INSIGHT

FP7-318225

D6.1:

Use Cases

Lead Partner: BBK

Contributing Partners: DCC, Fraunhofer, IBM, UoA

28/08/2013

Status: Final
Scheduled Delivery Date: 31/08/2013

Executive Summary

The deliverable 6.1 presents the two elaborated use cases of the INSIGHT project as real-world test-beds to demonstrate the benefits of the INSIGHT system for public safety and civil protection. Requirements for each use case regarding data sources, analysis methods and technology, visualisation and application of INSIGHT solutions get presented, as well as a design of a validation experiment.

Document Information

Contract Number	FP7-318225	**Acronym**	INSIGHT
Full title	Intelligent Synthesis and Real-time Response using Massive Streaming of Heterogeneous Data		
Project URL	http://www.insight-ict.eu/		
EU Project officer	Mr. Treinen		

Deliverable	**Number**	D6.1	**Name**	Use Case	
Work package	**Number**	WP6			
Date of delivery	31/08/2013		M12	**Actual**	30/08/2013
Status	final				
Nature	Report				
Distribution Type	Public				
Authoring Partner	BBK				
QA Partner	UoA				
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1. Introduction

The INSIGHT project envisions two use cases as real-world test beds to demonstrate the benefits of Big Data Analysis for public safety and civil protection. The choice of the use cases and their specific characteristics will demonstrate that the work proposed in the project is useful, relevant and timely.

The use cases described in this deliverable are: traffic congestion, incidents and flooding in Dublin, and a nation-wide emergency (extreme high tide; flood) in northern Germany.

This deliverable is based on task 6.1 (Months 1-10) and task 6.2 (Months 6-12) with the involvement of the Federal Office for Civil Protection and Disaster Assistance (BBK), Dublin City Council (DCC), Fraunhofer Institute (IAIS), IBM and the University of Athens (UoA).

The purpose of this document is to elaborate the background, current situation, specification and description of the two use cases as well as a requirement analysis. For both test-beds, data sources, needed technologies and analysis methods, workflow and visualisations will be defined. In addition, contemplated applications for INSIGHT solutions get introduced. For each use case a validation and usability testing experiments will be designed so that a realistic and systematic evaluation can take place.

The document is structured as follows: after the introduction, the main sections are the two use cases. Within these two sections the general framework and challenges, overall goals of the INSIGHT system, current situations respectively the scenario description and requirements as well as the design of a validation experiment get described. A section about the relevance of the INSIGHT project and conclusion will sum up the deliverable 6.1.

2. City-level Use Case

The city-level use case is located in Dublin City, Ireland with traffic congestions, incidents and flooding being the focal point of this use case. In the following sections the general framework and challenges of Dublin City Council (DCC) and its Road and Traffic Department, overall goals of the INSIGHT system, the scenario of the use case, requirements as well as the design of the validation experiment will be described.

2.1 General Framework and Challenges

Dublin City Council (DCC) is the democratic body governing Dublin City. It is the largest local authority in the Republic of Ireland with a staff of approximately 6,000. The DCC provides a wide range of services for its citizens and businesses, which include:

- Housing
- Planning & Development
- Environment
- Roads & Traffic
- Engineering
- Culture & Amenity

Dublin City covers an area of 11,496 hectares and has a current population of 495,781.

The Roads and Traffic Department of Dublin City Council develops, maintains and manages the city's road network for the benefit of pedestrians, cyclists, motorists and public service and commercial vehicles. The department is currently pursuing the following strategies:

- Providing alternatives to car commuting
- Developing, optimising and maintaining the city's road network
- Managing on-street parking
- Improving the city's environment

Dublin city faces challenges in the area of sustainable mobility. There has been considerable success in the provision of public transport for commuting over the past ten years. However, the demand for travel and movement of goods will continue to expand.

The city street network is finite and the historic street pattern does not lend itself to significant expansion. It is necessary to optimise the network to provide sustainable transport to meet the needs of business, residents, commuters, shoppers and disabled people.

Accessibility is the ability to reach desired goods, services, activities and destinations and as such is a measure of the attractiveness of the city. It is the intention to continue data collection across the various travel modes, in order to refine an accessibility index to more accurately measure in a timely fashion, the success in meeting various objectives.

The current public transportation system in Dublin comprises bus services mainly operated by Dublin Bus and light rail transport comprising two Luas tram lines operated by Veolia.

Despite the expansion of public transport options over the past years, road congestion is, according to some metrics, on the rise. For the year 2012, a survey of the ten most-congested European cities by TomTom put Dublin in eleventh place[1]. The number of cars entering the Dublin city centre during morning rush hour changes unpredictably over the years: it has increase by 3000 from 2005 to 2009, and it has dropped back in

[1] TomTom International BV (2013): TomTom European Congestion Index. Amsterdam.

2012 to the same number as in 2006 (around 37 %). Nevertheless, the usage of a car is still the most important single travel mode during morning rush hour[2].

2.2 Current Situation

The Dublin City Council Traffic and Incident Management Centre (DCCTIMC) operates on a 24/7 basis staffed by a team of ten operators and one supervisor. This team manages the day-to-day traffic movements throughout the city.

This traffic management is enabled through the use of SCATS complemented with the network of CCTV (closed-circuit television) cameras and vast amounts of experience.

During peak times (Monday – Friday, 07:00 – 10:00 and 16:00 – 19:00) Live Drive, broadcasting from the DCCTIMC, assist the DCCTIMC operators with the observation of incidents and unusual events throughout the city that cause unwanted delays. Live Drive receives information in relation to traffic congestion etc. from its listenership, which it then re-broadcasts to all listeners.

AA Road Watch occupy a seat in the DCCTIMC and provide up-to-date information relating to traffic to the major radio stations e.g. RTE Radio 1, Newstalk etc.

During emergency events e.g. unusual weather events: flooding; snow etc. the Gardai (Police Service) provide a presence in the DCCTIMC which allows direct communication to the Gardai Traffic Corps thus shortening response times.
Dublin Bus also provides a resource during emergency situations to monitor the progression etc. of the bus fleet throughout the network and, again, shortening response time where appropriate.

Members of DCCs Intelligent Transportation Systems (ITS) section provide assistance to all members of the team during emergency situations where appropriate.

DCCs Press Office provides regular communication via all media during emergency scenarios with information from all relevant departments in DCC.

2.3 Overall Goals of the INSIGHT System

The goal of INSIGHT will be to enable traffic managers to detect with a high degree of certainty unusual events throughout the network. CCTV will enable the managers verify the events where there is sufficient CCTV coverage. More importantly, INSIGHT should be able to provide awareness of these unusual events where the CCTV network coverage is low or non-existent (e.g. in suburbs, housing estates etc.).

As an EU-funded project this will prove to be important. INSIGHT should be scalable and transferrable. Other EU cities should benefit from this project and cities less

[2] National Transport Authority (2012): Report on trends in mode share of people crossing the Canal Cordon - 2006 to 2011. Dublin.

resourced than Dublin City (in terms of traffic management – SCATS, CCTV etc.) should be able to utilise INSIGHT where there is sufficient existing data available.

In brief, INSIGHT will be used by two types of end-users: city operators and citizens. Its goals are to:

- automatically monitor all data sources at all times,
- automatically detect important events,
- automatically query specific human users for measurements,
- dispatch automatic or semi-automatic responses to these events,
- give labels (explanations) for these events, along with confidence levels for these labels.
- This system will also request for and combine the human operators' expert knowledge of the situation.

2.4 Requirements

In the following, requirements in the context of this city-level use case including data sources, analysis methods and technology, visualisation and application of INSIGHT solutions get described.

2.4.1 Data Sources

The data sources of the Dublin use case is described below. This data is divided into traffic data, weather data and twitter data (social media data).

Traffic Data

SCATS - Dublin City Council currently has systems monitoring real-time traffic density through a system called SCATS (Sydney Coordinated Adaptive Traffic System). SCATS is an innovative computerised traffic management system developed by Roads and Maritime Services (RMS) Australia. The evolution of SCATS started in the 1970s and is continually being improved by RMS to manage traffic signal networks around the world. SCATS has been distributed to 263 cities in 27 countries worldwide controlling more than 35,531 intersections. DCC manages approximately 600 SCATS controlled intersections.

TRIPS (Travel-time Reporting and Integrated Performance System software) is a sophisticated facility that directly integrates with and provides accurate travel time prediction information on road network performance and other important information on the operation of SCATS. TRIPS interfaces with SCATS in such a way that it guarantees high performance data streaming, with no impact on the operation on the SCATS system. TRIPS actively collects and processes travel time data every 60 seconds ensuring that TRIPS outputs are always consistent with current road demands. DCC has configured approximately 45 routes throughout the city on TRIPS.

Bus Data - In Dublin City, the main mode of public transport is by bus; it far outweighs both the heavy and light rail systems both in passenger numbers and in coverage. The main operator is Dublin Bus, a State owned company with a fleet of over a 1,000 buses, most of which either terminate or pass through the city centre area. For example at Trinity College there are almost 400 buses in both directions during the peak hour (08:00-09:00); O'Connell Bridge has around the same, except with competing movements. In 2008, Dublin Bus began the process of fitting an Automatic Vehicle Location (AVL) system to their fleet. Real-time GPS traces from buses are collected at 30-second intervals and is available in real-time.

CCTV - Through a network of over 200 CCTV cameras, traffic can be monitored throughout the network. Analytics on CCTV can be used to automatically detect rain or static water on the ground to avoid the current necessity requiring operators to pan cameras. DCC does not record any images from its CCTV network. Any use of this data would need to take place from within the DCC network: so any software etc. that the INSIGHT project develop/deploy must sit inside the DCC network which, in turn, may be accessed remotely.

Live Drive has been on air for over seven years and has become part of the fabric of Dublin radio. Boasting a daily listenership of 47,000, the show is a lively mix of music and the most accurate up-to-the-minute traffic information. Live Drive broadcast for 6 hours daily on 103.2 Dublin City FM - from 7am to 10am and from 4pm to 7pm - live from Dublin City Council's state-of-the-art traffic control centre. Through a combination of Twitter and text messages received from their listenership coupled with the access to CCTV, Live Drive provide the most up-to-date information to members of the travelling public in the Dublin City Region. This data is recorded on a spread sheet in real time by the Producer/Researcher of the Live Drive radio show and can be made available to the INSIGHT project.

Pedestrian Counters - There are a number of pedestrian counters (approximately ten) in the city centre for which data can be gleaned.

Weather Data

Flooding is an important issue in Dublin due to a combination of weather events and tides. Weather is fast-changing in Dublin: rainfall is frequent and very difficult to predict. Tides are easier to predict, but have a strong effect on the level of the river Liffey that bisects Dublin.

INSIGHT will seek to tap into measurements from dedicated sensors, social media sources, as well as human sensors to give accurate estimates, and possible predictions, of floods and other unusual weather events.

GPS traces and vehicle counts to infer the absence of flooding in some areas of the city will be used as well as twitter reports to infer flooding in other areas. Selective querying will be used to obtain flooding measurements where neither dedicated sensor nor social media reports are available.

The National Roads Authority (NRA) has a network of 54 weather monitoring stations and road sensors located on National Roads. These stations are part of an Ice Detection and Prediction System for the prediction and detection of ice formation on national roads during the winter months. Linked directly by modem, the meteorological information from the weather stations and road sensors is relayed to Met Eireann (see below). The data is then used to give forecasts on ice locations on the network. The forecasts are automatically relayed to the relevant local authority and provide a valuable management tool to aid authorities with their road salting and snow ploughing programmes.

The data is provided via web-page. The information provided includes road surface temperature, air temperature, wind speed, wind direction and the road state i.e. whether there is ice, frost, snow, wet or whether the road has been treated. The web-pages update automatically at ten minutes past the hour to display the most recent readings from the road sensors usually taken on the hour.

For the Dublin use case old NRA data sets get used. These data sets are only licensed for the INSIGHT partner IBM and cannot be shared with other project partners; thereby these data sets are only used internally by IBM for the INSIGHT project.

Met Éireann, the Irish National Meteorological Service, is a line division of the Department of the Environment, Community and Local Government. It is the leading provider of weather information and related services for Ireland. Individual members of the INSIGHT consortium can get the real-time data provided by Met Eireann from their website www.met.ie.

Rain Gauge Data - Dublin City Council is the municipal authority with responsibility for the coordination of the flood risk management strategy for the entire Dublin region and is responsible for the delivery of the fire and rescue services to the region's population. The Water and Drainage department in DCC has access to a number of rain gauges**.** Whilst this data is currently not available on-line it is hoped the data can be made available to the INSIGHT project during the lifetime of the project.

Twitter Data

Twitter data will be interrogated as part of the INSIGHT project by individual contributing partners of the IMSIGHT consortium.

2.4.2 Required Analysis Methods and Technology

DCC current traffic monitoring system is interactive: a human operator must manually select which areas of the city to observe. The operator must then continuously monitor the incoming signals on computer displays. Important events are not automatically detected, and responses to these events are decided at a local level, often excluding global factors across the network.

Traffic signals are monitored manually in real-time by human traffic managers. In the event of severe congestion, they respond with solutions such as diverting traffic along alternate routes and/or altering the frequency of green time etc. These responses are not automatic and must be executed manually.

The INSIGHT project will seek to develop a smartphone app that automatically queries smartphone users for labels (explanations) whenever important events are detected from dedicated sensors (e.g., SCATS, GPS). The queries will be very selective so as not to disturb users too much. Moreover, only users who have enrolled will be queried. Smartphone users have a number of incentives to enroll: they can receive rewards for responding to queries, they can also receive customized traffic reports and recommendations from the INSIGHT system. These reports are customized by learning which roads every user is likely to take on particular days.

An interactive map displaying all issues detected by INSIGHT is desirable by the staff of the DCCTIMC. The system developed by INSIGHT should be web enabled allowing ease of access to relevant users.

INSIGHT must be intelligent enough to know when it is not receiving enough inputs. For example, SCATS makes use of inductive loops set into the road surface to detect the presence or otherwise of vehicles. Occasionally, these inductive loops become damaged (e.g. during roadworks etc.) and do not detect the presence of vehicles. If INSIGHT intends using these inputs (SCATS inputs) the system must be aware when these inputs are no longer active and that the accuracy of the detection of an unusual event will be diminished.

2.4.3 Visualisation Requirements

In this use case, the DCCTIMC requires a Graphical User Interface (GUI) that visualises a map of the city of Dublin. On this map INSIGHT plots locations of events of interest supported by data led evidence.

The map should have the following locations pinned on the map: (not exhaustive)

- SCATS junctions
- CCTV cameras
- Hospitals
- Fire brigade stations
- Gardai stations
- Road maintenance depots
- Public transport hubs

The map should have zoom and pan functions so that operators can focus on areas of particular interest within the city.

The interactive map should be web based so that relevant traffic managers can access the application.

2.4.4 Application of INSIGHT Solutions

The INSIGHT system will generally work as follows in this use case:

- Continual monitoring of data inputs
- Flag raised early in response to potential unusual event(s) (congestion, flooding etc. observed)
- Control Room operator notified of potential unusual event
- Control Room Operator acknowledges receipt of flag and offline verifies unusual event via CCTV etc.
- Options advised to Control Room operators
- Incidents logged - a log of all unusual events recognised by INSIGHT system should be logged in a daily log file
- Simulation ability – the INSIGHT programme should have the ability to re-play historical events based on the log file

2.5 Design of Validation Experiment

A validation and assessment experiment will be carried out to proof the usability and to emphasize the additional benefits of the INSIGHT system. This section includes the description of the experiment as well as the validation procedure.

2.5.1 Description of Experiment

It is proposed to test and validate INSIGHT on two corridors in Dublin City, as follows:

- N11 route (Leeson Street Bridge – Donnybrook Church – Foxrock)[3]
- Fairview Strand – Memorial Bridge[4]

[3] https://maps.google.com/maps?saddr=Leeson+Street+Bridge,+Dublin,+Ireland&daddr=Foxrock+Church,+Foxrock+Court,+Foxrock,+Ireland&hl=en&sll=37.0625,-95.677068&sspn=62.484575,134.912109&geocode=FZrILQMd-Zag_ykNMrAhow5nSDEv1gg7cW9UAQ%3BFUblLAMdsM6h_yGD8kbFq9DZoyk1TspgXwhnSDGD8kbFq9DZow&oq=foxrock+ch&mra=ls&t=m&z=13

[4] https://maps.google.com/maps?saddr=Marino+Mart&daddr=Memorial+Road&hl=en&sll=53.357416,-

These routes were chosen as they have a high coverage of SCATS junctions and high coverage of CCTV.

INSIGHT shall be evaluated along these corridors by comparison of all the data inputs, results from INSIGHT system versus observations on CCTV etc.

2.5.2 Validation Procedure

The social media stream collected via Twitter provide a resource for evaluation of the INSIGHT project. Events derived from the streams of Live Drive, AA Roadwatch and Garda Traffic provide real, user-annotated descriptions of incidents, and traffic conditions in the city of Dublin. The information from these trusted sources, as well as opinion from city operators, can be taken as the ground truth. The following components of the INSIGHT project may be evaluated against this ground truth.

- Automated data monitoring—the location of events of interest may be identified in the data set and the algorithmic solution for identifying locations of interest for monitoring in the city may be validated.

- Automated event detection—events detected in real-time by the INSIGHT system can be compared with the ground truth in hindsight. It should be noted that the evaluation dataset will not contain a complete collection of all incidents and anomalies in the system; however those that are known should be accurately identified to a satisfactory level.

6.244526&sspn=0.023436,0.065875&geocode=FY5GLgMdDPCg_w%3BFVoILgMdFpyg_w&oq=amiens+street&mra=dme&mrsp=1&sz=15&t=m&z=15

3. Nation-wide Use Case

The nation-wide emergency use case is broaching the issue of an extreme high tide affecting northern Germany. In the following the general framework and challenges of civil protection in Germany, overall goals of the INSIGHT system, scenario of the use case, requirements as well as the design of the validation experiment are described.

3.1 General Framework and Challenges

Germany is in comparison not as much exposed to natural hazards than other countries. But like in other countries the number of disasters triggered by natural hazards is rising. Especially floods and storms as well as extreme weather events led in the last years and decades to increased need of civil protection in Germany. Areas around inland water bodies as well as the coast line of the North and Baltic Sea are often affected. As an example, within a bit more than a decade two one hundred year floods (2002, 2013) caused massive damages in wide areas around divers German rivers.

The administration and legislation of disaster control and disaster relief in Germany is in general an area of responsibility of each of the sixteen federal states. Generally, counties and district-free cities are responsible for the organisation of the needed emergency services in case of disasters.

The INSIGHT project operates in this use case on federal level (Federal Office for Civil Protection and Disaster Assistance, BBK), more precisely within the German Joint Information and Situation Centre (GMLZ). The GMLZ provides information and resource management across all federal states and organisations during large-scale disasters and other incidents with a national importance. Different sources of information get constantly monitored and interpreted for a comprehensive overview of the situation. Main tasks of the GMLZ are collection, acceptance, analysis, converting, coordination, transmission and exchange of announcements and information. Overall goal of the GMLZ is near real-time recognition of complex emergency or disastrous incidents, prediction of the development of an incident as well as to keep the overall situation awareness up-to-date.

The general course of a disaster (natural or man-made) can be divided into eight phases. Each phase has different challenges which are considered from of the perspective of the GMLZ:

1. Pre-disaster
2. Occurrence of a disaster
3. Relief units[5] have not yet arrived at the place of incident
4. Insufficient numbers of relief units have arrived

[5] Relief units are defined as aider of governmental and non-governmental organisations trained for disasters. Other people giving assistance in a case of disaster are called Unorganised Volunteers (UOV).

5. Sufficient numbers of relief units have arrived
6. Too many relief units are at the place of incident
7. Relief units are leaving the affected area of an incident
8. Transition to a normal state

Derived challenges for the INSIGHT project based on these phases of a general course of a disaster:

- Phase 1: Early detection of events that may lead to critical incidents; preparation for different scenarios
- Phase 2: Detection of events faster than news live ticker (media); detection of time, location and type of an event
- Phase 3: Accuracy of information, evaluation of validity
- Phase 4: Assessment of the extent of an incident, direct feedback integration
- Phase 5: Monitoring of the success of counter measures, reaction of the population
- Phase 6: Integrate validated secure on-site information, learning
- Phase 7 + 8: Differentiating between worsening and improving situation

Generally speaking there is a need of a dynamic monitoring of the course of a situation (fast changes); complex adaptive systems are needed.

The worldwide disasters of the past years (earthquakes in Haiti, Chile and Christchurch, Queensland Flooding, Hurricane Sandy, Flooding in Germany 2002, 2013) are showing of the trend of affected population helping themselves, especially during phase two and three of a disaster. In these cases the affected population can be considered as the 'real' first responders. But also a rising number of Unorganized Volunteers (UOV) is assisting during disaster response in different ways; social media gets increasingly used by these volunteers. Additionally, worldwide so called Volunteers and Technical Communities (V&TC) are providing information via information and communication technologies.

All these volunteers are additional and especially the V&TC are new challenges civil protection including the GMLZ has to face.

In civil protection not only human lives are subjects of protection. Especially, the protection of critical infrastructures gains in importance in an industrialised country like Germany. Critical infrastructures are defined as organisations and facilities with a high importance for the public community. Failure of these infrastructures could lead to a lasting effect on supply shortfall, extensive disruption of public safety or other serious consequences for the public[6].

[6] BMI (2009): Nationale Strategie zum Schutz Kritischer Infrastrukturen (KRITIS-Strategie). Berlin.

Critical infrastructure can be allocated to the following sectors[7]:

- Energy
- Information and telecommunication technologies
- Health
- Water
- Food
- Transport and traffic
- Finance and insurance industry
- Government and public administration
- Media and culture

3.2 Overall Goals of the INSIGHT System

Big data or more precisely the analysis of big data, like the INSIGHT system is providing, can be used for several tasks for civil protection.

On the basis of the challenges derived in Section 3.1 the INSIGHT system aims to provide analytical and visual methods for:

1. Early detection of an incident
2. Early response (spreading of information)
3. Verifying an incident through direct feedback integration
4. Preparation of a comprehensive overview of the situation (situational awareness)
5. Support the exploration of a situation (crowdsourcing etc.)
6. Monitoring of the reaction of the affected population (e.g. to official measures and orders)
7. Post disaster assessment

The specific contemplated applications for INSIGHT solutions for this use case are described in 3.4.4.

3.3 Scenario Description

The following section describes the scenario behind the use case of a nation-wide emergency situation in Germany; including setting and course of the scenario.

[7] BBK (2011): Was sind eigentlich Kritische Infrastrukturen? Neue Sektoren- und Brancheneinteilung. Bonn.

3.3.1 Setting

The nation-wide use case scenario is based on the assumption of a 'once-in-a-millennium high tide' in the northern part of Germany at the North Sea coast. Besides Germany, also Denmark and the Netherlands are affected by this situation.

The affected area in Germany is mainly situated in the federal state of Lower Saxony, but also parts of Schleswig-Holstein and the city states of Hamburg and Bremen are affected as well (see figure 1).

Figure 1: Affected area in northern Germany

The city of Hamburg shows of the greatest population of about 1.8 million inhabitants in this area directly situated at the Elbe River. Also the city of Bremen (population 547,976) and the city of Emden (population 51,528) are directly located at the Weser River respectively at the Ems River. Besides these and other smaller agglomerations the described area shows of a relatively low population density. Especially industrial livestock farming is an important sector of the economy in this low populated area of Lower Saxony.

It is November and after days of rain also strong winds draw over northern Germany. This strong wind stays over days from the direction of Great Britain. The wind develops to a heavy winter storm already causing some minor damages in Great Britain; news stations are reporting about it and concerned messages get posted over social media.

The GMLZ is monitoring this situation over days and finally a heavy storm surge gets forecasted for the North Sea Coast. Using the described data sources the GMLZ works

out different predictions for the storm surge on behalf of the federal government. These predictions and information get distributed to the situation rooms of the federal states, responsible for disaster management in Germany. In this use case the federal states of Lower Saxony, Schleswig-Holstein, Bremen and Hamburg get affected.

Even without power supply notebooks and smartphones are still operating for several hours. Connected devices are used as a source of information and also to share it even when radios or televisions are offline. Fears, experiences, insecurities, search for family and friends get shared via divers social media platforms. Pictures and videos get exchanged stoking additional fears, but also the willingness of not affected people to help. In general connected devices may be regarded as sensors.

3.3.2 Course of the Scenario

First warnings of the population get distributed through divers channels by the responsible agencies of the affected federal states.

In Germany, the North Sea Islands and little holms get flooded first. The dwellers, especially of the little holms, normally have the experience, knowledge and precautions to adapt to such situations. But through emergency calls and social media postings are the dwellers informing and describing the exceptional power of the storm surge and its devastating destructions. Official sources of the North Sea Islands are reporting first crevasses and apprehensions of further crevasses. Further, trusted volunteers (voluntary fire brigades, dike watch etc.) forward feedbacks about the occurrence of an event (e.g. crevasse) from the site as well as feedbacks about the development of the situation and response measures via smartphone and smartphone applications (crowdsourcing).

When the storm surge hits the mainland it is expected that these dykes as well cannot resist the water mass. Therefore, the responsible authorities have to make the decision between evacuation of the affected population or supplying them in the flooded areas. As precautions the immediately affected areas close to the dykes get the order for evacuation first (in Lower Saxony and Schleswig-Holstein).

The dykes of the German North Sea coast finally cannot resist the storm surge anymore and are breaking. Additionally, the storm surge also pushes the water mass up the rivers Ems, Weser and Elbe at which also the cities of Emden, Bremen and Hamburg are located. An order for a mass evacuation of the entire affected area and areas at risk gets pronounced by each of the four affected federal states. Critical infrastructures get affected as well and as a cascade effect also the power breaks down in parts of these regions. Amongst others this highly affects the industrial livestock farming.

Such a large-scale evacuation holds a lot of risks and uncertainties. Besides the inhabitants of the German flooded regions, also affected population of Denmark or even from the Netherlands are using the defined evacuation routes multiplying the number of cars on these motorways.

As main evacuation routes the motorways from the north to Hanover and to the Ruhr area get defined (see figure 2). Reception centres for the evacuees with no opportunity to stay with family members or friends get established in these areas.

Figure 2: Evacuation routes

Hospital patients get evacuated by aircrafts either from the airport Bremen or Hamburg. Simultaneously to the mass evacuations, also relief units and logistics get distributed into the flooded areas using the opposing directions of the evacuation routes.

Besides other responsibilities the GMLZ is monitoring reaction and behaviour of the population during and after the disaster. Not all affected persons follow the official orders and stay behind in their houses/accommodations, others do not use the given evacuation routes.

The described evacuation results in bad and chaotic traffic congestions, especially at important bottlenecks like the "Elbe tube" in Hamburg. This fosters the decision of evacuees to use alternative routes instead of the appointed evacuation routes.

In summary the setting of an exceptional high tide at the North Sea Coast results in a highly complex situation, including a mass evacuation of a high number of the affected population. Because of the complexity and dynamic of the situation the decision makers highly depend on real time information and an up to date situational awareness.

3.4 Requirements

In the following, requirements in the context of this use case including data sources, analysis methods and technology, visualisation and application of INSIGHT solutions get described.

3.4.1 Data Sources

The INSIGHT system is depending on data and data sources to achieve the above described goals.

The following data sources are already available in the GMLZ to support early detect and to monitor situations (disaster); until now only manual:

- Flood gauge (present situation; future scenarios)
- Flood report
- Flood forecast
- Severe weather watch
- Rain radar
- News ticker
- Situation reports (federal states, NGOs)
- EM-DAT (The International Disaster Database established by the Centre for Research on Epidemiology of Disasters – CRED)

For the described use case the INSIGHT system will focus in integrating the following data sources:

- Twitter messages
- Mobile network data
- Traffic data (freeway/ railway)
- Frequency atlas mobility

Especially Twitter data as well as the mobile network data are the main sources of information for the described use case.

3.4.2 Required Analysis Methods and Technology

To date the GMLZ is running without any system automatically analysing incoming data or even big data. 24 hours a day at all seven days of the week staff members with diverse backgrounds manually monitoring nation-wide situations concerning civil protection. In order to detect situations staff members are monitoring and analysing flood gauge, severe weather watch, rain radar, news ticker, television broadcasts etc. separately. In case of a severe situation additional staff members are supporting them taking over special tasks. Situations have to get validated and information about situations/ disasters gets verified for distribution; if needed expertise can actively be requested.

In this use case the INSIGHT system is designed to be part of the daily monitoring routine of the GMLZ staff. During the monitoring/ event detection process of the

INSIGHT system, phases from normality to future trends are covered (see figure 3). Figure three illustrates the six different phases for a better understanding.

Phase 1: **Normality understanding** – This phase aims to model normality (green traffic light) for each individual data source (sensor network).

Phase 2: **Observation** – Unusual events get discovered (yellow traffic light). Those observations may be anomalies in sensor readings or observations in unstructured data such as textural data. This phase supports the detection of unusual observations in the data.

Phase 3: **Event** – Phase three is about understanding the observation with respect to relevance to the detection of a potential crisis situation or threat. To do so a round table approach is introduced (see Deliverable 2.1).

Phase 4: **Incident** – Through historic data (location, event types, feedback, labels), event description, or expert feedback the incident gets labelled thereby adding semantics to an event.

Phase 5: **Situation** – In this phase a situation is reconstructed based on one or a course of incidents. The information is continuously updated.

Phase 6: **Future Trend** – Using new and historic data future trends, predictions and scenarios get developed by human experts, the system supports this with current information and trend discovery.

Staff members of the GMLZ get alerted in or involved at the beginning of phase three. The system should require the assistants of a human expert responsibly. The challenge of phase four and five is to identify situations by staff members of GMLZ. In order to do so they need to be constantly updated on the current situation, also for them to develop future scenarios.

Unfortunately, a black swan event[8] for example may not be understood by the system; it is not able to label the event because of missing historic data or human knowledge.

All results or findings of the INSIGHT system has to be transparent and documented to be able to base decisions on these findings. The INSIGHT system has to log all findings to follow up the course of the event, important findings and decisions in a post disaster assessment.

[8] Black swan event: A rare, unexpected and extremely difficult event to predict with a high impact

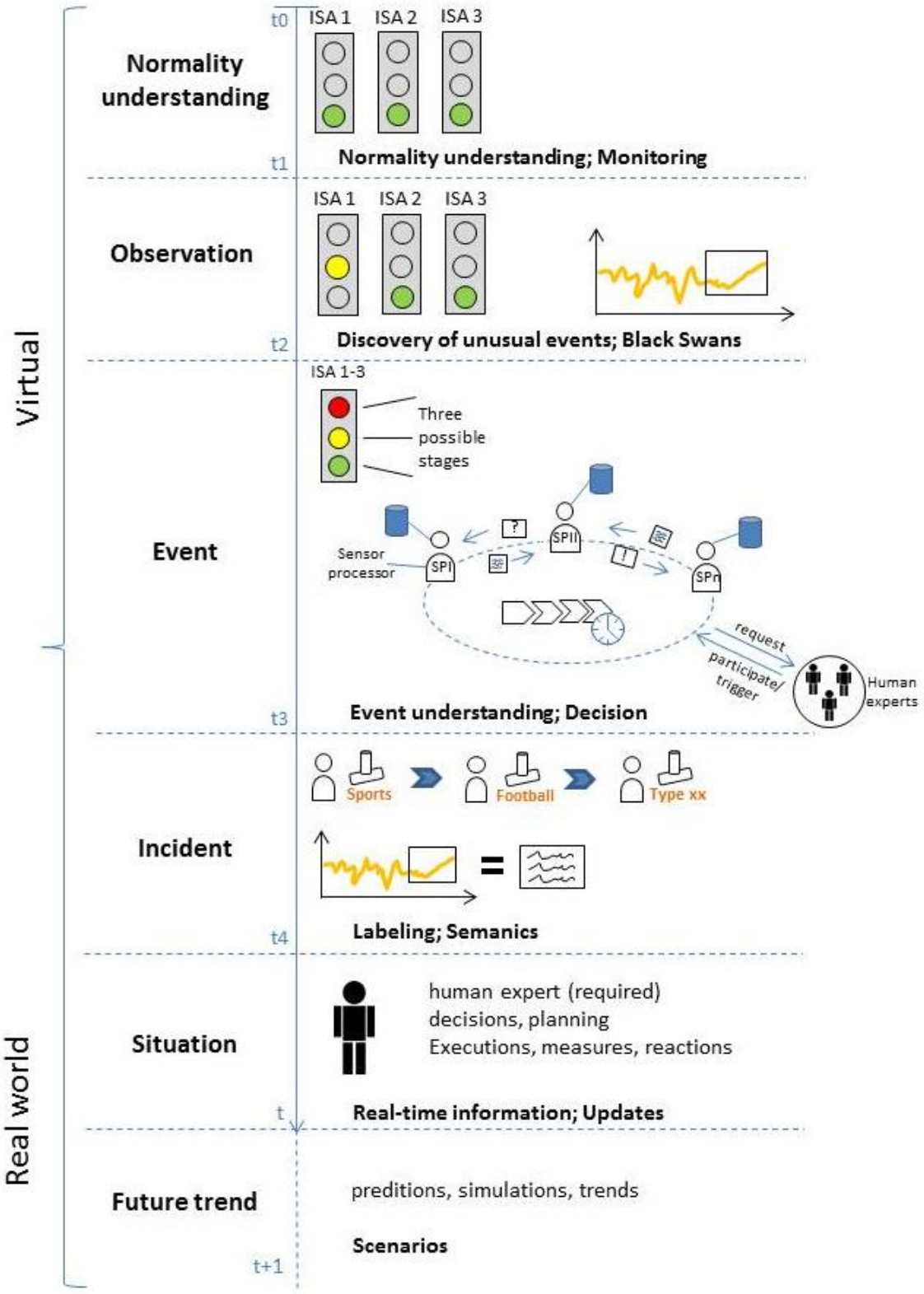

Figure 3: Sketch of an event detection process

The INSIGHT monitoring and response system will be used by professionals at the GMLZ. All professionals have an emergency management, rescue or disaster relief background. Thus, the system shall be easy to use.

3.4.3 Visualisation Requirements

The visualisation of the findings of the INSIGHT system is one part of the information shown on the big wall display in the GMLZ (about one-third of the big wall display). Beside this information still a situation overview, incoming CESIS information as well as a news ticker will be shown on the big wall display.

During phase 1 and 2 one situation map should showing Germany respectively Europe for displaying the INSIGHT findings. This simplifies the traditional usage of the display wall at the GMLZ. Today, several maps showing different content have to be monitored by the staff members.

In the case the INSIGHT system detects an event, a window should immediately pop up with a symbol (the same symbols used in the GMLZ supporting software deNIS KM) and flash at the big wall display in the situation room as well as on the individual monitors of the staff members of the GMLZ. An alarm signal should additionally be visible in the footer of the displays during such a situation with the possibility to turn it off after recognition. Further, the INSIGHT user interface should provide the possibility to open and to scale windows with different content on each monitor or additional analysis tables if needed.

After recognition of an event the sources indicating such an event should be shown. This simplifies the estimation about the reliability of the shown data; desirable would be a scale about the reliability of the data. In either way the reliability estimation of the data is needed for upcoming decisions making. Whether e.g. only a few tweets suggest a possibility of an event or a few hundreds, which are also validated through other data sources, make a big difference in further steps of the decision makers.

The INSIGHT solution shall also seek to integrate the human expert into the process of visually analysing a current event or situation. Due to the complexity of information and various sources of events it is desirable to combine interactive visualizations with automated analysis techniques. In disaster and emergency situations visual representations are the most effective means to convey information to human’s mind and prompt human cognition and reasoning. Therefore, Visual Analytics shall be integrated into the INSIGHT nationwide disaster use case scenario demonstrator.

3.4.4 Application of INSIGHT Solutions

The INSIGHT system will be used at the GMLZ by professionals in the field of disaster management and emergency response. Along the eight phases of the course of a disaster (see section 3.1) the focus of the system will be twofold: rapid detection of critical events and delivering a comprehensive data-driven overview of an emergency situation to support early response and post disaster evaluation.

The system integrates data handling (processing, storing, pre-processing), real-time and off-line analytics and visualisation capabilities. From the use case point of view real-time refers to an on-line processing and detection of potentially relevant events with no or only little delay.

The main task of the system is to monitor the incoming streams of structured and unstructured data for relevant events related to the nation-wide flood scenario. The system will also be used to understand normality in the forefront of a disaster and to perform complex analysis on historic data (e.g. in the backlash of a disaster).

Motivated by the recent gain on importance the INSIGHT system shall be able to perform event detection and complex event processing on unstructured textual data from the microblogging service Twitter (social media data) and anonymized data from mobile networks.

From a disaster management point of view, Twitter data may be used for detecting, validating and semantically enrich events. Anonymous mobile network data may be also used to detect and validate events but in addition they may be used to quantify the extent of an incident (e.g. estimation of civilians affected, range of event) and monitor general movement patterns during a disaster, e.g. for monitoring the reaction of persons concerned. Both data sources shall be utilized to monitor a situation in space and time.

Additional insights such as information on the road network or general traffic information are used for defining evacuation areas and planning evacuation routes. The system shall support this planning task as well as monitoring the evacuation process.

All discovered information on a situation shall be integrated and visualised. Core components of the visualisation are a map, time bar, and event description including a label of the event. The visualisation platform will be a situation table or the display wall.

In order to validate or label events the system may involve human experts or volunteers via crowdsourcing. Human experts have only limited resources. Also the involvement of volunteers must be coordinated and controlled to an efficient and effective instrument of labelling and validating events.

When an incident has been monitored, the system issues an alarm to the personnel at the GMLZ. The personnel will respond to these alerts. Any decision and response to the current situation will be issued by human experts. The system shall accept these decisions as a standardised feedback on the discovered incident/ situation.

The system shall provide logging capabilities for later debriefing and learning purposes. This may also be required for legal reasons.

3.5 Design of Validation Experiment

In the following the validation experiment as well as the validation procedure for the nation-wide use case gets described.

3.5.1 Description of Experiment

For the nation-wide emergency use case in Germany two validation option will be considered: testing of the INSIGHT tool at the GMLZ and it is also highly desirable to test the system during the LÜKEX 2015.

Validation Option 1: Testing at the GMLZ

This validation experiment takes place as an exercise. It is planned to input collected data of prototypic events, simulating the described use case. The prototypic events can differ from prominent sports events to traffic congestions during start and end of the summer holidays. But also the collected data of the floods in Germany in 2013 are an important data resource. The collected data demonstrate single sequences of the scenario e.g. the movement of the population during a mass evacuation through data of traffic congestions during summer holidays.

During this exercise the GMLZ takes over additional responsibilities (e.g. decision making) to its appointed duties to expand the testing of the INSIGHT system and to create a more dynamic scenario.

Validation Option 2: Testing during LÜKEX Exercise 2015

LÜKEX is a short form for "Länderübergreifende Krisenmanagementübung" – a crisis management exercise across several federal states in Germany. This series of crisis management exercises on a national political-administrative level have started in 2004 as a collective exercise of the federal administration and the federal states. Goals are a systematically development of a coordination and decision-making culture within the strategic crisis management. In practice it means the establishment of cross-federal states proceedings and coordination committees, training of a strategic crisis management to protect the population including the society as a whole, especially through inclusion of private operator of critical infrastructures and other relevant facilities.

LÜKEX is designed as a strategic tabletop exercise for the political-administrative level of governmental departments. This exercise exclusively regards to decision-making and the work within crisis teams. Only genuine decision makers are taking part in this exercise; actors and supernumerary do not get appointed in it.

In the process of the realisation of the exercise are taking a number up to 3,000 people part in it. This includes crisis teams and administrative crisis teams of federal and state federal departments respectively subordinated authorities responsible for crisis management. Additionally, selected companies of critical infrastructures affected by the particular scenario as well as affected organisations, aid organisation, the German armed forces (civil-military collaboration) and affected facilities.

The upcoming LÜKEX 2015 will broach the issue of a storm surge affecting northern Germany similar to the described nation-wide emergency use case of the INSIGHT project. Therefore, it would be a great opportunity to test the INSIGHT tool parallel to the LÜKEX 2015.

The assigned time for the LÜKEX 2015 is about a few months outside the official INSIGHT cycle for which reason it is difficult to include this option of testing in the official evaluation report. But an informal additional testing after completion of the project is desirable. Therefore, also the conduction of both validation options is possible.

3.5.2 Validation Procedure

Both exercise validation option will be observed and validated by GMLZ external experts. Experts of the Emergency Response Centre of the European Commission, Euro-Atlantic Disaster Response Coordination Centre of the NATO, teaching staff members of the Academy for Crisis Management, Emergency Planning and Civil Protection (AKNZ) are considered for this observation. Additionally, the staff members of the GMLZ, taking an active part during this exercise, will be questioned after the exercise about their experiences using the INSIGHT system.

This evaluation assess the course of action of the exercise, the usage of the INSIGHT system (how, how often, intensity, etc.) and its additional benefits for the GMLZ.

4. Relevance of INSIGHT Project

The elaboration of the two use cases, the consideration of the end-user requirements within the use cases and technical developments of the project indicates a high relevance, importance and good timely setting of the proposed INSIGHT system.

The current situation of the end-users within the use cases show of the need of a high number of employees to manual monitor available data. The end-users DCC and GMLZ would have the benefit to (semi-) automatic monitor and analyse these data; an analysis of additional data streams is also contemplated. This broader and more specific monitoring and analysis probably enables the end-users to get warnings about incidents and events earlier, a comprehensive situational awareness and thereby a better base for further actions.

The work of the INSIGHT project is timely, because the scientific community can now exploit the availability of large datasets by leveraging the development of technology and algorithms that are progressing to the point that analysing such a large streaming dataset is possible in today's hardware and equipment. Additionally, recent events regarding civil protection world-wide but also within Germany (Floods 2013) showed the need of benefitting of large data sets produced through social media by the affected population.

Finally, the use cases demonstrate that the project's goals are relevant to the needs of the end-user partners of the project, and it is highly expected that the INSIGHT system also be of high relevance to the needs and requirements of other entities or organisations as well.

5. Conclusions

In summary, the city-level use case in Dublin and the nation-wide emergency use case in Germany got enhanced and specified in the last 12 months. The overall goal of the usage of these use cases as real-world test beds is to to demonstrate the benefits of Big Data Analysis by the INSIGHT system for public safety and civil protection.

Especially requirements for each use case regarding data sources, analysis methods and technology, visualisation and application of INSIGHT solutions got elaborated so far. Based on the specific current situation in the test-bed respectively elaborated scenario of the use case, validation experiments including validation procedure got introduced in this deliverable.

The INSIGHT system in the city-level use case in Dublin is going to be tested in the Traffic and Incident Management Centre of the city. The scenario of the use case is based on the day-to-day routine and congestion situations on the roads; intensified by regularly occurring floods and other incidents. The decision was made not to divide the test-bed Dublin into two use cases (congestion and flooding) but to view it as one use case with incidents or floods as intensifying factors.

The nation-wide use case will be tested at the GMLZ on federal level. The scenario is based on an assumption of a ‘once-in-a-millennium high tide’ in northern Germany, an exceptional situation. Therefore, this scenario will be played as a tabletop exercise for the INSIGHT system as validation experiment. But lately heavy floods in eastern and southern Germany in June 2013 showed the need to think in such dimensions in civil protection.

The different setting, scale and dimensions, the different challenges of the use cases as well as different overall goals regarding the INSIGHT system shall ensure a reusability of the INSIGHT system in other contexts.