RECONASS

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Next Generation Damage and Post-Crisis Needs Assessment Tool for Reconstruction and Recovery Planning

Capability Project

The Proceedings of the Workshop in Month 29

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ABBREVIATIONS AND ACRONYMS

ABBREVIATION	DESCRIPTION
DBA	D. Bairaktaris & Associates Structural Design Office LTD
EC	European Commission
FEMA	Federal Emergency Management Agency (US)
FOI	Swedish Defense Research Agency
GDACS	Global Disaster Alert and Coordination System
GIS	Geographic Information Systems
GS	GeoSIG AG Switzerland
ICCS	Institute of Communications and Computer Systems
INSARAG	International Search and Rescue Advisory Group, UN organization
ITC	University of Twente, Department of Earth Systems Analysis, Faculty of Geo-Information Science and Earth Observation
NGO	Non-governmental organisation
OCHA	Office for the Coordination of Humanitarian Affairs (UN)
PDNA	Post Disaster Needs Assessment
RISA	RISA Sicherheitsanalysen GmbH/RISA Safety Analysis Ltd
TECNIC	Techniche e Consulenze Nell' Ingegneria Civile SPA - Consulting Engineers S.p.A
THW	Federal Agency for Technical Relief
TUD	Technical University of Dresden
UAV	Unmanned Aerial Vehicle
WLAN	Wireless Local Area Network

GLOSSARY OF TERMS

Term	Definition
Functional Requirement (FR)	An FR is a statement of an action or expectation of what the system will take or do. It is measured by concrete means like data values, decision making logic and algorithms.
GEM (Global Earthquake Model)	In the GEM project researchers from different countries are developing a physical earthquake risk estimation model of global use. In it a common terminology or taxonomy is critical to document variations in building design and construction practices around the world
Non-functional Requirement (NR)	An NR is a low-level requirement that focuses on the specific characteristics that must be addressed in order to be acceptable as an end product. NRs have a focus on messaging, security, and system interaction.
Non-structural Components	In this work these are components that are a permanent part of the building and are not part of the structural system.
Scenario	A scenario is a sequence of steps taken to complete a user requirement, similar to a use case.
Structural Components	Building components that are part of the intended gravity, seismic, blast/impact or fire forces resisting system, or that provide measurable resistance to these forces.
Unreinforced Masonry Wall	Clay brick, concrete or natural stone units bound together using lime or cement mortar to form o wall, without any reinforcing elements such as steel reinforcing bars.
Use Case	A use case is a description of a system's behaviour as it responds to a request that originates from outside of that system. The use case is made up of a set of possible sequences of interactions between systems and users in a particular environment and related to a particular goal. The use case should contain all system activities that have significance to the users. Use cases typically avoid technical jargon, preferring instead the language of the subject matter expert.
User Requirement (UR)	A UR is a statement of what users need to accomplish. It is a mid-level requirement describing specific operations for a user (e.g., a business user, system administrator, or the system itself). They are usually written in the user's language and define what the user expects from the end product.

EXECUTIVE SUMMARY

The present deliverable of work package 9 includes the proceedings of the second RECONASS End-User workshop that was realised on the 22nd and 23rd of June 2016 in Wesel, Germany. The main goals of the workshop have been to present the prototyped RECONASS system to End-Users and compare it to the state of the art systems that are currently used by relief units when conducting structural and needs assessment of damaged buildings. Another goal of the workshop has been to allow the participants to interface with the RECONASS system and see it in action by training them to operate it. The 2-day workshop was divided in themes, the first day (responders' day) was on training them on the system, whereas the second day (general users' day) dealt with discussing its exploitation potential and extracting relevant end user feedback.

The workshop commenced with the description of THW's training facility in Wesel and the activities that THW are conducting to train their personnel by THW's Facility Manager. Klaus Dieter Büttgen (THW Director of Research) and Evangelos Sdongos (ICCS RECONASS Project Manager) presented and explained the RECONASS concept, its components and the actual developments that have been performed by the consortium to reach a functional prototype.

The workshop included a live demonstration of the state-of-the-art system that THW is using to assess damaged buildings, as well as a demonstration of the remote sensing module that RECONASS is featuring. Before the former's exhibition, Michael Markus (THW Researcher) gave the audience an overview of how it operates, its components and installation principles. Furthermore, Annika Nitschke (THW RECONASS Project Manager) described the scenario to be deployed in the live demonstration session and provided safety and security guidelines for the audience.

During the live demo, the participants witnessed in operation the German THW system for assessing the structural integrity of a damaged building, essentially comprising a combination of expert inputs and monitoring equipment (robotic total station with prism reflectors). Advantages and disadvantages to the RECONASS system were also openly discussed during the session that involved the UAV module deployment (RECONASS component).

The next session included a presentation of the RECONASS hardware and the functionalities served towards the holistic assessment of the monitored building. On the RECONASS system User Training, Dora Karali (RISA Researcher) and Stephanos Camarinopoulos (RISA RECONASS Project Manager) explained the main operational instructions for using the *Post Crisis Needs Assessment Tool in regards to Construction Damage and related Needs* (PCCDN tool), essentially the RECONASS Disaster Management Platform for building monitoring. The system training process included also provision of background information in regards to the embedded structural and needs assessment algorithms, presented by Dimitrios Bairaktaris (DBA RECONASS Structural Expert). To continue system training, Markus Gerke (ITC RECONASS Geoinformatics Expert) presented the logic of the damage assessment module which uses Air- and Space-borne Remote Sensing to assess the external status of the building and complement the structural and needs assessments conducted by in-building sensors. After the briefing the audience was trained on operating the PCCDN tool. The remote sensing live demo was the session that concluded the first day of the workshop, during which the participants witnessed a UAV tele-operated flight and the point cloud creation, the latter essentially providing a 3D representation of a given building being monitored.

The "general users' day" started with a brief introduction by E. Sdongos on the main goals to be pursued under the relevant sessions. The session to follow was held by Markus Gerke who explained in more detail the automatic process that RECONASS system features towards a 3D representation of a given monitored building and the annotation of the potentially damaged areas (external view). Progressing on exploitation potentials of the system, Wayne Kimberlin (GS RECONASS Project Manager) presented a wide set of merits that the RECONASS system provides to the different types of End-Users (disaster relief agencies, building owners, assessment experts and insurance companies). He outlined the attempts to promote the system and initiated a discussion with the participants. The workshop concluded with an open discussion, engaging the participants to

express their opinions on the usability of the system, the topics of improvement they envision and their experiences for promoting such disaster management platforms within their organisations.

For the majority of the participating End-Users, there was no doubt that the RECONASS system is very useful and should be installed in critical buildings, especially in geographical areas with higher risks of damaged buildings such as earthquake prone areas. Noteworthy, a hot discussion topic for the system's exploitation has been the approach to be followed for designated end user groups to own the system as well as the regulatory and legislative decisions to be taken nationwide for such a system to be commercially operational.

1. INTRODUCTION

1.1. Objectives

After the First End-User workshop, held in Berlin in 2014, where the dialogue with End-Users started and the End-User requirements were collected, the 2nd RECONASS End-User workshop aimed at presenting the already developed RECONASS functionalities to End-Users and at discussing with them the presented results. The opportunity was used to collect user input for the last phase of the RECONASS project. Another vital goal of the workshop was to push exploitation of the RECONASS system in a face-to-face engagement of potential future users and to introduce the exploitation strategy envisioned under a strong brand name, SHOX – Structural Health Monitoring in a BOX.

1.2. Document Structure

After an executive summary, this document includes an introductory chapter, where the basic goals of the workshop, the methodology of the workshop and the End-User Group are described. To better understand the terminology and the context of the workshop, the RECONASS system and its components are described in the second chapter. Chapter 3 refers to the training facility, where theoretical and practical demonstration and training took place, and also includes the participant list. Chapter 4 describes in detail the proceedings of the workshop and gives and overview of the presentations, demonstrations and training sessions. Chapter 5 summarizes the discussions and End-User feedback. The input is analysed and categorized. Chapter 6 concludes the document, describing the most relevant results. The Annex includes workshop documents and presentations.

1.3. Methodology

The workshop was divided in two thematic sessions, the “responders’ day” and the “general users’ day” (see Figure 1) to deal with the different needs of the wide variety of potential RECONASS End-Users. Additionally, with the help of practical demonstrations and training sessions, the state of the art was demonstrated and compared to the possibilities offered by the novel RECONASS system which offers significant reduction in the time needed to conduct structural and needs assessment to damaged monitoring buildings.

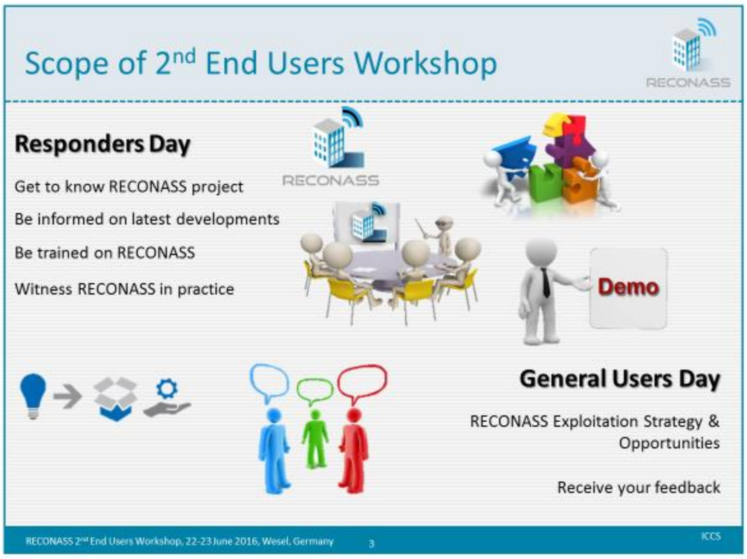

Figure 1: Scope of the End-User workshop from scope and introduction presentation, E. Sdongos

The active involvement of the End-Users facilitated a fruitful exchange within the End-User Group and with the RECONASS project team.

The workshop began with an introduction round of all participants, with focus on their expertise, of their organisation, their specific interest and contact points with RECONASS, as well as their expectations of the RECONASS End-User workshop. ICCS (RECONASS Project Coordinator) gave a concise and comprehensive overview of the RECONASS concept, expected results and impacts. A key point that proved to be effective and at the same time strengthened the workshop process was the participation of most of the RECONASS partners in the workshop. ICCS, ITC, GeoSIG, ARU and DBA attended the meeting and actively participated in training the end users and providing the specifics of the technology behind RECONASS. Furthermore, it resulted in useful outcomes from the End-Users since the technology providing partners were able, whenever needed, to provide the End-Users with additional details on functionalities of the features that the RECONASS addresses.

1.4. The RECONASS End-User Group

In preparation of the first End-User workshop, an End-User group was established. The main challenge of this group is its heterogeneous composition. This is highly desirable, since the requirements of the End-Users reflect different needs coming from different fields of operation such as structural assessment crisis mapping, crisis communications, local positioning, etc.

The following six End-User categories were identified for the RECONASS End-User Group:

A) Governmental Emergency / Disaster Response Organisations
B) Non-Governmental Emergency / Disaster Response Organisations
C) Public Operators of Critical Buildings
D) Private Operators of Critical Buildings
E) Organisations involved in the development of remote sensing based damage maps
F) Organisations involved in synoptic damage prediction based on acceleration measurements, insurance companies, etc.

Figure 2: Map of Europe presenting the End-User Group

The End-User Group includes 56 End-Users originating from more than 17 countries covering a wide range of EU states plus USA, Turkey and Israel. All the End-Users organisations matching the above End-User categories and additional End-Users from the area were contacted. A set of informative dissemination material was provided. The dissemination material included the following documents:

- The workshop information package (see Annex C)
- The 2nd End-User workshop agenda (see Annex B)

2. RECONASS SYSTEM AND USER REQUIREMENTS

2.1. Introduction

This chapter provides background information to understand the RECONASS system and the user requirements that are collected in D1.3 “User Requirements” [1]. The RECONASS system and the modules are described. The user requirements are divided into functional and non-functional requirements and prioritised.

2.2. The RECONASS System

The RECONASS system can be divided into the main sub systems “RECONASS Monitoring System”, “RECONASS Structural, Economic Loss and Needs Assessment Module” and “UAV Damage Mapping System”. These three sub systems consist of further modules that are compiled in the following Table 1 with the responsible RECONASS partners.

Table 1: The RECONASS system and its sub systems with responsible partners

1.	**RECONASS Monitoring System**
1.1.	Overall Monitoring System and interfaces
1.2.	Acceleration Sensors(GS)
1.3.	Strain Sensors (GS)
1.4.	Temperature Sensors (GS)
1.5.	Local Positioning System (TUD)
1.6.	Data Hub (GS)
1.7.	Communication Gateway Module (ICCS)
2.	**RECONASS Structural, Economic Loss and Needs Assessment Module**
2.1.	Assessment Module and interfaces (DBA, TECNIC AND RISA)
2.2.	Structural Assessment Module (DBA)
2.3.	Economic Loss and Needs Assessment Module (TECNIC)
2.4.	PCCDN Software Tool (RISA)
3.	**UAV Damage Mapping System**
3.1.	UAV System and Interfaces(ITC)
3.2.	UAV Damage Mapping (ITC)

The enumeration system is used to classify the user requirements and was used to classify the sub systems in the deliverbale “D1.4: Full specification set for the RECONASS system”.

2.3. User requirements types

The user requirements are distinguished between **functional (FR)** and **non-functional (NFR)** after [2]:

1. Functional requirements (FR): These are statements of services the system should provide, how the system should react to particular inputs and how the system should behave in particular situations. In some cases, the functional requirements may also explicitly state what the system should not do.

2. Non-functional requirements (NFR): These are constraints on the services or functions offered by the system. They include timing constraints, constraints on the development process and standards. Non-functional requirements often apply to the system as a whole. They do not usually just apply to individual system features or services.

In reality, the distinction between different types of requirement is not as clear-cut as these simple definitions suggest. A user requirement concerned with security, such as a statement limiting access to authorized users, may appear to be a non-functional requirement. However, when developed in more detail, this requirement may generate other requirements that are clearly functional, such as the need to include user authentication facilities in the system (Sommerville 2011). Especially the interface requirements – both user interfaces and interfaces with other systems - are here defined as non-functional requirements because the interfaces describe how the system behaves.

The ISO/IEC 25010 standard classifies software quality and is used to classify non-functional requirements. It includes sub-types such as “interoperability”, “usability”, performance and “availability” and it is used for a more detailed classification of the final user requirements, see D1.3 “RECONASS’ user requirements” [1].

2.4. User requirements prioritisation

The prioritization of the user requirements uses the MoSCow attempt [3] using the following four cathegories:

M - MUST: Describes a requirement that must be satisfied in the final solution for the solution to be considered a success.

S - SHOULD: Represents a high-priority item that should be included in the solution if it is possible. This is often a critical requirement but one which can be satisfied in other ways if strictly necessary.

C - COULD: Describes a requirement which is considered desirable but not necessary. This will be included if time and resources permit.

W - WONT: Represents a requirement that stakeholders have agreed will not be implemented in a given release, but may be considered for the future. (Note: occasionally the word "Would" is substituted for "Won't" to give a clearer understanding of this choice)

3. THE SECOND END USER WORKSHOP

3.1. Wesel Training Facility

The 2nd RECONASS End User workshop was held at the THW Wesel Regional Office Training Facility, located approximately 5 kilometres outside Wesel city centre (Kanonenberge 4, D-46487, Germany). The premises host the Training Facility, the THW Wesel Regional Office as well as the THW Wesel Local Section. Apart from general use as a training ground, the Training Facility is one of the facilities used regularly by UN INSARAG to certify USAR teams.

The training facility was chosen due to its large training ground with collapsed and partially collapsed building structures, which despite its realistically damaged condition they remain stable, hence training safety is preserved. This set-up has been carefully selected to permit demonstrations of the state of the art equipment of THW as well as the training sessions of the RECONASS system. Additionally, automated damage assessment using UAV (Unmanned Aerial Vehicles) could be demonstrated with real data collected from the area of interest.

Figure 3: Wesel THW Training Facility

3.1. Workshop Participants

End-Users from France, Germany, Greece and, the Netherlands on operational and management level joined the workshop. Table 2 shows the list of participants. A key point that proved to be effective and at the same time strengthened the workshop process was the participation of most of the RECONASS partners in the workshop. ICCS, ITC, GeoSIG, ARU and DBA attended the meeting and participated. Furthermore, it resulted in useful outcomes from the End-Users since the technically involved partners were able, whenever needed, to provide the End-Users with additional details on functionalities of the features that the RECONASS addresses.

Table 2: RECONASS Second End-User workshop participant list

First Name	Last Name	Organisation	Country
Hannah	Henske	Wesel Fire Service	Germany
Carsten	Nienhaus	Wesel Fire Service	Germany
Thomas	Verbeet	Wesel Fire Service	Germany
Thomas	von Heesen	Wesel Fire Service	Germany
Michael	Andres	Federal Agency for Technical Relief (THW) building/structural expert	Germany
Frank	Blockhaus	Federal Agency for Technical Relief (THW) building/structural expert	Germany
Martin	Boelicke	Federal Agency for Technical Relief (THW) building/structural expert	Germany
Jochen	Werkmüller	Federal Agency for Technical Relief (THW) building/structural expert	Germany
Peter	Braunisch	Federal Agency for Technical Relief (THW) structural monitoring	Germany
Tobias	Martin	Federal Agency for Technical Relief (THW) structural monitoring	Germany
Harald	Auding	THW Rapid Deployment Unit Search and Rescue Abroad (SEEBA)	Germany
Erik	Dreyer	THW Rapid Deployment Unit Search and Rescue Abroad (SEEBA)	Germany
Martin	Keller	THW Rapid Deployment Unit Search and Rescue Abroad (SEEBA)	Germany
Michael	Schwagmeier	THW Rapid Deployment Unit Search and Rescue Abroad (SEEBA)	Germany
Frederic	Monard	DGSCGC/ French DG for civil protection and crisis management	France
George	Beldecos	Hellenic Air Force	Greece
Sotirios	Glykofrydis	Hellenic Ministry of National Defence	Greece
Johannes	Kleintjens	Brandweer Twente	Netherlands
Sathish	Nammi	ARU	UK
Hassan	Shirvani	ARU	UK
Evangelos	Sdongos	ICCS	Greece
Dimitrios	Bairaktaris	DBA	Greece
Emmanouil	Bairaktaris	DBA	Greece
Markus	Gerke	ITC	Netherlands

Watse	Siderius	ITC	Netherlands
Anand	Vetrivel	ITC	Netherlands
Wayne	Kimberlin	Geosig	UK
Jonathan	Naundrup	Geosig	Switzerland
Stephanos	Camarinopoulos	RISA	Germany
Dora	Karali	RISA	Germany
Klaus-Dieter	Büttgen	THW	Germany
Michael	Markus	THW	Germany
Mike	Nienhaus	THW	Germany
Annika	Nitschke	THW	Germany
Bianca	Reinel	THW	Germany
Daniela	Schmidt	THW	Germany

Figure 4: Group photo of workshop participants

4. RECONASS END-USER WORKSHOP PROCEEDINGS

4.1. Introduction

This chapter provides an overview of the presentations held during the workshop, the demonstration activities and the training sessions occurred to familiarise end users with the RECONASS concept of operations. The End-User feedback collected can be found in chapter 5.

4.2. Workshop Demonstration Scenario

In order to enable a better understanding of the RECONASS system and to compare this system to the state of the art, a realistic scenario was provided and used for demonstration and training purposes. The full scenario description can be found in Annex D. It describes explosions in a mall near the city centre of Cologne. The danger of collapse of the building must be assessed to rescue victims from the building. The implementation of the scenario at Wesel training facilities is described as well.

4.3. Welcome “responders’ day”

After the opening and key-note speech by Klaus-Dieter Büttgen (THW), the workshop began with an introduction round of all participants (see Figure 5), with focus on their expertise, of their organisation, their specific interest and points of contact with RECONASS, as well as their expectations of the RECONASS End-User workshop.

Figure 5: Round of introductions at the beginning of the workshop

After the introduction round E. Sdongos from ICCS gave an overview of the RECONASS concept, expected results and strategies. The RECONASS Monitoring and Assessment System consists of sensor systems such as the Local Positioning System (LPS) and strain, acceleration and temperature sensors. A communication module is necessary for fast, resilient and robust data exchange. It is comprised of data hubs, gateway, WSNs (wireless sensor networks) and heterogeneous Wide Area Networks. In addition to the in building sensors, the RECONASS platform receives input also from external sensors including air and space – borne sensing that show the building’s damage status from its exterior (incl. neighborhood’s damage status) for validation and calibration purposes and to get additional damage state information. The Post Crisis Needs Assessment Tool in regards to

Construction Damage and Related Needs (PCCDN) is the user interface and allows interaction with the RECONASS system. It presents the results of the Structural and Economic Loss and Needs Assessment Modules (compare Figure 6).

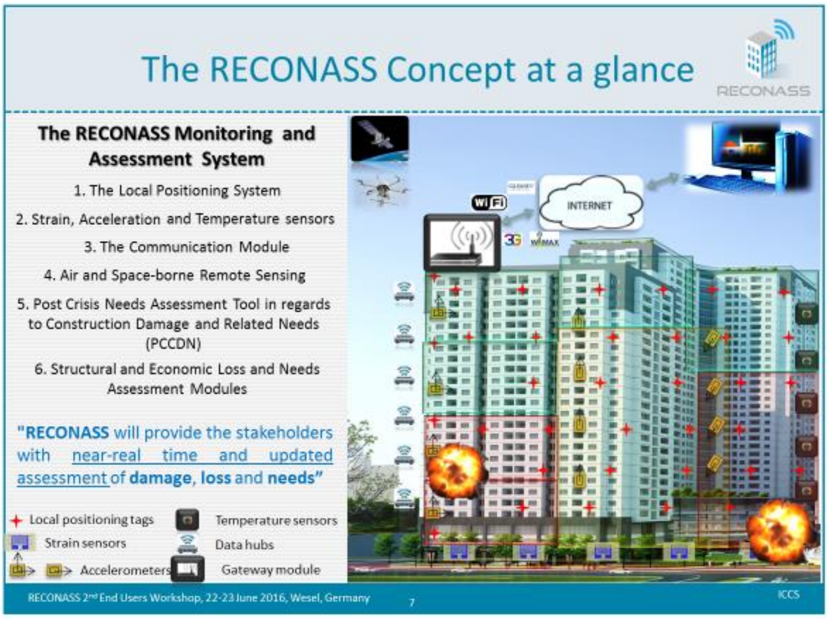

Figure 6: RECONASS concept and overview from ICCS presentation

E. Sdongos then explained the planned RECONASS pilot tests in Sweden to the End-Users. A building fully equipped with the RECONASS system was being prepared, and two different explosions were planned, an external and an internal one, of different explosives' loadings at the end of August 2016. The End-Users were invited to the tests. The proceedings of the preparations and the planned experiments were very much appreciated by the audience.

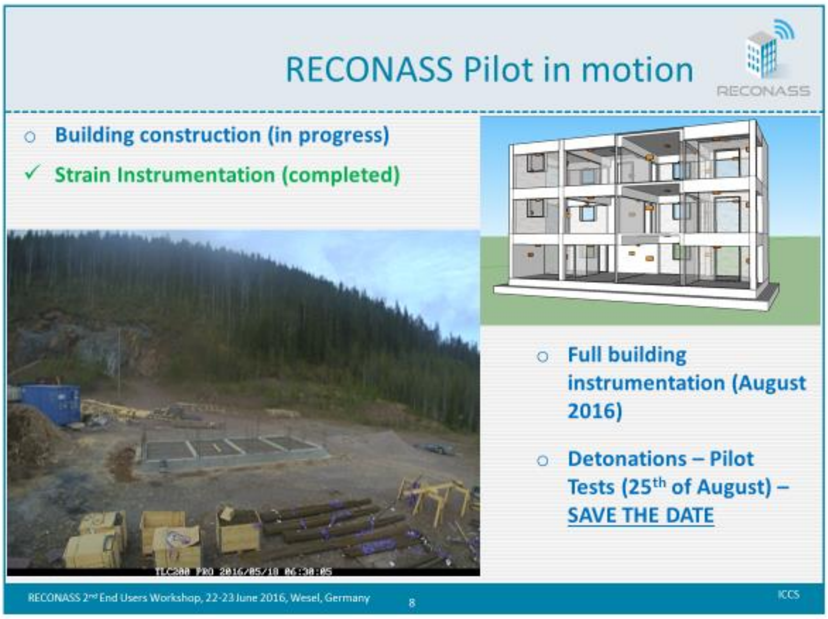

Figure 7: RECONASS pilot tests

The presentation was concluded by the desired goals of the RECONASS project and the expected results on EU level. The RECONASS project's outcomes address the "Response" and the "Recovery" phases of the Disaster management cycle (boosting Civil Protection efforts in EU); as RECONASS is expected to assist first responders to precisely classify buildings' damages at an early stage thus permitting effective interventions whilst at the same time recovery phase is clearly enhanced through assessment of buildings' functionality and repair needs, permitting in addition for effective reconstruction efforts.

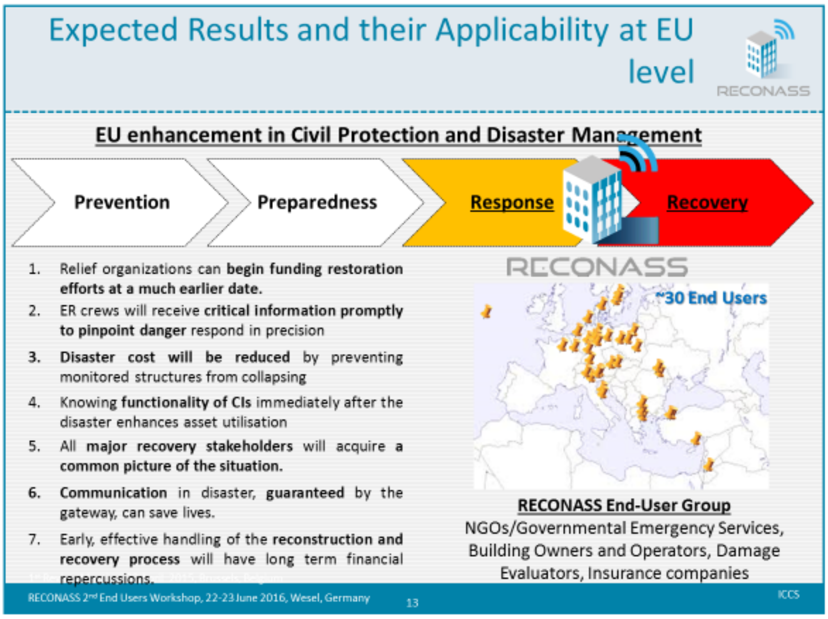

Figure 8: RECONASS – expected results

To prepare for the live demo of the state of the art, M Markus (THW) presented the Leica monitoring system, which is used by THW to monitor damaged buildings and structures during rescue operations and other technical assistance. This system is based on a robotic total station, which automatically measures the 3D position of measurement points (prism reflectors), see Figure 9. These prism reflectors must be attached to the structure, which can be dangerous for the responders. Additionally, only measurement points visible from the total station can be used. But this method is still one of the best solutions to date.

Figure 9: Presentation of the State of the art of building monitoring for emergency response

Following this presentation, the participants received a safety briefing from Annika Nitschke (THW) before leaving the training room to move to the training ground.

4.1. Live Demo – State of the Art

The live demo of the state started with the arrival of a THW team and inspection of the situation. The scenario (see Annex D) assumed that the Cologne fire department assigned the operations to this THW team. The inspection results of the assessment team stated a possibility of further collapse of the building and a special safety and security officer was alarmed to determine the necessary actions to safely enter the building for further search and rescue operations inside the building. Due to structural damages, the safety and security officers decided to activate the THW monitoring system. To start monitoring, reflectors had to be attached to the building. For this task, a turntable ladder is necessary. All these delays were demonstrated but explained to the audience.
The standard operation procedures in different countries were discussed, but in Germany such measures are necessary before entering a building with structural damages.

Figure 10: Presentation of THW's state of the art of building monitoring using robotic total stations (left); scenario: damaged structure (right)

4.2. Presentation of RECONASS components

The hardware components of the RECONASS system were shown to the audience in a small exhibition. Sensors such as local positioning sensors, strain sensors, acceleration sensors as well as data hubs, communication devices and different housings were presented to the participants. All participants had the possibility to put their hands on the components and talk directly with the developers of these components. Most questions were about durability for long term operation and the possibility to survive structural damages of the building and shut down of electrical supply.

4.3. Presentation of RECONASS PCCDN Tool and training

In order to prepare the training of the participants, D. Karali and S. Camarinopoulos (RISA) presented the basics of the Post Crisis Needs Assessment Tool in regards to Construction Damage and related Needs (PCCDN), its functions and the operation of the web based user interface. The concept can be seen in Figure 18.

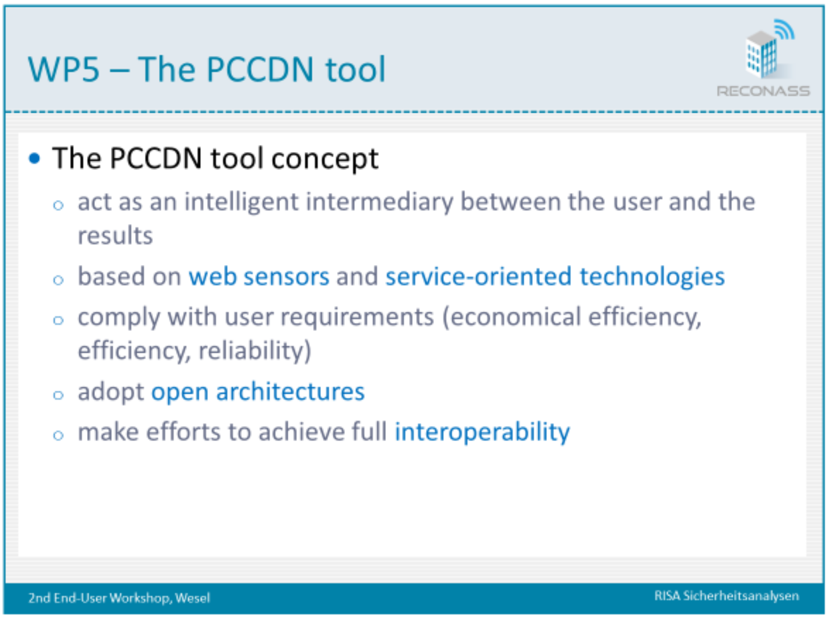

Figure 11: Concept of the PCCDN tool

The PCCDN tool includes a sensor data service implementation to access sensor data and manage the sensors. The web service and file formats are in accordance with the Open Geospatial Consortium (OGC) standard, the implementation of the sensor event service is based on the open source N52 SOS implementation (see Figure 12).

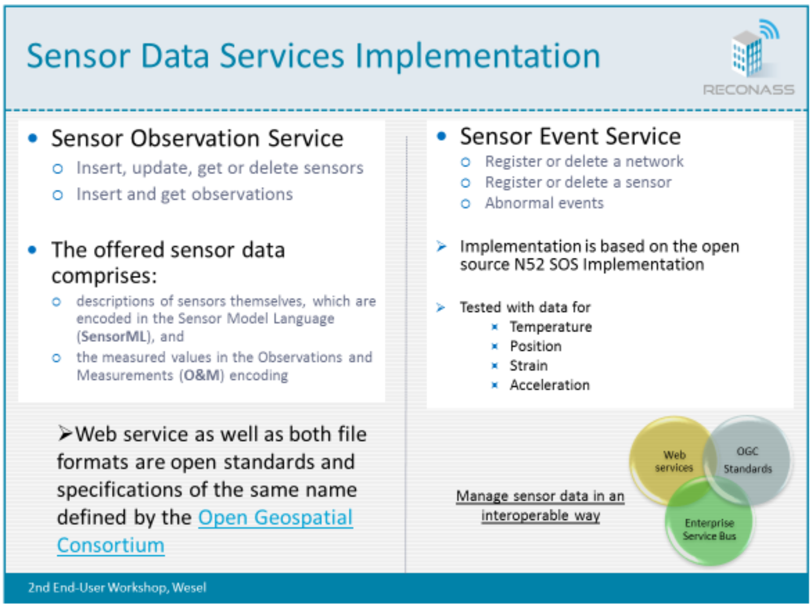

Figure 12: PCCDN tool – sensor data implementation

Secure access to the RECONASS services is granted trough measures in different layers such as Transport level security (Https), access control, authentication and authorization.

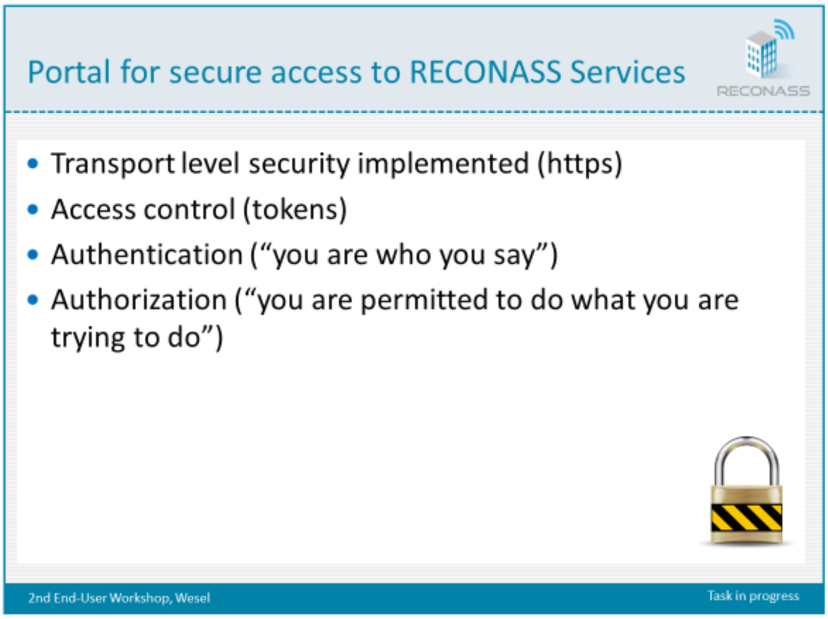

Figure 13: PCCDN tool – secure access to RECONASS services

The theoretical background of the damage loss and needs assessment methodology, presented by D. Bairaktaris, supplemented the PCCDN tool presentation. Aspects such as the loads and deformations under operational conditions of the building were explained and the theoretical background was clarified (see Figure 14).

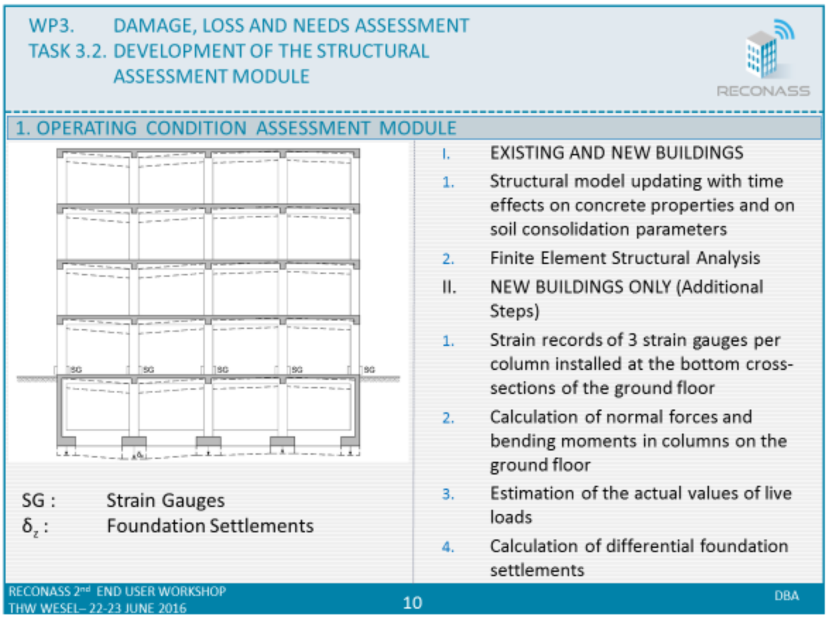

Figure 14: Damage, loss and needs assessment module, operational conditions

The next presentation by M. Gerke (ITC) about Damage Assessment with Air- and Space-borne Remote Sensing and its representation within the PCCDN tool aroused much interest among the participants. M. Gerke showed, how 3D point clouds with the help of photos taken from Unmanned Aerial Vehicles (UAV) are generated (see Figure 15). This 3D model is already very helpful for first responders as the participants stated. But in a next step the solution from ITC automatically detects damages such as spalling, debris piles and structural openings. The complex process to reach these results includes the detection of buildings and built structures within the 3D model, the automatic detection of spalling and debris regions, the automatic detection of cracks and structural openings and the representation of the results within the 3D model of the building.

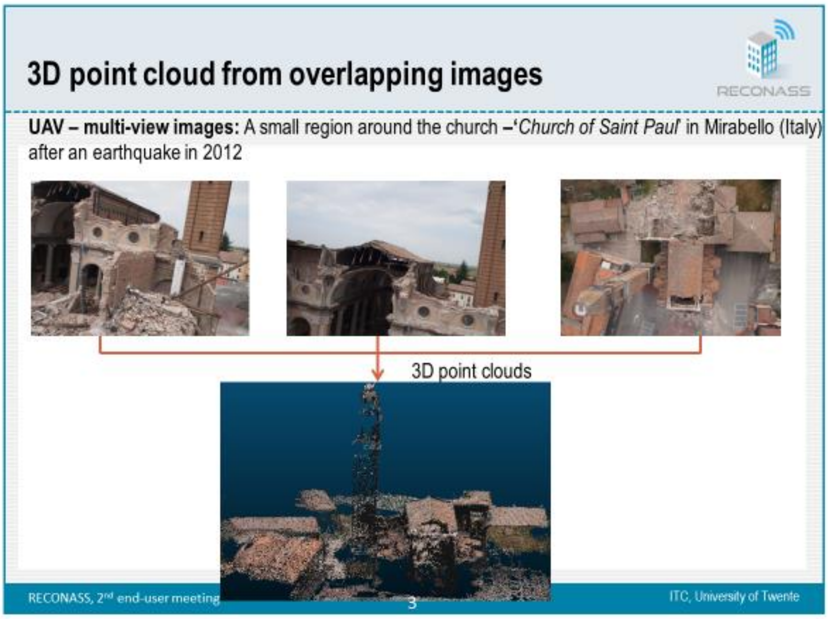

Figure 15: ITC presentation – 3D point cloud generation

Figure 16 shows the result of the step to detect spalling and debris areas.

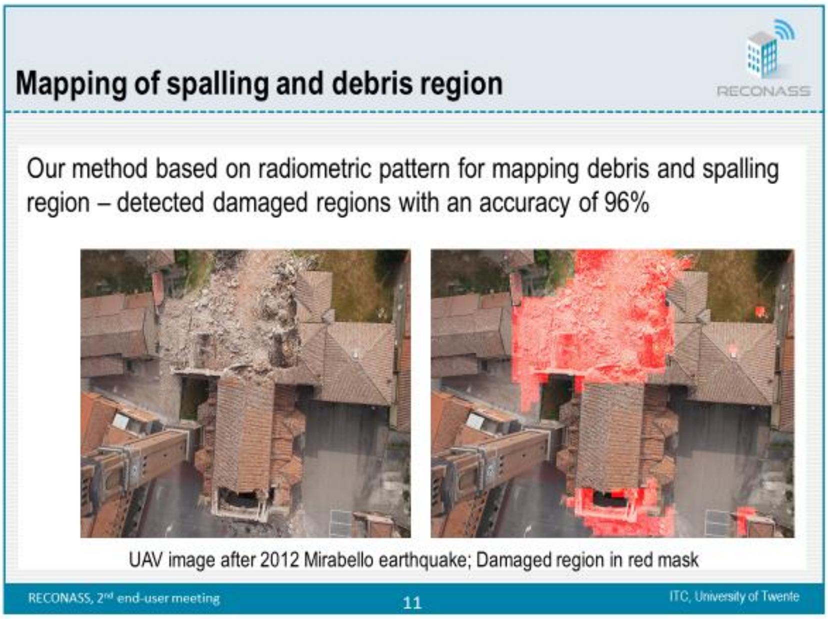

Figure 16: Automatic mapping of spalling and debris

In a next step, the results of the damage detection process are assigned to the existing RECONASS 3D building model (see Figure 17). This step allows the PCCDN tool to represent the results and to directly compare the measurement, assessment and observation results in a single tool.

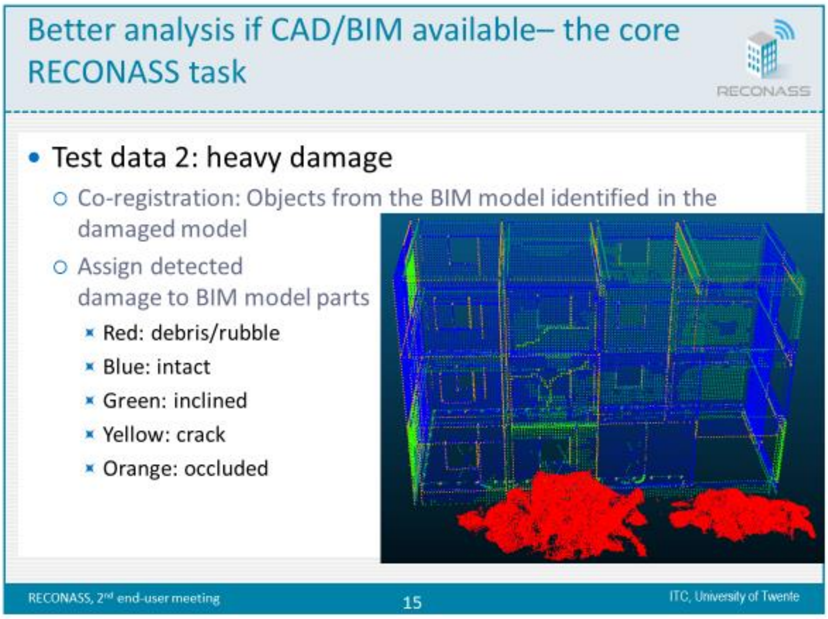

Figure 17: Assignment of detected damages to the RECONASS 3D building model

After these theoretical introductions, the participants received a demonstration of the PCCDN tool (compare Figure 18) beginning with a map view, with different layers such as debris areas and instrumented buildings. The participants suggested to include standard symbols, but this would be a question of where the system is implemented. Depending on the user type, such adaptions are possible.

Due to the fact that the system is web-based, the participants were able to easily use the system and receive needed information, such as 3D models of the damaged building, in depth information of single members of the building structure, measurements and the assessed damages.

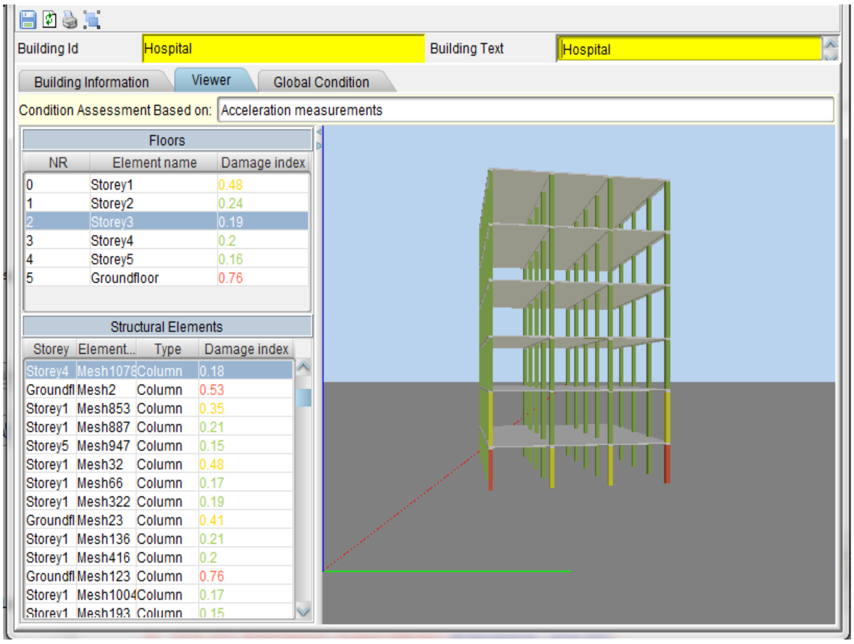

Figure 18: Presentation of the PCCDN tool and training

4.4. Demonstration and Training

After the training with the PCCDN tool, the participants followed the ITC Unmanned Aerial Vehicle (UAV) operators outside to see the automated collection of aerial photos using UAV. Two UAV types were used, an Aibot hexacopter (six propellers) with enhanced camera equipment (Canon EOS 600d taking 17,9 Megapixels photos), and a DJI Phantom 4 quadrocopter taking 12 Megapixels photos. The participants were informed, how to plan the waypoints and start the data acquisition. The THW Wesel training facility has good preconditions for this kind of demonstration, because there are different types of damaged buildings and debris to be analysed.

Figure 19: Live Demo-Damage assessment using airborne imagery at the training ground

Figure 20 shows the camera positions when taking photos. The resulting meshed point cloud is visible as well. The flight time to receive the photos is about 5 minutes. After take-off and climbing, the UAV autonomously approaches the photo positions and triggers the camera.

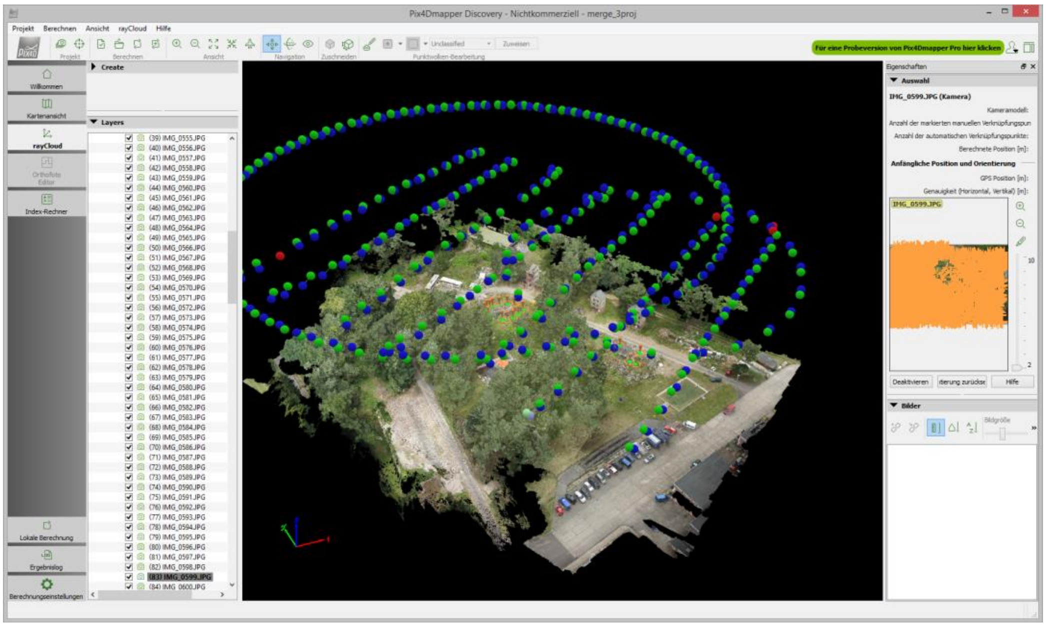

Figure 20: Camera position during UAV photo flight

After this demonstration, a short wrap up session led by E. Sdongos concluded the first day of the workshop at the training facility. The advice given and the questions asked can be found in the next chapter. The participants had dinner together and used this event to directly exchange impressions and advise between End-Users and RECONASS developers.

4.5. General users' day, opening and welcome

The day started with a brief introduction of the general users' day with the focus on building operators, planners and architects, insurances and service providers in this field. The End-Users in the field of emergency and disaster response were interested to hear about financing, possible clients and maintenance plans.

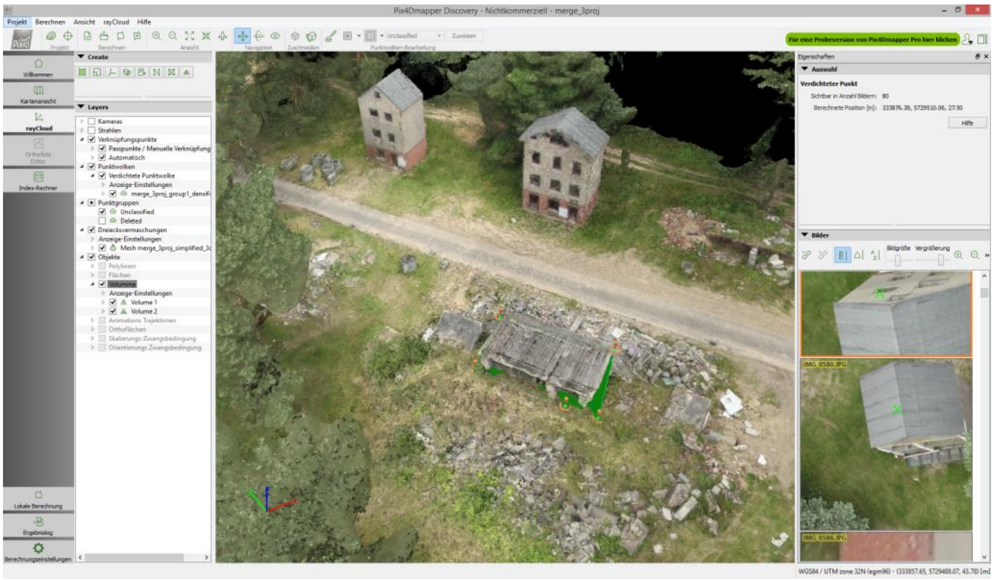

Figure 21: 3D model generated from aerial imagery collected at the workshop

After the introduction, M. Gerke presented the results of the data acquisition and processing from the UAV flights. Figure 21 shows a part of the resulting 3D model of the scanned area with a highlighted collapse structure.

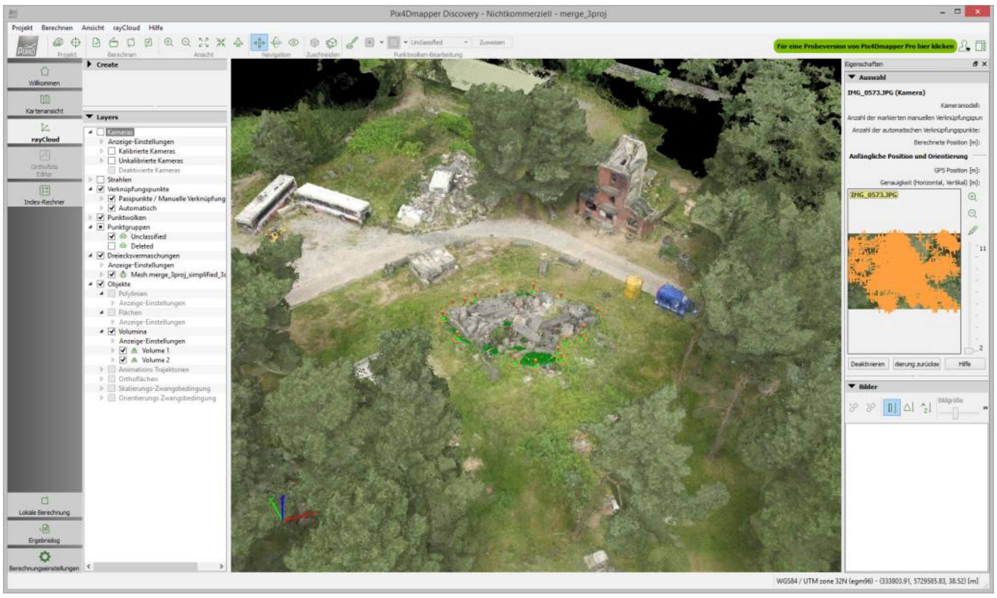

Figure 22: 3D model with rubble pile

Figure 22 shows another part of the training facility with a highlighted rubble pile. The user can turn the 3D model, zoom in and view the original photos. For a single building, the photo flight can be planned to concentrate on the respective building. This shortens the flight time and the processing time and results in a higher resolution of the 3D Model.

4.6. Presentation of the RECONASS functionalities beyond deployment

W. Kimberlin, GeoSIG, talked in his presentation about End-User benefits beyond the already demonstrated functionalities. He focussed especially on the End-Users operators of critical buildings, damage map providers, insurance companies etc. Participants were very interested in exploitation and commercial issues (see Figure 23. Surveys and exploitation models were explained.

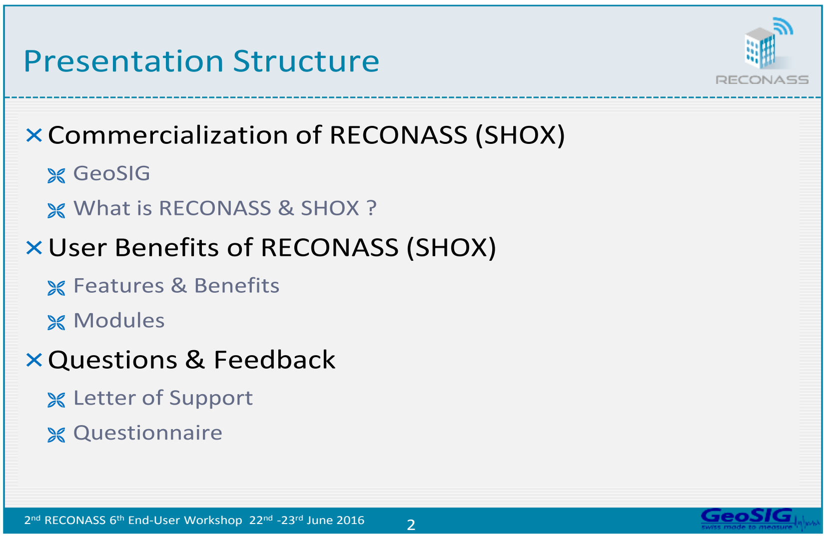

Figure 23: Presentation about exploitation of the RECONASS system

The SHOX website [4] was presented which gives a very easy to understand explanation of the RECONASS system and its advantages (see Figure 24). Due to the fact that GeoSIG is already a well-known participant in the market of accelerometers and monitoring solutions, the marketing campaign has a great likelihood to be successful.

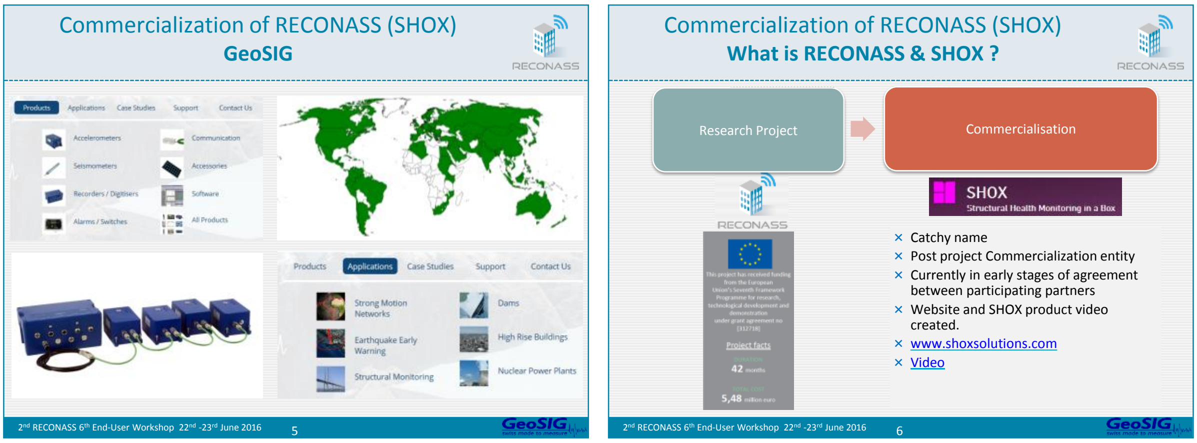

Figure 24: Product support, the shox website

The participants pointed out, that insurance companies will be a key factor to promote the RECONASS system. Furthermore, regulations requesting such systems for buildings of critical infrastructure such as hospitals would be useful as well.

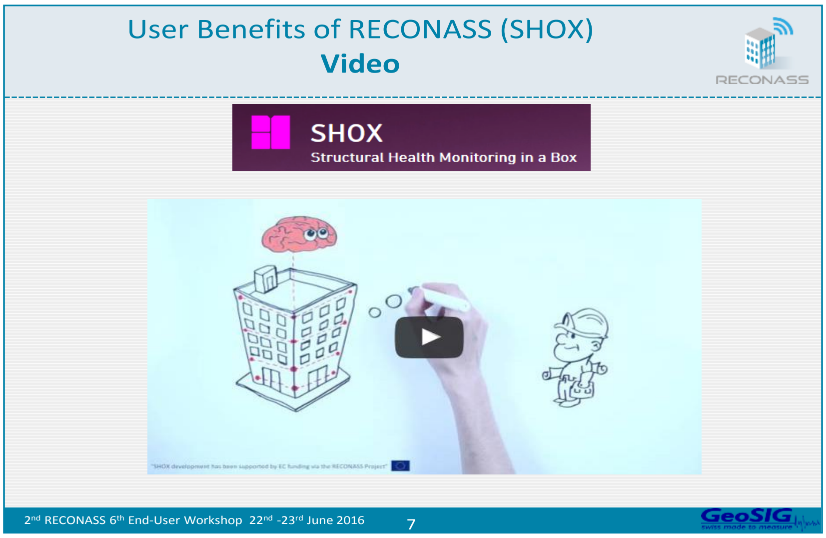

Figure 25: The SHOX website

Additionally, questionnaires were circulated to the participants which are evaluated in Work Package (WP) 8 “exploitation”. Three questionnaires directly from the workshop participants can be found in Annex G.

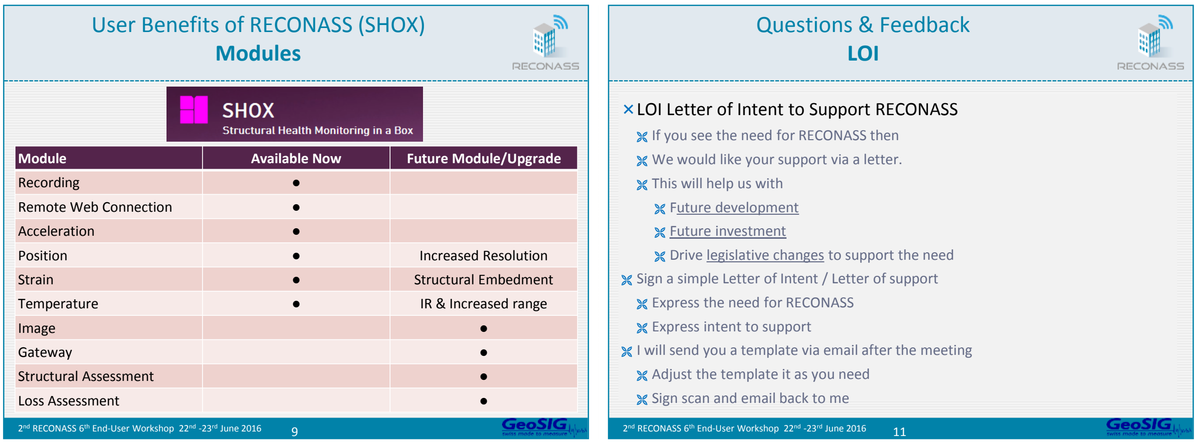

Figure 26: Marketing and end -user interaction

Additionally, questionnaires were circulated to the participants which are evaluated in Work Package (WP) 8 “exploitation”.

4.7. Discussion and Feedback

The workshop ended with feedback from each participant. For most of the participating End-Users, there was no doubt that the RECONASS system is very useful and should be installed in buildings of critical infrastructure in areas with higher risks of building damages such as earthquake prone areas.

Depending on the End-Users function, aspects such as reliability, costs and technical aspects were highlighted. The feedback was collected and processed and the results are presented in the next chapter.

5. RESULTS OF THE WORKSHOP

5.1. Introduction

Presentations and main contents were highlighted in the previous chapter. In this chapter, the End-User feedback is compiled and analysed. The full list of the questions and advice from participating End-Users can be found in Annex A. Most of the End-User Input was already considered during the user requirement definition [1], translated into system specifications [5] and implemented in the RECONASS system. However, the users stressed in this workshop the crucial points and the RECONASS developers had the opportunity to learn from the users.

The discussions and brainstorming sessions took place in the training room, at the exhibition and on the training ground with varying participants. Therefore, End-User input and discussions are aggregated for specific topics in the following paragraphs.

5.2. Supported building types and installation

The participants were interested in the scope of application of the RECONASS system and asked for clarification concerning the supported building types and how to install the system. The relevant questions can be found in Table 3. These questions could be answered immediately by the RECONASS team members: The RECONASS system is designed for buildings with reinforced concrete load bearing structures, and to be installed during the construction phase. However, the installation is possible in existing buildings. However, to install strain gauges at the reinforcements and the wiring is much more complex in existing buildings. Furthermore, the strain sensors will only measure additional strains from loads varying from the load condition, when the sensors were added. The initial load condition must thus be calculated. Only an implementation of the strain sensors during construction phase will allow to measure the complete strains and to deduce initial load conditions.

Table 3: End-User feedback about supported building types and installation

No.	related	Question/Statement
1		Who would be in charge to install the RECONASS system?
2	1	Installation of the RECONASS system: Are there differences between existing and new buildings?
9		How many data hubs must be installed in a building?
13		Are the sensors and the setup of the RECONASS system only for reinforced concrete buildings?
19		Does the RECONASS system work with large buildings and large areas?
23		In Germany, snow loads at public buildings are typical use cases. Can RECONASS be adapted to these conditions?

Accordingly, the participants wanted to know whether the system may be adapted to other building types and to use cases such as snow load. This is possible at the request of customers. The system may also be installed in large buildings and a group of buildings. Data acquisition and processing is scalable. The number of necessary data hubs depends on the number of floors; typically one data hub for each floor is necessary. The building owner or operator would be responsible to install the system.

5.3. Responsibility

After these clarifications, responsibilities of different future users and especially financing aspects were addressed (See Table 4). W. Kimberlin was able to present the plans to implement the system in his work package 8 “exploitation” presentation. He answered the question about a long-term strategy to finance and maintain the system as follows: The financial advantage of the RECONASS system after an event is the reduced time to assess the further usability of an instrumented building or to plan reinforcement measures. Thus, downtime costs are minimised for insurance companies as well as for operators. When buildings are part of the critical infrastructure and the community is responsible for uninterrupted supply for the population (e.g. medical care in hospitals), the RECONASS system will reduce the building downtime as well.

Table 4: End-User feedback about responsibility

No.	related	Question/Statement
1		Who would be in charge to install the RECONASS system?
7		What is the long-term strategy to finance and maintain the RECONASS system?
14		Who will be able to access the software?
15	14	What is the possibility to exchange data, when the internet is down?
17		Who is responsible to enable access to the system for external users?
18	17	Who is responsible for training with the system, especially to train first responders?

The questions: “Who is able to access the software (output)?” and “Who is responsible to enable access to the system for external users?” were answered with the following considerations. The operator of the RECONASS system has the responsibility to provide building usability. In this context, he is the first to access RECONASS data but is responsible to provide RECONASS system output to first responders. This includes physical access to the system such as WLAN access points and user authentication but as well training of first responders for this task.

Especially when private building owners operate the system, training of first responders and other potential users must be supported by government agencies.

The participants clearly stated, that the RECONASS system is very useful and should be implemented where possible. In order to implement such systems, they pointed out that responsibilities must be very clear, best to be regulated within a legal framework.

5.4. Access to assessment and monitoring data in case of first responder operations

The discussion about responsibility led directly to first responders’ questions about how to access measurement and assessment data during their operations. The discussion about questions 14 and 16 to 18 (compare Table 5) is already covered in the previous paragraph “responsibility”. All participants agreed that “the information from the system (debris volumes, layers for GIS maps…) must be passed to the local emergency management system.” This is possible using the web interface. Special interfaces are easy to add due to the interoperability of the RECONASS system. The participants were very clear with the demand that this data transfer, not only to the local emergency management system but also to fire brigades and international teams, must be realised very fast (Question/Statement No 40).

But not only the local emergency managers in their control centres need the RECONASS data. On-site team leaders must be provided in a simple and easy way with access to the system in case of an emergency, even in situations without internet availability. Question 15 deals with this situation. In this case, a local system with a WLAN access point provides data exchange. This situation will be relevant for fire fighters, who will be on scene early after the event.

The RECONASS system measures temperature values inside the building and fire fighters need this information very fast (See Table 5 No 28). This was answered as follows: when connected via the internet or a local access point, the sensor readings can be retrieved immediately. In this context, the need for training for fire fighters was stated (No 31). This is necessary and this topic was already discussed in the previous paragraph.

Table 5: End-User feedback about first responders' access to RECONASS data

No.	related	Question/Statement
14		Who will be able to access the software?
15	14	What is the possibility to exchange data, when the internet is down?
16	14	What is necessary to access the RECONASS information and data?
17		Who is responsible to enable access to the system for external users?
18	17	Who is responsible for training with the system, especially to train first responders?
20		The information from the system (debris volumes, layers for GIS maps…) must be passed to the local emergency management system!
28		Fire services are interested in the temperatures inside the building before entering it.
31		Fire fighters need training to use the system.
32		The system must be able to give an assessment in 10 - 15 minutes after the event, otherwise fire fighters would enter the building anyway.
40		RECONASS information must be delivered very fast to control centres, fire brigades, international units.

The majority of the participants argued that the RECONASS system should be capable to provide structural and needs assessment of a damaged building in approximately 10-15 mins (compare No 32, Table 5). It should be noted that the audience mainly originated from the disaster relief community and their main interest lies on the response phase. RECONASS has been primarily designed to support reconstruction and recovery despite the fact that it may be operational and provide assessment results in the early stages of response. Due to the complexity of the algorithms running in the background the system's assessments are bound to restrictions as opposed by different types of monitored buildings. For example, the building's size is a constraining factor that limits the assessment speed; the larger the building, the more structural elements it embeds, hence assessment times are increased. However, development of computer systems leads to higher computing speed of new products. When the calculation runs on rented compute engines via the internet, calculation times of 10 to 15 minutes can already be realised for small to medium sized buildings.

5.5. Reliability

As described above, many of the participants were used to work in dangerous life-threatening situations. The question of reliability is crucial in this case. The RECONASS system relies on sensor measurement data and an automated calculation and assessment process, whereas the state-of-the-art is a visual inspection by experts or by the team leader. The state-of-the-art demonstration already showed that the application of structural experts and proper monitoring measures with tachymeters are time consuming. Especially in complex situations, one to two hours can be pass for this process, and even experts cannot see the real stresses inside the structure. However, experts are more flexible and can decide, even if there are partial collapses in the structure.

The described assessment process with experts is suitable for assessments during rescue operations. Assessment of the structural health of a building with the goal to decide about further usability of the building takes much more time. Depending on the situation and the number of buildings affected, periods of weeks and months are common for this task when performed with state-of-the-art technology and processes. The participating first responders were more interested in data collected by the RECONASS system, and many would prefer to rely on the assessment of their own staff rather than on calculations of the system.

Table 6: End-User feedback about reliability

No.	related	Question/Statement
4		Communication infrastructure: What is the strategy to maintain functionality when the communication infrastructure breaks down?
37		The RECONASS system is good for external experts, but some firefighter teams would enter even without safety information to rescue persons.
38	37	Entering unsafe buildings is not standard for THW and other organisations, see INSARAG guidelines.
39		Do not believe, that RECONASS safety assessment is 100% reliable.
42	41	RECONASS building monitoring in case of disasters is useful, but the responsible person will do his own inspection before sending his group members into such a damaged building.

One statement was: "I do not believe, that RECONASS safety assessment is 100% reliable." (compare No 39, Table 6) Some firefighters would enter a building without safety information from a structural expert or a system such as the RECONASS team (compare No 37), but first responders from THW stated that before entering a structural assessment is necessary (No 38). This was a very controversial debate and concerned the first visual inspection. In any case the responders would rely on the assessment of their staff or external experts, and would include RECONASS data and calculation results in this assessment. For an assessment of the further usability of the building after rescue operations, the RECONASS system was clearly identified as a very useful and fast possibility to allow quick recovery to standard building usage, especially for critical infrastructure buildings such as hospitals.

5.6. Operation and maintenance

The discussions about reliability led directly to questions about operation and maintenance. The same questions were already covered at the first End-User workshop and in the user requirements. The first question related to maintenance was about the planned lifetime of the RECONASS system installed in one building (see No 6, Table 7). It is planned that the lifetime of the installed RECONASS system will be the lifetime of the building. Therefore, maintenance is necessary. This includes updates of computer equipment and exchange of rechargeable batteries. The system will detect needs to maintain components. To keep the system operational, maintenance intervals must be defined and observed. These intervals depend on the size of the building but the system should work at least 2 years without maintenance. Part of the maintenance will be exchange of rechargeable batteries. These batteries will be charged automatically and are necessary for power failures and damages to cables, but not for the day to day operation of the system (No 11, Table 7).

Table 7: End-User feedback about operation and maintenance

No.	related	Question/Statement
6		What is the lifetime of the RECONASS system and its sensors?
7		What is the long-term strategy to finance and maintain the RECONASS system?
10		Maintenance, how often must the system be maintained?
11	10	How are the batteries in the sensors and data hubs charged?

5.7. Financial aspects and support

Due to the broad acceptance of the RECONASS system among the participants, there were many questions about pricing and how to support market entry of the product (compare Table 8). One main possibility is that insurance companies support owners of the RECONASS system with lower insurance fees (No 8, Table 8). Furthermore, insurance companies can find new customers in high risk areas when supporting the implementation of such systems. These options will be discussed with End-Users from the insurance sector within Work Package 8 "Exploitation". Another possibility to support such systems is a regulatory framework. Participants used safety technology in cars as an example for this attempt. Innovations such as airbags or anti-lock breaking systems were first rare add-ons, but are becoming state of the art. This led to regulations that demanded such safety systems for further cars.

Participants stated that such legislative pressure to install systems like the RECONASS system would be very helpful. THW members pointed out that legislative encouragement to introduce new technologies could be supported. On the other hand, governmental organisations cannot support specific companies or providers of technical solutions. First steps could be to initiate regulations concerning buildings which must be used in emergency situations, such as hospitals. When such buildings are damaged, it would be vital to know, whether the hospital can further be used, even partially, or whether it must be closed. The RECONASS system would provide such an assessment in a fast and accurate way.

Implementation of such systems can be supported by legal initiatives, but the implementation and maintenance costs are crucial for private building operators. These costs will be less than 2% of the total costs of the building. This is part of the user requirements and will be feasible.

Table 8: End-User feedback about financial aspects and support

No.	related	Question/Statement
8	7	Can insurance companies support the building owner to finance the RECONASS system?
12		What are the costs to install the system?
21		Mostly a question of costs, is a reduction of insurance costs possible for owners of the RECONASS system?
22		A set of different instrumentations, structure types, use cases and scenarios should be provided for potential clients.
24		Insurance companies could attract more customers when supporting the system!
25		National or EU certification is necessary!
26		Legislative pressure to install such a system would be helpful.
27		THW cannot promote specific products and companies.
29		VDS is a possible organisation in Germany to approve the RECONASS system.
30		An overview about prices to install and to maintain the system is necessary.
34		The market history of should be taken into account. Safe buildings can be compared to safe cars. Safe cars sold at the first time to well-paying clients, then the regulations demanded the state of the art for all cars. The same could be possible for safe buildings.
36	34	Especially hospitals should be safe buildings!

In order to further support sales activities, a participant suggested to prepare an overview over installation and maintenance costs. Another proposed a catalogue of different instrumentation alternatives for building structure types, use cases and scenarios.

5.8. Use of Unmanned Aerial Vehicles (UAV)

Another aspect of the RECONASS system is the use of UAVs to gather aerial imagery, generate a 3D situation map and automatically detect damages, collapsed structures and rubble piles. The UAV presentation impressed the participants. Especially for typical situations after disasters, the use of UAV was stated as very useful. The first responders can receive a detailed situation overview without entering dangerous areas. Large areas can be automatically mapped and analysed to send teams to sites where they can perform effective rescue operations.

Table 9: End-User feedback about Aerial Imagery

No.	related	Question/Statement
5		The authorisation to use UAV may be necessary depending on the country and situation!
35		UAV mapping and 3D modelling is very helpful to enhance the security of first responders, because a better situation awareness can be obtained with less time and less risks for the persons exploring the situation.
41		The use of UAV fits in the INSARAG system and is very useful.
43		UAV: Is the air-transport of UAV batteries (LiPo) possible, what restrictions do you know?
44		A possible partner to gather aerial imagery would be UAViators.
45		Post processing of aerial images is necessary to receive a 3D Model.

The participants considered the technology as compatible with standard operating procedures such as INSARAG guidelines (International Search and Rescue Advisory Group). Some legal and practical questions concerning transport and use of UAVs were posed. The participants asked about restrictions in air transport of UAVs. Standard UAV batteries for smaller UAVs such as DJI Phantom 4 can be transported with cabin luggage, large batteries with more than 160 WH must be presented at check-in. Additionally, there is a variety of different local restrictions to use UAVs. But experience shows, that UAVs are more and more common and even when it wouldn't be possible for rescue teams to transport UAVs to their operation areas, the RECONASS technology can be used with any imagery located in the area or with data from aerial imagery service companies. One of possible partners to access aerial imagery would be UAViators [6]. The organisation describes itself briefly: "With over 2,500 members in 80+ countries, our mission is to promote the safe, coordinated and effective use of UAVs for data collection and cargo delivery in a wide range of humanitarian and development settings." Wherever a disaster happens, members of this organisations are near and can provide aerial imagery.

5.9. Further aspects

Some questions and advice was related to the presentations and cannot be assigned to the preceding sections. Concerning the Pilot test building, participants wanted to know, how the forces would be applied. Two explosions were planned at the presented test building, the first outside the building, the second inside. A further discussion was about the representation of assessment results for first responders. Team leaders asked for a summarised result with the three categories red, yellow and green. This is implemented, but in depth information will also be provided.

Table 10: End-User feedback about reliability

No.	related	Question/Statement
3		Pilot test building: How will the forces be applied to the test building?
33		A traffic light type categorization (green, yellow, red) of the assessment results is necessary for a first overview.

6. CONCLUSIONS

The second RECONASS End-User workshop in Wesel continued the successful first RECONASS workshop in Berlin in 2014. Again, End-Users and RECONASS team members had a fruitful exchange about the RECONASS system. But in this workshop, the RECONASS system could be presented in depth, and the workshop included practical demonstrations and training. The choice of the Wesel training facility for this workshop allowed this. For the majority of the participating End-Users, there was no doubt that the RECONASS system is very useful and should be installed in buildings of critical infrastructure in areas with higher risks of building damages such as earthquake prone areas. The discussions focused on the possibilities to support the introductory phase and how legal support was possible.

The following Table 11 summarizes main results of the workshop that should be considered in the further development, dissemination and exploitation activities of the RECONASS system.

Table 11: main results and findings of the workshop

No	Category and results	Related questions
1.	**Supported Building types and installation**	
1.1	The RECONASS system is designed for buildings with reinforced concrete load bearing structures to be installed during the construction phase. But installation in existing buildings should be possible.	2
1.2	Other than reinforced concrete building constructions such as masonry buildings should be supported by the RECONASS system.	13
1.3	Further use cases such as snow load should be considered.	23
2.	**Responsibility**	
2.1	Main advantage for commercial building operators is to reduce down-time and related costs after a damaging event. This should be used to promote the system.	7
2.2	The possibility to reduce costs is a benefit for insurance companies and should lead to lower insurance premiums. Further meetings with potential insurers should be arranged.	7
2.3	Public authorities are responsible to maintain functionality of critical infrastructure. The RECONASS system helps to regain functionality and should be promoted for hospitals and similar institutions.	1, 7
2.4	The future operator and owner of the building equipped with a RECONASS system will have the responsibility to maintain functionality of the building. He must provide responders and emergency managers with RECONASS data and the possibility to access these data in case of an emergency. This includes training. Concepts, how training and access could be supported by public authorities should be developed.	14, 17, 18
3.	**Access to assessment and monitoring data in case of first responder operations**	
3.1	The RECONASS system should be capable of providing access when internet access is not possible.	15
3.2	Sensor measurement data such as temperatures should be provided directly without delay.	28
3.3	Training to retrieve the sensor data should be provided.	31

3.4	The possibility to provide interfaces to emergency management systems should be provided.	20, 40
3.5	The RECONASS system should be capable to provide structural and needs assessment of a damaged building in approximately 10-15 mins. The RECONASS system is not designed to reach this goal because the calculation results will be primary for the reconstruction and recovery phase. Such fast calculation times will be a medium-term goal for the future development of the system.	32
4.	**Reliability**	
4.1	End-Users must be well trained about possibilities and shortfalls of the system to rate the reliability of the RECONASS system calculation results for their respective tasks, especially for inspections of first responders.	39, 42
4.2	The system must provide sensor measurement data and detailed calculation results, to enable structural experts to perform safety considerations based on RECONASS system data.	42
4.3	At the moment, first responders seem to use very different methods to assess structural aspects before entering a damaged building.	37, 38
5.	**Operation and maintenance**	
5.1	Maintenance is necessary to ensure full functionality of the system. The automatic detection of maintenance needs is seen as highly beneficial.	10
5.2	Maintenance intervals and activities must be planned in an early stage of implementation.	7, 11
6.	**Financial aspects and support**	
6.1	Insurance companies should be contacted to develop common promotion strategies.	
6.2	Legislative encouragement to install such systems should be triggered.	
6.3	Meaningful system overviews with financial examples, cost-benefit analyses and instrumentation alternatives should be provided.	
7.	**Use of Unmanned Aerial Vehicles (UAV)**	
7.1	Possibilities to use aerial imagery of local persons and organisations should be elaborated for disasters, when transporting own UAVs to the area is time-consuming or not feasible.	
7.2	Legal constraints for transport and use of UAVs must be considered.	
7.3	Additional usage of the technology as stand-alone solution should be considered.	

The GeoSIG initiative to promote the system using the SHOX website was greatly appreciated. The End-Users were very impressed by the possibilities of using of Unmanned Aerial Vehicles. Especially the automated detection of damages was exiting for the participants and led to many discussions about its implementation.

The user requirements collected in the beginning of the project translated into system specifications proved to be reasonable. Only minor further additions to the system were encouraged such as a red/yellow green ample indicator for the assessment of the state of the whole instrumented building. The participants were confident that now it is time to disseminate and promote the system and to find partners at insurance companies to support these steps.

7. REFERENCES

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ANNEXES

Annex A: End-Users Questions and statements

No.	related	Question/Statement
1		Who would be in charge to install the RECONASS system?
2	1	Installation of the RECONASS system: Are there differences between existing and new buildings?
3		Pilot test building: How will the forces be applied to the test building?
4		Communication infrastructure: What is the strategy to maintain functionality when the communication infrastructure breaks down?
5		The authorisation to use UAV may be necessary depending on the country and situation!
6		What is the lifetime of the RECONASS system and its sensors?
7		What is the long-term strategy to finance and maintain the RECONASS system?
8	7	Can insurance companies support the building owner to finance the RECONASS system?
9		How many data hubs must be installed in a building?
10		Maintenance, how often must the system be maintained?
11	10	How are the batteries in the sensors and data hubs charged?
12		What are the costs to install the system?
13		Are the sensors and the setup of the RECONASS system only for reinforced concrete buildings?
14		Who will be able to access the software?
15	14	What is the possibility to exchange data, when the internet is down?
16	14	What is necessary to access the RECONASS information and data?
17		Who is responsible to enable access to the system for external users?
18	17	Who is responsible for training with the system, especially to train first responders?
19		Does the RECONASS system work with large buildings and large areas?
20		The information from the system (debris volumes, layers for GIS maps…) must be passed to the local emergency management system!
21		Mostly a question of costs, is a reduction of insurance costs possible for owners of the RECONASS system?
22		A set of different instrumentations, structure types, use cases and scenarios should be provided for potential clients.
23		In Germany, snow loads at public buildings are typical use cases. Can RECONASS be adapted to these conditions?
24		Insurance companies could attract more customers when supporting the system!
25		National or EU certification is necessary!
26		Legislative pressure to install such a system would be helpful.
27		THW cannot promote specific products and companies.

28		Fire services are interested in the temperatures inside the building before entering it.
29		VDS is a possible organisation in Germany to approve the RECONASS system.
30		An overview about prices to install and to maintain the system is necessary.
31		Fire fighters need training to use the system.
32		The system must be able to give an assessment in 10 - 15 minutes after the event, otherwise fire fighters would enter the building anyway.
33		A traffic light type categorization (green, yellow, red) of the assessment results is necessary for a first overview.
34		The market history of should be taken into account. Safe buildings can be compared to safe cars. Safe cars sold at the first time to well-paying clients, then the regulations demanded the state of the art for all cars. The same could be possible for safe buildings.
35		UAV mapping and 3D modelling is very helpful to enhance the security of first responders, because a better situation awareness can be obtained with less time and less risks for the persons exploring the situation.
36	34	Especially hospitals should be safe buildings!
37		The RECONASS system is good for external experts, but some firefighter teams would enter even without safety information to rescue persons.
38	37	Entering unsafe buildings is not standard for THW and other organisations, see INSARAG guidelines.
39		Do not believe, that RECONASS safety assessment is 100% reliable.
40		RECONASS information must be delivered very fast to control centers, fire brigades, international units.
41		The use of UAV fits in the INSARAG system and is very useful.
42	41	RECONASS building monitoring in case of disasters is useful, but the responsible person will do his own inspection before sending his group members into such a damaged building.
43		UAV: Is the air-transport of UAV batteries (LiPo) possible, what restrictions do you know?
44		A possible partner to gather aerial imagery would be UAViators.
45		Post processing of aerial images is necessary to receive a 3D Model.

Annex B: 2nd RECONAS End-User workshop agenda

RECONASS

Reconstruction and REcovery Planning: Rapid and Continuously Updated COnstruction Damage and Related Needs ASSessment

7th Framework Programme - FP7-SEC-2012.4.3-1
Next Generation Damage and Post-Crisis Needs Assessment Tool for Reconstruction and Recovery Planning
Capability Project

Agenda for 2nd RECONASS End-User Workshop "RECONASS under Stress"! , June 22-23, 2016, Wesel, Germany

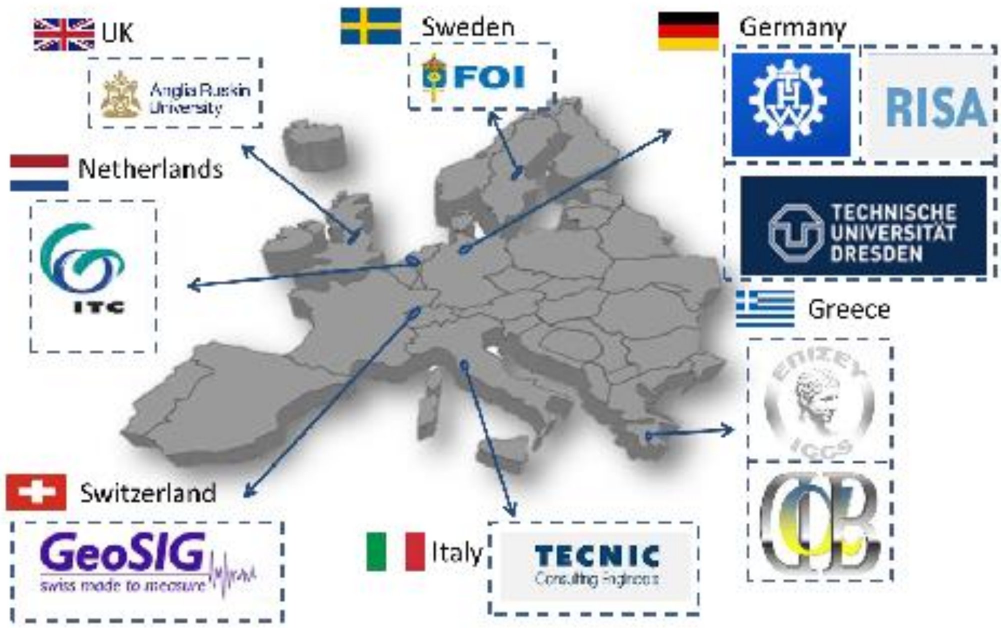
Organising partner	Federal Agency for Technical Relief (THW)
Contact person	THW Staff Unit Research & Innovation Management project.reconass@thw.de / +49-228-940-1453
Status	Final
Issue Date	21.06.2016

Grant Agreement №: 312718
Start: 01.12.2013 - *End:* 31.05.2017

"This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no [312718]"

RECONASS CONSORTIUM:

1. *Institute of Communications and Computer Systems (**ICCS**)*
2. *Technical University of Dresden (**TUD**)*
3. *Swedish Defense Research Agency (**FOI**)*
4. ***RISA** GmbH*
5. ***TECNIC** S.p.A.*
6. *D. Bairaktaris and Associates Ltd. (**DBA**)*
7. *GeoSIG Ltd (**GS**)*
8. *University of Twente, Faculty of Geo-Information Science and Earth 9. Observation (**ITC**)*
9. *Federal Agency for Technical Relief (**THW**)*
10. *Anglia Ruskin University (**ARU**)*



AGENDA

Day 1 – Wednesday 22nd of June 2016 || "Responders Day"

12:00 – 13:30	**Arrival / Registration / Lunch / Coffee**
13:30 – 13:45	**Opening key-note speech by host** Klaus-Dieter Büttgen, THW
13:45 – 14:30	**Welcome "Responders Day"** • Perspective on Day 1, training and demonstration • Introduction to RECONASS and where we stand Evangelos Sdongos, ICCS **Short introduction to the THW monitoring system "ESS"** • Components and examples Michael Markus, THW **Live Demo - Short briefing** • And walk to the scenario building Annika Nitschke, THW
14:30 – 15:00	**Live Demo – Current state of the art** **training ground** • Demonstration of operations using current state of the art equipment • Scenario: Explosion of unknown nature in 3-story mixed- occupancy dwelling Annika Nitschke, THW
15:00 – 15:30	**Presentation of RECONASS components** **conference room** • Circuit of Information: exhibition of RECONASS components • Attendees can obtain in-depth information about RECONASS at several stands Evangelos Sdongos, ICCS / RISA / ARU / DBA / GeoSIG / TUD
15:30 – 16:00	**Networking coffee break**
16:00 – 17:00	**Presentation of RECONASS PCCDN Tool** • Introduction of the Post Crisis needs assessment tool in regards to Construction Damage and related Needs ○ End-User attendees will be able to provide feedback / discuss setup, functionalities, ergonomics, ... with RECONASS Partners Stephanos Camarinopoulos, RISA **DBA contribution: Structural assessment** • Short information about the results of the Structural Assessment Module Dimitris Bairaktaris, DBA **ITC contribution: damage assessment using airborne imagery** • Short information about the module Markus Gerke, ITC

2nd RECONASS End-User Workshop
June 22-23, 2016
Wesel, Germany

Copyright RECONASS
(Grant Agreement No. 312718)

AGENDA

17:00 – 17:30	Live Demo – damage assessment using airborne imagery — training ground • Demonstration of the UAV system • Scenario: Explosion of unknown nature with extensive damages Markus Gerke, ITC / Annika Nitschke, THW
17:30 – 18:00	Wrap-up Day 1 & Discussion Evangelos Sdongos, ICCS / RECONASS Partners
18:00	End of Day 1 / Social Event

Day 2 – Thursday 23rd of June 2016 || "General Users Day"

09:00 – 09:30	Arrival / Registration / Coffee
09:30 – 09:45	Opening / Welcome "General Users Day" • Perspective on Day 2 Evangelos Sdongos, ICCS
09:45 – 10:45	Presentation of RECONASS functionalities beyond deployment • Presentation of accompanying aspects o End-User benefits beyond the presented • Exploitation Campaign o LoI signing o Attendees will be asked to provide feedback using questionnaires that will be provided Wayne Kimberlin, GS
10:30 – 11:00	Networking coffee break
11:00 – 12:00	Wrap-up Day 2 • Discussion and individual written feedback • Q & A Session Michael Markus, THW / RECONASS Partners
12:00	Lunch & End of Day 2

Page 4 of 4

Annex C: Information package

RECONASS

7th Framework Programme

FP7-SEC-2012.4.3-1

Next Generation Damage and Post-Crisis Needs Assessment Tool for Reconstruction and Recovery Planning Capability Project

Travel / Accommodation / General Information for the

2nd RECONASS End-User Workshop

"RECONASS under Stress"

Wesel, Germany
June 22 – 23, 2016

EXECUTIVE SUMMARY OF THE RECONASS PROJECT

RECONASS will provide a monitoring system for constructed facilities that will provide a near real time, reliable, and continuously updated assessment of the structural condition of the monitored facilities after a disaster, with enough detail to be useful for early and full recovery planning. The above assessment will be seamlessly integrated with automated, near real-time and continuously updated assessment of physical damage, loss of functionality, direct economic loss and needs of the monitored facilities and will provide the required input for the prioritization of their repair.

Such detailed monitoring is only economical for selected facilities that are essential for response and recovery or facilities that have a high value as a target for terrorist attacks. In case of spatially extended events, in order to assess the physical damage in the whole affected area, the detailed assessment of damage in the monitored facilities will be used for the speedy local calibration of satellite and oblique aerial photography dramatically reducing the required time to inform the post disaster/crisis needs assessment process and provide base data for reconstruction efforts.

The above will be part of the RECONASS next generation post-crisis needs assessment tool in regards to construction damage and related needs. This tool will enable fusion of external information, allow for future expansion of the system, provide international interoperability between the involved units for reconstruction and recovery planning and support the collaborative work between these actors.

Page 2 of 6

2ND END-USER WORKSHOP

We would like to cordially invite you to attend to the 2nd RECONASS End-User Workshop in Wesel, Germany, on June 22 – 23, 2016.

Following the 1st End-User Workshop in Berlin and the preliminary Component Testing at FOI's premises in Stockholm, Sweden, the 2nd End-User Workshop will offer ample opportunities to all interested RECONASS End-Users (Civil Protection Agencies and NGOs, building owners, organizations involved in sensing technologies for disaster management, and insurance companies) to gain first-hand impressions on how the integrated RECONASS system can assist stakeholders.

You will be able to witness a live demonstration of how RECONASS can assist responders in their often times dangerous day-to-day work whilst in parallel you will be informed on how RECONASS improves recovery and reconstruction efforts. Furthermore, there will be considerable time to get into dialogue with the RECONASS Consortium Partners. Here, participants of the 2nd RECONASS End-User Workshop will obtain information on design, architecture, and technical specifications of the RECONASS system.

The preliminary agenda for the Workshop is attached.

The registration for the Workshop must be done online: http://www.reconass.eu/workshop (you will be redirected to Eventbrite).
Please do not get confused: attending the Workshop is free of charge. You, nevertheless, will have to register beforehand, using the register button on the web page.

The registration page will remain open until June 15, 2016, midnight. However, for the sake of logistics, we would be glad to have an overview as early as possible (i.e. beginning of June).
In the unlikely event that you are not able to log on to the website, feel free to send an e-mail to: project.reconass@thw.de.

Since the THW premise is a training ground with large amounts of "artificial" debris and rubble, wearing sturdy clothes and shoes (e.g. bunker gear & turnout boots / Personal Protective Equipment) is advised.

VENUE INFORMATION

The THW Wesel Regional Office Training Facility is located approximately 5 kilometers outside the Wesel city center (N/NW). The premises host the Training Facility, the THW Wesel Regional Office as well as the THW Wesel Local Section. Apart from general use as a training ground, the Training Facility is one of the facilities used regularly by UN INSARAG to certify USAR teams.

The address is

- **Kanonenberge 4, D-46487, Germany (suitable for SATNAV)**

- Coordinates decimal degrees (WGS84): Lat 51.6912557, Long6.5935504
- Coordinates Standard UTM (WGS84): 32N 3336735729441
- Coordinates NATO UTM (WGS84): 32ULC 33673 29441

The City of Wesel itself is a medium sized city in North Rhine-Westphalia, Germany. It is situated at the confluence of the Lippe River and the Rhine.
The total area covered by the municipality is roughly 122,000 km², hosting a little over 60,000 inhabitants.

The city originated from a Franconian manor that was first recorded in the 8th century. In the 12th century, the Duke of Clèves took possession of Wesel. The city became a member of the Hanseatic League during the 15th century. Within the Duchy of Cleves, Wesel was second only to Cologne in the lower Rhine region as an entrepôt. It was an important commercial centre: a clearing station for the transshipment and trading of goods.

Nowadays, Wesel lies north of the well-known industrial heart of Germany, the Ruhr-Area (Ruhrgebiet).

16th Century Wesel

Contemporary city layout

TRAVEL INFORMATION & ACCOMMODATION

There are two advisable options for travelling to Wesel:

1) By car – The Autobahn A3 passes Wesel close by and is a well developed transit route connecting the Netherlands with the Ruhr-Area, the Frankfurt area, Bavaria, and Austria. However, the THW facility has very limited parking space.

2) By plane – The nearest airports are Düsseldorf International (DUS) and Weeze Airport (NRN). At both airports you will have access to numerous major car rentals.
   - Distance to DUS is around 60 kilometers.
   - Distance to NRN is around 40 kilometers.

THW will operate a shuttle service from DUS to the greater Wesel area:

1) DUS – Wesel City Center DAY1 (prior to Workshop)
2) Wesel City Center – THW Wesel DAY1 (prior to Workshop)
3) THW Wesel – Wesel City Center DAY1 (after Workshop)

4) Wesel City Center – THW Wesel DAY2 (prior to Workshop)
5) THW Wesel – Wesel City Center DAY2 (after Workshop)
6) Wesel City Center – DUS DAY2 (after Workshop)

Please make use of the shuttle reservation handler when registering for the Workshop (you will be asked to indicate your preferences when entering your contact details) and indicate your arrival time at DUS to: project.reconass@thw.de. Subsequently, departure times for collective shuttle rides will be issued.

Wesel hosts a number of hotels, mainly near the city center (see: https://www.weselmarketing.de/marketing-en/system/hotels/).

Since it is very centrally situated, the Hotel Kaiserhof is recommended.

Hotel Restaurant Kaiserhof
Kaiserring 1
46483 Wesel, Germany
Tel. +49(0)281 - 33932 0
Fax. +49(0)281 - 33932 22
info@hotelkaiserhof.de
http://www.hotelkaiserhof.de/en/

Additional accommodation could be found in the vicinity of Wesel.
If you chose to stay in a hotel other than the above and need a shuttle to and from the Workshop, please indicate your hotel to project.reconass@thw.de.

Please note that hotel reservations are the sole responsibility of attendees and accommodation costs cannot be reimbursed.

CONTACT INFORMATION

For further general information concerning the RECONASS effort you can always log on to the RECONASS website: http://www.reconass.eu.

For further detailed information concerning the 2nd End-User Workshop feel free to contact the organizer: project.reconass@thw.de or +49-228-940-1456.

Annex D: Scenario Cologne - Wesel

This is a scenario and not a report of real events.

Background

A train loaded with ammunition is waiting near the Hohenzollern bridge in Cologne when one of the waggons catches fire. Four of the ammunition waggons explode, artillery shells explode in buildings near the railway track.

The situation resembles the explosion of a fireworks factory in Enschede, Netherland 2000. The fire started in the work area of the central warehouse where some 900 kg of fireworks were stored. The fire extended to two full containers that had been placed illegally outside of the building. Since the fire department could not contain the fire initially, it was able to spread to a third container, which exploded shortly afterwards. A chain reaction of explosions eventually led to the ignition of the firework bunker. An estimated 177 tons of fireworks exploded, virtually destroying the surrounding residential area.

In a three-storey mall next to the tracks, an explosion is reported, probably at the first floor. Most visitors and employees left the building, but it is likely that there are still some casualties inside the building.

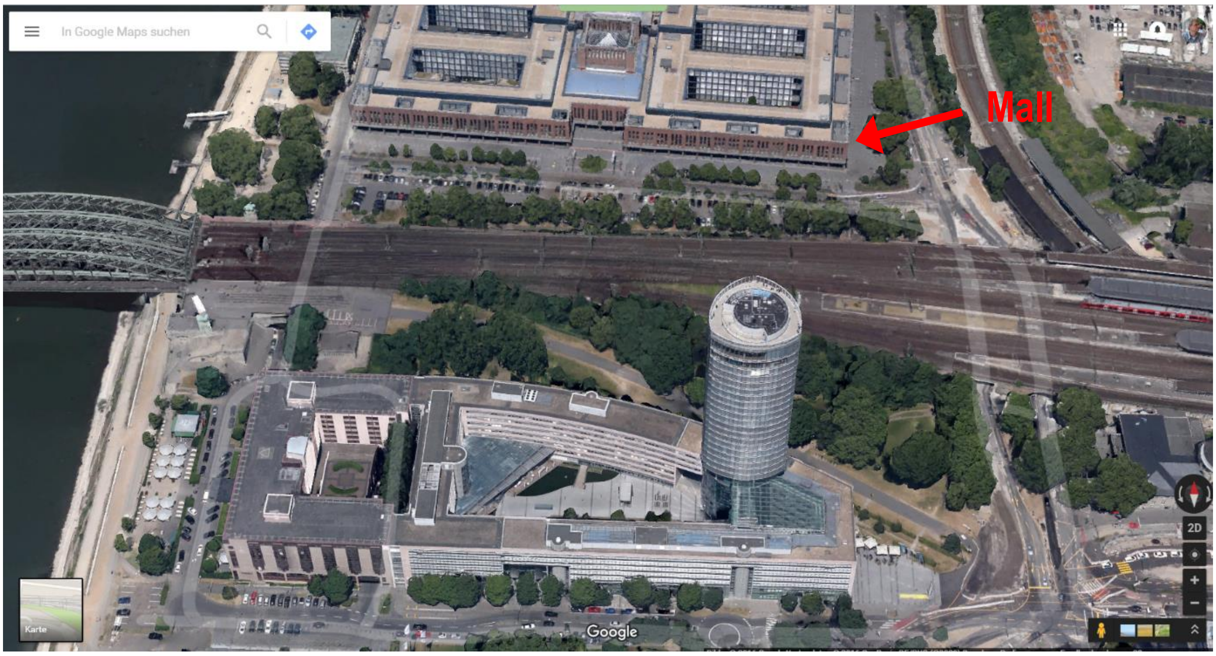


Figure 27: Railway track near Hohenzollern Bridge in Cologne

The cologne fire department is working to capacity extinguishing fires, volunteer fire departments and THW units are alarmed and back up the Cologne firefighters.

The mall is not on fire and a THW unit is declared responsible for the operations at the mall. The danger of collapse must be assessed, a safe access to the interior of the building is to be established and victims must be rescued from the building.

First Live Demo – current state of the art

Demonstration of operations using current state-of-the-art equipment.
Wednesday, 22.06.2016 14:30 – 15:00

Figure 28: Building 1 to be used for the demonstration

The building (see Figure 28) is used for the demonstrations. It represents a reinforced concrete building with concrete frame construction, infill masonry walls and partly covered with precast concrete panels.

Team members of the SEEBA, an internationally operating THW unit for urban search and rescue operations after disasters such as earthquakes support the live demo because of their language skills and experience, but the scenario is a national or better local event.

Team members of specialised monitoring teams with surveying equipment also participate.

The first assessment THW team reaches the building and collects information. One artillery shells exploded inside at the first floor, further unexploded explosives did not reach the building. Before search and rescue operations can be performed, a safety and security officer has to enter the building to assess the interior damages and to plan support measures.

This specialist is not part of every assessment team/first responder team and must be alarmed separately.

The safety and security officer determines that a column at the front left side, first floor is severely damaged and can cause a partial building collapse (see Figure 29). The safety and security officer decides, that a permanent monitoring of the building structure I necessary before support measures can start inside the building.

Figure 29: One column severely damaged. The damages can only be seen after entering the building.

Reflectors of the ESS surveying/monitoring system must be attached with the aid of ladders or a turntable ladder. First monitoring results are shown.

Participants can enter the building after the demonstration with guides.

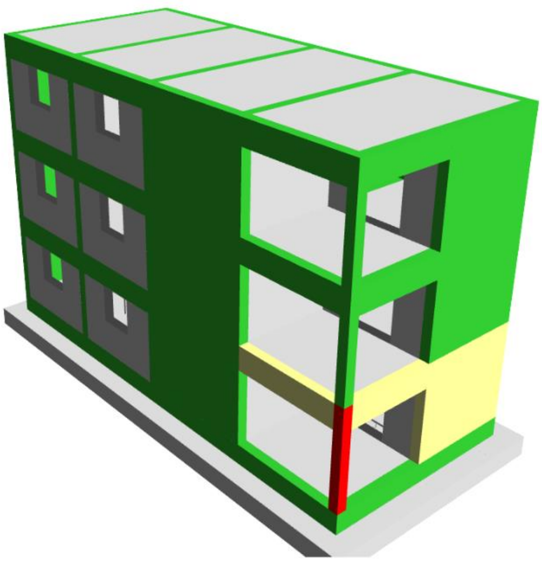


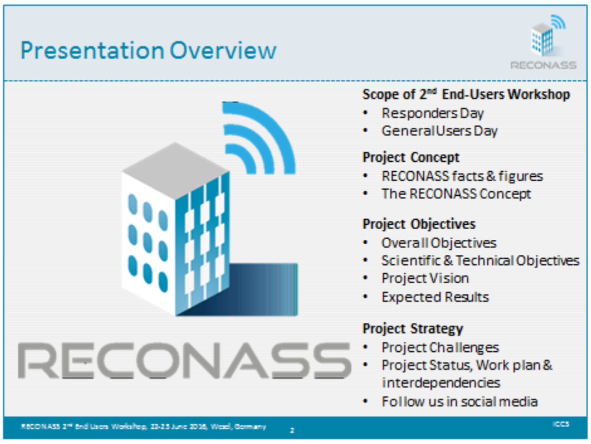
Figure 30: RECONASS PCCDN tool visualisation of the damaged building (red: heavily damaged or collapsed, yellow: damaged, green: no significant loss of load bearing capacity)

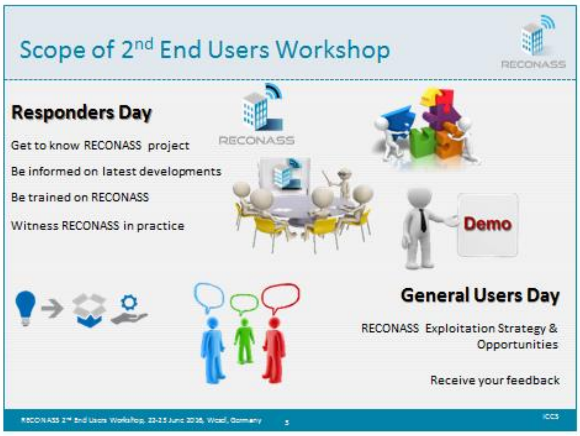
With aid of the PCCDN tool, the damaged column can be identified before entering the building.
Monitoring of the structure is performed using dummy data.
ITC uses its UAV to generate aerial photos of the first building and a totally damaged building nearby.

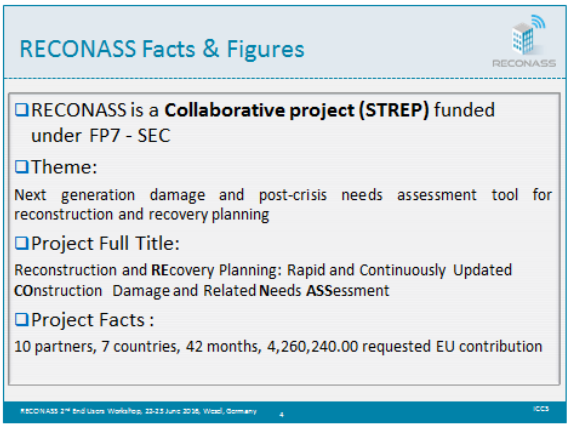
Annex E: Presentations

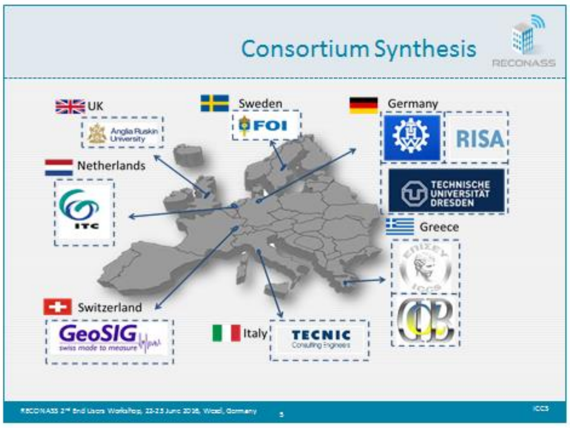
Welcome "Responders Day"

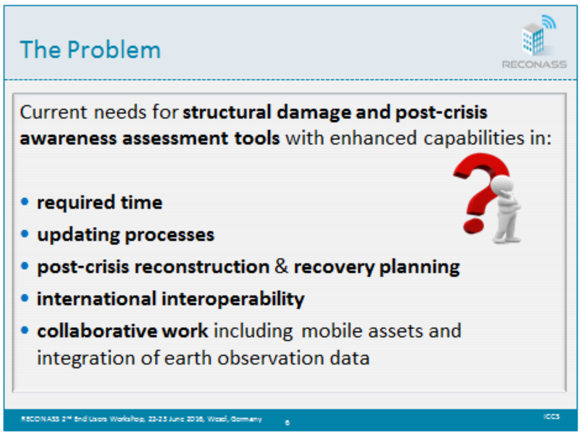
"Welcome Address Scope & Introduction to RECONASS by Evangelos Sdongos, ICCS"












The RECONASS Concept at a glance
The RECONASS Monitoring and Assessment System
1. The Local Positioning System
2. Strain, Acceleration and Temperature sensors
3. The Communication Module
4. Air and Space-borne Remote Sensing
5. Post Crisis Needs Assessment Tool in regards to Construction Damage and Related Needs (PCCDN)
6. Structural and Economic Loss and Needs Assessment Modules
"RECONASS will provide the stakeholders with near-real time and updated assessment of damage, loss and needs"
Local positioning tags
Temperature sensors
Strain sensors
Data hubs
Accelerometers
Gateway module
INTERNET
RECONASS 2nd End Users Workshop, 22-23 June 2016, Wesel, Germany
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RECONASS Pilot in motion
Building construction (in progress)
Strain Instrumentation (completed)
Full building instrumentation (August 2016)
Detonations – Pilot Tests (25th of August) – SAVE THE DATE
RECONASS 2nd End Users Workshop, 22-23 June 2016, Wesel, Germany
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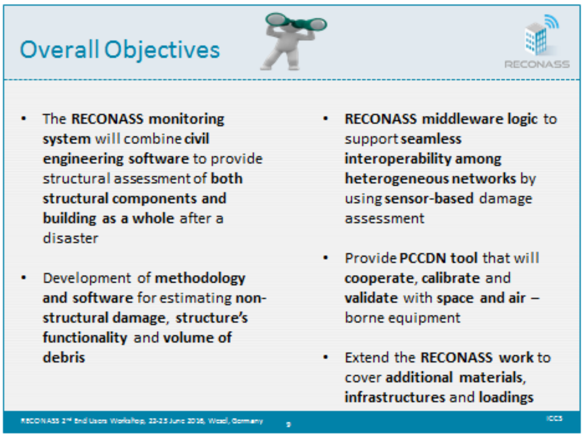
Overall Objectives
The RECONASS monitoring system will combine civil engineering software to provide structural assessment of both structural components and building as a whole after a disaster
Development of methodology and software for estimating non-structural damage, structure's functionality and volume of debris
RECONASS middleware logic to support seamless interoperability among heterogeneous networks by using sensor-based damage assessment
Provide PCCDN tool that will cooperate, calibrate and validate with space and air – borne equipment
Extend the RECONASS work to cover additional materials, infrastructures and loadings
RECONASS 2nd End Users Workshop, 22-23 June 2016, Wesel, Germany
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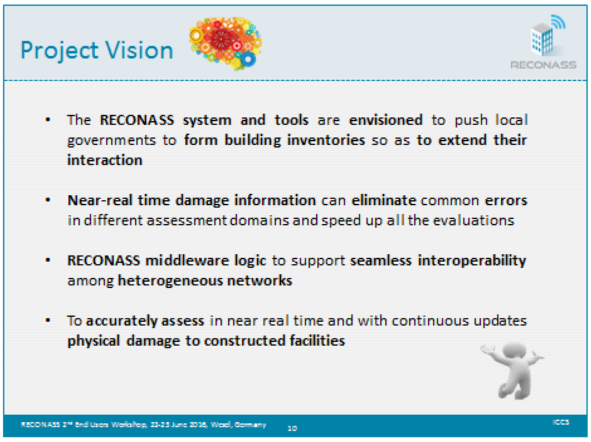
Project Vision
The RECONASS system and tools are envisioned to push local governments to form building inventories so as to extend their interaction
Near-real time damage information can eliminate common errors in different assessment domains and speed up all the evaluations
RECONASS middleware logic to support seamless interoperability among heterogeneous networks
To accurately assess in near real time and with continuous updates physical damage to constructed facilities
RECONASS 2nd End Users Workshop, 22-23 June 2016, Wesel, Germany
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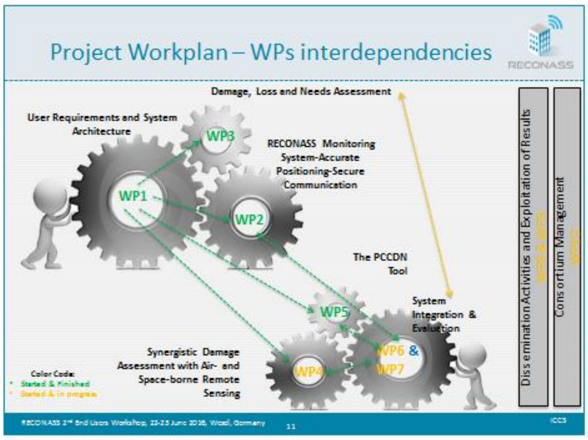
Project Workplan – WPs interdependencies
Damage, Loss and Needs Assessment
User Requirements and System Architecture
RECONASS Monitoring System-Accurate Positioning-Secure Communication
The PCCDN Tool
System Integration & Evaluation
Synergistic Damage Assessment with Air- and Space-borne Remote Sensing
WP1
WP2
WP3
WP4
WP5
WP6 &
WP7
Dissemination Activities and Exploitation of Results
Consortium Management
Color Code:
Started & Finished
Started & in progress
RECONASS 2nd End Users Workshop, 22-23 June 2016, Wesel, Germany
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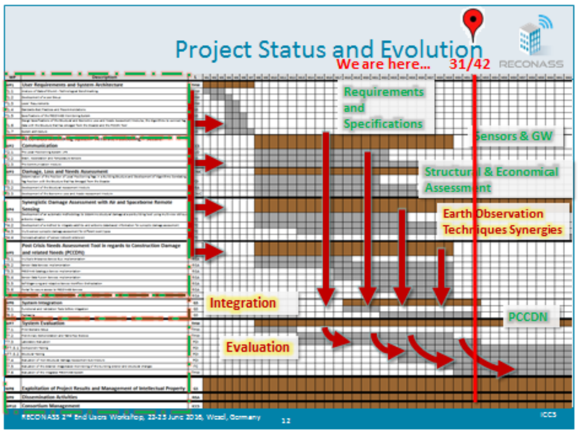
Project Status and Evolution
We are here...
31/42
Requirements and Specifications
Sensors & GW
Structural & Economical Assessment
Earth Observation Techniques Synergies
Integration
PCCDN
Evaluation
RECONASS 2nd End Users Workshop, 22-23 June 2016, Wesel, Germany
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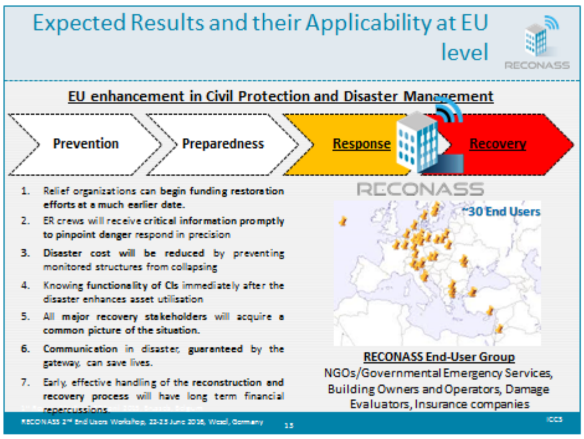
Expected Results and their Applicability at EU level
EU enhancement in Civil Protection and Disaster Management
Prevention
Preparedness
Response
Recovery
1. Relief organizations can begin funding restoration efforts at a much earlier date.
2. ER crews will receive critical information promptly to pinpoint danger respond in precision
3. Disaster cost will be reduced by preventing monitored structures from collapsing
4. Knowing functionality of CIs immediately after the disaster enhances asset utilisation
5. All major recovery stakeholders will acquire a common picture of the situation.
6. Communication in disaster, guaranteed by the gateway, can save lives.
7. Early, effective handling of the reconstruction and recovery process will have long term financial repercussions
RECONASS
~30 End Users
RECONASS End-User Group
NGOs/Governmental Emergency Services, Building Owners and Operators, Damage Evaluators, Insurance companies
RECONASS 2nd End Users Workshop, 22-23 June 2016, Wesel, Germany
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Group "RECONASS"
http://www.shoxsolutions.com/
SHOX – Structural Health Monitoring in a Box
RECONASS 2nd End Users Workshop, 22-23 June 2016, Wesel, Germany
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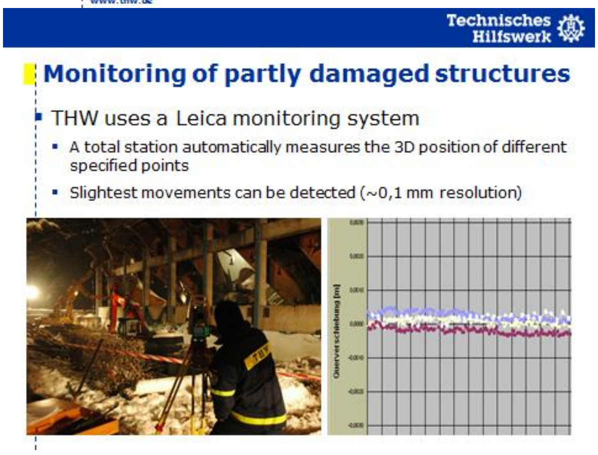
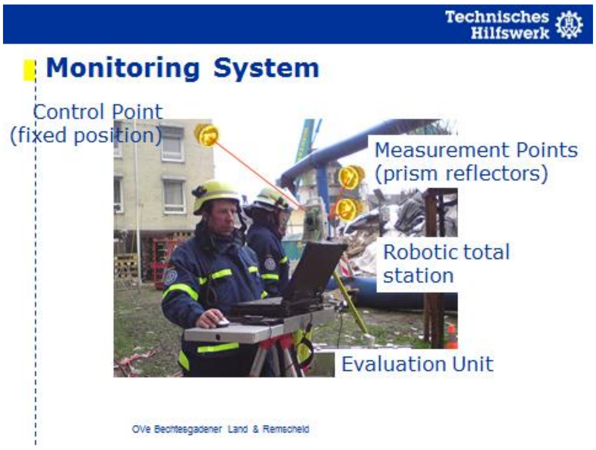
Short introduction to the THW monitoring system "ESS"

"Monitoring of damaged structures for Disaster Response and Damage Assessment by Michael Markus, THW"





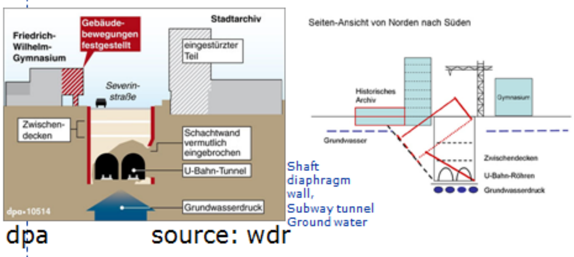
Technisches Hilfswerk

Example: Cologne City Archive Collapse

Cologne City archive collapse, 2 deaths   Cologne fire service 2003

Technisches Hilfswerk

Collapse process



dpa   source: wdr

Köln, Stadtarchiv am 03.03.2009

Technisches Hilfswerk

Example 2: Konstanz, 23.12.2010

Technisches Hilfswerk

Example 2: Konstanz, 23.12.2010

Technisches Hilfswerk

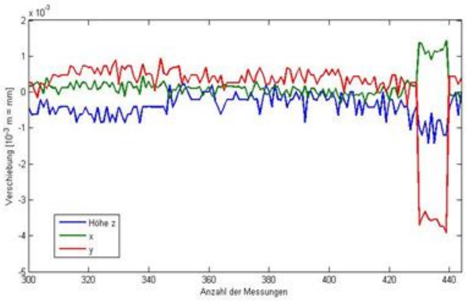
Attachment of prism reflectors

Attachment of the metal sheet

Konstanz 2010, M.Markus

Single point observation

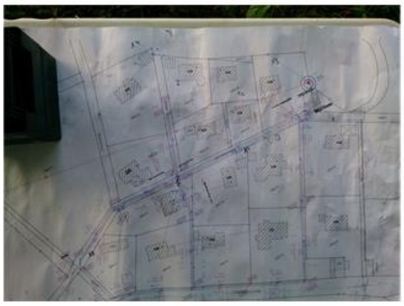
Konstanz, measured event



Example 5: Landslide in Mössingen near Stuttgart

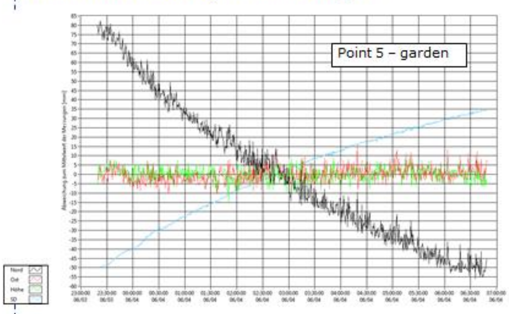
Example 3: Landslide in Mössingen near Stuttgart

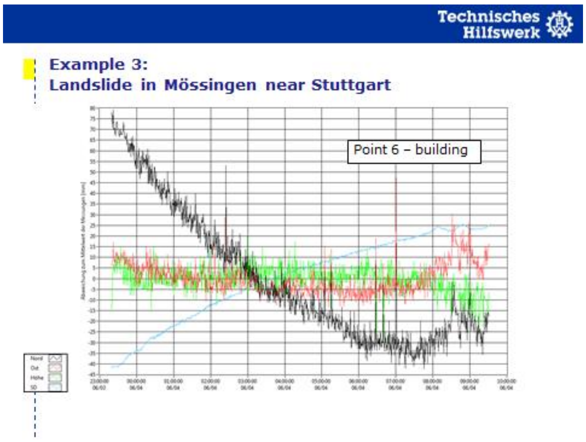
Example 3: Landslide in Mössingen near Stuttgart



Example 3: Landslide in Mössingen near Stuttgart

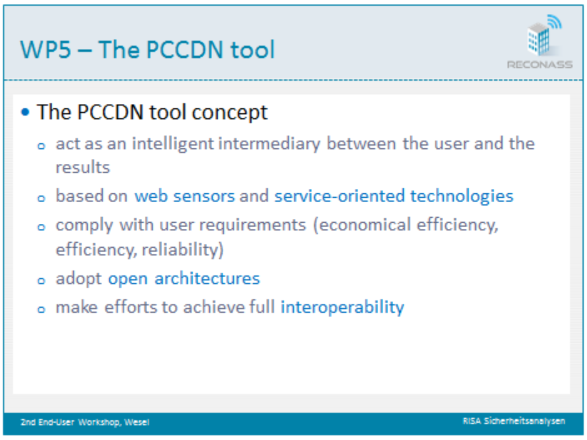
Example 3: Landslide in Mössingen near Stuttgart

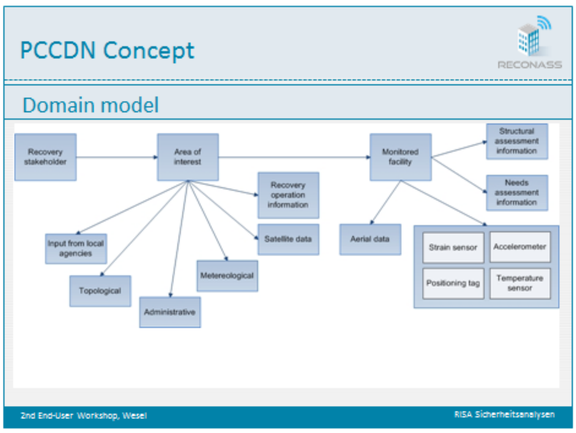


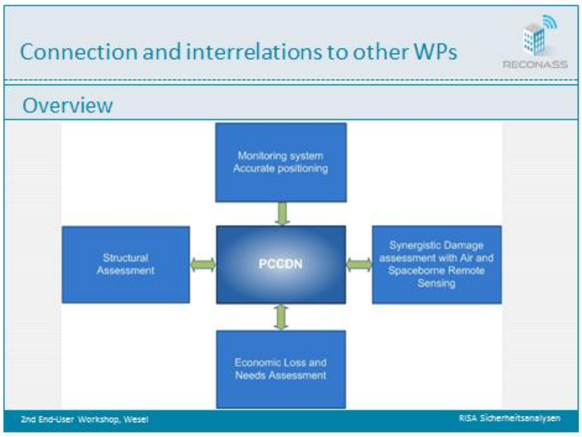


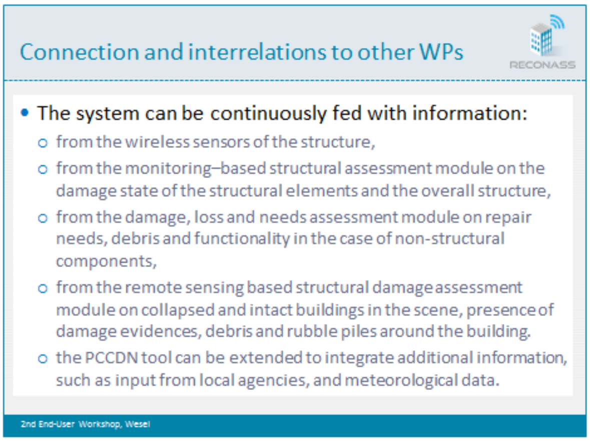
Presentation of RECONASS PCCDN Tool

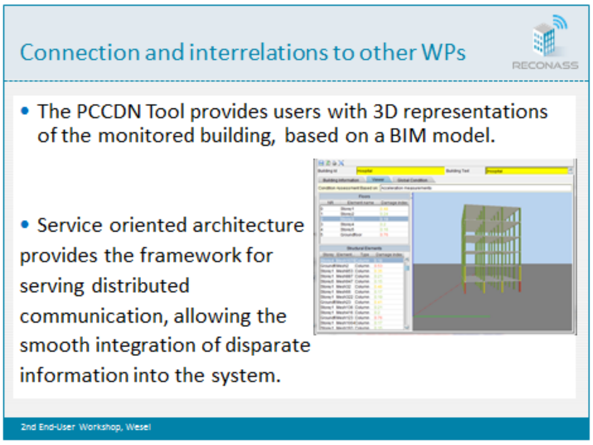
"Post Crisis Needs Assessment Tool in regards to Construction Damage and related Needs (PCCDN) by Stephanos Camarinopoulos, RISA"

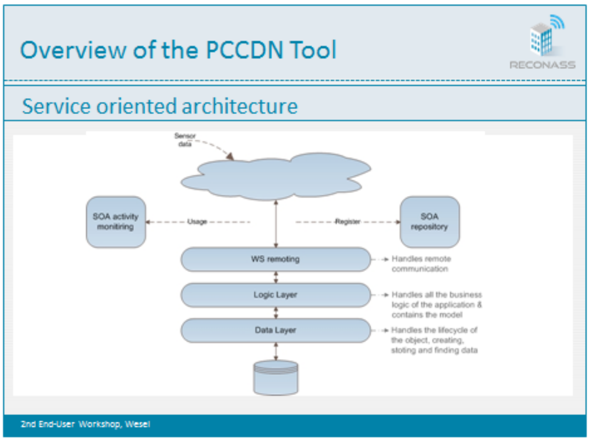


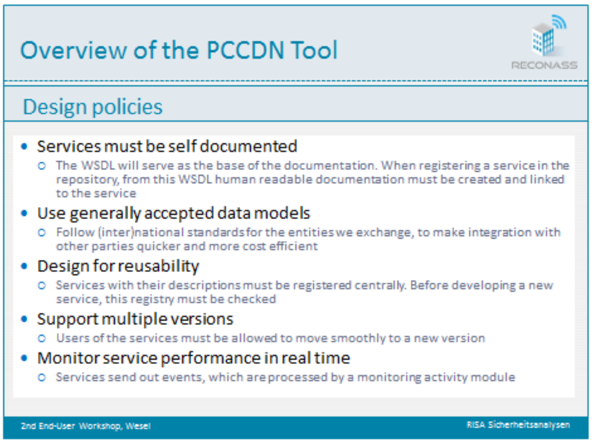


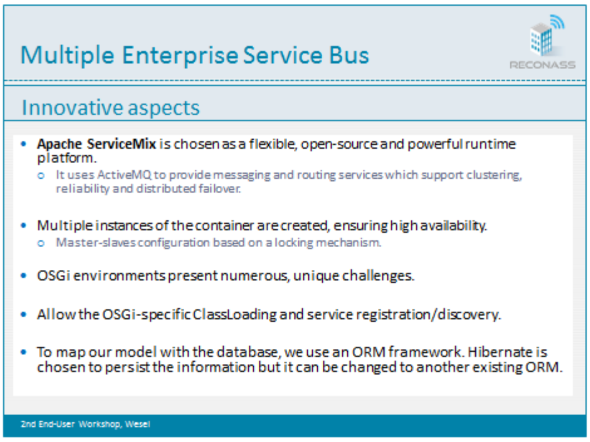


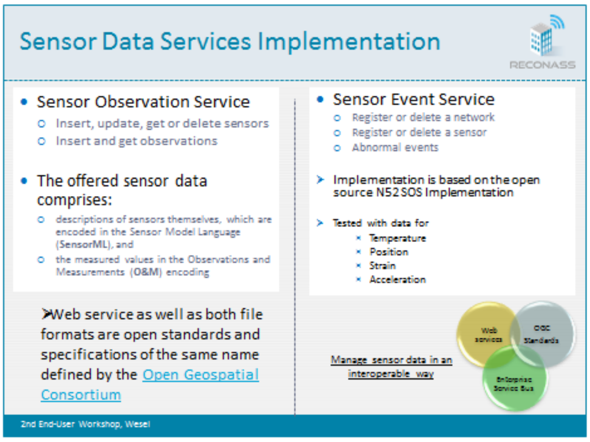

Connection and interrelations to other WPs
RECONASS
The system can be continuously fed with information:
from the wireless sensors of the structure,
from the monitoring–based structural assessment module on the damage state of the structural elements and the overall structure,
from the damage, loss and needs assessment module on repair needs, debris and functionality in the case of non-structural components,
from the remote sensing based structural damage assessment module on collapsed and intact buildings in the scene, presence of damage evidences, debris and rubble piles around the building.
the PCCDN tool can be extended to integrate additional information, such as input from local agencies, and meteorological data.
2nd End-User Workshop, Wesel

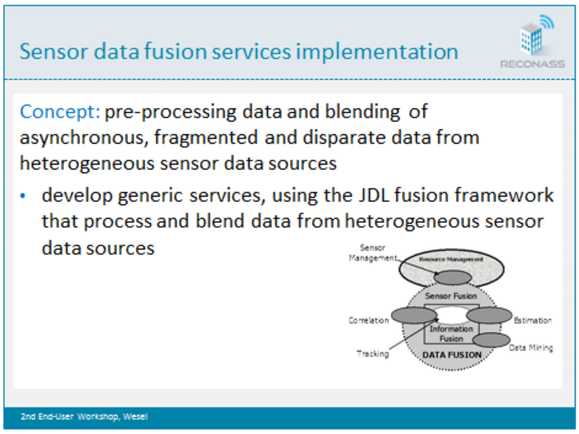

Connection and interrelations to other WPs
RECONASS
The PCCDN Tool provides users with 3D representations of the monitored building, based on a BIM model.
Service oriented architecture provides the framework for serving distributed communication, allowing the smooth integration of disparate information into the system.
2nd End-User Workshop, Wesel

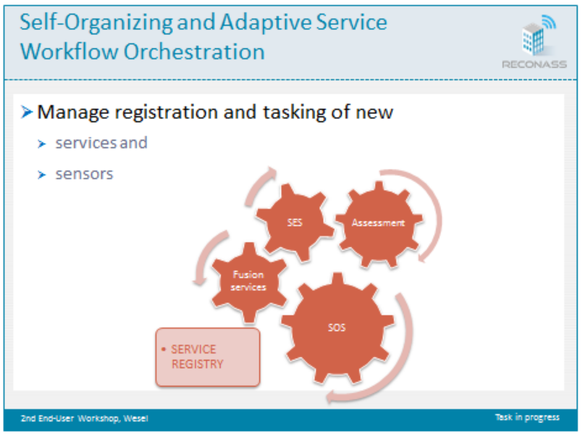

Overview of the PCCDN Tool
RECONASS
Service oriented architecture
Sensor data
SOA activity monitoring
Usage
Register
SOA repository
WS remoting
Handles remote communication
Logic Layer
Handles all the business logic of the application & contains the model
Data Layer
Handles the lifecycle of the object, creating, storing and finding data
2nd End-User Workshop, Wesel

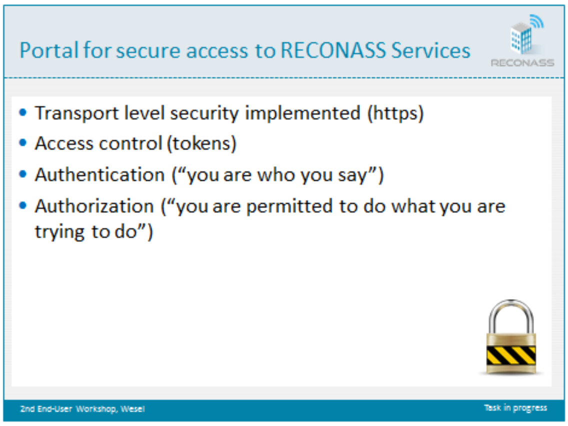

Overview of the PCCDN Tool
RECONASS
Design policies
Services must be self documented
The WSDL will serve as the base of the documentation. When registering a service in the repository, from this WSDL human readable documentation must be created and linked to the service
Use generally accepted data models
Follow (inter)national standards for the entities we exchange, to make integration with other parties quicker and more cost efficient
Design for reusability
Services with their descriptions must be registered centrally. Before developing a new service, this registry must be checked
Support multiple versions
Users of the services must be allowed to move smoothly to a new version
Monitor service performance in real time
Services send out events, which are processed by a monitoring activity module
2nd End-User Workshop, Wesel
RISA Sicherheitsanalysen


Multiple Enterprise Service Bus
RECONASS
Innovative aspects
Apache ServiceMix is chosen as a flexible, open-source and powerful runtime platform.
It uses ActiveMQ to provide messaging and routing services which support clustering, reliability and distributed failover.
Multiple instances of the container are created, ensuring high availability.
Master-slaves configuration based on a locking mechanism.
OSGi environments present numerous, unique challenges.
Allow the OSGi-specific ClassLoading and service registration/discovery.
To map our model with the database, we use an ORM framework. Hibernate is chosen to persist the information but it can be changed to another existing ORM.
2nd End-User Workshop, Wesel


Sensor Data Services Implementation
RECONASS
Sensor Observation Service
Insert, update, get or delete sensors
Insert and get observations
The offered sensor data comprises:
descriptions of sensors themselves, which are encoded in the Sensor Model Language (SensorML), and
the measured values in the Observations and Measurements (O&M) encoding
Sensor Event Service
Register or delete a network
Register or delete a sensor
Abnormal events
Implementation is based on the open source N52 SOS Implementation
Tested with data for
Temperature
Position
Strain
Acceleration
Web service as well as both file formats are open standards and specifications of the same name defined by the Open Geospatial Consortium
Manage sensor data in an interoperable way
Web services
OGC Standards
Enterprise Service Bus
2nd End-User Workshop, Wesel

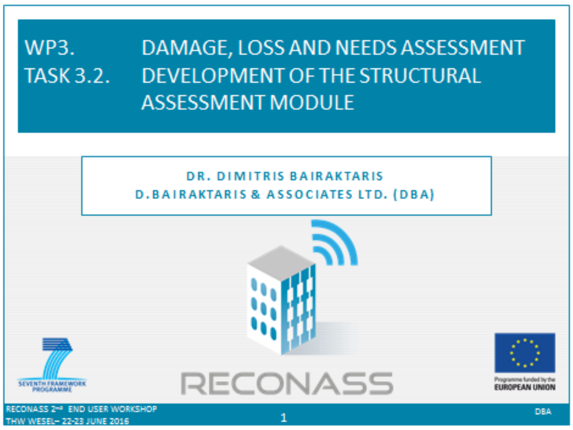

Sensor data fusion services implementation
RECONASS
Concept: pre-processing data and blending of asynchronous, fragmented and disparate data from heterogeneous sensor data sources
develop generic services, using the JDL fusion framework that process and blend data from heterogeneous sensor data sources
Sensor Management
Resource Management
Sensor Fusion
Correlation
Information Fusion
Estimation
Tracking
DATA FUSION
Data Mining
2nd End-User Workshop, Wesel

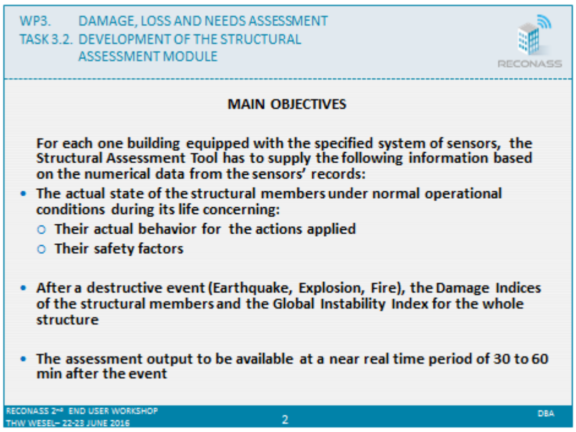

Self-Organizing and Adaptive Service Workflow Orchestration
RECONASS
Manage registration and tasking of new
services and
sensors
SES
Assessment
Fusion services
SOS
SERVICE REGISTRY
2nd End-User Workshop, Wesel
Task in progress

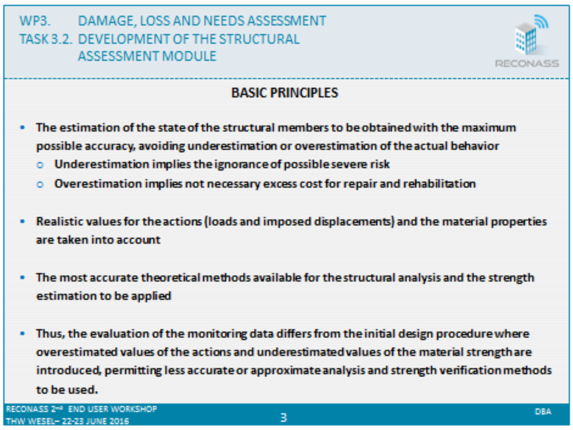


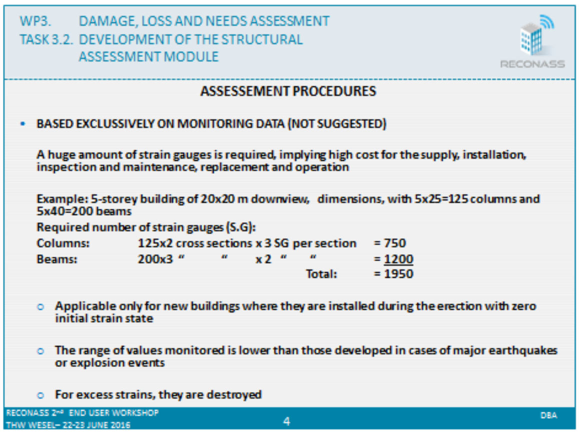
Structural assessment

"Development of the Structural Assessment Module by Dr. Dimitrios Bairaktaris, DBA"









WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE

ASSESSEMENT PROCEDURES

- **COMBINATION OF MONITORING DATA AND STRUCTURAL ANALYSIS – STRENGTH VERIFICATION SOFTWARE**

Non linear analysis software packets of increased reliability are commercially available

Additional complimentary software for specific items to be prepared

Required amount of sensors (Example)

Strain gauges:	**(Columns in ground floor):**	**25x3**	**= 75***
Accelerometer: (2 per storey)		**(5+1) x2**	**= 12**
LTS: (Midspan points of beams and columns):		**125+200**	**= 325**
Temperature sensors: (6 per storey)		**5x6**	**= 30**

(*: New buildings only)

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WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE

STRUCTURAL ASSESSMENT SCENARIOS

1. Operating Conditions
2. Earthquake
3. Explosion
4. Fire

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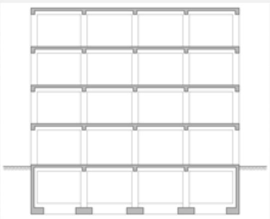
WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE

PRELIMINARY PHASE



STRUCTURAL MODEL PREPARATION

- Coordinates of the nodes
- Connectivity of members
- Cross-sections' shapes and dimensions
- Reinforcement
- Material properties
- Geotechnical parameters
- Dead loads of filling structures
- Temporary and quasi permanent live loads
- Time of erection

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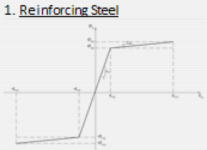
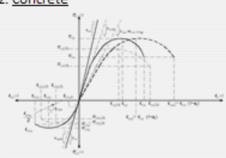
WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE

MATERIALS

1. Reinforcing Steel



2. Concrete



3. Time Effects:

a. Strength

b. Creep

c. Shrinkage

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WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
STRENGTH AND DEFORMATION PARAMETERS OF CONCRETE

$\sigma_{cy}=\sigma_{cy,sub}-1,25\sigma_{y,sy}-f_{ck,sub}+10-f_{ck,sy}+8$	MPa	-20	-30	-40	-50	-60	-70	-80	-90	-100
$\varepsilon_{cy}=[(1+\sigma_{cy}/110)^3-2]/740$		-0,00180	-0,00199	-0,00216	-0,00230	-0,00242	-0,00252	-0,00260	-0,00266	-0,00269
$\varepsilon_{cu}=[(1+\sigma_{cy}/40)^3-12]/3700$		-0,00345	-0,00350	-0,00351	-0,00350	-0,00345	-0,00336	-0,00324	-0,00309	-0,00291
$\sigma_{cu}=e\cdot\sigma_{cy}\cdot\varepsilon_{cu}/\varepsilon_{cy}\cdot\exp(-\varepsilon_{cu}/\varepsilon_{cy})$	MPa	-15,33909	-24,70432	-34,72429	-45,18600	-55,94906	-66,90180	-77,93659	-88,92705	-99,70054
$E_{c0}=e\cdot\sigma_{cy}/\varepsilon_{cy}$	MPa	30225,40	41021,62	50444,55	59076,45	67298,14	75287,82	83569,08	92040,11	100993,76
$f_{cu}=-e\cdot\sigma_{cy}\cdot(\varepsilon_{cy}/\varepsilon_{cu})\cdot[(1+\varepsilon_{cu}/\varepsilon_{cy})\cdot\exp(-\varepsilon_{cu}/\varepsilon_{cy})-1]$	MN/m²	-16,19544	-24,33254	-32,33297	-40,13402	-47,68265	-54,92097	-61,77564	-68,14692	-73,89450
$m_{cu}=e\cdot\sigma_{cy}\cdot(\varepsilon_{cy}/\varepsilon_{cu})^2\cdot[[1+(1+\varepsilon_{cu}/\varepsilon_{cy})^2]\cdot\exp(-\varepsilon_{cu}/\varepsilon_{cy})-2]$	MNm/m²	8,90276	13,62245	18,36852	23,08268	27,72102	32,24212	36,59857	40,72908	44,54861
$\sigma_{ct,y}=11\cdot\sigma_{cy}/(\sigma_{cy}-125)$	MPa	1,51724	2,12903	2,66667	3,14286	3,56757	3,94872	4,29268	4,60465	4,88889
$(\sigma_{ct,y}')=2,30\cdot\sigma_{cy}/(-\sigma_{cy})^{1/3}$	MPa	2,71871	3,68822	4,51016	5,21761	5,83339	6,37420	6,85276	7,27899	7,66075
$\varepsilon_{ct,y}=e\cdot\sigma_{ct,y}/E_{c0}$		0,0001364	0,0001411	0,0001437	0,0001446	0,0001441	0,0001424	0,0001396	0,0001360	0,0001316
$\varepsilon_{ct,u}=[154\cdot(20+\sigma_{cy}^{...})]^{-1}$		0,0002018	0,00019	0,000179	0,000169	0,000159	0,000151	0,000144	0,0001372	0,0001316
$\varepsilon_{ct,u,r}=\varepsilon_{ct,u}-(2\cdot\varepsilon_{ct,y}/3)\cdot(\varepsilon_{ct,u}/\varepsilon_{ct,y})^{1/3}$		0,0000818	0,0000742	0,0000672	0,0000612	0,0000562	0,0000521	0,0000487	0,0000460	0,0000439
$\sigma_{ct,u}=E_{c0}\cdot\varepsilon_{ct,u}\cdot\exp(-\varepsilon_{ct,u}/\varepsilon_{ct,y})$	MPa	1,38975	2,02549	2,59758	3,10364	3,54887	3,94166	4,29085	4,60444	4,88889
$E_{ct,u}=\sigma_{ct,u}/(2\cdot(\varepsilon_{ct,u}-\varepsilon_{ct,u,r}))$		5792,82	8709,73	11598,59	14431,62	17200,36	19911,16	22579,13	25222,39	27863,20
$f_{ct,u}=-e\cdot\sigma_{ct,y}\cdot(\varepsilon_{ct,y}/\varepsilon_{ct,u})\cdot[(1+\varepsilon_{ct,u}/\varepsilon_{ct,y})\cdot\exp(-\varepsilon_{ct,u}/\varepsilon_{ct,y})-1]$	MN/m²	1,21342	1,67521	2,05945	2,38220	2,65827	2,90015	3,11796	3,31972	3,51174
$m_{ct,u}=-e\cdot\sigma_{ct,y}\cdot(\varepsilon_{ct,y}/\varepsilon_{ct,u})^2\cdot[[1+(1+\varepsilon_{ct,u}/\varepsilon_{ct,y})^2]\cdot\exp(-\varepsilon_{ct,u}/\varepsilon_{ct,y})-2]$	MNm/m²	0,70101	0,98155	1,22002	1,42317	1,59819	1,75172	1,88938	2,01572	2,13437

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WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE

1. OPERATING CONDITION ASSESSMENT MODULE

SG : Strain Gauges
δ_z : Foundation Settlements

I. EXISTING AND NEW BUILDINGS
1. Structural model updating with time effects on concrete properties and on soil consolidation parameters
2. Finite Element Structural Analysis

II. NEW BUILDINGS ONLY (Additional Steps)
1. Strain records of 3 strain gauges per column installed at the bottom cross-sections of the ground floor
2. Calculation of normal forces and bending moments in columns on the ground floor
3. Estimation of the actual values of live loads
4. Calculation of differential foundation settlements

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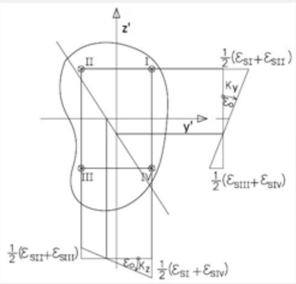
WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE



Axial Strains & Curvatures

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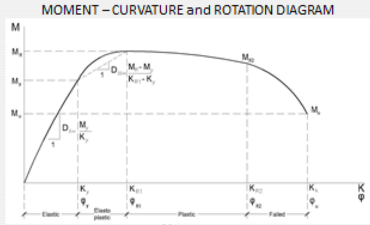
WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE

PLASTIC HINGE
MOMENT – CURVATURE and ROTATION DIAGRAM



Plastic hinge length: $l_p=\frac{1}{\mu}\left(1-\frac{M_Y}{M_R}\right),\ \frac{1}{\mu}$: Distance of zero moment from the hinge

Plastic hinge rotation: $\varphi=\frac{l_p}{3}\left[\kappa+\frac{\kappa_y l}{2(1-\mu l_p)}\right],\quad \kappa=\frac{3\varphi}{l_p}-\frac{\kappa_y l}{2(1-\mu l_p)}$

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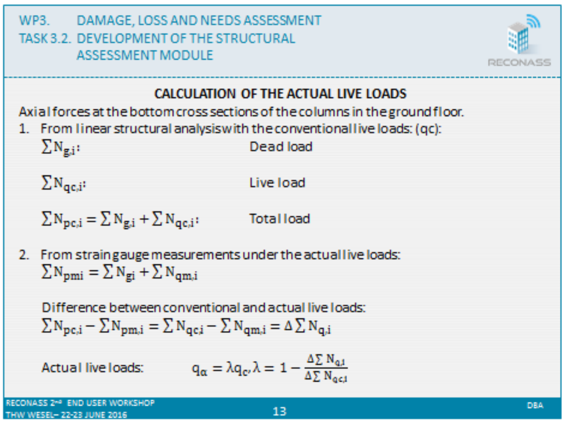
WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
RECONASS
CALCULATION OF THE ACTUAL LIVE LOADS
Axial forces at the bottom cross sections of the columns in the ground floor.
1. From linear structural analysis with the conventional live loads: (qc):
$\sum N_{g,i}$: Dead load
$\sum N_{qc,i}$: Live load
$\sum N_{pc,i} = \sum N_{g,i} + \sum N_{qc,i}$: Total load
2. From strain gauge measurements under the actual live loads:
$\sum N_{pmi} = \sum N_{gi} + \sum N_{qm,i}$
Difference between conventional and actual live loads:
$\sum N_{pc,i} - \sum N_{pm,i} = \sum N_{qc,i} - \sum N_{qm,i} = \Delta \sum N_{q,i}$
Actual live loads: $q_\alpha = \lambda q_c, \lambda = 1 - \frac{\Delta \sum N_{q,i}}{\Delta \sum N_{qc,i}}$
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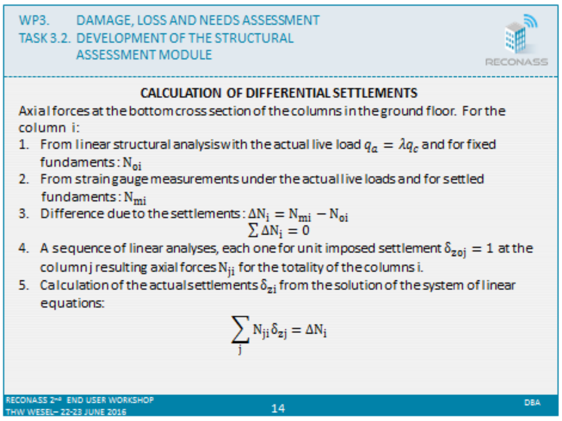
DBA


WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
RECONASS
CALCULATION OF DIFFERENTIAL SETTLEMENTS
Axial forces at the bottom cross section of the columns in the ground floor. For the column i:
1. From linear structural analysis with the actual live load $q_\alpha = \lambda q_c$ and for fixed fundaments: N_{oi}
2. From strain gauge measurements under the actual live loads and for settled fundaments: N_{mi}
3. Difference due to the settlements: $\Delta N_i = N_{mi} - N_{oi}$
$\sum \Delta N_i = 0$
4. A sequence of linear analyses, each one for unit imposed settlement $\delta_{zoj} = 1$ at the column j resulting axial forces N_{ji} for the totality of the columns i.
5. Calculation of the actual settlements δ_{zi} from the solution of the system of linear equations:
$\sum_j N_{ji} \delta_{zj} = \Delta N_i$
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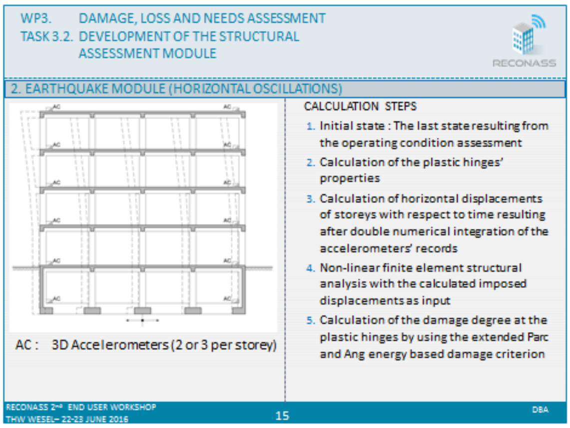
DBA


WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
RECONASS
2. EARTHQUAKE MODULE (HORIZONTAL OSCILLATIONS)
AC
AC : 3D Accelerometers (2 or 3 per storey)
CALCULATION STEPS
1. Initial state : The last state resulting from the operating condition assessment
2. Calculation of the plastic hinges' properties
3. Calculation of horizontal displacements of storeys with respect to time resulting after double numerical integration of the accelerometers' records
4. Non-linear finite element structural analysis with the calculated imposed displacements as input
5. Calculation of the damage degree at the plastic hinges by using the extended Parc and Ang energy based damage criterion
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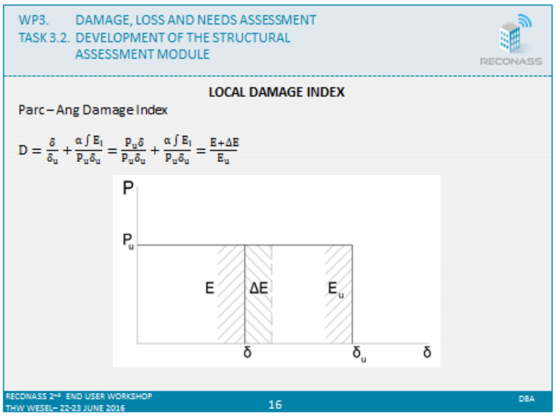
THW WESEL– 22-23 JUNE 2016
15
DBA


WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
RECONASS
LOCAL DAMAGE INDEX
Parc – Ang Damage Index
$D = \frac{\delta}{\delta_u} + \frac{\alpha \int E_I}{P_u \delta_u} = \frac{P_u \delta}{P_u \delta_u} + \frac{\alpha \int E_I}{P_u \delta_u} = \frac{E + \Delta E}{E_u}$
P
P_u
E
ΔE
E_u
δ
δ_u
δ
RECONASS 2nd END USER WORKSHOP
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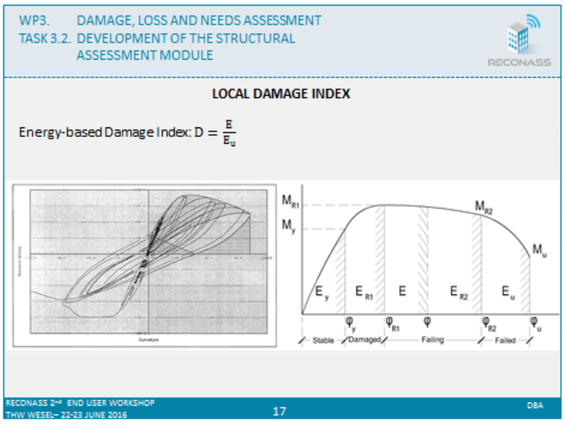
DBA


WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
RECONASS
LOCAL DAMAGE INDEX
Energy-based Damage Index: $D = \frac{E}{E_u}$
M_{R1}
M_y
M_{R2}
M_u
E_y
E_{R1}
E
E_{R2}
E_u
φ_y
φ_{R1}
φ
φ_{R2}
φ_u
Stable
Damaged
Failing
Failed
RECONASS 2nd END USER WORKSHOP
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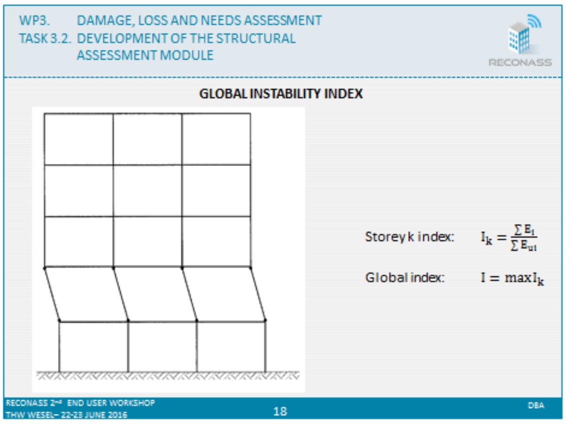
DBA


WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
RECONASS
GLOBAL INSTABILITY INDEX
Storey k index: $I_k = \frac{\sum E_i}{\sum E_{ui}}$
Global index: $I = \max I_k$
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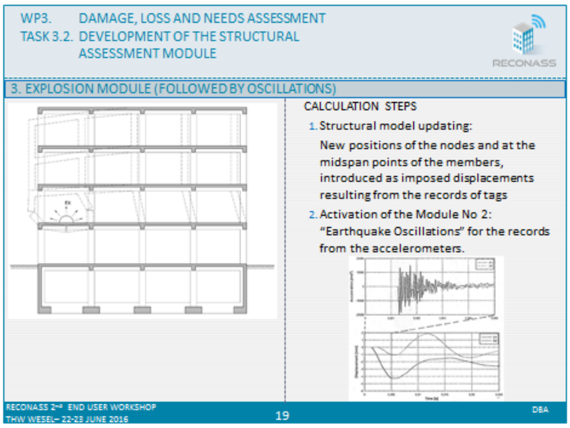
WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
RECONASS
3. EXPLOSION MODULE (FOLLOWED BY OSCILLATIONS)
CALCULATION STEPS
1. Structural model updating:
New positions of the nodes and at the midspan points of the members, introduced as imposed displacements resulting from the records of tags
2. Activation of the Module No 2: "Earthquake Oscillations" for the records from the accelerometers.
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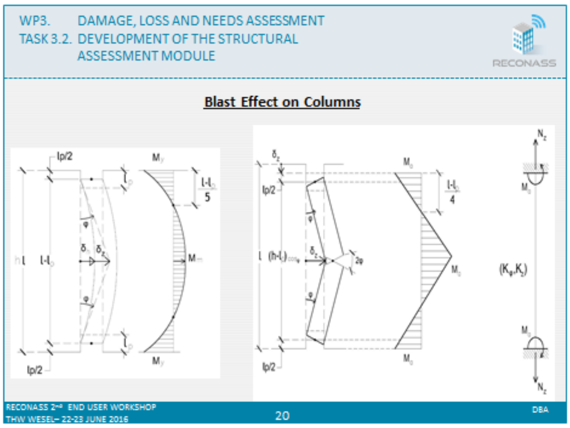
WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
RECONASS
Blast Effect on Columns
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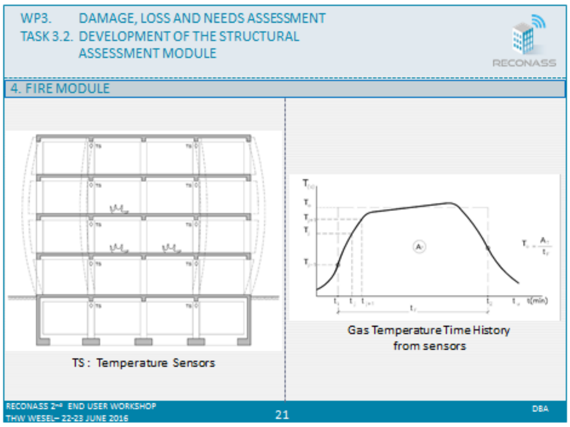
WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
RECONASS
4. FIRE MODULE
TS : Temperature Sensors
Gas Temperature Time History from sensors
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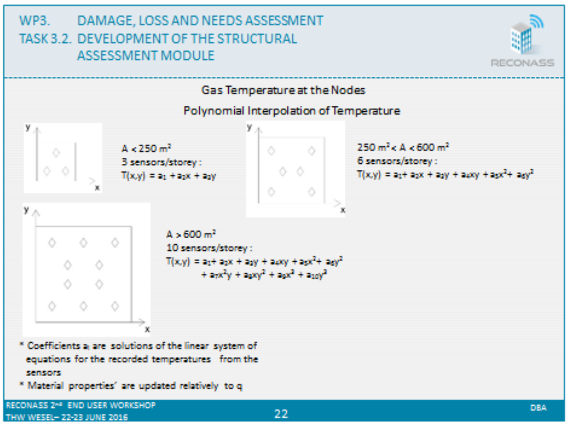
WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
RECONASS
Gas Temperature at the Nodes
Polynomial Interpolation of Temperature
A < 250 m²
3 sensors/storey :
T(x,y) = a1 + a2x + a3y
250 m² < A < 600 m²
6 sensors/storey :
T(x,y) = a1+ a2x + a3y + a4xy + a5x²+ a6y²
A > 600 m²
10 sensors/storey :
T(x,y) = a1+ a2x + a3y + a4xy + a5x²+ a6y² + a7x²y + a8xy² + a9x³ + a10y³
* Coefficients ai are solutions of the linear system of equations for the recorded temperatures from the sensors
* Material properties' are updated relatively to q
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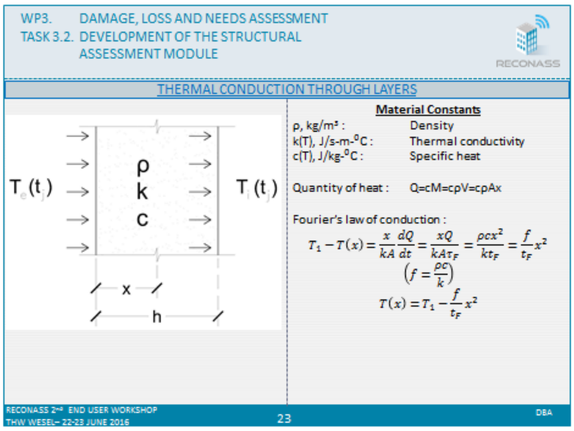
WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
RECONASS
THERMAL CONDUCTION THROUGH LAYERS
Material Constants
ρ, kg/m³ : Density
k(T), J/s-m-°C : Thermal conductivity
c(T), J/kg-°C : Specific heat
Quantity of heat : Q=cM=cpV=cpAx
Fourier's law of conduction :
$T_1 - T(x) = \frac{x}{kA}\frac{dQ}{dt} = \frac{xQ}{kA t_F} = \frac{\rho c x^2}{k t_F} = \frac{f}{t_F}x^2$
$\left(f = \frac{\rho c}{k}\right)$
$T(x) = T_1 - \frac{f}{t_F}x^2$
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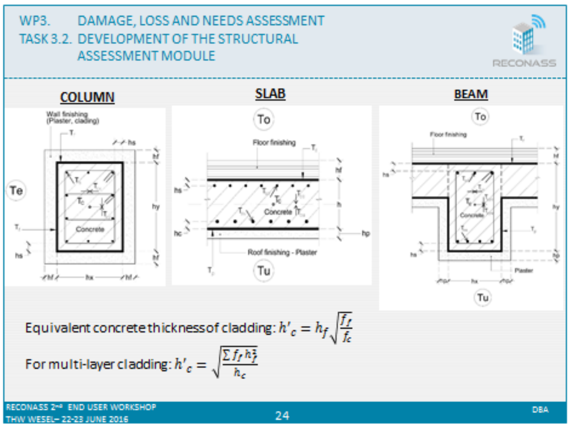
WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
RECONASS
COLUMN
SLAB
BEAM
Equivalent concrete thickness of cladding: $h'_c = h_f\sqrt{\frac{f_f}{f_c}}$
For multi-layer cladding: $h'_c = \sqrt{\frac{\sum f_f h_f^2}{h_c}}$
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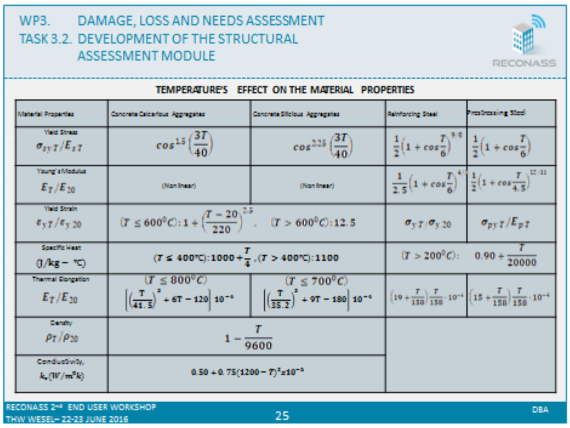
WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
RECONASS
TEMPERATURE'S EFFECT ON THE MATERIAL PROPERTIES
Material Properties
Concrete Calcarious Aggregates
Concrete Silicious Aggregates
Reinforcing Steel
Prestressing Steel
Yield Stress
Young's Modulus
Yield Strain
Specific Heat
Thermal Elongation
Density
Conductivity
$1 - \frac{T}{9600}$
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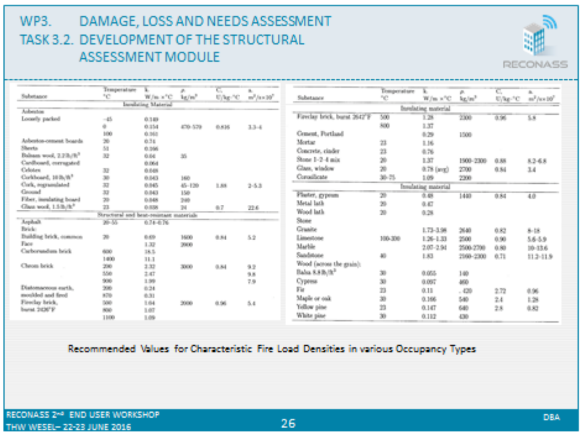
WP3. DAMAGE, LOSS AND NEEDS ASSESSMENT
TASK 3.2. DEVELOPMENT OF THE STRUCTURAL ASSESSMENT MODULE
RECONASS
Recommended Values for Characteristic Fire Load Densities in various Occupancy Types
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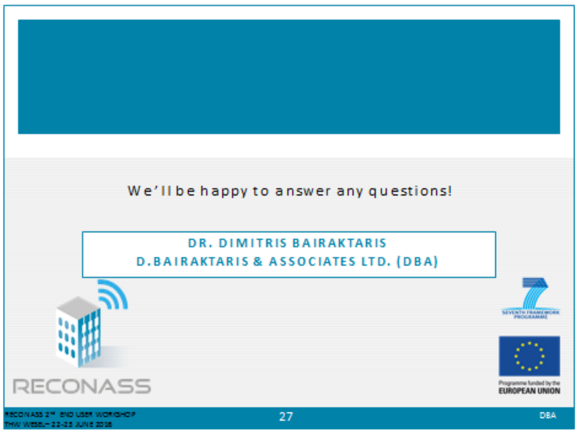
We'll be happy to answer any questions!
DR. DIMITRIS BAIRAKTARIS
D.BAIRAKTARIS & ASSOCIATES LTD. (DBA)
RECONASS
SEVENTH FRAMEWORK PROGRAMME
Programme funded by the EUROPEAN UNION
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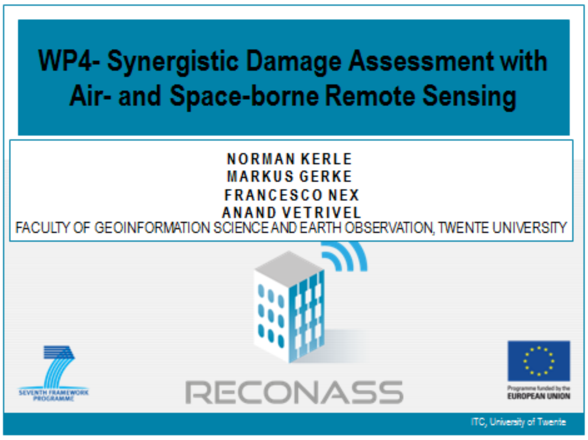
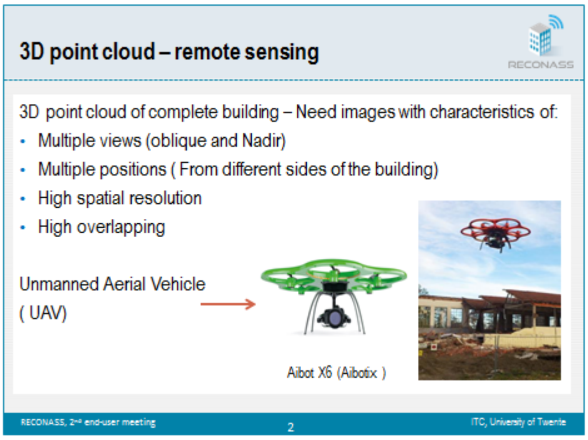
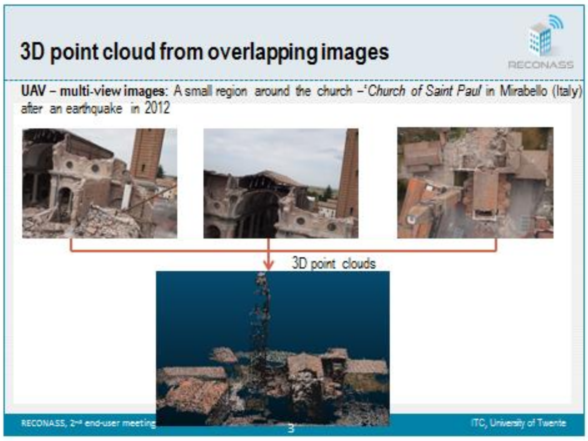
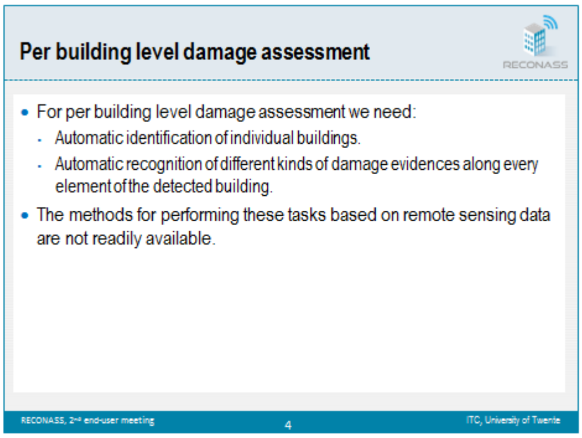
Damage assessment using airborne imagery

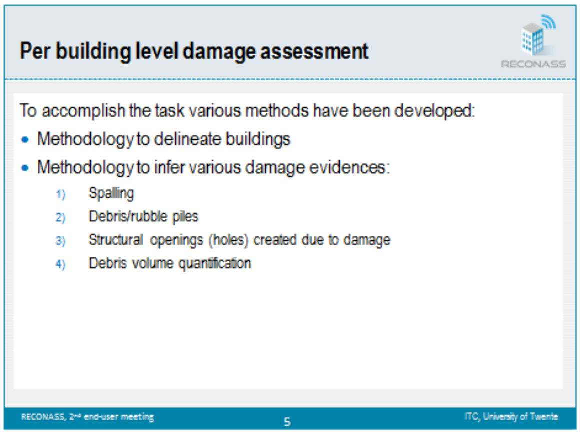
"Synergistic Damage Assessment with Air- and Space-borne Remote Sensing by Markus Gerke, ITC"

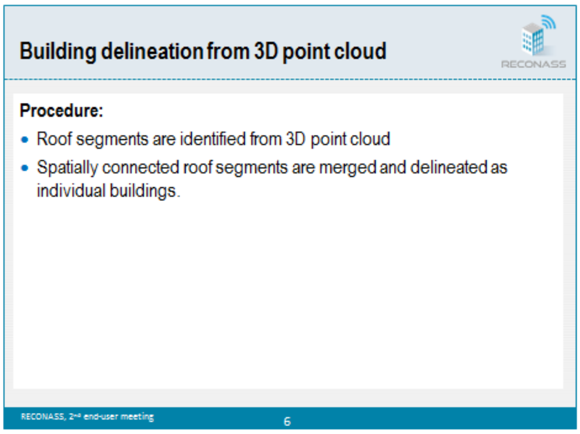


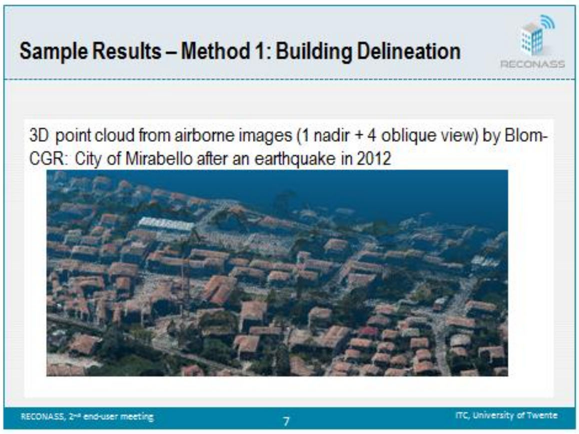











Sample Results – Method 1: Building Delineation
RECONASS
3D point cloud from airborne images (1 nadir + 4 oblique view) by Blom-CGR: City of Mirabello after an earthquake in 2012
RECONASS, 2nd end-user meeting
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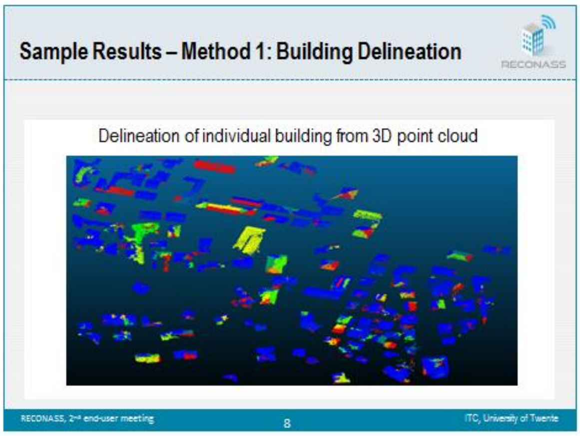
ITC, University of Twente


Sample Results – Method 1: Building Delineation
RECONASS
Delineation of individual building from 3D point cloud
RECONASS, 2nd end-user meeting
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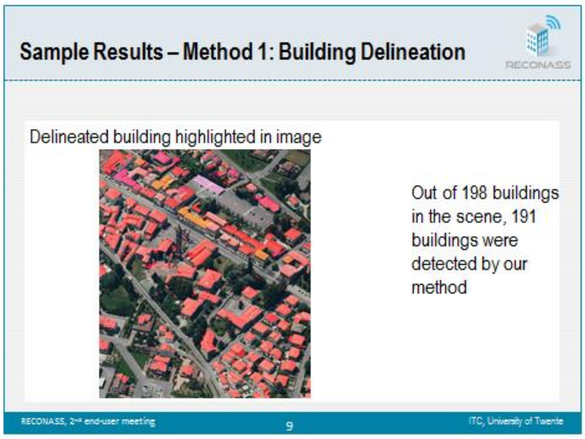
ITC, University of Twente


Sample Results – Method 1: Building Delineation
RECONASS
Delineated building highlighted in image
Out of 198 buildings in the scene, 191 buildings were detected by our method
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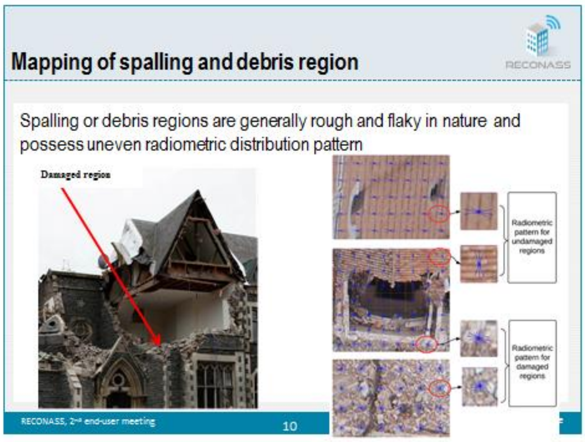
Mapping of spalling and debris region
RECONASS
Spalling or debris regions are generally rough and flaky in nature and possess uneven radiometric distribution pattern
Damaged region
Radiometric pattern for undamaged regions
Radiometric pattern for damaged regions
RECONASS, 2nd end-user meeting
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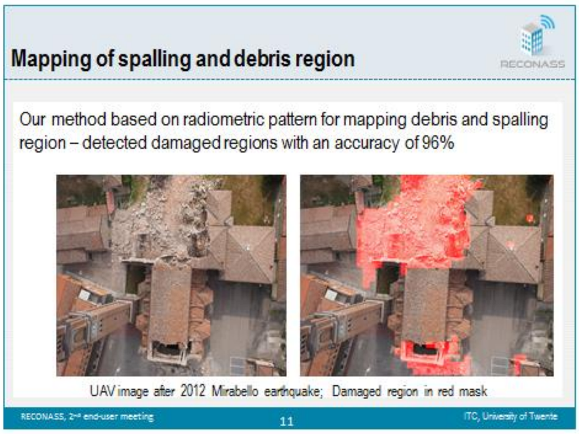
Mapping of spalling and debris region
RECONASS
Our method based on radiometric pattern for mapping debris and spalling region – detected damaged regions with an accuracy of 96%
UAV image after 2012 Mirabello earthquake; Damaged region in red mask
RECONASS, 2nd end-user meeting
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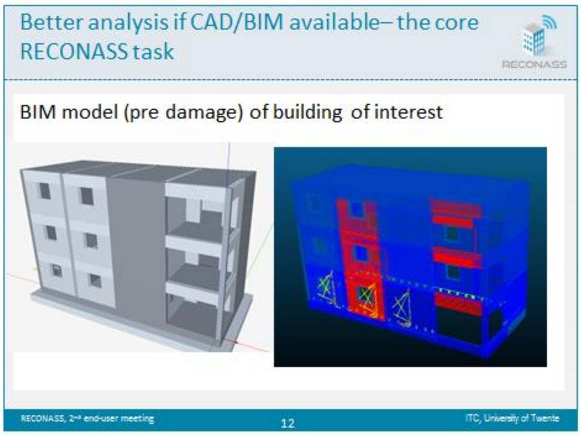
Better analysis if CAD/BIM available– the core RECONASS task
RECONASS
BIM model (pre damage) of building of interest
RECONASS, 2nd end-user meeting
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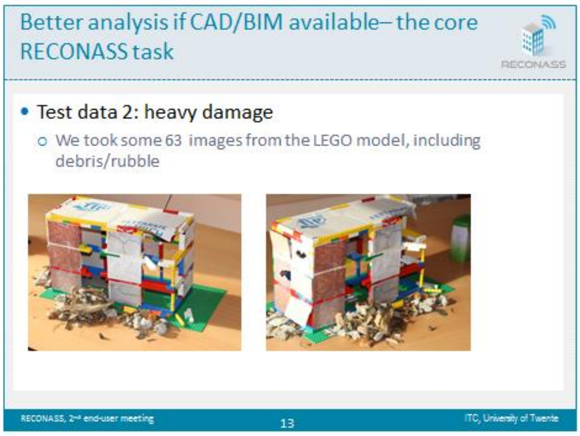
Better analysis if CAD/BIM available– the core RECONASS task
RECONASS
Test data 2: heavy damage
We took some 63 images from the LEGO model, including debris/rubble
RECONASS, 2nd end-user meeting
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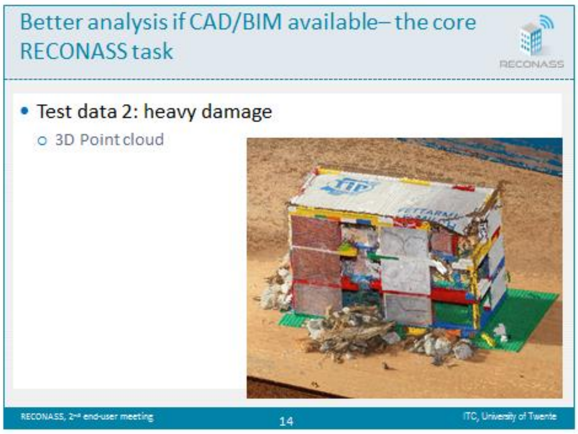
Better analysis if CAD/BIM available– the core RECONASS task
RECONASS
Test data 2: heavy damage
3D Point cloud
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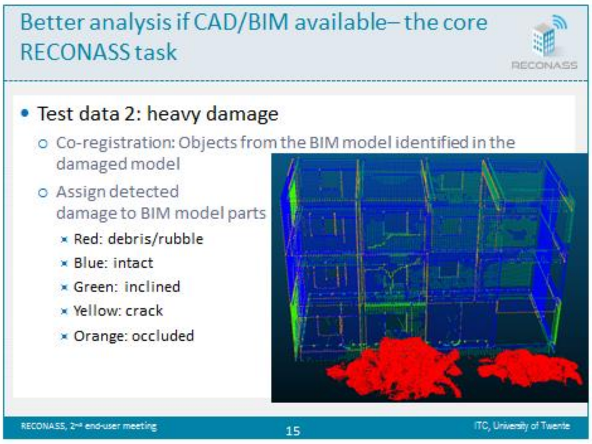
Better analysis if CAD/BIM available– the core RECONASS task
RECONASS
Test data 2: heavy damage
Co-registration: Objects from the BIM model identified in the damaged model
Assign detected damage to BIM model parts
Red: debris/rubble
Blue: intact
Green: inclined
Yellow: crack
Orange: occluded
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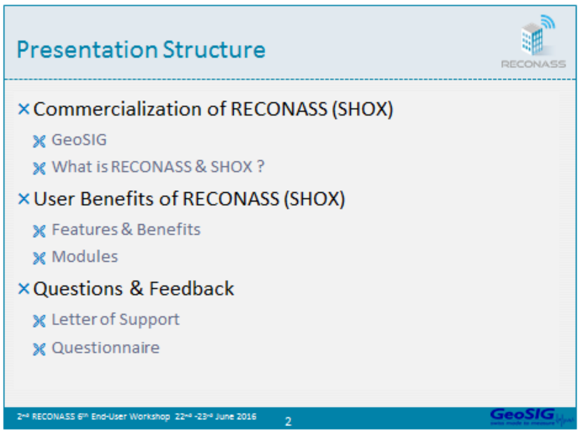
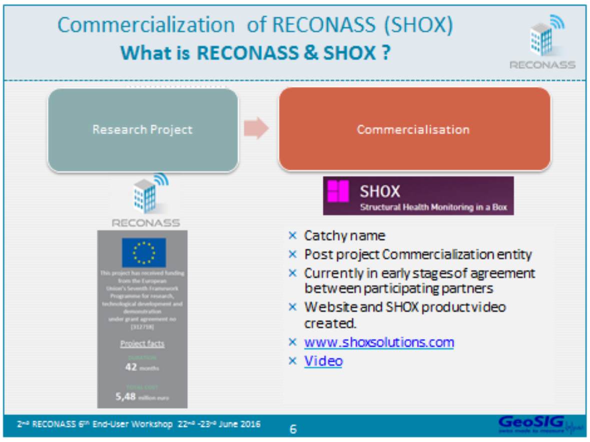
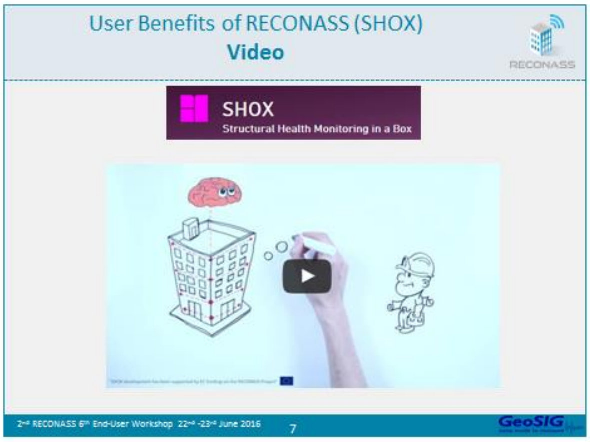
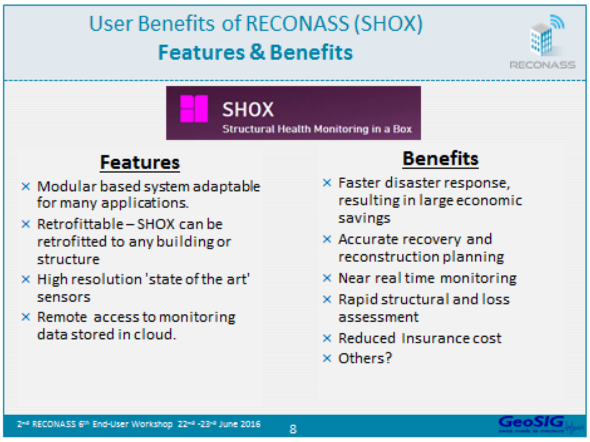
Presentation of RECONASS functionalities beyond deployment

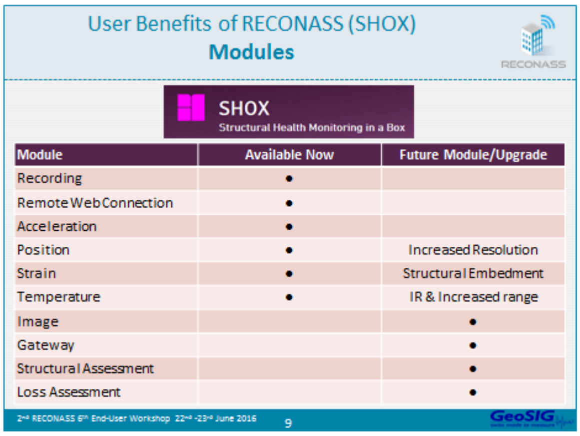
"RECONASS Functionalities and Future Developments by Wayne Kimberlin, GS"











Module	Available Now	Future Module/Upgrade
Recording	•	
Remote Web Connection	•	
Acceleration	•	
Position	•	Increased Resolution
Strain	•	Structural Embedment
Temperature	•	IR & Increased range
Image		•
Gateway		•
Structural Assessment		•
Loss Assessment		•