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DORA – Integration of air transport in overall urban and regional mobility information

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Abstract

DORA stands for "Door to Door Information for Passengers and Airports" and targets on seamless integration of air mobility in the overall urban and regional transport systems. Integrating real time data and incident information of both transport modes in one information system the DORA closes the information gap between air transport and landside transportation. The overall goal of the DORA project activities is to optimise and reduce the total travel time, taking into account origins and final destinations of the travels and make sure that even in case of land traffic disruptions and critical situations at the airports the passengers arrive at the airport in time to complete all necessary clearance procedures before entering the plane. The DORA system is based on two innovations: A cross-modal incident management and information system to ensure the accessibility of airports at all times. This system is based on the cooperation of all transport operators to manage disturbances in the airport bound public transport system and road traffic based on pre-defined action plans and information strategies. The second pillar is a multimodal mobile information service for air passengers. This DORA app helps passengers to plan their trip to the airport, to find the shortest way in the terminals and provides passengers with the trip recommendation on how to travel from the destination airport to their final destination. The third pillar is the exploring of technologies for time efficient procedures in the terminal. Special emphasis is put on detection of waiting times at check-ins or security checks and indoor routing and navigation technologies to improve the service quality in the terminal. DORA will be a seamless solution through considering scheduled and real time services of all flight connection and urban transport modes and terminal proceedings (luggage belt, security gate, departure gates), The system will integrate services for a door-to-door journey planning, booking and ticketing for landside transport with strategic compliancy (with static and dynamic control strategies) of operator and municipalities, as well as online trip monitoring.

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1. Objectives

DORA is a research and innovation project funded by the European Commission in the framework of Horizon 202. The project addresses the call MG1.3-2014: Seamless Air Mobility. DORA is planned as a 3 year project that started in 06/2015. The project consortium is coordinated by Eurescom and consists of a European expert consortium of airports (FBB for Berlin, AENA for Palma) industry partners (VMZ; ETRA), transport operators (VBB, EMT), academia (UPVLC, TUB, LUT) and public authorities (City of Berlin and City of Palma de Mallorca) (see www.dora-project.eu).

DORA project is aiming at the design and establishment of a seamless and integrated information system that helps passengers optimise travel time from the origin of a trip to the airplane at the departing airport as well as from the arrival airport, to the final destination. Accordingly, the DORA integrated information system, is aiming at the reduction of overall time needed for a typical European air travel including the necessary time needed for transport to and from the airports. The integrated solution will be providing consequently, beyond the added value of travel optimisation, a single point of visualization of the overall trip eliminating the need for combining information (public transport schedules, ticket, maps) that has to be collected manually by travelers from different and heterogeneous sources.

To ensure this, the DORA system will provide mobile, seamless, and time optimised route recommendations for travels to the airport and time optimised routing within the airports, leading the passengers through terminals to the right security and departure gates.

The collaboration of strong operating partners in the sites ensure that the necessary data for landside and air transport can be incorporated in a real-time and seamless information chain. The airports involved provide up-to-date time flight information. The real time information of all land side transport options available in the sites will be provided by the traffic information centers and transportation associations in the sites.

Furthermore, DORA will integrate all necessary real time information on disruptions in the land transport environments and on incidents in the airport terminals to provide the fastest route alternatives, ensuring the accessibility of airport and airplane at any time in accordance with individual passengers' requirements. The DORA system will be designed in a generic way and provide software development templates and open Application Programming Interfaces (APIs), to ensure that it can be widely adopted independently on passengers and airports locations.

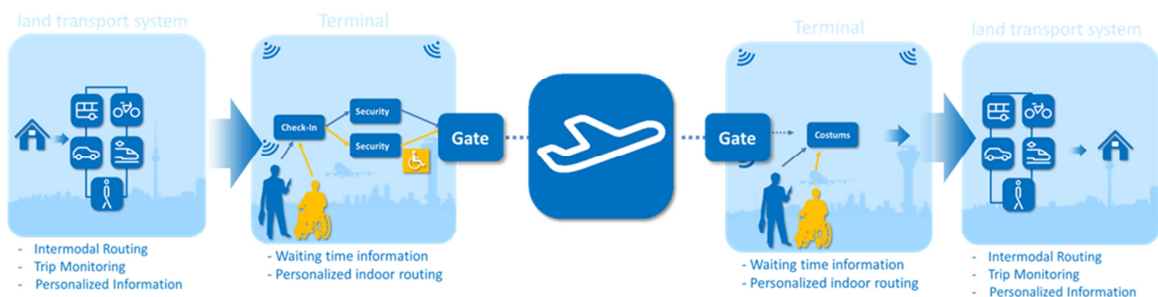


Fig. 1: Dora – Information Services for Passengers

The DORA system will be a **seamless** solution through considering scheduled and real time services of

- all terminal proceedings (luggage belt, security gate, departure gates)
- all flight connections
- all urban transport modes (car, public transport, bike, walk)
- all urban flexible service provider (car sharing, bike sharing, taxi, car rental)

The DORA system will be an **integrated** solution through considering one single system for

- door-to-door journey planning (App and Web-GUI)
- booking and ticketing for landside transport (car- and bike sharing, public transport)
- guidance and navigation (disruptions, re-routing)
- strategic compliancy (with static and dynamic control strategies of operator and municipalities)
- personalized services (routing and navigation criteria, mobility constraints)

The DORA system will be implemented and tested in realistic environments involving the cities of Berlin and Palma de Mallorca as well as their corresponding airports in both cities and involve real end users – passengers – in the trials. To support the passengers' route optimisation, the DORA project will investigate and design technologies for recognition of waiting queues and indoor location services in airports, which will be integrated into the DORA system and tested within the project trials.

The overall goal of the mentioned DORA project activities is to optimise and reduce the total travel time, taking into account origins and final destinations of the travels (home, office, hotels ...), of air passengers and make sure that even in case of land traffic disruptions, critical situations and congestions at the airports the passengers arrive at the airport in time to complete all necessary clearance procedures before entering the plane and after landing at the destination airport.

2. Research and innovation objectives

DORA combines research and innovation. Research is done by exploring new technologies to better organize terminal procedures. Innovation is focused by implementing new services integrating existing information systems that are already in use in one seamless information system.

DORA partners are DORA's main objectives are:

2.1. Long Term Door-to-Door Journey Planner

As the basic DORA component a seamless and integrated Door-to-Door Journey Planner Service will be realized to integrate existing transport mode specific real time information services in one overall intermodal traffic information platform for land and air transport. The intermodal platform will gather and analyse the required traffic information in real time, which is necessary to provide needed information to the air passenger on his journey to the airport, with a seamless information covering all transport modes and all stages of the journey, and suggest optimal routes for travels to and from airports. The platform will also be designed for usage by further interested parties, such as travel agencies, airlines, airports, etc. By open interfaces which will be established, they can embed the DORA functionalities in already existing or new applications.

The concrete target of the objective is to make the intermodal platform for Air and Land transport available in its full functionality. Furthermore, the Journey Planer will enable the end user applications for routing optimisation and will integrate technology solutions for recognition of waiting queues and indoor location services in airports.

2.2. Applications for Seamless Mobility Information

Based on the concept of the Intermodal Journey Planner, described above, the DORA project will design and implement applications for smartphones and the internet. These applications are enabling the end users to receive seamless mobility information covering all transport modes and the entire mobility chain from the origin to the

airports and planes, including the final destination. The route, the mode change nodes and the indoor path in the terminal is shown on maps to support the orientation of the passenger. Detailed information on expected disruptions like road works and un-predictable events are given. The smartphone application will be realised as an intermodal routing planner that integrates and processes the available real time information on land transport means, terminal procedures, and air transport. Ticketing for land transport means will also be integrated. A trip monitoring function of the smartphone applications will register disturbances on the selected route and provides alternative routes when necessary. Beside the smartphone applications, the project will also create a corresponding web application and web interfaces for the end users with the same functionality, to be integrated to web-portals or existing and new mobile applications of airlines, airports, and further interested stakeholders to allow a broader usage.

2.3. Personal Information Service

The DORA mobility information platform and the smartphone application will be also designed to ensure personalised services, in order to meet requirements of individual passengers and specific end users' groups, such as people with reduced mobility, families with children, frequent travellers, etc. Thus, the target is that the end users individually can configure the smartphone application so that the provided routing information is calculated in accordance with individual mobility preferences and constraints. The system will take into account the needs of specific user group such as family travellers, business traveller, senior, people with mobility impairments and others.

2.4. Incident and Information Management for Airports

DORA will use the Incident and Information Management for Airports system available in Berlin. It is based on a cooperation of all operation centres involved in control and information of airport-bound transport and ensures that in case of disruption the airport remains accessible and air passengers are informed consistently. The DORA information portal will also be linked with this incident and information management system for land and air transport, which is already in place in Berlin. The AIRVIS system will be extended by terminal strategies including security gates terminal incidents.

2.5. System for Detection of Waiting Time in Airports

It is the traveller's responsibility to arrive at the airport with enough time to complete all ticketing, baggage check, and security clearance procedures, but the waiting times at check-in and security control are not predictable. To handle this, the DORA project will design and implement a waiting time detection system in the airports based on image recognition. The information gathered in this way will be processed by the DORA information platform and corresponding end user applications for route optimisation. To ensure privacy of the passengers and employees in the airports, the planned video observation procedures will be fully anonymised without possibility to recognise individuals on the images.

Additionally, users can also contribute into detection of delays and queues by verifying and uploading events into the system. These notifications can be triggered by detection of any changes in the regular or current moving pattern of the user in combination with the current location.

2.6. Indoor Location and Terminal Navigation Service

The DORA project will explore innovative technologies, e.g. on the WLAN or beacon technologies, for indoor location in the airports to be used by the DORA system to suggest optimal routes to the passengers through terminals, security gates, etc. The passengers will be located in the airport buildings by analysis of the data available in the WLAN base stations installed in the airports, so that optimal routes through the buildings can be estimated based on the passengers locations. Beside usage of the WLAN based stations, the project will also elaborate further opportunities for the location service. After selection of appropriate approach, the location service will be

implemented and linked to the overall DORA platform, including its functional testing. The location service will also be a part of the planned field trials.

3. Concept

DORA provides up-to-date information on the whole travel chain – from home to the final destination covering all journey stages.

Technically, DORA system consists of its main component intermodal router, connected with the components processing the waiting time detection in the airports and the in-door location and routing. These components will be investigated, designed and implemented in the scope of the DORA project.

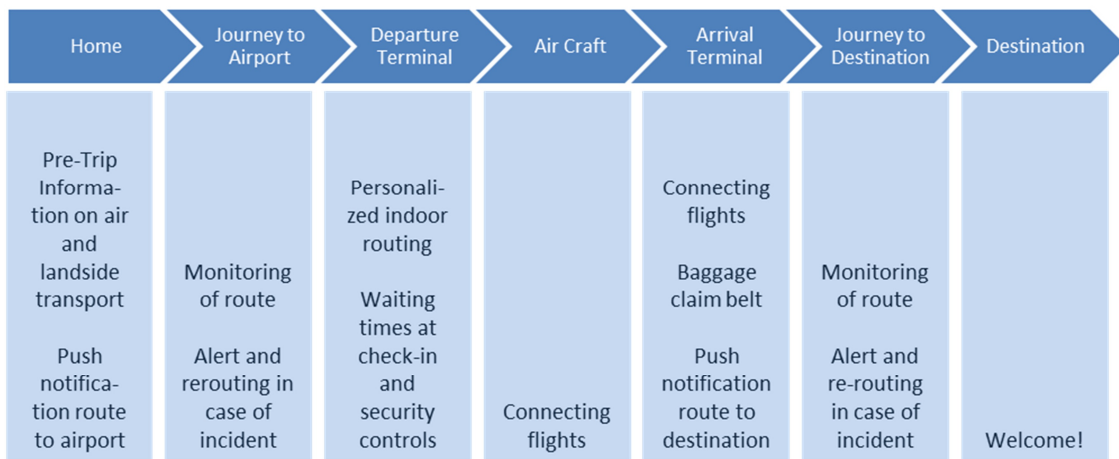


Fig. 2: DORA travel chain and information

On the other hand, the intermodal router is connected with AIRVIS and FARMS systems for gathering necessary information on land traffic conditions on transport way to the airports and status of the air transportation timetables. These two components already exist and DORA project will ensure that they are connected with the overall DORA system and will design necessary interfaces.

The **intermodal router** processes the available information from these four components and provides related routing information to the end users' smartphones and web applications, which will be also created and implemented in the DORA project. The intermodal router relies on real time information provided by the public transport operators and traffic information centres as well as DORA modules for waiting time detection and in-door location and routing, which is processed and made available to the end users in form of route suggestions. The intermodal router can be implemented as a central component covering a particular region (e.g. City of Berlin and Palma Island) or several areas in the scope of a generic approach. Furthermore, to support passengers routing within airports, instances of the intermodal router can be implemented locally. The communication with end users is ensured through public Internet service and also by using the WLAN networks in the airports.

The **Waiting time Detection** component will ensure collection and analysis of the gathered data from cameras distributed in the airports and provides necessary feedback information to the intermodal router on the waiting queues.

The DORA component for **Indoor Router** will include localisation of the passengers in the airports based on data available from WLAN base stations Access Points distributed in the airports, and complemented from

cooperative information from other users; smartphones IMU (Inertial Measurement Unit) and other wireless sources like Bluetooth beacons; supported by signal processing and filtering techniques. By having this information available it will be possible to suggest the best possible route through the airport in accordance with the building structure and actual waiting time at various positions and routing strategies. The main challenge on the indoor-routing will have to meet is the accuracy of the positioning provided.

Incident and Information Management for Airport-bound traffic (AIRVIS) system supports traffic control and operation centres with a cooperative management of major disruptions. Based on pre-defined strategies the control centres of air transport, public transport and road traffic manage disruptions consistently and inform the passenger using information services of different operators. The system is presently being tested in Berlin and will be adapted to the needs of the DORA project for its both field trial sites.

FARMS – Flight and Resource Management System is the central flight management system at the airports. It is a database (AODB – Airport Operational Database) holding all information about planned and processed inbound and outbound flights combined with the resource management system (RMS). FARMS receives in advance the time tables of planned flights and the resource management combines these with the available airport resources such as gates, air bridges, parking positions etc. Out of these data, daily time tables are generated in combination with information of the airport operator and air traffic control.

4. DORA Architecture

The DORA concept and approach outlined in the previous section will be addressed in an open, distributed and scalable architecture. The aim is to achieve and validate a transferable solution that enables easy implementation in other airports and in systems of other third parties (e.g. airlines, travel agencies and booking platforms). The system requires a smart connection of some existing, local services and the creation of integrated core services to provide the system with the seamless intermodal door-to-door functionalities. The overall architecture is a decentralized with a central platform and central applications. The architecture consists of three parts: The application-layer, the DORA platform and the distributed existing, new or modified services in each pilot site.

The key design principle is a service oriented approach, being followed in the definition and realisation of the DORA platform. There are a lot of existing decentralized local basic real time traffic and mobility services in the pilot sites in Berlin and Palma de Mallorca. One challenge of this project is the integration of real time information. There are very ambitious data, quality and non-functional requirements on the integration of online data. This leads to the architectural approach of integration of real time services, not in real time data integration.

To make sure that the seamless mobility information of the DORA system is consistent to the local existing information services of the operation centres like public transport operators or airports, these stakeholders are involved in this project and the technical systems are cross-linked and integrated within the DORA platform. Even in case of incidents or disruptions, real time information services are very important and can achieve a very high benefit, if incident information strategies exist and if these strategies are linked to the end user information systems.

4.1. The DORA Platform

The DORA Platform provides the main services and functionalities of this project and has open interfaces for providing the services to the end user services and operation centre applications. The DORA platform is a central platform and contains all universal services which are not pilot site specific and which have open interfaces, are scalable and highly transferable. The DORA platform is the main outcome of this research project. All platform services except the Intermodal Landside Router will be entirely developed within this project.

The scalability of the DORA platform will be realized by using advanced **cloud computing** techniques. It allows to process more transactions and more services at the same time and to scale regarding the actual load. The DORA platform will be equipped with **open interfaces** to both sides: The application side and the distributed services side.

The Journey planning service is the major resource for the personal seamless mobility planning and operation processes supported in DORA. The DORA platform will feature an open interface, based on reference standards, to

interoperate with the DORA application. In addition, the open interface is suitable for the integration of the journey planner service in 3rd party apps being published by airports, airlines or public administrations.

For easy integration of local ITS and mobility services in the DORA platform, to reach a high transferability of the DORA system and to ensure **interoperability**, the DORA platform will offer provider group specific open interfaces. Starting points of the open interface development are EU ITS and national standards and de facto standards. The main functional elements of the DORA platform are briefly outlined as depicted in figure 3.

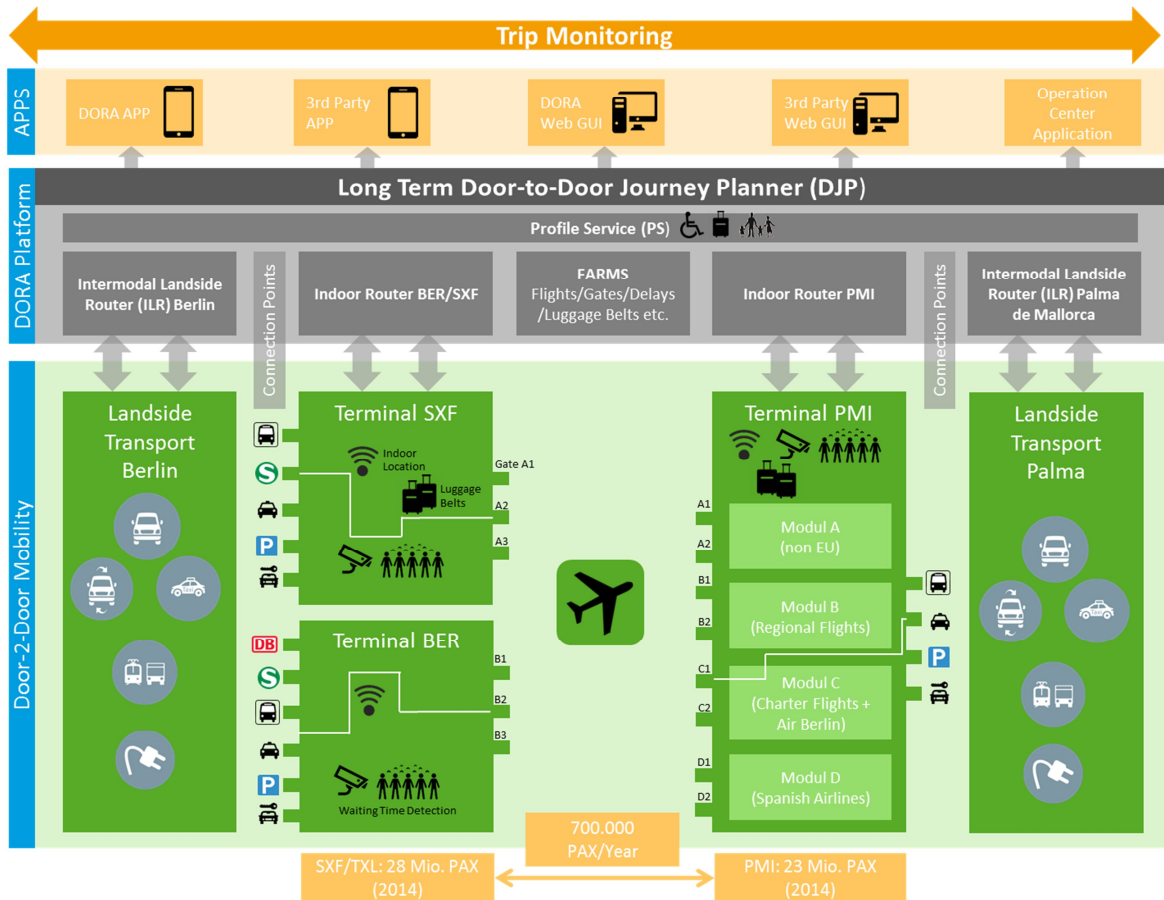


Fig. 3: DORA Platform

4.2. Distributed Services

Service integration is a design paradigm of the DORA system. In order to provide a reusable and transferable overall solution to support efficient planning and operation of seamless door-to-door services, the DORA services are built by using a set of decentralized existing services. Because the focus is put on service integration and not on data integration, we can use existing high quality value added real time services.

There are two types of distributed services: Services which provide real time data for the journey Planner and services in operation centres of the information and incident management system.

Except of the operation centre services all distributed services are existing services. The task in this project is the integration of these services in the journey Planner and to derive a general method for the integration of external, distributed services in the DORA platform.

The distributed services are either connected via their proprietary interfaces or via open interfaces to the DORA platform.

4.3. Applications

Based on the underlying components of the DORA platform this layer is comprised of services and applications providing end user support for personal mobility and for operation centres.

The goal of the end user **DORA smartphone application** is to provide citizens highly personalized services for seamless mobility door-to-door planning and travel assistance during the trip including rerouting if necessary in one application. The recommended journeys and assistance information are concerted to incident and information strategies. The planning part of the allocation helps to find the fastest way and the assistance part reduces the required time buffer, because the user is informed proactively of delays and supported with alternative connections if necessary. The smartphone application is exclusively connected with the open interface to the DORA platform. The app is a multi-language app and should be easy to use and available at least for Android and iPhone to guarantee a large group of test users.

In addition **3rd party apps** are invited to use the open interface and SDK for an integration of the Journey Planner service in apps of other actors. The benefit of this is a much higher dissemination of the Journey Planner services and that different business models of different actors can co-exist.

The **incident and information management panel** provides public administration and traffic control and operation centre with cooperative management mechanisms and tools to support DORA's Incident and Information Strategy service with routing policies and strategies for urban street environments and airport terminals. In case of major disruptions, based on pre-defined strategies the control centres of air transport, public transport and road traffic, manage disruptions consistently. Through information services of these different operators and the storage of dynamic strategies in the DORA platform, the passenger will be informed consistently and promptly via the DORA end user information.

5. Test sites



Fig. 4: DORA Test sites

The proof of the DORA concept and the test of the system will be executed in the field trials at the airports of Palma de Mallorca and Berlin (SXF and BER), including respective transportation regions.

The two airports reach more than 40 million of air passengers per year which corresponds to almost 5 % of all intra-European flights.

Germany's 2nd largest airline Air Berlin holds a major hub at Berlin-Tegel airport and serves connection to Palma de Mallorca up to six times a day, which together with other airlines amounts to a total of 690,000 passengers travelling between these two destinations in 2013.

6. Business models

In order to realize the benefits of DORA, the business framework need to be established. The business model typically considers critical factors related to economic (sources of revenues and costs), business architecture, value proposition and value chain position. It gives guidance on how value is created and delivered.

DORA generates value in multiple ways: financial benefits (such as cost savings and revenue), societal benefits (e.g. increased efficiency of public transport, prevention and mitigation of disruptive events), environmental benefits (e.g. reducing traffic emissions due to added use of (greener) public transport) etc. Today, many business frameworks need to be dynamic and take into account multiple stakeholders. In DORA the value is created in multiple ways and divided across the involved (public and private) stakeholders. Also costs are maintained in close collaboration within several actors. The core of the business framework for DORA is to manage the ecosystem of multiple types of actors ensuring the value generation and capture for all parties within the network.

In the heart of DORA business model is the core solution including the most crucial actors (passenger, airports, airlines, transport operators) and features (e.g. development of software and secure information flows). DORA delivers value for stakeholders by managing the information and money flows within actors.

After successful establishment of the core DORA business solution, additional features may be implemented. This means integration of new stakeholders such as airport shops, cities, information centers etc. DORA offers also possibilities to the integration to other already established platforms (such as Tripadvisor). These set new requirements for the system development but also need dynamic approach to business models. The sustainability of DORA operation may be solved by appropriate, dynamic networked business model(s) including the approach of open and continuous innovation.

7. Ongoing works:

DORA started in June 2015 with a Market Analysis and the definition of user and stakeholder requirements. It is planned to start development of the services in the beginning of 2016 to have them available for testing in late 2016. The trials are scheduled to start in the beginning of 2017 and last for 12 months.