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PROJECT FINAL REPORT

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4.1 Final publishable summary report

4.1.1 Executive summary

Be it snow, volcanic ash or strikes, crisis events impose huge costs on the air transport system and society and it is the passenger who bears the practical consequences. Collaborative Decision Making (CDM) has been hugely successful at enabling advanced air transportation concepts such as ground delay programs and airport departure managers. Implementing Airport CDM (A-CDM) helps to mitigate the effects of delay upon Air Traffic Flow Management (ATFM) slot adherence and although it helps airports, airlines and ground handlers in optimising their resource allocation, landside efficiency is not within its current scope. To fully handle crisis events and include the passenger in the CDM process an extension of A-CDM to the landside is needed.

The MetaCDM (Multimodal, Efficient Transportation in Airports – Collaborative Decision Making) project aims to define the future of A-CDM – a future where CDM techniques can be used to address major disruption, and where the needs of the passenger are the centre of attention. The project had three main phases:

- A comprehensive literature review of existing CDM efforts and responses to disruptive events,
- A series of stakeholder interviews to gain insight into how disruption is currently handled,
- A concept development phase in which the lessons learned were used to formulate a framework for landside CDM processes in response to disruption and the potential economic and environmental benefits of utilising this framework were assessed.

The outcomes of these phases were reviewed throughout the project via a series of stakeholder workshops, at which participants advised on future steps and influenced the concepts being developed. At every step, the practical advice of those who have dealt with air transport system disruption was vital. The three-stage workshop process reviewed the current state of CDM and response to crisis events, focused on lessons learned from MetaCDM's series of on-site interviews with affected stakeholders and discussed the final project outcomes, future directions, enabling technologies, and steps towards a new passenger-centric concept of operations.

The data-gathering and information synthesis carried out during the project form the first steps towards bringing together an extended CDM concept – one in which airside, landside and ground transportation providers work together to optimise the passenger experience and reduce disruption costs. Based on the existing A-CDM standard, this report outlines the key functional groups needed to bring extended CDM into practice. We propose a milestone-based approach for door-to-door air passenger journeys which is straightforwardly adaptable to cases of severe disruption. The concept is designed to provide benefits to stakeholders even under normal conditions. In crisis situations, the milestone approach adapts to encompass ground transportation and other alternatives. The passenger is kept fully informed and in control of their journey.

Detailed reports on MetaCDM results and workshops can be downloaded freely from the MetaCDM website (www.meta-cdm.org).

4.1.2 Project context and objectives

Recent years have seen a number of major disruptions due to natural elements (for example, ash clouds and heavy snow storms) causing severe delays and cancellations in the European aviation system. The volcanic eruption in Iceland in 2010 resulted in the cancellation of 90% of flights in Northern Europe over six days, costing airlines more than a billion euros in revenue. In such cases, airlines have little control over cancellations and passengers may be re-accommodated several days later. However, the majority of passengers' journey disruptions can be attributed to everyday delays and cancellations.

Flight delays or cancellation data reflect an aircraft-centric point of view. For a passenger, a disruption corresponds to any change to the itinerary planned or the package purchased. To an airline, "Irregular operations" encompass delays, missed connections and cancellations. They may be due to natural causes (such as bad weather) or air traffic delays, factors that are beyond the airline's control, or to strikes or mechanical problems, which the airline may be able to influence. No matter the cause, for a passenger, an irregular operation corresponds to any change to a booked element of their original itinerary. Depending on the purpose of the trip, even a moderate flight delay can be a major disruption to the passenger's overall journey. A passenger-centric viewpoint is also key to understanding the passenger's door-to-door journey as a whole, in which airport disruption may be caused by or may impact on disruption for passengers travelling to or from the airport. Although airlines are obligated to provide passenger assistance when major delays occur, passengers are often not aware of their rights and many complain of not being given enough information in these situations. Airlines are required to provide alternative transportation to stranded passengers (nearly always a later flight, often the next day) and/or a refund. Sometimes passengers decide not to use this re-accommodation provided by the airline and instead find alternate transportation modes on their own. Although they may get to their destination sooner by this method, it requires both confidence and access to information which is often hard to obtain in the situations stranded passengers find themselves in.

The 9th annual SITA survey [1], in partnership with Airports Council International (ACI) and Airline Business, reports that improving passenger experience is the number one driver of Information Technology (IT) investment by the majority (59%) of the world's airports. An example of changes passengers can expect to see in future is a rapid increase in mobile and social media apps to deliver a more personalized customer experience. Keeping passengers informed about their flight status and wait times is the top reason for airports providing mobile apps, with 88% planning to invest in them by the end of 2015. During this period, 78% of airports also plan to invest in social media.

As the number of passengers continues to rise at airports across the world, optimizing the use of the available real estate is a priority and passenger flow management will become more and more important; half of the airports see geolocation as a top priority for reducing passenger congestion. Within the next three years, new way-finding services are set to become commonplace on mobile devices, allowing passengers to navigate easily through the airport.

Just 10% of airports provide them today but this figure is set to jump to 70% by 2015. Airports are also investing in business intelligence solutions to deliver an improved passenger experience. Some 86% of airports see it as a priority for sharing information and collaborating with partners; 83% to ensure more accurate service information for passengers; and 76% to reduce flight delays due to ground operational issues [1].

With airports planning to invest in business intelligence, and using it to better collaborate with partners, it is clear that there is a strong desire among operators to work together with stakeholders, including airlines and ground handlers, to create a better passenger journey. While the growth of personal mobile devices is an opportunity for air transportation providers to decrease fixed asset costs, the delivery of relevant time-critical information has the potential to enhance the situational awareness of travellers and their opportunities to either actively participate in the decision making process regarding the planned travel and/or to re-plan the travel on their own.

These ongoing trends and identified needs lead directly to the MetaCDM project, which aims to investigate how A-CDM concepts can be extended to provide more support to passengers, particularly during crisis situations. The project has developed a concept of operations that describes what is operationally needed to allow travellers to participate in the CDM-process to their own benefit. Because there is already an existing standard for A-CDM, the ETSI EN 303 212 V1.1.1 (2010-06) [18], the project partners decided to choose an analogous set-up for describing how MetaCDM should work. This concept of operations focuses on the operational needs and procedures required, but does not go into detail on the functional requirements and on what must be implemented to make MetaCDM a reality. It does, however, suggest a number of actions that would need to be taken by stakeholders to move towards that reality.

The project had three main phases:

A comprehensive review of existing CDM activities

The initial stage of the MetaCDM project brought together existing information on CDM activities, both practical and theoretical, into one comprehensive source. By identifying the state of the art in airside, landside and total airport CDM, and by reviewing past disruptive events and the literature available on how they were managed, MetaCDM formed an initial knowledge base upon which the interview and concept development phases of the project were built. This review is freely available from the MetaCDM website, and the findings are discussed further in Section 4.1.3.1 of this report.

Stakeholder Interviews

On-site interviews and questionnaires with stakeholders formed a key part of the MetaCDM project. We interviewed stakeholders who have had to deal with disruptive events in the past and prepare for those in the future – airlines, airports, air navigation service providers, ground transportation providers and others. Amongst other questions we sought to understand: What strategies and response plans to major disruption exist for each stakeholder? How do they (or could they) interact with A-CDM? To what extent are they currently coordinated beyond the air transport system, and what means exist for greater cooperation? What are the potential benefits (and risks) of doing so? What new ideas in disruption management deserve to be pushed forward? Our report on the interview outcomes is freely available from the MetaCDM website, and our findings are discussed further in Section 4.1.3.2 of this report.

Laying the foundations for an extended CDM concept

Landside and Airside CDM can be united in the concept of Total Airport CDM. But responding to disruption may require CDM that reaches beyond the airport boundaries to encompass other stakeholders, including providers of alternative transportation modes and, most importantly, passengers. To do this, we need to move beyond current system metrics that measure airport and airline success by aircraft delays, and focus on the whole of a passenger's door-to-door journey. We envisage a future where passengers can access integrated real-time information on flight delays, congestion and expected airport process times throughout their journey, enabling them to make better-informed decisions about their travel. When disruption strikes, passengers will be informed rapidly and can choose from a range of alternative solutions, including ground transportation.

The data-gathering and information synthesis carried out during the project were vital first steps towards bringing together an extended CDM concept – one in which airside, landside and ground transportation providers work together to optimise the passenger experience and reduce disruption costs. The final project outcome is the MetaCDM Concept of Operations. Based on the existing A-CDM standard, we outline the key functional groups needed to bring extended CDM into practice. We propose a milestone-based approach for door-to-door air passenger journeys which is straightforwardly adaptable even to cases of severe disruption. The concept is designed to provide benefits to stakeholders (including shorter journey times and a reduction in uncertainty) even under normal conditions. In crisis situations, the milestone approach adapts to encompass ground transportation and other alternatives. The passenger is kept fully informed and in control of their journey.

Our Concept of Operations is described in Section 4.1.3.3, and is also available via a standalone, more detailed document freely downloadable from the MetaCDM website. As well as a full description of the concept, it includes an initial benefit assessment and a roadmap for future research towards the goal of seamless air mobility in Europe.

Workshops

To validate the three project phases, the MetaCDM project centred around a series of workshops at which stakeholders reviewed the outcomes of the project so far, advised on future steps and influenced the concepts being developed. At every step, the practical advice of those who have dealt with air transport system disruption was vital.

- **Workshop 1**, held at London Heathrow Airport in January 2013, reviewed the current state of CDM and response to crisis events.
- **Workshop 2**, at Frankfurt Airport in November 2013, focused on lessons learned from MetaCDM's series of on-site interviews with affected stakeholders, and on the contribution of multimodality.

- **Workshop 3**, in Toulouse in May 2014, discussed the final project outcomes, future directions, enabling technologies, and steps towards a new passenger-centric concept of operations.

Detailed reports on all three workshops can be downloaded freely from the MetaCDM website.

4.1.3 Main results and foregrounds

4.1.3.1 WP1: CDM State of the Art

This work package provides an overview of current literature and practice, including lessons learnt from historical disruptive events, the current state of A-CDM and efforts to extend CDM, and metrics to assess the success or failure of these efforts from a passenger-centric perspective. This process highlighted a number of problems that MetaCDM should address, as well as issues that need to be considered in the design of the MetaCDM concept. For example, the accessibility of passenger information is highlighted as a particular problem during crisis events. When faced with inadequate information about whether their flight was operating, many passengers chose to travel to the airport in search of better information, causing major congestion in the terminals. Similarly, when aviation is disrupted, often the same event is disrupting other modes too. Several examples can be found of passengers being transferred to other modes only to experience disruption a second time. Information sharing and collaborative decision-making is highlighted as a prerequisite for crisis management. Best practice airports are considered to be those where the crisis command and control structures have given priority to information sharing, with coordination through a single point (the airport).

Passenger behaviour linked to delay situations and the impacts of disruption from the passengers' point of view were also studied. Existing literature stresses that experiencing flight delays affects passengers' future choices and the quality of crisis management affects air traffic demand at the respective airports. In order to be able to fulfil passenger needs, the report identifies performance indicators for passenger satisfaction, combining measures of subjective customer satisfaction and objective production of service. The report ends with an outlook on the next MetaCDM project phases, including interviews with stakeholders to get a more detailed look into practical experiences and current procedures at airports. The main findings of the literature review are discussed, by area, below.

Collaborative Decision Making at Airports

A number of European airports have, over the past decade, taken major steps that aim at collaborative decision making between all stakeholders at airports. This process is initiated and guided by the Airport CDM program, which has resulted from many years of concept work and implementation efforts. The objectives of A-CDM are to reduce delays and improve system predictability, while optimizing the utilization of resources and reducing environmental impact. This is achieved by real-time information sharing between key stakeholders, including airports, airlines and Air Navigation Service Providers. Current CDM efforts focus primarily on airside operations, with landside CDM usually considered separately. A-CDM is one of the five priority measures in the Flight Efficiency Plan published by IATA, CANSO and EUROCONTROL. In Europe, A-CDM has been implemented successfully at several airports. Details about A-CDM in Europe can be found in the Airport CDM Implementation Manual [19].

A number of recent projects have aimed at enhancing, extending and further integrating airside and landside CDM to reduce passenger disruption (both of the everyday sort and from major disruptive events). Two of the most important recent projects in the context of MetaCDM are the TAMS project, which looked at integrating landside and airside CDM, and the ASSET project, which looked at the efficiency of landside processes. TAMS is the first project that implemented, simulated and validated a whole Airport Operation Centre. This can be taken as reference for what can be done to enhance collaboration with more information becoming available on the landside, see integration of Passenger Management (PaxMan) into the Turnaround Manager of an Airline or Ground Handler. The aim of ASSET was to develop and assess solutions for airport process improvements in terms of punctuality regarding passenger, baggage handling and aircraft turnaround processes in an integrated approach. The objective was to enable a higher punctuality and performance of the whole air transport network in Europe by improving predictability and punctuality of the off-block time of departures.

Disruptive Events affecting Airport Operations

In order to formulate an extended CDM concept to deal with disruption, it is important to understand both how disruption affects aviation networks in general, and to look at specific examples of historical disruption and lessons learnt from their handling.

For Europe, a summary of all major disruptive events is included in the Eurocontrol Network Operations Reports [20] and the CODA delay digest [21].These review network activities and disruptive events across Europe by month and season. The most common disruptive events noted in the NOR are weather (mainly snow, low visibility, high winds and thunderstorms), strikes, and disruption caused by the implementation of new infrastructure. Other disruptive events include accidents, security alerts or attacks, IT systems failures, measures to prevent the spread of infectious diseases, and infrastructure upgrades. Their impacts can vary significantly - for example, closure of airspace or airports, absent staff or significantly increased process times. Some specific examples from the past few years include snow storms paralyzing flights in Western Europe (December 2010); volcanic ash clouds grounding a vast portion of European traffic for a week (April 2010); a crash at Amsterdam Schipol (February 2009); radar failure at Athens Airport (September 2012); and strikes affecting French airports (April 2012). Eurocontrol also gathers detailed delay data for the CODA database and publishes reports about specific disruptive events as well as about its data collection, KPI calculation and delay cost estimation processes. The Association of European Airlines (AEA) publishes regular Consumer Reports which also list major disruptive events affecting AEA member airlines. A detailed analysis of recent disruptive events in Europe and the US, using this data, is included in the first MetaCDM report [28]; it finds that snow and ice, volcanic ash, high winds and strikes were the largest sources of disruption in Europe over the 2003-2012 period on an impact x frequency metric. The Eyjafjallajokull volcanic eruption in 2010 was the single largest event, and had such an impact on aviation that it also had a series of knock-on effects on other modes of transportation. These were exacerbated by the rigidity and complex nature of transport networks, as well as by the lack of appropriate preparation.

When a disruptive event occurs, airline schedule recovery action tries to maintain operations and get back to schedule as quickly as possible while minimizing additional costs. The different mechanisms they rely on are aircraft swaps, flight cancellations, crew swaps, reserve crews and passenger rebooking. Usually airlines react by solving the problem in a sequential manner. In this process, the passengers' issues are the last to be accommodated. In Europe, reactionary delays, or "knock-on" effects, add up to nearly half of the delay minutes. For example, Cook et al. [12] evaluate the costs of reactionary delays as a non-linear function of primary delay duration. They contrast flight-centric and passenger-centric delay propagation, and highlight the need for tactical delay models, taking into account marginal costs, reactionary costs and non-linearities.

The response by airports, governments and aviation authorities to major airport disruption events is often to commission reports looking in to what happened and whether the disruption could have been handled better. The recommendations made as part of these investigations give an insight into current best practice, and share a number of common themes even where the events differ significantly. For example, the importance of good relationships and communication with other stakeholders; the need for early action when disruption is forecast; for a proactive approach to cancellations and airport closures; regularly updated contingency plans with clearly defined roles and responsibilities; and the importance of providing timely and correct passenger information.

The most comprehensive set of recommendations for airports dealing with disruption is made by ACRP (2012) [3]. This report discusses in a US context how airports can best develop, evaluate and update contingency plans for the occurrence of irregular operations (IROPS) as a result of disruptive events. Four types of IROPS impact situations are identified: surge, in which extra aircraft and passengers flow into an airport; capacity, in which the airport terminal becomes full of passengers or ramp space/gates become full of aircraft; after-hours, in which aircraft land and passengers need to deplane at irregular hours; and extended stay, in which passengers and aircraft may be stuck at the airport for an extended period of time. Bolic et al. [8] offer recommendations to better address such large disruptions, stressing the need for better information exchanges between all the stakeholders with, for instance, a central repository of all information related to a given crisis.

CAA (2011) [10] addresses airport best practice in the event of disruption, in the context of the severe snow disruption experienced by the UK in 2010. In particular, an online survey of passengers was carried out to assess how passenger welfare could be improved during disruption. Considerable room for improvement was found; 74% of respondents were dissatisfied with the quality of information they were given, 75% were not informed of their rights, and 60% received no care or assistance from their airline. The accessibility of passenger information was highlighted as a particular problem during the snow crisis; when faced with inadequate information about whether their flight was operating, many passengers chose to travel to the airport in search of better information; and, when they were at the airport, many passengers were reluctant to leave for similar reasons. In some cases passengers visited the airport daily to see if there was any news of their flight being rescheduled. Some passengers travelled to the airport unnecessarily because they had been told they needed to check in before the airline could give them assistance. The need for clarity on information about what costs airlines would refund if passengers organised hotels, food or onward journeys themselves was also noted.

At the first MetaCDM workshop, an audience questionnaire also identified several factors that are likely to be important for future crisis events. As the aviation system grows, more airports will be operating close to capacity, leading to decreased ability to recover from or mitigate disruption. However, progress on technologies will likely facilitate increased warning times of disruptive events, better recovery from disruption, increased safety (hence fewer accident/incident-related disruptions) and increased systems robustness. These trends need to be considered when formulating future concepts.

Passenger perspective

Flight delays do not accurately reflect the passenger experience or even the delays imposed upon passengers' full multi-modal itinerary. The growing interest to measure ATM performance calls for metrics that reflect the passenger's experience. Cook and al. [13] design propagation-centric and passenger-centric performance metrics, and compare them with existing classical metrics, with regard to intelligibility, sensitivity and consistency. The authors also identify the top ten critical airports in Europe according to three different network classifications. Bratu et al. [9] calculate passenger delay using monthly data from a major airline operating a hub-and-spoke network. They show that disrupted passengers, whose journey was interrupted by a capacity reduction, are only 3% of the total passengers, but suffer 39% of the total passenger delay. Wang [42] shows that high passenger trip delays are disproportionately generated by cancelled flights and missed connections. Moreover, congestion flight delay, load factor, flight cancellation time and airline cooperation policy are the most significant factors affecting total passenger trip delay. Flight delays have a direct impact on airline operating costs; with an average additional cost of 72 euros per minute (Cook, Tanner, & Jovanovic) [12], they may also have non-negligible indirect impacts on a longer term on their passenger demand for travel.

The current methods used for assessing aviation system performance typically focus on metrics more relevant to airports and airlines than to passengers. However, passenger-centric quality criteria do exist, particularly in other modes of transport. The European norm EN 13816:2002 [16] defines quality criteria connected to passenger satisfaction and a quality assessment procedure for assurance of these criteria. Eight criteria for quality are defined: availability, accessibility, information, time, customer support, comfort, safety and environmental impact.

Tyrinopoulos et al. [41] proposed a methodology for the quality control of passenger services in the public transport business. The methodology is based on 39 indicators classified in seven major categories, covering safety – comfort – cleanliness, information – communication with the passengers, accessibility, terminals and stop points performance, queue performance, general elements of the public transport system and compound indicators consisting of customer satisfaction, vehicle scheduling performance and easiness in the tickets purchase and validation.

4.1.3.2 WP 2: Contributions of Information Sharing, Collaborative Decision Making and Multimodality in improving passenger experience during disruptive events

The literature review in MetaCDM Work Package 1 [28] identified a number of key areas that the MetaCDM concept could focus on, including increased information sharing with passengers, the extension of CDM beyond the traditional airside stakeholders, and the use of alternative modes to transport passengers during major disruptive events. The next stage of the project took the exploration of these ideas further via a series of interviews with stakeholders associated with European airports. The interview process was tailored to each individual airport, with a range of experts in different roles interviewed at larger airports and smaller airports handled via interviews with one or two managers responsible for CDM and/or crisis management at the airport. Experts interviewed included legacy, low cost and freight airlines; handling agents; Air Navigation Service Providers (ANSPs); ‘Blue light’ services; border agencies; ground transport providers; government departments; and local authorities. A list of the airports covered is given in

Table 1. The interview process was also informed by partner links and information from airports in North America and New Zealand.

Table 1. Airports involved in the MetaCDM interview process

Airport	A-CDM in use?	Other considerations
London Heathrow	Yes	Major hub; capacity constraints; multiple-airport system; recent crisis event experience including snow, volcanic ash, aircraft incidents etc.
Paris Charles de Gaulle	Yes	Major hub; multi-airport system; recent crisis event experience including snow, volcanic ash, strikes etc.; high-speed rail link
Frankfurt	Yes	Major hub; capacity constraints; recent crisis event experience including snow, volcanic ash, strikes etc.; high-speed rail link
Brussels Zavantem	Yes	A-CDM early adopter; medium-sized airport; high-speed rail link
Toulouse Blagnac	No	Smaller, non A-CDM airport; recent crisis experience as a diversion airport
London Luton	No	Multi-airport system; low-cost carriers
Vienna	Yes	Medium-sized airport
Dusseldorf	Yes	Medium-sized airport; high-speed rail link

Based on the outcomes of Work Package 1 [28] it was clear that the project needed to focus on improving passenger door-to-door journeys via the extension of A-CDM concepts, concentrating particularly on disruptive events. Therefore the interviews results centred on four key areas: airport resilience, A-CDM, multimodal connectivity and the passenger experience. Our findings in each area are summarised below. A more comprehensive discussion of the interview findings is given in the MetaCDM Work Package 2 Final Report [30].

Airport Resilience

The resilience section of the interviews focused on past disruptive events, how they were handled, and stakeholder suggestions for future improvements; on current operational and projected disruption-handling mechanisms; and on the current interactions between disruption handling and A-CDM. Due to the high profile of recent snow events, particularly in 2010, a common theme of the interviews was winter weather.

Resilience is a priority for major airports, which typically have dedicated crisis centres, recovery plans and a co-ordinated multi-stakeholder response to crisis events. Airlines may have their own crisis cells in close collaboration with those at the airport, and their own equipment and procedures for dealing with stranded passengers (for example, camp beds, and arrangements with hotel and bus companies for transport to overnight accommodation). At the highest level, governments will also have oversight of airports that are classified as ‘national assets’, with monitoring meetings between government, airports, civil aviation authorities and other bodies such as Air Navigation Service Providers (ANSPs) to review plans, threats and resilience, and potentially to intervene in significant disruptive events. One hazard is the potentially large number of agencies who may be involved in crisis response at larger airports, meaning that sometimes responsibilities and lines of command are not clear.

For smaller airports the risks associated with disruptive events are typically lower, as are the corresponding resources. Resilience planning may be just one of several responsibilities for a particular manager, and training may be covered by just a formal annual exercise combined with desktop training.

At all airports, contingency planning and risk management are ongoing activities, involving many stakeholders, and, particularly at large airports, plans are subject to regular review. Revisions may also be made based on ‘lessons learned’ after disruptive events. For example, following the December 2010 Winter season, Heathrow adopted a three-tier ‘Bronze, Silver, Gold’ framework as used by emergency services, representing operational control, tactical command and strategic command to be activated sequentially depending on the severity of the incident. Similarly, staff training needs to be a regular and continuing activity. Alert processes typically vary significantly depending on the type of incident. Information on current or projected disruption can come from ANSPs, airlines, government, security and ‘blue light’ services, meteorological services, local authorities or web and media scanning.

Contingency planning distinguishes between predictable and unpredictable crisis irregularities. A longer notice period means an event is typically easier to deal with. For example, schemes such as Frankfurt Airport’s Terminal Colour Concept (discussed below) require a day’s notice to set up. One example of a longer notice period here is the role of Heathrow for the 2012 London Olympics, in which significant extra traffic was handled without extra disruption due to the long planning time and extensive training exercises.

Currently, CDM does not strongly interact with crisis management. CDM processes are typically not used in a crisis situation and airports switch to face-to-face and/or phone communication for the majority of interactions. For example, there is a dedicated crisis room at Paris Charles de Gaulle (CDG) airport where stakeholders may be gathered in the event of a crisis to ensure common situational awareness and improved decision processes. In general, the focus on face-to-face information means that communication in crisis situations can be delayed, particularly to bodies outside the immediate crisis response cell. Similarly, external information is mainly collected via phone calls to different stakeholders. As a result, passengers may not be able to access information about the situation because it is simply not available. This was the case during the December 2010 snow crisis for passengers stranded in Toulouse airport. Any scheme to increase information provision to passengers, therefore, may need to be accompanied by greater automation of crisis communications.

Stakeholders also felt that there is not enough information available at a network level, given that disruption at one airport may have impacts at many others. One key example this is during the severe winter weather which affected many Northern European airports in December 2010. The impacts on Heathrow, which had to shut down operations, are well documented (e.g. [7], [38]). During this period, Paris CDG was operating close to maximum capacity. CDG was not aware of the closure of Heathrow until shortly beforehand and had to accommodate long-haul flights bound for Heathrow at short notice. Subsequently, CDG also had to close due to a lack of deicing fluids for passenger aircraft (cargo airlines still had deicing fluid, but were not consulted about the closure). As an airport with an A380-capable runway, Toulouse Blagnac had to accept long-haul flights bound for CDG at very short notice. Although Toulouse Airport was unaffected by snow, it suffered severe disruption because of the large numbers of stranded passengers from the diverted flights and a lack of aircraft parking space. Improving information sharing on a network level is therefore also a desirable goal.

A-CDM

Most of the airports at which interviews were carried out had adopted A-CDM. The interviews focused on the operation of A-CDM at the airport and its intersection with major disruptive events. Airports considered that the main benefits of A-CDM in disrupted conditions were improved situational awareness and communication. However, typically in major crisis situations CDM techniques are used only minimally or not at all. In crisis situations at Paris CDG, stakeholders move to what is known as 'Plateau CDM', with meetings in a designated crisis room. Information is still supplied via the airport's CDM website, including changes to schedules, and can act as an alert process if an unusually large number of delayed flights are displayed. An additional problem in data sharing is verifying that data. In crisis situations, stakeholders try to get information by whatever means possible, leading to data that is sometimes inadequate, incorrect or inconsistent. One case was discussed during the interview process of two different organisations at the same airport using meteorological data from different companies; one indicated it was safe to continue operations, the other did not, and the resulting confusion led to further disruption and costs for both companies.

Whilst A-CDM focuses on airside performance monitoring, there are some technologies already used to facilitate landside performance monitoring, including Bluetooth, video and light barrier passenger detection in the airport. However, few decision support tools are used for landside processes. In general, the airports and airlines interviewed were interested in the idea of extending CDM concepts to the landside in principle. A number of non A-CDM airports have indicated that they would be interested in a 'CDM-lite' approach allowing for some of the benefits at a lower level of investment. These airports were concerned about the cost of a full implementation, and also that A-CDM benefits might be less for smaller airports due to their greater flexibility to respond to disruption. As discussed above, there is also interest in CDM-type sharing of information at a network level to give airports and airlines greater warning about problems elsewhere that may impact on their operations.

As both A-CDM airports and airports considering taking the first steps toward A-CDM status were involved in the interview process, it was also possible to discuss the process of gaining A-CDM status. This highlights the processes, barriers and potential challenges that could be faced in adopting similar concepts. The interested airports highlighted better information sharing, visibility and image as reasons for their interest. Current A-CDM airports reported common situational awareness between stakeholders and an increase in operational predictability as being major benefits. The first step of the A-CDM process is gaining buy-in from all involved stakeholders. To do this, the benefits of A-CDM need to be clearly and specifically laid out. This stage is followed by workshops on improving or changing current processes, leading to an initial basis for information exchange. The next step is to ascertain whether current tools can be used or if new tools need to be developed or bought. Perhaps understandably, airports wish to maintain their competitive edge, so 'best practice' guidance in relation to CDM functionality and experience and training is not usually shared.

Multimodal Connectivity

One key part of the MetaCDM concept is the use of alternative modes to transport stranded passengers in crisis situations, where feasible. As such, the interview process and workshop discussion also covered the existing and potential future integration of ground modes in door-to-door air journeys, both during crisis situations and under normal conditions. The picture here was mixed. Many airports are linked into long-distance ground transport systems, including high-speed rail [11]. There is some use already of ground modes to transport stranded passengers: for example, this option is used for stranded passengers on domestic routes from Frankfurt, and has also been used by Toulouse Blagnac. However, this is dependent on the transport links available at the airport. Airports like Frankfurt, which are connected directly into the high-speed rail network, can put passengers onto high-speed trains relatively quickly. Even at airports with the most advanced planning systems, where alternative modes are directly involved in disruption planning, there are still problems and gaps in coverage. For example, rail operators tend to be more included than bus, coach or taxi operators and highways authorities. In general it was felt that any increased engagement with ground transport networks in airport crisis situations had to be on a win-win basis for all involved.

Under non-disrupted conditions, several schemes exist integrating rail and air services (e.g. AIRail, Flyrail, TGV Air). However, there are some key hurdles to closer formal integration between air and rail services in general. Systems and database formats are typically incompatible and are designed specifically for the needs of the individual mode. As one example, train services can only be included in a limited way in air schedules because there are not enough location codes available for more than a small number of stations. Rail, air, coach and ferry services serve different core target markets, with ground modes typically serving (and optimising their schedules for) shorter-distance travel. Information exchange and linking systems across organisational boundaries may be particularly difficult between modes which regard themselves as competitors. There are limitations imposed by safety and liability concerns, such as not being able to check baggage through from train to air services, the lack of airline representatives on the ground transport journey, and the question of who is responsible if a late train causes a passenger to miss a flight.

Airlines typically do not facilitate mode-switching in crisis situations and where passengers do this it is usually on their own initiative. As discussed in [28], however, switching stranded passengers to other modes has been tried during some previous major disruptive events, with mixed success. Ground transport is only a viable option if the ground transport mode is not also disrupted; if the passenger is able to travel through all the countries on the ground route; and if the ground journey meets the passenger’s accessibility, comfort and safety requirements. Ground transport operators were generally felt to be under-informed during crisis situations, although information to passengers is sometimes distributed via ground transport modes (e.g. contact via loudspeaker announcements at stations or dot matrix signs on motorways; Heathrow authorities can reroute traffic accessing the airport during disrupted periods). Although exercises and training were carried out by ground transport operators and government authorities dealing with disruption in the air transport system, there was felt to be too little inter-agency involvement on exercises.

Increased future crisis involvement of ground transport operators could be via dedicated extra services, or by making use of existing schedules. Putting on extra ground transport services for stranded passengers would require a notice period, the availability of suitable rolling stock, and suitable capacity. For rail services this may be difficult. One participant estimated a timescale of around a day would be needed to provide extra train services, but that the requirement for drivers to be trained on the specific route used, and the constraint that rail track is typically used at or near capacity, would impose significant limitations. There are similar issues affecting coach services [44], although airlines do use coaches for short-distance travel in crisis situations (e.g. diversion response and transport to hotels). For these reasons, solutions which require dedicated extra ground transport services for stranded air passengers may not be practical, at least for crisis situations with short or no notice periods. However, sufficient data is already available about existing schedules, ticketing and disruption by mode to enable passengers to make their own decisions in disrupted conditions, although it is not convenient to do so because the data is available from multiple sources. Improving this process and making it more accessible, rather than providing new ground transport services, may be the key to making use of ground transport in the short term for MetaCDM.

Passenger Experience

The interview process also covered the passenger experience, and current and projected future methodologies for improving passenger journeys, particularly under disrupted conditions. It should be noted that the perspectives here are from airports, airlines and other stakeholders rather than directly from individual passengers, as the project did not include a passenger survey component. However, numerous passenger surveys already exist and were discussed by stakeholders. For example, the Airports Council International (ACI) was highlighted as an organisation that supports airports in service quality management [5]; however, it does not cover all indicators from a passenger perspective. One example is the provision of the predictability of average transfer time at an airport, which is not included in the ACI survey. This type of information in particular may be withheld by stakeholders due to business interests.

Airports and airlines vary in the amount and type of support and facilities available for stranded passengers. The airlines interviewed had various methods to get information to passengers in the case of disruption, including email, phone calls and smartphone apps. The information supplied depends on what is available to the airline at the time. For example, one airline interviewed at Paris CDG only had access to CDG-related information, but could request information about disruption at other airports from its headquarters. This links into the point previously made about the speed of information exchange between stakeholders in crisis situations; if information is not available to the airline, they cannot share it with passengers.

Several examples of best practice were highlighted. One key example is Lufthansa and Fraport, which have developed a 'Terminal Colour Concept' for crisis situations in which each area of the terminals is associated with a specific colour (including on numerous direction signs). Passengers are informed of the colour of the area they need to go to. On reaching this area, staff with tablet computers take the passengers through the options available to them, using real-time information from the Lufthansa system. Options can include rebooking on an alternative flight, rebooking on a train and hotel booking. This concept has already been used 5 or 6 times and has received positive feedback. The key success factors in this situation were considered to be having a flexible number of service staff equipped with tablet computers and specialised apps for information provision, and talking directly to passengers in queues to provide information rather than waiting for them to reach the counter. However, this process is not directly linked to the CDM crisis suite and so does not accelerate communication of information about the situation.

Airlines and airports were interested in R&D into strategies to reduce terminal congestion in disrupted conditions, in being able to calculate terminal occupancy by destination region and hotel occupancy, and in solutions that simplify handling the growing numbers of older people in airports. Improved data provision was highlighted here, including better information about the number and location of passengers requiring mobility assistance. Some of these areas may be addressed by improved data exchange with passengers, as envisaged by MetaCDM.

4.1.3.3 WP3: MetaCDM Concept of Operations

Key Concept Elements

The main result of WP3 and the project was the elaboration of a concept for MetaCDM that defines how the passenger can be involved in the CDM process. The passengers' priority is to enjoy a stress-free journey, meaning going through processes that are faster, more convenient and easy to use, even if they are not frequent fliers. The MetaCDM WP3 report [32] describes an operational concept to exchange information on the status of the passenger door-to-door journey under both normal and crisis situations, enabling the transportation service provider(s) to incorporate this information into the planning of the transportation service. In return the concept foresees an earlier and more accurate feedback of flight updates to the passenger. The aims are to improve passenger travel experience, to reduce door-to-door journey time and delays, and to allow transportation service and facility providers to better optimise their use of resources.

A prerequisite for successful MetaCDM is informed engagement between stakeholders. The pivotal role of the passenger, though obvious, becomes clear when considering the role of the main stakeholders involved in the door-to-door travel experience in normal and disrupted conditions. Only passengers (or their luggage) connect with all stakeholders. Other stakeholders have one or a few connections up or down the line but they do not have an immediate operational reason to be aware of the needs, priorities and issues facing the full run of stakeholders involved in the journey process.

Passengers can differ significantly in their travel behaviour, requirements and preferences. The MetaCDM analysis considers two main traveller profiles which are the two extremes of a continuous spectrum of passenger profiles:

> **Empowered travellers** take control of their travel strategies, want access to information at their discretion, plan and often book their own individual journey elements, take control of and responsibility for timings and connections and react to and adjust plans according to circumstance.
>
> **Guided travellers** specify a requirement, entrust much of their journey planning and delivery to an agent, and rely upon their agent to address and solve problems and adjust or reroute the journey plan as necessary to achieve the original purpose of the trip.

An intermediate form of empowered and guided travel might be enabled through significant changes in air booking and ticketing technology aiming at giving more control to passengers. The next step is to direct the traveller to access to the Global Distribution System (GDS), with no company-approved portal or online booking tool needed. GDS is a network operated by a company that enables automated transactions between third parties and booking agents in order to provide travel-related services to the end consumers. The level of access could likely depend on the traveller’s frequent flier status.

While information from all involved stakeholders is needed for consolidated decision-making the two main actors involved are the traveller (or their agent) and the service provider of the chosen mode of transportation (flight, train, bus or ferry) or combinations thereof. For the benefit of the empowered and guided travellers alike, service providers must be incentivized to share their information and make it publicly available. In the case of a disruptive event, the service provider should provide the traveller with intelligent re-accommodation to enable empowered travelling. A passenger-centric approach entails gathering information about each passenger’s preferences and trip purposes so they can choose an adequate alternative.

MetaCDM aims at streamlining the passenger journey under normal and disruptive conditions. The typical passenger door-to-door journey under normal conditions involves the usage of ground transport modes and hence these modes need to be part of the MetaCDM process. However, the principal benefits of MetaCDM may come under disrupted and/or crisis conditions. When flights are cancelled, many passengers already check the schedules and availability of alternative modes, attempt to find out if using alternative modes could be reimbursed by the airline, assess whether those modes themselves are subject to disruption, and potentially book tickets and rely on them for travel. However, these actions require effort, confidence and sometimes specialised knowledge. Streamlining this process, either by offering passengers the information to make this process much easier or offering specific alternative ground itineraries with the intervention of a travel agent (for the guided traveller), would allow many more passengers to take advantage of ground transport options when faced with cancelled flights. A travel agent has the opportunity to “pool” passengers and therefore has more weight in negotiations with transportation service providers.

Another key idea behind the MetaCDM multimodality concept is that the passenger journey begins at home, rather than at the airport. Information on cancelled flights is supplied to passengers (whenever possible) before they leave home. Passengers who are rebooked on ground modes may then travel directly to the access point for that mode (train or coach station, car hire, etc.) instead of travelling to the airport. In practice this means that the airport does not need to be directly connected to the mode of interest, and the passenger does not have to physically pass through the airport to access the alternative journey. It also means that the resources available to stranded passengers are those of the whole city region rather than just those surrounding the airport.

In practical terms, this means that the individual aspects of MetaCDM need to be adjustable to a journey in which the main link is by a ground transportation mode. Data flows from and to ground transport providers are needed for the MetaCDM concept as well as data sharing between airports, airlines and passengers.

Considering ground transportation in MetaCDM leads to the need to include milestones for important stages of the journey. The possibility that a door-to-door journey under disrupted conditions may not pass through the airport or involve a flight means that the MetaCDM milestone approach needs to be more flexible than the corresponding A-CDM process.

Each ground transport link in the passenger’s journey has a scheduled or predicted travel time, which may change depending on conditions (e.g. road congestion). Similarly, interchanges between legs in the passenger’s ground journey have predicted transfer times. These interchanges allow the calculation of expected time between different milestones from which collaborative management of passenger flows, analogously to A-CDM, can be carried out.

A-CDM bases its monitoring on the calculation and reachability of the Target Start-Up Approval Time (TSAT) and Target Take-Off Time (TTOT) of an aircraft departure, mainly to check if a regulated flight is able to depart within its CFMU slot. The information on the timeliness of the flight is sent as Departure Planning Information (DPI) to the CFMU. Transferred to MetaCDM, the TSAT corresponds to the planned/target time when the traveller starts their journey. Instead of a CFMU slot, there are critical transport services such as long haul flights or long distance trains that must be reached or the travel will be significantly delayed. In this case, the TTOT would be the planned/target time for the traveller to reach a critical milestone of this transport service such as arriving at the gate for the long haul flight or on the platform for a long distance train. Instead of re-allocating a CFMU slot in case of a flight delay, in MetaCDM the travel connection might need to be changed/re-booked in case of a passenger delay (missed connection instead of missed CFMU slot). MetaCDM would be directly linked into the existing A-CDM process via the two A-CDM milestones 11, "boarding starts", and 12, Actual Ready Time ("ARDT"), of the booked flight connection.

The equivalents in MetaCDM to the Functional Groups from A-CDM are given by Table 2.

Number	A-CDM Functional Group	MetaCDM Functional Group
1	Information Sharing	Information Sharing
2	Collaborative Turn-Round Process	Passenger Travel Milestones
3	Variable Taxi Time Calculation	Variable Process and Travel Time Prediction
4	Collaborative Management of Flight Updates	Collaborative Management of Travel Updates
5	Collaborative Pre-Departure Sequence	Performance Based Travel Management
6	CDM in Adverse Conditions	MetaCDM in Adverse Conditions

Table 2: Functional Groups of A-CDM and equivalents in MetaCDM

Information Sharing

Empowered and guided travel assumes some information sharing in order to function properly. If not all information is provided this limits the forecast ability, e.g. if no position data or at least a message for reaching a milestone is provided by the traveller, there is no possibility for the service provider to calculate alternatives. A bigger difficulty would be missing information on schedule changes of the chosen travel connection, as this would disable empowered travelling entirely.

The timeliness and transparency of the communication is critical, especially when third-party apps or social media sometimes provide real-time information from other sources that may not be accurate. It is important that any information provided to the traveller is in their chosen language. Maps and/or schedules regarding other modes should be provided on screens or available on mobile devices. Table 3 lists what information should be exchanged between the traveller and the service provider or travel agent to enable MetaCDM.

Form of travel	Information needed from traveller	Information provided to traveller
Empowered	Source of travel, e.g. home address (mandatory), Actual position data (GPS - recommended) or At least a message if a milestone is reached (mandatory, if GPS data is not provided).	Information about the travel connection, e.g. flight number (mandatory), Milestones (mandatory) with target time at milestones (mandatory) and Estimated travel time between milestones (recommended).
Guided	Source of travel, e.g. home address (mandatory), Travel destination (address, mandatory), Target time for arrival at destination (recommended), Actual position data (GPS - recommended) or At least a message if a milestone is reached (mandatory, if GPS data is not provided).	Information about the travel connections, e.g. flight number (mandatory), Milestones (mandatory) with target time at milestones (mandatory), Estimated travel time between milestones (mandatory) and Alternative routes if needed in adverse conditions (mandatory); this includes the important milestones, e.g. a stop at a hotel, change of transportation mode etc.

Table 3: Flow of information from and to the traveller

Passenger Travel Milestone Approach

After booking a travel connection from a service provider, this provider is usually responsible for defining the target time at a resource, such as the time at gate for a flight with an airline, or the time at platform for journey by train with a railway company. In order to empower the traveller to meet this target time, which is also in the interest of the service provider, milestones are defined by MetaCDM. At these milestones the travel itinerary should be recalculated to check if the traveller is still able to reach the defined target time at the resource. The service provider should provide estimates on travel time between milestones and the traveller is responsible to plan their own "processes", e.g. the transfer time from parking deck to airport entrance, in order to meet the milestones.

All milestones in MetaCDM refer to calculating or predicting the planned or target time when the traveller starts their journey (the A-CDM equivalent is the TSAT) and to reaching a critical transport service such as long haul flights or long distance trains that must be reached or the travel will be significantly delayed (the A-CDM equivalent is the TTOT). The equivalent for the Calculated Take-Off Time (CTOT) is the critical transport service itself which must be changed or re-booked in case of a passenger delay.

It is important to notice that travellers can book more than one travel connection from one or more service providers in order to reach their destination. The describe the nodes that should be used for each of these travel connections. The destination/end of one travel connection is then the initiation (milestone 3) of the next travel connection. For the remaining connection(s), milestones 1 and 2 might be executed before the travel starts or while the traveller is already journeying.

<u>MetaCDM milestones for empowered travel:</u>

1. <u>Activation of travel connection</u>: The traveller books a certain travel connection from a service provider and provides information necessary to empowered travel. Travellers receive a ticket for their chosen travel connections including mandatory and chosen recommended milestones, e.g. their departure time.
2. <u>Provision of details on travel connection</u>: The service provider informs empowered travellers about target times at milestones and estimated travel time between milestones.
3. <u>Start of travel (to booked connection):</u> The empowered traveller either starts their journey (e.g. leaving home), or is at the destination of the previous travel connection and ready to transfer to the following travel connection.
4. <u>Reaching the start site of the booked travel connection</u>: The traveller arrives at the desired entry point to the booked travel connection which might be an airport, a train or bus station or a car rental, for example.
5. <u>Passing of milestone(s) at the start site of the travel connection</u>: This milestone might consist of one or more resources for which times are planned and monitored, such as check-in, baggage drop, border control or security screening at an airport. How many resources are separately monitored heavily depends upon the chosen mode of transport and of the possibilities offered by the start site, e.g. check-in at car rental agency.
6. <u>Boarding of the booked travel connection</u>: The traveller boards the booked travel connection and in the case of a flight, is no longer able to influence the arrival time at their destination or next travel connection.
7. <u>De-boarding of the booked travel connection</u>: The traveller disembarks from their chosen transport vehicle and enters the end site of their travel connection.

8. Passing of milestone(s) at the end site of the travel connection: This milestone might consist of one or more resources for which times are planned and monitored, such as border control, baggage claim or toll at an airport. The number of monitored resources heavily depends upon the chosen mode of transport and differs in case of a connection flight/train/bus with the same service provider, e.g. a connecting flight. In the latter case the next milestone for the follow-up travel connection would be milestone 5.
9. Leaving the end site of the booked travel connection: The traveller leaves the desired exit point from the booked travel connection which might be at an airport, a train station or bus terminal or a car rental location, for example.

The MetaCDM milestones for guided travel include the nine milestones for empowered travel that might be repeated if more than one critical transfer resource is needed for the door-to-door travel. Because the service provider is responsible for planning and monitoring the whole journey from door to door, an additional milestone is added for the passenger reaching their final destination.

Variable Process and Transfer Time Predictions (VPTT)

While the duration for long distance connections is in most cases predictable with good accuracy, the arrival of the traveller at milestones and at planned/monitored resources (milestones 5 and 8) of the chosen travel connection might be subject to changes on short notice. Thus the calculation of travel times between milestones and planned/monitored resources is an important addition to MetaCDM. The (re-)planning of the travel connection should factor in flexible route durations according to dynamic travel changes and calculation of queuing at milestones and planned/monitored resources, e.g. at check-in, at security etc.

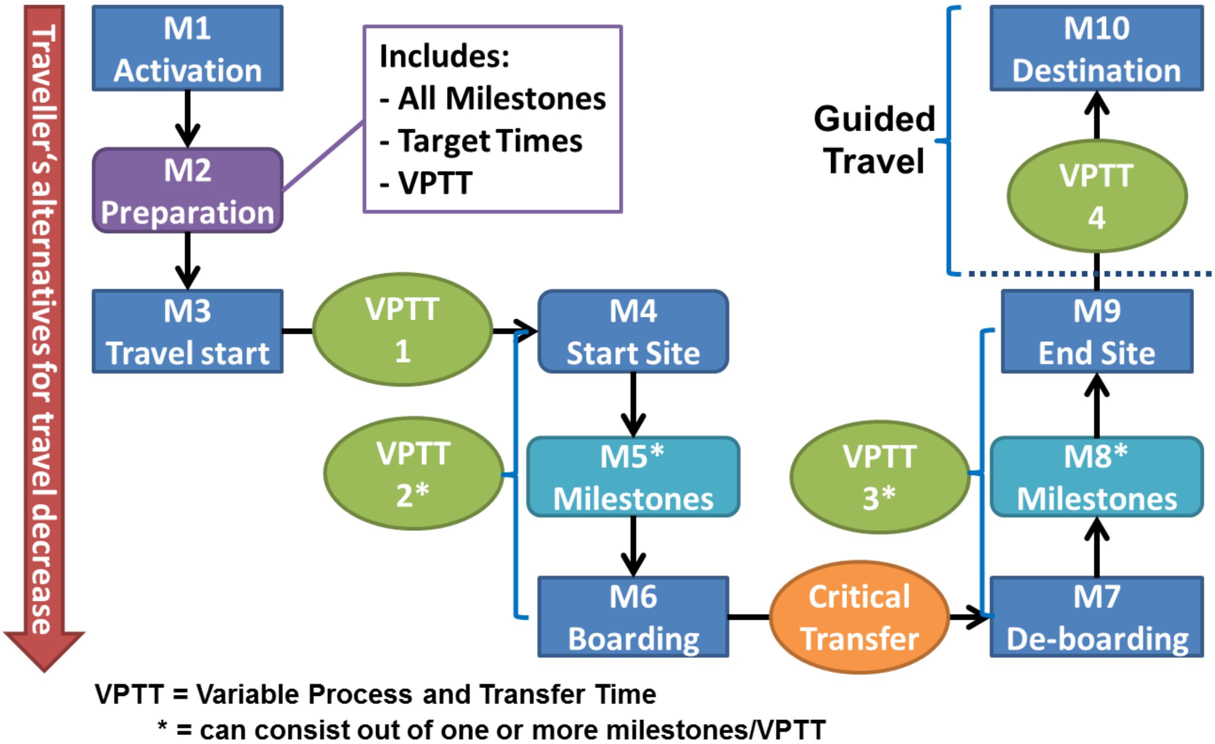

Figure 1: Flowchart on Milestones and VPTT

Predictions of variable process at and variable transfer times between milestones for empowered and guided travel should be calculated for the following durations:

- VPTT(1) between milestones 3 and 4: Transfer time between start of travel (origin) and reaching the start site of the booked travel connection. Transfer might be by car/taxi, public transportation, bicycle or walk.

- VPTT(2*) between milestones 4 and 6: The number of monitored resources at milestone 5 differs depending upon the size and complexity of the start site. One VPTT for all resources should be sufficient for small train stations and airports; complex train stations and especially hub airports might provide more than one VPTT.

- VPTT(3*) between milestones 7 and 9: The number of monitored resources at milestone 8 differs depending upon the size and complexity of the end site. One VPTT for all resources should be sufficient for small train stations and airports; large and complex train stations and especially hub airports might provide more than one VPTT.

- VPTT(4) between milestones 9 and 10 for guided travel: This Transfer Time is added at the end of the overall travel. Transfer might be by car/taxi, public transportation, bicycle or walk.

Collaborative Management of Travel Updates

Travel updates include both updates triggered by management of disruptive events (e.g. flight delays and cancellations) as well as passenger travel updates (e.g. road traffic jam). The related Functional Group in A-CDM is Collaborative Management of Flight Updates (COFU) and in general it refers to Monitoring / Alerting and the exchange of Flight Update Messages (FUM) and Departure Planning Information (DPI). This section lists the general criteria to enable a collaborative management of travel updates for MetaCDM. Details for these criteria as given by the A-CDM documents (e.g. A-CDM Functional Requirement Document [4]) are out of scope for this project and should be developed in a longer research and test phase.

The accuracy of exchanged data is critical to enable informed decisions for empowered and guided travel. While in most cases the data is not very precise a long time before approaching a milestone, the data should become more precise as the traveller nears this milestone and be exact when the traveller reaches a milestone providing actual time and location.

In the case of a long journey some uncertainties normally will cancel each other out which could be estimated with error propagation. However, some sources of delay may affect multiple stages, leading to greater-than-usual journey times throughout the journey. In the end the traveller chooses a trade-off between big buffers for Milestones resulting in a higher certainty to reach a critical travel connection and low or no buffers resulting in a lower certainty to reach a critical travel connection.

The timeliness of data exchange is very important for empowering the traveller, and also enables the travel service provider to make a good prognosis of the progress of the journey, for example if a milestone is reachable in time. The later information is exchanged, the more limited will be the availability of alternatives and/or countermeasures. For example: If the traveller received information on congestion on their way to the airport too late and is already within a traffic jam on the highway, either this delay can be absorbed through journey time buffers, or processes later in the journey could be shortened to allow the traveller to board their critical travel connection in time. If neither of these options are possible, the journey would have to be re-planned.

The Variable Process and Travel Time Predictions (VPTT) should be under continuous monitoring meaning that either in real time or at short time-based intervals (e.g. every 5 minutes) process and travel time predictions should be recalculated and compared to the previous predictions. If a deviation above a defined tolerance is detected, the new prediction should be published as a process and/or travel time update.

The Process Times at milestones are usually predicted and monitored on behalf of the travel service provider. Depending upon the complexity of the travel start site, e.g. an airport, the prediction might be a rule of thumb based on best guess or historical data or the prediction might be based on monitoring of e.g. the queue length or on measuring the time that a traveller needs from end of queue until being served at the resource.

A Travel Time Update informs the traveller about deviations of their actual progress from the last travel time prediction. The source for the prediction of travel times between milestones will differ. In some cases a Travel Time Update may be received from a third party, e.g. heard in traffic news. Here the traveller could update their travel progress between two milestones if they estimate that the foreseen travel or process time is not fitting anymore. In these cases the traveller should provide the travel service provider with an estimated arrival time at the next milestone based on the best information they have.

Performance Based Travel Management

A passenger-centric approach takes into account loyalty, lifetime value and passenger influence, in addition to direct costs. A passenger's journey disruption may impact brand loyalty and future booking behaviour. They may also influence other passengers' opinions through social media channels. Thus performance-based travel management is important for travellers and service providers / travel agents alike.

Metrics for assessing passenger satisfaction were discussed in the first MetaCDM report. The European Norm EN 13816:2002-07 [16] defines eight quality criteria connected to passenger satisfaction: availability, accessibility, information, time, customer support, comfort, safety and environmental impact. The overall price for travel is a further performance criterion for MetaCDM because many customers are willing to sacrifice quality in return for cheaper travel. The areas are discussed individually below. As environmental impact is discussed in Section 4.1.4, it is omitted from the list here.

- **Availability** refers to the extent of the service offered in terms of geography, time, frequency and transport mode.
- **Accessibility** includes ticket accessibility, transport mode accessibility to passengers with reduced mobility, staff accessibility, connections within and between transport modes, and an accessible complaint handling mechanism. MetaCDM aims specifically to improve communication between passengers and transport providers and to streamline the rebooking process when flights are cancelled.
- **Information**: MetaCDM specifically aims at improving the provision of information to passengers. In a MetaCDM environment we would expect passengers to have earlier and more reliable information about: flight delays and cancellations; problems getting to/into the airport; available options if their flight is cancelled and their rights in cases of disruption.

- **Time**: As with the information criterion, MetaCDM is directly aimed at reducing journey duration, both under non-disrupted conditions (via better information about journey and process times enroute) and in crisis situations (by offering the use of alternative modes).
- **Customer Support**: Empowered Travellers receive more and clearer information about their journey but make their own decisions about how to use that information. Guided Travellers would receive extra support from a travel agent, for example with the selection and booking of alternative itineraries using ground transport.
- **Comfort** under non-disrupted and/or delayed conditions: MetaCDM estimates of journey and arrival times should lead to passengers being able to spend more time at their desired place (e.g. at home) and decrease uncertainty, which provides the potential to increase satisfaction on comfort-related criteria.
- **Safety**, and passenger perception of safety, should not change much under MetaCDM in non-disrupted or delayed conditions. Under crisis situations passengers may have the option (depending on their preferences) to trade off journey time for options that have reduced comfort or perceived safety, for example, taking an overnight bus or train journey, or ground travel through a country they do not speak the language of. In this situation the passenger would have reduced comfort/safety but an overall increased utility. MetaCDM should also reduce passenger congestion and overnight passenger waits in airports, leading in turn to improvements in safety and comfort criteria.
- The **overall travel fare** will act in many cases as a limitation for the types of connection that can be chosen.

In order to provide the most fitting service to passengers, particularly in cases of disruption, ticket purchase would be accompanied by a selection of performance parameters by the passenger indicating their needs and preferences. To set the desired performance parameters, a simple interface should be offered to the traveller. Ideally the performance of the available services is already rated according to European standards [17]. In this case the chosen performance parameters allow the service provider or travel agency to select the most fitting service.

MetaCDM in adverse conditions

We define a crisis event as an episode of major disruption that results in many cancellations at one or more airports, for example, major snow events, volcanic ash, aircraft accidents, strikes, technical failures, fires or terrorism. Such situations differ from disruptive events which lead primarily to delays. A crisis situation interrupts all MetaCDM successive milestones for empowered or guided passengers. Their connection no longer exists and as a consequence transfer times between milestones cannot be updated.

In case of flight cancellation, the succession of MetaCDM milestones presented above is stopped somewhere between milestone 1 and milestone 9. Figure 2 illustrates the milestone chain with needed reaction times. MetaCDM crisis milestones are:

A. Information on flight cancellation provided by the air transport operator,

B. Information on the list of options for alternative solutions,

C. Choice between options to be given by the passenger,

D. Information on practical details relative to the chosen option.

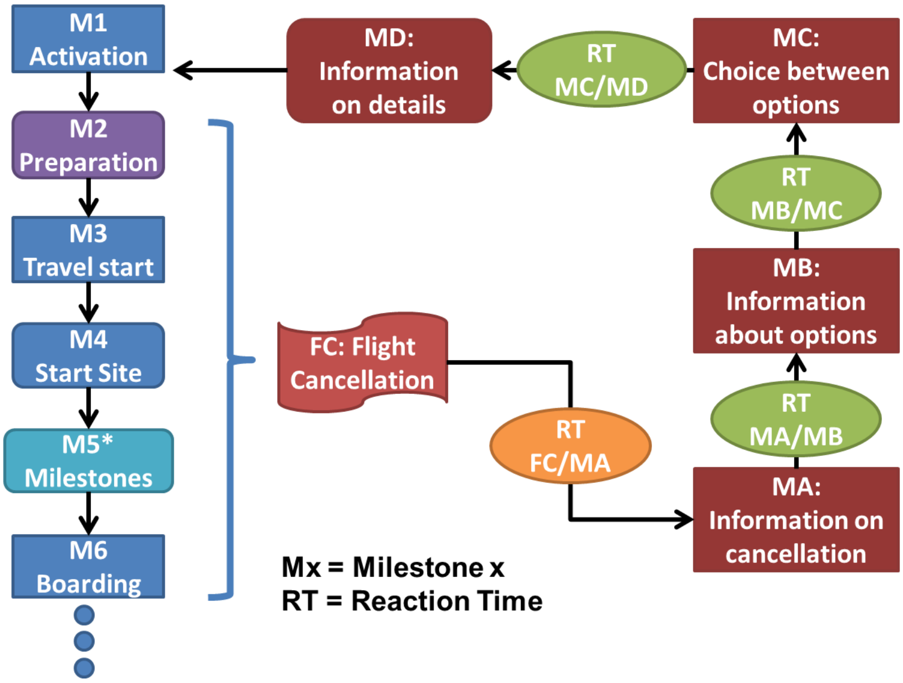

Figure 2: Illustration of MetaCDM milestones chain in a situation of flight cancellation

The reaction times (RT) between milestones that should be defined in the situation of flight cancellation are:

- RT FC/MA: The time between the decision of flight cancellation and the provision of the corresponding information to the passenger,
- RT MA/MB: The time between the informing the passenger about the flight cancellation and the provision of options to the passenger,
- RT MB/MC: Time between the provision of options to the passenger and the choice between options made by the passenger,
- RT MC/MD: Time between the option choice of the passenger and the provision of practical details relative to this choice.

Capacity of other transport modes

The capacity of other air services to provide spare seats for passengers from cancelled flights is a key factor affecting recovery from crisis events. In normal operations, airlines try to maximise their load factors. In crisis events, however, faster recovery is aided by lower load factors on subsequent flights so that there is more space to reallocate passengers. In conclusion, putting passengers on ground transport is feasible only if there are sufficient seats at suitable times for them.

Based on information from the interview stage of MetaCDM, the ability of ground transportation providers to lay on extra services for stranded passengers is limited. These limitations arise from many sources, including lack of spare rolling stock, staff availability and training for the routes needed, and infrastructure limits. Even if these constraints can be overcome, a notice period is typically needed to assemble the necessary resources. Thus existing ground transportation services should be used rather than expecting ground transportation companies to provide extra services.

4.1.4 Potential impacts

MetaCDM is a concept development project, bringing together ideas from the literature and from stakeholder interviews to develop ideas for extending CDM beyond its current airside focus. As such, its impacts lie mainly in three areas.

First, as a Coordination and Support Action the project brought together stakeholders from multiple areas related to the passenger journey. Representatives from different airports were able to meet and compare their strategies for handling passengers in disrupted situations at the project's three workshops, at which extensive discussion took place ([27],[29],[31]). The workshops focused on A-CDM practice, implementation and future directions; disruption handling; the passenger experience and how to improve it, particularly in disruptive conditions; and current research and future research directions into information sharing, particularly with passengers.

These workshops facilitated information exchange between participants and the dissemination of existing best practice and innovative ideas. These interactions have already had tangible results; for example, participants have collaborated on two research proposals aimed at taking MetaCDM-related ideas further.

Second, the project provides a benefit for researchers and bodies, such as the EC, which commission research. The literature review and interview stages of the project concentrated on bringing together existing information in disparate areas (A-CDM, passenger experience, landside performance monitoring, disruption handling, …) to form an integrated knowledge base that is useful as a basis for future research and more concrete development projects. Where gaps were identified in the literature review process, an attempt was made to fill them via the interview process. As such, the project reports bring together a synthesis of existing and new data. As the project reports are all publically available via the project website (http://www.meta-cdm.org), anyone may make use of the information gathered by the project, including other researchers, companies seeking to capitalise on the insights gained in the project, or even interested passenger representatives seeking perspectives on how to improve the aviation system. The project outcomes include a roadmap for future research which can help improve air passenger journeys (e.g. [32]). This aids both bodies which commission research, helping to guide the direction of future research projects and ultimately concepts put into practice, and also the wider research community (in better knowing where gaps exist and where to concentrate their efforts).

Third, the project provided a specific Concept of Operations which may also be used as a roadmap for research and development (as discussed below, project members are currently involved in funding proposals aimed at taking this concept further). The potential impacts of implementing the concept are wide-ranging. Broadly, the MetaCDM concept has the following aims:

- Improving passenger satisfaction by reducing door-to-door travel time, reducing uncertainty, and better information provision.

- Reducing congestion in airport terminals, both under normal conditions (as passengers spend less unnecessary time in the terminal) and in crisis situations.
- Helping airlines to better maintain schedules by reducing the uncertainty associated with late passenger arrival at the gate
- Allowing stakeholders to optimize resource allocation (for example, improving prediction of how many immigration desks will need to be open at a given time in a given airport)

Expected impacts by individual stakeholders

Implementation of a MetaCDM concept would have significant beneficial effects for passengers and sector stakeholders alike. Whilst there are system compatibility, data, communications, trust and other issues to address, it is believed that the prospect of long term gains will encourage stakeholders to engage positively with the MetaCDM debate. Table 4 shows the expected impacts by individual stakeholder.

Table 4. Impacts by stakeholder of implementing the MetaCDM concept.

Stakeholder	Expected Benefits	Expected Costs/Disbenefits
Passengers	Shorter journey times under disrupted conditions; improved experience of delay (e.g. at home rather than in queues); reduction in uncertainty	Reduced accessibility to travellers without smartphones; passengers may have to transport own baggage; data provision may cause privacy concerns
Airlines	Reduction in passenger accommodation costs, complaints and uncertainty over passenger location in disrupted conditions	Cost of funding travel via alternative mode; staff and infrastructure costs for information provision
Airports	Reduction in terminal crowding under disruption; reduction in uncertainty over passenger location	Staff and infrastructure costs for information provision; Passengers may spend less long in shopping areas
Ground Handlers	Minimal impact (with the exception of terminal-based services, e.g. ground handlers providing counter service will benefit from smaller numbers of passengers arriving at the disrupted airport)	Minimal impact
ANSPs/Network Managers	Minimal impact	Minimal impact
Federal Police	Decreased uncertainty about passenger location (so can e.g. plan staffing levels to reduce queues at immigration)	Potential infrastructure/information handling costs
Local Authorities	Reduction in congestion associated with disrupted airports	Infrastructure costs for information provision (e.g. if motorway dot matrix signs are used)
Ground Transportation Providers	Greater knowledge about where and when extra demand from stranded air passengers will arise, allowing better capacity/schedule planning; increased passenger revenue	Potential for overcrowding and complaints from existing passengers; issues of duty of care/legal liability for air passenger transportation
Information Service Providers/Media	New business opportunity (service providers); more, better and faster information (media)	Startup/infrastructure costs
Travel Agents	New business opportunity; opens up potential new market (services to independent travellers)	Startup/infrastructure costs

As discussed in detail in the Concept of Operations [32], the benefits split broadly into two areas. In the first case, the aviation system is operating normally or with mild delays. In this case, the primary difference passengers could expect to see in a MetaCDM-enabled journey is that they will receive more information that enables them to streamline their journey and to reduce uncertainty; for example, better estimates of when to leave home for the airport based on real-time information about traffic, check-in and security queues. The primary difference airlines, airports and other stakeholders can expect is better information about where passengers are, enabling them to better plan and use resources. In the second case, there is major disruption with long delays and/or cancelled flights. In this case, passengers benefit from earlier and better information about any changes to their flight, and a greater range of alternative options if their flight is cancelled.

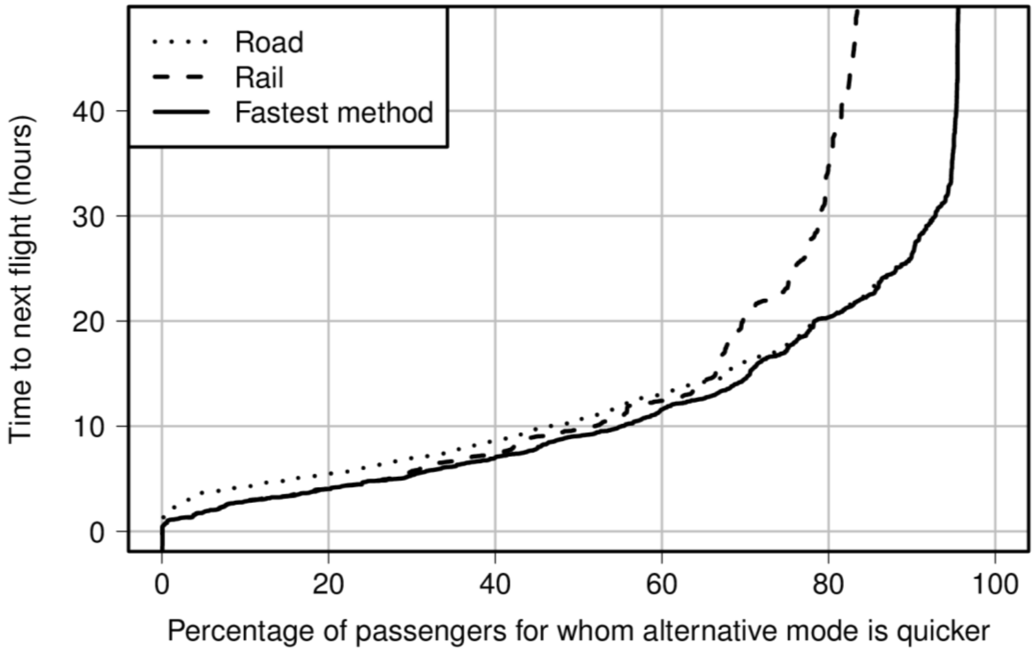

Figure 3. Percentage of passengers who could reach their destination sooner by taking an alternative mode rather than by waiting for the next flight, by time to next flight.

Depending on the alternative option they choose, the arrival time of these passengers at their destination may also be significantly earlier. For example, Figure 3 shows the percentage of passengers who could arrive at their destination earlier by ground transportation rather than waiting for a later flight, by time to the next flight, based on an analysis of flight and ground transport journey times between the fifty busiest airports in Europe in 2012 [32]. For a ten-hour time to next flight, around 50% of passengers can potentially arrive sooner by ground transportation. In practice, the time to next available flight depends on the airline's schedule, the number of cancellations and the number of available seats on operating flights. Figure 4 shows the impact of allowing various ground transportation options for a hypothetical ten-hour closure at a range of European airports, based on year-2012 schedule, load factor and ground transport availability data by route, as described in detail in [32]. The different options are: 'Same Carrier', in which passengers may be re-accommodated only on flights by their original carrier; 'Any Carrier, in which they may be re-accommodated additionally by other carriers once those carriers have re-accommodated any stranded passengers of their own on that route; 'Alt. Destination', in which passengers may also be re-accommodated on flights to other airports serving the same destination city; 'Ground', in which passengers may take rail or road transport to the destination city; and 'Alt. Origin', where they may additionally take ground transportation to another airport, from which they catch a flight to their destination. Delay costs are estimated using hard and soft cost of passenger delay estimates by delay length, and estimates of ticket price and the number of passengers requesting ticket cost reimbursement, from [13].

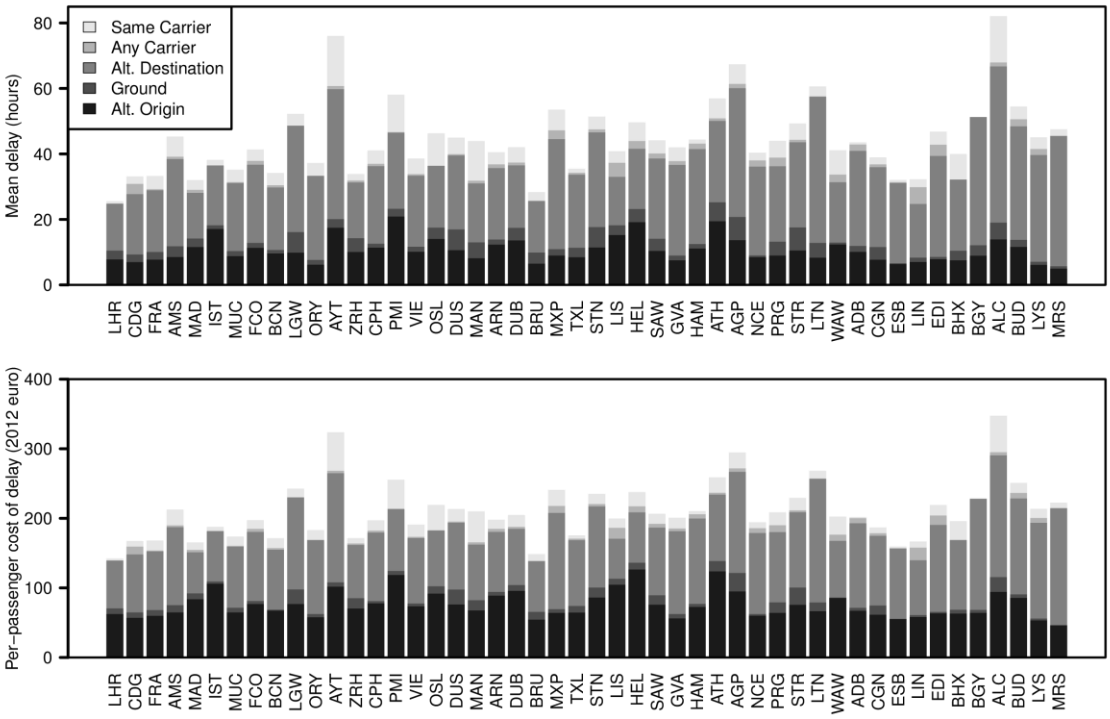

Figure 4. MetaCDM impact on mean delay and per-passenger delay cost for a hypothetical ten-hour airport closure situation.

Whilst it appears that a potentially large impact on mean passenger delay at their final destination on offering ground transportation alternatives (typically more than halving the mean passenger delay in our hypothetical ten-hour closure situation), this must be offset against the cost of providing the alternative transport. A saving of €50 - €150 (year 2012 euros) in terms of delay cost to the airline per passenger is typical, and results mainly from a reduced need to provide overnight hotel accommodation. This is lower than many long-distance walk-up train fares but compares favourably with advance rail ticket prices, indicating any MetaCDM implementation would need to involve pre-arranged agreements between airlines and rail companies, similar to those currently in place between airlines and hotels, to provide services to stranded air passengers at less than walk-up prices. In this scenario, airlines would likely make a small financial gain but a larger reputational one from implementing crisis MetaCDM, and passengers would have the option of a substantial time saving.

Journey time is, however, only one of a range of criteria by which passenger journeys are judged. The European Norm EN 13816:2002-07 [16] defines eight quality criteria connected to passenger satisfaction: availability (the extent of the service offered in terms of geography, time, frequency and transport mode); accessibility; information; time; customer support; comfort; safety; and environmental impact. As discussed in [32], implementing MetaCDM should produce clear benefits in terms of shorter journey time and better information, both under undisrupted and disrupted conditions. The environmental impact is also projected to be similar to or lower than the undisrupted baseline. We would also anticipate that implementing this concept could have a positive impact in terms of availability, social equity and accessibility, provided that these concerns are kept in mind during the implementation process. For example, switching modes in cases of disruption is currently only open to those passengers who have the resources (in terms of money, technology and knowledge) and confidence to do so. One aim of MetaCDM is to open up this process to a greater proportion of passengers. Customer support is a more complex issue since MetaCDM is envisaged to provide greater support via electronic means, potentially leading to a reduction in face-to-face support. Whilst some passengers will be happy with this shift, others may not be (however, there should be no requirement for these passengers to use MetaCDM). Actual and perceived safety and comfort should be improved (for example, passengers should be able to spend more time at home and less in queues in disrupted situations) but passengers may also have the option to trade off comfort and journey time if they wish to. For example, taking a night coach may be less comfortable than staying in a hotel and taking a flight the following day, but a passenger who strongly values arriving as soon as possible may wish to choose this option.

Environmental Impacts

For the types of major disruptive events targeted by MetaCDM total environmental impacts are likely to be lower than they would be in the non-disrupted case. For less severe disruption, improved passenger information is aimed at streamlining the passenger journey. When disruption is severe enough, passengers may be given advice that leads them to take another mode. In this case, environmental impacts can be assessed by comparing the GHG-intensity of different modes. Mode-switching in response to disruption is likely to apply primarily to short-haul flights which have significantly higher emissions per passenger-kilometre (pkm) than nearly all other transport modes. In particular, redirecting passengers to existing bus and train services is likely to roughly quarter the emissions associated with those trips compared with the equivalent air journey.

Because disruptive events involving cancellations lead to fewer flights taking off and landing, noise and local emissions will also be lower than the non-disrupted case. As the MetaCDM concept assumes that passengers taking ground transport modes will join existing services, only marginal increases in environmental impacts from increased load factors on these services are anticipated. Table 5 gives a summary of the expected effects of disruption and MetaCDM on the main areas of aviation environmental impact.

Impact type	Behaviour under severe disruption	Expected effect of MetaCDM concept
GHG emissions	Flight cancellations plus rebooking strongly reduce per-passenger emissions; delays may increase per-passenger emissions if incurred with engines on.	Passengers taking trains or coaches should have lower per-passenger emissions than those flying, so emissions should remain below those in the non-disrupted case.
Noise	Flight cancellations plus rebooking strongly reduce per-passenger noise impact; delays have minimal effect (but may lead to flights operating during noise embargo periods)	Aircraft noise will remain close to the current level under severe disruption, i.e. significantly lower than non-disrupted case; possible but marginal noise increases from ground transportation.
Air quality	Flight cancellations plus rebooking strongly reduce per-passenger air quality impact; delays may increase per-passenger local emissions if incurred with engines on	Similar to noise impact, i.e. much lower aircraft local emissions than non-disrupted case, possible but marginal increase in emissions from ground transportation.
Water quality	De-icing may impact on airport runoff under winter weather conditions.	Minimal change from normal disrupted conditions.
Terminal energy and water use	Stranded passengers may stay longer in the airport, requiring more heating, lighting and water than under non-disrupted conditions.	Fewer passengers at the disrupted airport, leading to lower excess energy use.

Table 5: Effects of disruption and MetaCDM on aviation environmental impacts*

4.1.5 Engaging the enablers and next steps

The Meta-CDM concept necessarily involves multiple stakeholders. The systemic nature of aviation means that those stakeholders are international as well as national and local. Logically therefore, to effect meaningful MetaCDM control and cooperation there has to be input from the higher level organisations that can help to prevent, forestall and contain any crises. Similarly, working together, these organisations can enhance the passenger experience in normal as well as disrupted conditions.

The key to delivering effective MetaCDM is communication. Airport networks are generally thought to operate well but their scope can be limited to the first tier collaborators. MetaCDM requires that this is extended to second and third tier organisations and that means introducing:

- Wider local to regional planning and resilience networks that deliver integrated service and share infromation;

- A national dialogue of interested parties under the auspices of the relevant government departments.;

- National guidelines and protocols that make it easier for the sharing of knowledge and data and minimize the competitive sensitivities of business

- Simplified communication conduits for intelligence on transport disruption.

Recent events such as the Icelandic Volcano eruption and the ensuing transport chaos across Europe and beyond clearly illustrated the fragility of the system, the costs associated with not reacting effectively and therefore the importance of international coordination. The EC, Eurocontrol and others have responded positively to mitigate disruptive events and spread the A-CDM concept but more could be done, such as:

- Delivering protocols that enable levels of filtered alert information to be passed through the network;

- A web 'dashboard' of status information, based upon a 'traffic light' approach, to which stakeholders could contribute;

- The establishment of intelligence/alert units that can capture non-operational features such as meteorological or security data and make that available to the network.

Furthermore, the Commission could consider promoting an international conference, aligned with the 4- hour door-to-door journey time goal that gathers together those who could:

- Expose experience and lessons learned from major disruptive events;

- Identify obstacles to realizing MetaCDM;

- Share research knowledge and current best practice in the sector;

- Outline a policy path towards development of systems and protocols that enable MetaCDM.

Encouraging the trade organisations and others to engage would be an important step towards advancing MetaCDM. Whilst the aviation industry has moved towards adopting A-CDM, broadening take up of the CDM philosophy requires that organisations that have little knowledge of it or are sceptical to be won over. In the first instance that means pushing the idea of A-CDM 'Lite', with lower costs and simplified procedures, for smaller airports but it also means opening dialogues with ground transport providers, highways agencies, local authorities and others based upon an understanding of the benefits that a MetaCDM approach could bring. Existing airport resilience fora provide a starting point but the push also needs to be top-down from the EC, governments and the trade bodies. MetaCDM presumes that a new culture will be adopted, one where there is openness to share data and move towards some harmonization of systems or, at least, improve interfaces between them.

Perhaps unsurprisingly for a new concept, further research will be needed to prove the case for MetaCDM. Apart from demonstrating the economic case, there is a need to address many logistical and attitudinal issues that are part of the new culture. MetaCDM is as much a matter of winning hearts and minds over to the approach as it is about hard numbers on a balance sheet. The Work Package 3 report [32] sets out a number of business, operational, technical and perceptual topics where understanding is not yet mature. However, discussions undertaken within this project show that there is an appetite on the part of key players to look seriously at the MetaCDM concept and to work on these open issues.

4.1.6 Main dissemination activities and exploitation of results

All information about the MetaCDM project (including deliverables and workshop presentations) is available on the project website: http://www.meta-cdm.org/

UNIVERSITY OF CAMBRIDGE ENAC BARCO

European Commission

Meta CDM

Multimodal, Efficient Transportation in Airports and Collaborative Decision Making

A partnership led by Barco-Orthogon, Cambridge University, and ENAC

Under the auspices of the European Community's Seventh Framework Programme (FP7)

establish the state-of the art in Collaborative Decision Making, considering first the air side, where CDM is most concerned about airline urred delay management and is named "airside CDM", and second the land side, named landside CDM, which focuses on the passenger s experienced as soon as entering the airport until he enters the aircraft, especially during significant adverse events. Our effort will aim at ifying the opportunities to link airside and landside CDM in a unified concept, labeled META-CDM: Multimodal (or Multi-user), Efficient Transportation in Airports – Collaborative Decision Making."

This website provides

- A project brochure

- Project Newsletters (Newsletters 1 & 2)
- A presentation of the team
- The different deliverables
- Research papers presented at conferences
- Programs and slides of the 3 workshops

The presented items on the website give an overview of the project's dissemination strategy, particularly the three project workshops. In addition, dissemination and exploitation of the results is ongoing, with two project proposals in place to take MetaCDM concepts further and two journal papers currently in preparation. For any further information please contact Isabelle Laplace, the MetaCDM project manager:isabelle.laplace@enac.fr, phone number: 0033 56225 9542.

4.2 Use and dissemination of foreground

Section A (public)

From the beginning of the MetaCDM project until October 2014, three kinds of dissemination activities have been organised: workshop organisation, Industry/Airports/policy maker dissemination, and Scientific dissemination.

Workshops

The MetaCDM project centred around a series of workshops at which stakeholders reviewed the outcomes of the project so far, advised on future steps and influenced the concepts being developed. At every step, the practical advice of those who have dealt with air transport system disruption was vital.

- **Workshop 1**, held at London Heathrow Airport in January 2013, reviewed the current state of CDM and response to crisis events,
- **Workshop 2**, at Frankfurt Airport in November 2013, focused on lessons learned from MetaCDM's series of on-site interviews with affected stakeholders, and on the contribution of multimodality,
- **Workshop 3**, in Toulouse in May 2014, discussed the final project outcomes, future directions, enabling technologies, and steps towards a new passenger-centric concept of operations.

Industry/Airports/policy maker dissemination

Team members presentated of the MetaCDM project at:

- NASA (USA) in summer 2013
- the European Commission premises in June 2014
- to airports during an Alpha-ACI meeting in October 2014

Scientific dissemination

Scientific papers presenting MetaCDM have been submitted, accepted and presented at the following scientific conferences

- Air Transport and Operations Symposium (ATOS) in July 2013
- Airport in Urban Network (AUN) in April 2014
- Air Transport Research Society (ATRS) in July 2014

Further scientific dissemination activities are ongoing, including the preparation of papers to submit to scientific journals.

TEMPLATE A2: LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities[1]	Main leader	Title	Date/Period	Place	Type of audience[2]	Size of audience	Countries addressed
1	Workshop	MetaCDM team	MetaCDM Workshop 1 “What comes next? – Moving towards Total Airport Management and putting the passenger at the heart of CDM”	January 15th & 16th 2013	London Heathrow airport, UK	Scientific Community, Airports, Industry, European Commission, EUROCONTROL	48 participants	France, UK, Germany, Hungary, Czech Republic, USA, China
2	Workshop	MetaCDM team	MetaCDM Workshop 2 “Improving Passenger Satisfaction at Airports – Contributions of Information Sharing, Collaborative Decision Making and Multimodality”	November 12th & 13th 2013	Frankfurt airport, Germany	Scientific Community, Airports, Airlines, Industry	23 participants	France, UK, Germany, Austria, USA,
3	Workshop	MetaCDM team	MetaCDM Workshop 3 “Improving Passenger experience in situation of disruptive events – The New Concept of MetaCDM”	May 14th & 15th	Toulouse (ENAC premises), France	Scientific Community, Airports, Airlines, Industry	46 participants	France, UK, Germany, Netherlands, Hungary, USA,
4	Presentation	NASA	MetaCDM presentation	July 2013	NASA (USA)	Scientific Community		USA
5	Presentation	European Commission	MetaCDM final presentation	June 26th 2014	EC premises	Airport, European Commission	10	Belgium, France, Germany, UK

[1] A drop down list allows choosing the dissemination activity: publications, conferences, workshops, web, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters, Other.

[2] A drop down list allows choosing the type of public: Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias, Other ('multiple choices' is possible).

6	Presentation	Alpha-ACI	Alpha-ACI meeting	October 9th 2014	Liege airport, Belgium	Airports	Not available	Francophone airports
7	Conference	ATOS	Air Transport and Operations Symposium	July 2013	Toulouse, France	Scientific Community	Not available	European countries
8	Conference	AUN	Airport in Urban Network	April 2014	Paris, France	Scientific Community, airports, Industry	20 attendees in the session	European countries
9	Conference	ATRS	Air Transport Research Society	July 2014	Bordeaux, France	Scientific Community, airports, Industry	30 attendees in the session	European countries

Section B (Confidential[3] or public: confidential information to be marked clearly)
Part B1

Not applicable for MetaCDM

[3] Note to be confused with the "EU CONFIDENTIAL" classification for some security research projects.

4.3 Report on societal implications

Replies to the following questions will assist the Commission to obtain statistics and indicators on societal and socio-economic issues addressed by projects. The questions are arranged in a number of key themes. As well as producing certain statistics, the replies will also help identify those projects that have shown a real engagement with wider societal issues, and thereby identify interesting approaches to these issues and best practices. The replies for individual projects will not be made public.

A General Information *(completed automatically when **Grant Agreement number** is entered.*	
Grant Agreement Number:	314453
Title of Project:	Multimodal, Efficient Transportation in Airports and
Name and Title of Coordinator:	ENAC (Ecole Nationale de l'Aviation Civile)

B Ethics	
1. Did your project undergo an Ethics Review (and/or Screening)? • If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final project reports? Special Reminder: the progress of compliance with the Ethics Review/Screening Requirements should be described in the Period/Final Project Reports under the Section 3.2.2 *'Work Progress and Achievements'*	***No***
2. Please indicate whether your project involved any of the following issues (tick box) :	***NO***
RESEARCH ON HUMANS	
• Did the project involve children?	
• Did the project involve patients?	
• Did the project involve persons not able to give consent?	
• Did the project involve adult healthy volunteers?	
• Did the project involve Human genetic material?	
• Did the project involve Human biological samples?	
• Did the project involve Human data collection?	
RESEARCH ON HUMAN EMBRYO/FOETUS	
• Did the project involve Human Embryos?	
• Did the project involve Human Foetal Tissue / Cells?	
• Did the project involve Human Embryonic Stem Cells (hESCs)?	
• Did the project on human Embryonic Stem Cells involve cells in culture?	
• Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos?	
PRIVACY	
• Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	
• Did the project involve tracking the location or observation of people?	
RESEARCH ON ANIMALS	
• Did the project involve research on animals?	
• Were those animals transgenic small laboratory animals?	

• Were those animals transgenic farm animals?	
• Were those animals cloned farm animals?	
• Were those animals non-human primates?	
RESEARCH INVOLVING DEVELOPING COUNTRIES	
• Did the project involve the use of local resources (genetic, animal, plant etc)?	
• Was the project of benefit to local community (capacity building, access to healthcare, education etc)?	
DUAL USE	
• Research having direct military use	0 Yes 0 No
• Research having the potential for terrorist abuse	

C Workforce Statistics

3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).

Type of Position	Number of Women	Number of Men
Scientific Coordinator	1	
Work package leaders	2	1
Experienced researchers (i.e. PhD holders)	2	3
PhD Students	1	1
Other		2

4. How many additional researchers (in companies and universities) were recruited specifically for this project?	**2**
Of which, indicate the number of men:	1

D Gender Aspects

5. Did you carry out specific Gender Equality Actions under the project?

○ Yes
☑ No

6. Which of the following actions did you carry out and how effective were they?

		Not at all effective				Very effective
❑	Design and implement an equal opportunity policy	○	○	○	○	○
❑	Set targets to achieve a gender balance in the workforce	○	○	○	○	○
❑	Organise conferences and workshops on gender	○	○	○	○	○
❑	Actions to improve work-life balance	○	○	○	○	○
○	Other:					

7. Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?

○ Yes- please specify

☑ No

E Synergies with Science Education

8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?

○ Yes- please specify

☑ No

9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?

○ Yes- please specify

☑ No

F Interdisciplinarity

10. Which disciplines (see list below) are involved in your project?

○ Main discipline[4]: 2

○ Associated discipline[4]:2.3

○ Associated discipline[4]:

G Engaging with Civil society and policy makers

11a Did your project engage with societal actors beyond the research community? *(if 'No', go to Question 14)*

○ Yes
☑ No

11b If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?

○ No
○ Yes- in determining what research should be performed
○ Yes - in implementing the research
○ Yes, in communicating /disseminating / using the results of the project

[4] Insert number from list below (Frascati Manual).

11c	**In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?**	○ ☑	Yes No

12. Did you engage with government / public bodies or policy makers (including international organisations)

- ○ No
- ○ Yes- in framing the research agenda
- ○ Yes - in implementing the research agenda
- ☑ Yes, in communicating /disseminating / using the results of the project

13a Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?

- ☑ Yes – as a **primary** objective (please indicate areas below- multiple answers possible)
- ○ Yes – as a **secondary** objective (please indicate areas below - multiple answer possible)
- ○ No

13b If Yes, in which fields?

				Information Society Regional Policy Research and Innovation Transport	

13c If Yes, at which level? ○ Local / regional levels ☑ National level ☑ European level ○ International level	

H Use and dissemination

14. How many Articles were published/accepted for publication in peer-reviewed journals?	**0**
To how many of these is open access[5] provided?	
How many of these are published in open access journals?	
How many of these are published in open repositories?	
To how many of these is open access not provided?	
Please check all applicable reasons for not providing open access:	
❑ publisher's licensing agreement would not permit publishing in a repository ❑ no suitable repository available ❑ no suitable open access journal available ❑ no funds available to publish in an open access journal ❑ lack of time and resources ❑ lack of information on open access ❑ other[6]: ……………	

15. How many new patent applications ('priority filings') have been made? *("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).*	**0**

16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).	Trademark	**0**
	Registered design	**0**
	Other	**0**

17. How many spin-off companies were created / are planned as a direct result of the project?	**0**
Indicate the approximate number of additional jobs in these companies:	

18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:

❑ Increase in employment, or	❑ In small & medium-sized enterprises
❑ Safeguard employment, or	❑ In large companies
❑ Decrease in employment,	❑ None of the above / not relevant to the project
☑ Difficult to estimate / not possible to quantify	

19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (*FTE = one person working fulltime for a year*) jobs:	*Indicate figure:* *6.22*

[5] Open Access is defined as free of charge access for anyone via Internet.
[6] For instance: classification for security project.

Difficult to estimate / not possible to quantify	❑

I Media and Communication to the general public

20. As part of the project, were any of the beneficiaries professionals in communication or media relations?

○ Yes ☑ No

21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?

○ Yes ☑ No

22 Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?

❑	Press Release	❑	Coverage in specialist press
❑	Media briefing	❑	Coverage in general (non-specialist) press
❑	TV coverage / report	❑	Coverage in national press
❑	Radio coverage / report	❑	Coverage in international press
☑	Brochures /posters / flyers	☑	Website for the general public / internet
❑	DVD /Film /Multimedia	☑	Event targeting general public (festival, conference, exhibition, science café)

23 In which languages are the information products for the general public produced?

❑	Language of the coordinator	☑	English
❑	Other language(s)		

***Question F-10*:** Classification of Scientific Disciplines according to the Frascati Manual 2002 (Proposed Standard Practice for Surveys on Research and Experimental Development, OECD 2002):

FIELDS OF SCIENCE AND TECHNOLOGY

1. NATURAL SCIENCES
1.1 Mathematics and computer sciences [mathematics and other allied fields: computer sciences and other allied subjects (software development only; hardware development should be classified in the engineering fields)]
1.2 Physical sciences (astronomy and space sciences, physics and other allied subjects)
1.3 Chemical sciences (chemistry, other allied subjects)
1.4 Earth and related environmental sciences (geology, geophysics, mineralogy, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, oceanography, vulcanology, palaeoecology, other allied sciences)
1.5 Biological sciences (biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences)

2 ENGINEERING AND TECHNOLOGY
2.1 Civil engineering (architecture engineering, building science and engineering, construction engineering, municipal and structural engineering and other allied subjects)
2.2 Electrical engineering, electronics [electrical engineering, electronics, communication engineering and systems, computer engineering (hardware only) and other allied subjects]
2.3. Other engineering sciences (such as chemical, aeronautical and space, mechanical, metallurgical and materials engineering, and their specialised subdivisions; forest products; applied sciences such as

geodesy, industrial chemistry, etc.; the science and technology of food production; specialised technologies of interdisciplinary fields, e.g. systems analysis, metallurgy, mining, textile technology and other applied subjects)

3. MEDICAL SCIENCES

3.1 Basic medicine (anatomy, cytology, physiology, genetics, pharmacy, pharmacology, toxicology, immunology and immunohaematology, clinical chemistry, clinical microbiology, pathology)

3.2 Clinical medicine (anaesthesiology, paediatrics, obstetrics and gynaecology, internal medicine, surgery, dentistry, neurology, psychiatry, radiology, therapeutics, otorhinolaryngology, ophthalmology)

3.3 Health sciences (public health services, social medicine, hygiene, nursing, epidemiology)

4. AGRICULTURAL SCIENCES

4.1 Agriculture, forestry, fisheries and allied sciences (agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects)

4.2 Veterinary medicine

5. SOCIAL SCIENCES

5.1 Psychology

5.2 Economics

5.3 Educational sciences (education and training and other allied subjects)

5.4 Other social sciences [anthropology (social and cultural) and ethnology, demography, geography (human, economic and social), town and country planning, management, law, linguistics, political sciences, sociology, organisation and methods, miscellaneous social sciences and interdisciplinary , methodological and historical S1T activities relating to subjects in this group. Physical anthropology, physical geography and psychophysiology should normally be classified with the natural sciences].

6. HUMANITIES

6.1 History (history, prehistory and history, together with auxiliary historical disciplines such as archaeology, numismatics, palaeography, genealogy, etc.)

6.2 Languages and literature (ancient and modern)

6.3 Other humanities [philosophy (including the history of science and technology) arts, history of art, art criticism, painting, sculpture, musicology, dramatic art excluding artistic "research" of any kind, religion, theology, other fields and subjects pertaining to the humanities, methodological, historical and other S1T activities relating to the subjects in this group]

5. FINAL REPORT ON THE DISTRIBUTION OF THE EUROPEAN UNION FINANCIAL CONTRIBUTION

This report shall be submitted to the Commission within 30 days after receipt of the final payment of the European Union financial contribution.

Report on the distribution of the European Union financial contribution between beneficiaries

Name of beneficiary	Final amount of EU contribution per beneficiary in Euros
1.*ENAC*	
2.BARCO Orthogon	
3. University of Cambridge	
Total	

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Abbreviations

Abbreviation	Description
A-CDM	Airport Collaborative Decision Making
ACI	Airports Council International
AEA	Association of European Airlines
AMAN	Arrival Manager
ANSP	Air Navigation Service Provider
AODB	Airport Operations Database
AOP	Airport Operations Plan
APOC	Airport Operations Centre
A-SWIM	Airport – System Wide Information Management
ATIS	Advanced Transport Information System
ATC	Air Traffic Control
ATFCM	Air Traffic Flow and Capacity Management
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
CAA	Civil Aviation Authority
CANSO	Civil Air Navigation services Organisation
CDM	Collaborative Decision Making
CFMU	Central Flow management Unit
CODA	Central Office for Delay Analysis
COFU	Collaborative Management of Flight Updates
DMAN	Departure Manager
DPI	Departure Planning Information
EC	European Commission
FAA	Federal Aviation Authority
FUM	Flight Update Messages
IATA	International Air Transport Association
ICAO	International Civil Aviation Authority
IROPS	Irregular Operations
KPI	Key Performance Indicator
IT	Information Technology
Meta-CDM	Multimodal, Efficient Transportation in Airports and Collaborative Decision Making
TAM	Total Airport Management
TSAT	Target Start-up Approval Time