A holistic, scenario-independent, situation-awareness and guidance system for sustaining the Active Evacuation Route for large crowds

The dynamic capture of situational awareness concerning crowds in specific mass gathering venues and its intelligent enablement into emergency management information systems, using smart communication devices and spaces is critical for achieving rapid, timely guidance and safe evacuation of people out of dangerous areas. Humans could be overwhelmed by fast changes of potentially dangerous incidents occurring at confined environments with mass-gathering. They could fail to make objective decisions to find their way to safety. This condition may lead to mass panic and make emergency management more challenging. In eVACUATE, the intelligent fusion of sensors, geospatial and contextual information, with advanced multi-scale crowd behavior detection and recognition will be developed. The structured fusion of sensing information with dynamic estimated uncertainties on behavior predictions will advance eVACUATE crowd dynamic models; and virtual reality simulations of crowds in confined environments. A service orient Decision-Support System shall be developed to dynamically distribute on-demand evacuation information to emergency management actors as the crisis unfolds. Decision-makers at the command posts, first responders, front-line stewards and volunteers receive real-time situation aware information of updated evacuation strategies using robust and resilient eVACUATE information and communication infrastructure. Smart spaces of electronic, audio and other mobile devices shall be connected to the integrated system to provide safer evacuation routings for people. The eVACUATE system performance and scalability will be validated in four distinct scenarios involving incidents with large crowd at various venues with the requirements of evacuation time reductions and increases of safety and security. These are: 1) Underground stations in Bilbao; 2) Real Sociedad Football Stadium in San Sebastian, 3) Athens International Airport and 4) a STX Cruise ship.

Description of work performed in PY2

eVACUATE has currently completed the second project year of activity while exhibiting significant results. Work started in the second year with the final refinement of the initially defined User and System requirements in order to export the consolidated system specifications of our platform. Towards that direction a workshop was scheduled and obtained successfully within the frames of eVACUATE with the invitation and participation of several stakeholders. The final scenario upon which the eVACUATE platform will be demonstrated have been also refined and consolidated taking into account the technological limitations and constraints as those derived from the technical meetings. All results have been documented in D.2.4. Following the requirements analysis phase, the work in Y2 continued with the development and further improvement of our Hyper spectral imaging techniques towards the definition of crowd behavior detections as well as the development and further improvement of WP3 techniques for micro/meso and macro scale seed detection, interaction and unusual behavior recognition. A multi scale crowd behaviour recognition module was developed and the outcomes of this progressive work have been reported in D3.1-D.3.6. Apart from the progress in WP3, similar progress was also obtained in WP4. A beta and final version of eVACUATE predictive component has been developed and delivered successfully while validation
procedures over the efficiency of this components in view of calculating the optimum routes during evacuation in real time have been executed and reported in D4.2-D.4.4 reports. During the Y2 of the project in WP5, we achieved based on the end-user requirements analysis to refine the final COPSI specifications (D.5.4) and release a beta version of COPSI with many system functionalities already integrated in it (D.5.3). The appropriate databases containing 3D models of all 4 pilot locations were also created and delivered (D.5.5). In WP6 the 2nd year was focused on the implementation of the communication infrastructure based on Y1’s architecture. Through this infrastructure the eVACUATE platform achieved to communicate with all peripheral subsystems/sensors/actuators (D.6.2). Furthermore, the architecture defined in Y1 was further enriched to ensure secured and seamless interoperability between heterogeneous communication environments (D.6.3). Significant progress also obtained in WP7 where a series of RFID Tags prototypes were developed towards the definition of their final design (D7.1, D.7.3, D.7.7). The overall architecture of Smart spaces and the corresponding description of all relevant agents has been also achieved while including apart from the eVACUATE systems developed within the project, also the legacy systems already established at end-user premises and which will be used to further enhance eVACUATE’s capabilities (D.7.2, D7.4). A Rule set tool, data models and Ontologies used within eVACUATE were also defined and developed in Y2 (D.7.5, D.7.6). In WP8 the interfaces between fusion and mediation systems (D.8.2, D8.3) have been developed while a beta version of the foreseen EOC was also implemented (D.8.4). In the integration area, since the delivery of our first prototype (D9.1) of eVACUATE platform (showing the proof of concept), a significant improvement has been exhibited in Y2. Most of the work performed in all other technical WPs has been aligned towards the final integration of all subsystems into the common eVACUATE platform while interconnection between different systems has been already commenced towards the fully functional eVACUATE platform. In WP10 the pilot demonstrations have been planned accordingly in close collaboration with the end-users while 2 light versions of the forthcoming full pilots were scheduled and successfully obtained giving the opportunity to the technical partners to further test their developed equipment and assess the pilot locations (D.10.1). Regarding the ethical and legal issues in eVACUATE project, further specifications to the legal and ethical framework with a focus on privacy and data protection and ethical principles was achieved while assisting other WPs in further development of their solutions. Last but not least an amendment process initiated and finalized successfully in which a 2 months extension to the whole project was requested in order to coincide with the delivery dates of the cruise ship currently under construction in which the 4th pilot will take place while the extension to specific WPs was also approved following the justifications that prepared and communicated to the P.O. A 2nd review in Brussels was also obtained while considered as a successful one in which the eVACUATE consortium had the chance to exhibit the current developments to the E.C.

More detailed information for each WP can be found on the annual report submitted to the E.C.
On-going project activities / Expected results for PY3 (M33-M50)
eVACUATE has currently completed the second reporting year of activity, already exhibiting significant results. The following steps with respect to the on-going activities categorized per active WP are:

**WP3 - Crowd behaviour Detection & Recognition in Crisis Situations**
- Fully Integrated internal WP3 modular architecture
- Further integration of WP3 modules output with WP9 system and also WP5 COP
- Advanced crowd behaviour modules through training on AIA experimental data
- Lead and Set up the ANOETA stadium experimental data in December 2015
- Further advanced crowd behaviour modules through training on ANOETA Stadium data
- Preparation and participation in the evacuate pilots
- Dissemination of our state of the art work concerning automated crowd behaviour detection with advanced context knowledge modelling in reputable journal with high citations index and impact

**WP4 - Advanced Strategic Spatial Evacuation**
- Further Development of stand-alone software components to predict crowd congestion
- WP3 behaviour integration in eVACUATE platform
- Further route optimisation
- Final Crowd Modelling Techniques validation
- Further enhance the AER optimisation
- Inclusion of the modelling of behavioral parameters in the crowd models

**WP5 - 3D Interactive Common Operational Picture & Simulation**
- Finalize current active developments towards the delivery of the final release of COPSI
- Delivery of final release of COPSI
- Integration activities with all other system constituents
- Deployment of final release COPSI at each end –user’s premise

**WP6 - Resilient Communications and Adaptive Interfaces**
No major work has been scheduled for the next reporting period, since WP6 finishes within this reporting period. There is some remaining activities to be performed and can be summarized as follows:
- Submission of D6.3 in December 2015 (M33)
- Fine tuning of communication gateway modules and further integration testing with legacy systems that were not available within this period
- Complete integration and HW/SW set up of communication gateway components within the EOC
- Integration of Crisis Wi-Fi solution with eVACUATE system
- Complete implementation of Interoperability Layer for dynamic exit sign example
- Complete remaining security activities
- Preparation for the next integrated eVACUATE system release

**WP7 Smart Spaces**
- Updating of both the Agent Framework developed and delivery of a new release of the agent framework on M33.
- Completion of the definition of the Data Models and Ontology for the eVACUATE use cases that have been done during this period. Submission of deliverable D7.6 “Smart Space Information Model: Data Models and Ontologies” (New schedule M33).
- Under T.7.6 updating on the developments done during this period will be performed. The activities, as described before, are:
  - Completion of a 2nd reader test-bed
  - Performing of a Life-test campaign of chipless RFID system at TUD
  - Deep study of Human Body interference and evaluation of a feasible solution

WP8 - Decision making and Optimal “Situation-aware” Evacuation Strategy

- Phase 2 Implementation SW
  - Insertion of modified ontologies into SOFIA2/SIB (including WGS84 standards)
  - Adaptation of Building Maps algorithms with new map representation.
  - Implementation of Proximity Algorithm.
  - Implementation of Counting by Category Algorithm.
  - Definition of simple Rules to put into SOFIA2/CEP.

- Phase 3 Implementation SW.
  - Integration of algorithms for Features
  - Definition of complex Rules to put into SOFIA2/CEP
  - Insertion of Suggestions and Predictions into Notification Alerts

- Completion of following Documentations:
  - Adapting D8.2 “ICD Report Deliverable” Document to eVACUATE state of the art (Provide version 2.0)
  - Adapting D8.3 “Reasoning Definition” Deliverable Document to eVACUATE state of the art (Provide version 2.0)
  - Adapting T8.3 Report “Mediation and Database” Document to eVACUATE state of the art (Provide version 2.0)
  - Adapting T8.5 Report “Event Detection and Classification” Document to eVACUATE state of the art (Provide version 2.0)

WP9 – SAES (Situation Awareness and Evacuation System) Framework Design And System Integration

- Delivery of D9.2 Integration Protocol.
- Delivery of eVACUATE Integrated System release 2 - ready for Pilot Testing.
- In situ integration testing activities at end-users premises to ensure system’s efficient and smooth operation before final pilot activities.

WP10 - Pilot demonstration and Validation

- Testing the development at INDRA’s premises with prepared data
- Validation of the planning will be possible after evaluating the testing results and the assessment of the development schedule
- End users first training and education while participating in the test and being allowed to use some of the eVACUATE functions
- Preparation simulated/real exercises which will take place at the end of the project
- Preparation of the pilots implementation

WP11 - Ethics, Legal and Standardization Activities
• Preparation of the foreseen demos from the data protection part.
• Continue research on data processing in disaster situations, especially by the technical elements of eVACUATE (e.g. EVAMAPP, SoNeMa, RFID, crowd behaviour monitoring).
• Continue collaborate with CEN TC/391.

WP12 - Dissemination and exploitation Activities
• Participation of eVACUATE consortium members to a series of Events Worldwide in which the project activities will be advertised
• Participation of Industrial Partners to Conferences and Events
• Organization of dedicated events for the promotion of the eVACUATE project outcomes
• Update of the project web-site with new layout and additional info
• Definition of specific periodic reports which will be used to disseminate project results to stakeholders community
• Submission of eVACUATE updated exploitation plan and updated dissemination plan
• Further establishment of Synergies between eVACUATE and Other EU Projects

Expected final results and potential impact

TECHNOLOGICAL IMPACT: For Crowd safety in different venues, it is imperative that whatever technology results from eVACUATE, will first and foremost try to decrease casualties incurred from unorganized or unmonitored, evacuation operations. At the same time, eVACUATE will guarantee seamless information flow to and from the space being evacuated, harmonizing in that sense the entire chain of actors involved in these operations. The following gives specific information of the expect impact of the project upon its successful completion.

1. Increased situational awareness: eVACUATE will provide the necessary degree of situational awareness:
   a. To the evacuating crowd through the Active Evacuation Route.
   b. To the first responders that will be aware of what to expect during an intervention and will be continuously informed on the evolution of the operation.
   c. To the crisis managers through the COP provided in real-time, assisting them in the decision making process through the eVACUATE expert system.

2. Adhoc Wireless Communication Networks: Base stations will be mounted permanently on operational vehicles with some additional access points and range extenders deployed in a working area by responders. The smart spaces will also provide a unique sensor network collecting the signals from various sources and locations from the crowd’s movement and from the environment.

3. Roll-to-Roll Printed electronics: eVACUATE features the integration of an effective and accurate means of calculating crowd flow through a priori defined checkpoints (escape exits). eVACUATE will promote the use of low-cost roll-to-roll printing of RFIDs on low cost substrates such as paper.

4. Data fusion: The eVACUATE system structured fusion tools will provide fully integrative solutions to the problem of intelligent information management—solutions that could be applied to data and information integration problems in other commercial fields as well (Example: natural and/or anthropogenic disaster and crises management).

5. Mesh Network for Active Exit Signage: The Active Exit Signage promoted in eVACUATE as a key element within the dynamic evacuation route represents a new paradigm of Smart Connected Objects that deliver primary services by very natural means while including a bunch of new features transparent to the users.
6. **Interoperability of Systems:** The Smart Spaces proposed in eVACUATE addresses the seamless connectivity and middleware priority by targeting the interoperability between different kind of devices and embedded systems. The SOFIA architecture provides an interoperability platform based on ontologies, where every system/device is described to the other system/device in terms of cooperation, by ontology concepts.

7. **Multichannel information sharing:** eVACUATE will follow the trails of relevant technical committees like OASIS CAP, ITU X1303 and ETSI EMTEL, in order to supersede current status and offer information sharing over a plethora of channels including mobile terminals (SMS, Cell based broadcasts), social media, internet (E-mail alerts), Broadcast media (Radio, Television) and other communication means. 8. Augmented reality for individual’s safety in large gatherings. The eVACUATE AR application will combine the real and the virtual. It will be interactive in real time and registered in 3-D. By using such a technology during evacuation operations, it will potentially reduce the burden on local authorities in terms of protecting and guiding the large crowds while providing them with actionable information.

**Socio-Economic Benefits of the Project**

1. **Improved Command and Control Decision Making:** eVACUATE will help decision makers at command and control centers not only exert more centralized control over their forces, but to use this control in better ways in order to make better more educated decisions.

2. **Better Coordination of Emergency Services in Real Time:** eVACUATE will disperse the most up-to-date information it has immediately, and so gives more actionable information to decision makers to make a situation assessment. Thus, it helps them determine the best ways to neutralize the crisis. In turn, this will help save lives, cost and time when solving a crisis situation.

3. **Effective public alert system:** eVACUATE will allow the rapid dissemination of the alert messages to emergency authorities and to citizens allowing for a controlled evacuation that can make the difference between a controlled crisis and a mass tragedy.

4. **Improved emergency force preparedness:** eVACUATE will define rules and serving technologies for emergency or crisis response and recovery as well as providing historic data after the crisis for assessment and possible redefinition of crisis plans. This will increase emergency services preparedness, by defining rules for crisis management.

5. **Economic Benefits:** eVACUATE will do much to ameliorate the high costs of disasters, since it can be said almost without fail that an effective crisis response also translates to substantial monetary savings. These savings may be realized in a myriad of ways: direct disaster costs may be reduced through the limitation of disaster impact by its limitation to a specific geographic locale, by the reduction in medical costs through the effective eviction/evacuation of the population from danger zones, or through the reduction in subsequent insurance claims. Often, however, the true costs of disasters are indirect and can only be measured some time after the event. Terrorist attacks may result in a loss of tourist confidence leading to a decline in economic activity; mishandling of crises may lead to a decline in investor confidence in the municipality/nation’s ability to protect investments.

**Consortium and Contact Point**

The eVACUATE consortium consists of the following industrial, academic and research partners:

1. EXODUS S.A. (Greece) - Coordinator
2. IT INNOVATION – University of Southampton (UK)
3. Institution of Communication and Computer Systems (Greece)
4. HKV Consultants (Netherlands)
5. Telesto Technologies (Greece)
6. Tekniker IK4 (Spain)
7. Athens International Airport S.A (Greece)
8. Vitrociset spA (Italy)
9. Crowd Dynamics International ltd (UK)
10. INDRA systemas (Spain)
11. Leuven University (Belgium)
12. Diginext (France)
13. Politecnico Torino (Italy)
14. STX-France S.A (France)
15. Technische Universität Dresden (Germany)
16. Technische Universität Chemnitz (Germany)
17. Real Sociedad de Futbol S.A.D (Spain)
18. Metro Bilbao S.A (Spain)
19. Telecom Italia Group (Italy)

For more information on the project, please contact Dr. Dimitris Petrantonakis (dpetr@exus.co.uk), or visit the project’s web site: www.evacuate.eu