional Group	AOC Function/s
Operations Support	• *Airport analysis* • *Navigation data* • *NOTAM management* • *Post Flight Reporting* • *Training*

	• *Communications* • *Customer Data Service* • *Weather Services*
Operations Coordination	• *ATC* • *Aircraft Movement Control*
Operations Control	• *Flight Dispatch (Chief Dispatchers, Flight Dispatchers, ATC Coordinators)* • *Crew Briefing* • *Flight Planning* • *Weight and Balance Planning* • *Cargo, Load Control*
Crew Scheduling & Tracking	• *Crew Management* • *Crew Portal* • *Crew Tracking*
Maintenance Planning and Control	• *Maintenance Control* • *Long term maintenance planning*
Marketing Planning	• *Passenger services* • *Reservations* • *Schedule planning* • *Airport services*

Table 1: Overview of the Core Service Units within the AOC

Each one of the groups requires systems to facilitate its operations. The core systems accessed within the AOC environment can be loosely categorized as:

- Movement Control
- Flight Planning
- Flight Following
- Crew Management
- Load Planning
- Communications (messages, Radio, Phone Conferencing)
- Operations Analysis

To integrate with the actors who are not solely dedicated to interacting within the airline, access to external systems and interfaces can reach areas such as Slot Management, Maintenance Control, Reservations, Departure Control, Cargo and ATC.

In terms of TITAN integration within the AOC, TITAN will affect all those who require information about the aircraft whereabouts and the progress of the turnaround. It is not foreseen that TITAN will be required to integrate with the AOC services outside of the “day of operations” environment. However, the increased predictability of the turnaround process from the benefits of TITAN may be able to assist in the external planning and analysis tasks for the airline. With regard to the daily operations of the Airline, the integration requirements of the TITAN ConOps for the Airline environment are similar to the integration requirements of the airport environment. The AOC, especially those working in Operations Control, would benefit from having access to information in TIS, and some systems used in the AOC may benefit from updated information that is available from the TIS. The TITAN target milestones specific to the aircraft turnaround are locally specific to the TIS, therefore the critical airline milestone information can be separated and analysed for deviations that may endanger the reaching of the operational target milestones. Having this information decoupled from the other airline systems may also be useful for the airline as it gives flexibility to define other milestones or target activities that may not be central to the turnaround, but still have an effect on the operations.

The TITAN ConOps gives flexibility to the AOC to decide whether to apply the entire TITAN concept, or only parts which are of most interest to the airline’s individual operations.

2.2.8.10 Handling Agent Systems

Ground handling companies are using DCS (Departure Control System) and BRS (Baggage Reconciliation System) for automated passenger and baggage check-in at the airport. The DCS can be connected to an airline’s CRS (Computer Reservation System) thus enabling the identification, update and storage of passengers’ status in the PNR (Passenger Name Record).

The DCS handles all the basic operations required for passenger and baggage handling, such as:

- PNL/ADL message input
- Flight management
- Passenger check-in including seating
- Baggage registration
- Access baggage control
- Boarding control
- Flight closure reporting
- Post flight messaging

The BRS provides positive reconciliation matching checked baggage with the correct flight to meet with today’s security standards for international travel. In the event that baggage has to be offloaded, the baggage numbers are identified and transferred to the baggage loading scanners. After the pieces have been pulled, the database is updated accordingly.

CUTE (Common Use Terminal Equipment) is a common software, hardware and network airport solution that enables airlines and handling agents to access their own applications from workstations and printers shared by all users.

Another important system of the handling agent is the 'Weight and Balance' system, which can be connected to the DCS. Its aim is to analyse if the aircraft with the actual load is at or below the allowable limit(s) and whether its centre of gravity is within the proper range and whether both remains so during the duration of the flight.

Handling agents are also using software for contract management, service recording and billing.

Information from TITAN can help integrating data of different systems used by handling agents in real time thus enabling better situational awareness and enhancing the quality of the decisions taken. Decisions taken based on precise and timely information will result in better quality and faster disturbance resolution thus enhancing efficiency and productivity

2.2.8.11 Other partner Systems

One of the new features brought by TITAN is the ability to connect new partners (particularly on the landside) into the collaborative decision-making environment who have not taken part in CDM before. This complicates matters in as much as their data protocols may or may not be compatible with those used by TITAN and/or A-CDM. On the other hand, many organizations use various web-based applications where compatibility can be established relatively easily.

The range of potential partner systems is very wide, from transport companies via road maintenance and traffic control to city hotels or even the airport parking garages. In this respect the integration of TITAN means primarily coming to an agreement on what information they are able and willing to provide and what information they would like to have.

Only loosely coupled solutions are acceptable here to avoid the logistical problems that may arise from system changes undertaken in organizations too far removed from the core CDM environment.

2.2.8.12 Passenger Security Systems

In the time-frame considered by TITAN, the methods of security checking will continue to rely on discreet check-points and hence the potential for congestion will continue to exist. It is not foreseen that the scanning devices themselves will ever exchange information with TITAN, however, automatic or manual inputs to indicate a congestion situation to the passenger flow information service (PFIS) will be required. It is also possible that the passage of individual passengers will be recorded and the information shared to enable the proper tracing of missing passengers and to have a complete picture of the passenger flow. This may be of particular interest at airports where the new, risk-based screening policy is used, as different passengers will pass through security at different speeds and hence the use of average values is not appropriate or information about queues may need to be interpreted differently.

2.2.8.13 Information Technology Security

The TITAN environment must be properly protected against malicious intent both internally and externally. This is especially important in respect of the new, external partners.

Access to information must be strictly controlled and in particular, information of a competition or security sensitive nature must be protected so that only those partners/persons specifically authorised may access it.

A system for administering partner requests for participation and information must be set up and operated by a trusted organization.

It must be kept in mind that the A-CDM environment in which TITAN is implemented may already have some of the required IT security protocols in place. However, these are not likely to extend to the new, land-side partners.

2.2.8.14 Safety

The operation of TITAN does not have a direct influence on aviation safety. It must however satisfy all applicable safety requirements set against supporting equipment as defined by the appropriate authorities.

3. INTEGRATION PLAN FOR AIRPORT OPERATIONS

3.1 Operational Context and Benefits

Although airports increasingly earn their revenue from services to passengers (aviation services) and concessions in the terminal area and on the land side in general (non-aviation services), efficient operation of their airside resources, like gates and parking positions, play an important role in strengthening their attractiveness for aircraft operators and hence their competitive position in the face of other airports located in the same general area.

A more predictable turnaround process has a direct impact on the efficient use of gates and parking positions and consistent predictability brought by improvements like TITAN makes it possible to increase the gate and stand utilization ratio and hence capacity which is especially important at congested airports with scarce infrastructure resources.

The overall passenger experience is also an important competitive factor for airports everywhere. Since the TITAN services will enable better visibility of the passenger flows, airports will be able to optimize the flows to satisfy airline needs for punctual boarding, retail needs for revenue and the passengers' needs for a seamless, smooth, stress-free passage via the airport. Similarly, services dealing with the baggage flow will help in reducing problems that may arise as a result of baggage handling issues.

3.2 TITAN Usage within the Airport environment

3.2.1 General Considerations

It is expected that within the airport environment, TITAN will be integrated into an A-CDM environment. This is because TITAN draws from two of the major concepts within A-CDM; the sharing of information and the milestone approach to increase predictability of turnaround processes. However the TITAN concept is focused on the ground operations at the airport, taking into account only those stakeholders working at the airport itself.

Depending on the maturity of the airport and its adoption of Airport Operations Centre (APOC) concepts, the usage of TITAN within the airport environment can be viewed from multiple perspectives. As part of the future trajectory-based operations, TITAN is realised and used as a process to analyse the ground segment of the 4D trajectory. The planning of the 4D trajectory task is structured by the information model in TITAN and is facilitated by end-user applications making use of the information available from TITAN. The TITAN operational concept (ConOps) would be integrated into an airport environment which supports collaborative decision-making and is able to provide milestone information from its CDM process. As part of the TITAN ConOps, the ability to subscribe to and unsubscribe from shared data over the TITAN services suggests that airport actors involved in the aircraft turnaround can receive warnings and updates based on their assigned access and levels of information.

It is accepted that the TITAN ConOps practical implementation will offer a set of services which are loosely coupled. The services would most likely be made available over a Service Oriented Architecture (SOA) based solution, where the stakeholders can be connected to the services with IP (internet protocol) infrastructure. The available services for use within the airport environment would be the following (as part of TIS):

- Passenger Flow Information Service - PFIS
- Baggage Flow Information Service - BFIS

- Cargo/Mail Flow Information Service - CMFIS
- Aircraft Status Report Service - ASRS
- Airport Information Report Service - AIRS

It is then expected that for the successful use of TITAN at an airport, the TITAN Information Sharing (TIS) and its services shall be available (by request) to all stakeholders involved in the turnaround process. The TITAN ConOps is flexible in stating who should receive what information, and instead only defines the actors who should be receiving important information, and the services available to receive information from.

To realise the TITAN Turnaround Concept in the airport environment, it is proposed that all stakeholders involved in the turnaround process have access to the information shared through TIS, via their service subscriptions. Warnings should also advise the stakeholders on the current state of their activities within the turnaround, and whether specific/further actions are to be executed to reach target milestones in the turnaround. The TITAN milestones will be local to the TIS, however the milestones required for the turnaround which are local to Airport-CDM can be accessed and extracted from other systems without duplication within the TIS.

For TITAN usage in the airport environment, it is agreed that beyond information-sharing functions, TITAN must have extra decision-support functionalities as well as provide a higher level of granularity in turnaround information sharing and milestones than the one proposed by A-CDM; otherwise there is no point in implementing it over a working CDM system. Therefore, for TITAN usage by an airport, the landside and off-airport (e.g. public transport) information is shared also. The TITAN implementation at the airport should also allow for extensive automation in sensing facilities, trend analysis and early-warning decision support. Based on CDM and enhanced-resolution TIS data, TITAN focuses on the automated, multi-level early identification of possible problems of the operation, driven by customizable algorithms and notification policies.

Humans are still core resources within an airport environment, and TITAN still accepts this premise. Humans will decide what needs to be done, delegate the execution of the task(s) to automation and are able to intervene in the turnaround process if required. Taking benefits from the net-centric, information-sharing approach, automation will support the turnaround planning and management in many aspects such as supporting dynamic planning or decision-making procedures. The TITAN vision for stakeholders within the airport environment is to minimise the potential for errors; involved users in all phases of system design; emphasise that the human experience in the future system while different, is not less attractive or less important than today; and allow access to additional information and automation to assist humans to carry out their activities in a safe, efficient and effective way, without replacing them in systems. Implementation of the TITAN concept will allow each turnaround actor to optimize their decisions in collaboration with the other stakeholders knowing their preferences and constraints and the actual and predicted situation. The decision making is facilitated by the sharing of accurate and timely information and by adapted procedures, mechanisms and tools.

3.2.2 TITAN Communications and Support

Communications are a core part of the TITAN ConOps, in order to facilitate data sharing. The implementation of communications can vary within the airport environment – with extremes from a runner carrying a sheet of paper from point A to point B through to an automated system publishing a message to all subscribed listeners. To allow for the automation and subscription to TIS and its services (PFIS, BFIS, ASRS, CMFIS and AIRS), a service oriented communications architecture solution is expected, meaning that there is a connection to internet protocol infrastructure for information access. With access over internet protocol, this ensures that information can be filtered to stationary electronic devices (computers, stationary laptops), as well as mobile devices used in the airport environment (Smartphones, tablet PC's, portable laptops).

It is expected that operationally, TITAN will rely solely on electronic communications which can be implemented very robustly and with a degree of redundancy to minimize issues such as broken equipment preventing messages from arriving at their destination. Some extra details need to be considered [TitanToolReqs]:

- Data sources: the same information could be provided via different sources depending on the physical location (i.e. different airports with investment in different technologies, or even different stakeholders within an airport).
- Data ownership and integrity.
- Security, protecting sensitive information and blocking any malicious intent. This will be ensured by authorized and controlled access to the TITAN Information Model for all partners extracting and/or providing information to this network.

It is therefore expected that any information sharing shall define a common "language" for use within TITAN and use portals or gateways to interface with external systems that do not speak to TITAN natively.

3.3 Airport environments to consider

In general, aircraft operate in a heterogeneous environment and thus need to be able to interface with systems of different maturity levels, reaching from highly automated major hub airports to smaller airports with only basic infrastructure. This section introduces the different environments under which the TITAN system needs to operate. The goal of this section is to give a concise overview on legacy environments, airports within the SESAR/ECAC domain with or without an Airport Operations Centre and also airports of non-ECAC states.

3.3.1 SESAR APOC

Within the SESAR framework, the Airport Operations Centre is the „forum where operators will communicate and coordinate, develop and maintain dynamically joint plans and execute those in their respective area of responsibility." It is part of the "Total Airport Management" concept and complemented by the airport operations plan and the airport performance framework. Different possible APOC-implementations are expected (ranging from distributed virtual APOC to a high-tech physical APOC for example) depending on the size of the airport and its operations.

The APOC operates on information derived from the Network Operations Plan, i.e. information on shared and reference business trajectories (SBT and RBT), updates to RBTs, Capacity and Demand Balancing and further information derived from APOC peers.

By facilitating RBT and SBT updates, SESAR APOC airports are likely to operate at a higher degree of automation, offering automated interfaces to Airline Operations Centres, aircraft and other airport stakeholders to support the Collaborative Decision Making Process.

3.3.2 SESAR NON-APOC

ECAC airports that do not support an APOC are at least considered to facilitate the collaborative planning process, i.e. the collaborative update of the Airport Operations Plan (AOP) that will contribute to update the Network Operations Plan (NOP).

Given this, aircraft operators may expect that a certain performance target is met when servicing the given airport, but the turnaround process may not be as robust in respect to disturbances as for airports that have an APOC.

3.3.3 NON-ECAC States/Legacy environments

Airports that are located outside the European Civil Aviation Conference area may facilitate anything from full Collaborative Decision Making to basic services (i.e. legacy environments).

These airports may use systems with non-public and/or non-standardised interfaces and are from a CDM perspective the most difficult to operate on. Operations on these airports may not assume the existence of any digital interfaces, which would enable Airport Collaborative Decision Making. Nevertheless, when servicing major hub airports, airline operators may expect airports capable of CDM, though CDM is likely implemented using different interfaces and protocols.

3.3.4 Conclusion

Since airlines operate to airports of different types and sophistication, a tool like TITAN must be able to provide decision-making support in a variety of circumstances. Airports with sophisticated IT support are candidates for easier integration of TITAN, both functionally and from the IT perspective, than airports with less to offer.

Another complicating element is the availability of data to support the different milestones. At some airports getting all data required by TITAN may prove overly expensive and hence ruin the business case.

It is not true that a concept like TITAN would prove beneficial only at airports with high traffic and a complicated environment. TITAN may have a big impact on the operations of a simple airport with relatively many flights of a given airline if, for instance, the tarmac is regularly blocked by parked aircraft. A concept like TITAN, with its ability to signal possible disturbances well in advance, would then be extremely desirable at such a simple airport also. At the same time, it is such airports that might prove challenging in terms of IT support and/or the availability of data.

A scalable and flexible TITAN realization can ensure that the concept adapts to these varied circumstances and provides at least some of the potential benefits under all conditions, retaining a positive cost/benefit ratio.