[PRACTICE]

D5.3 SENSOR-BASED MODELLING SOFTWARE

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Summary Work Package 5

The overall aim of the project “Preparedness and Resilience Against CBRN Terrorism using Integrated Concepts and Equipment” (PRACTICE) is to improve the ability to respond to and recover from a Chemical (C), Biological (B), Radiological (R) or Nuclear (N) incident. The objective of the project is to create an integrated European approach to a CBRN crisis – i.e. a European Integrated CBRN Response System. This will be achieved through the development of an improved system of tools, methods and procedures that is going to provide EU with a capability to carry out a truly integrated and coordinated operational reaction following the occurrence of a CBRN crisis, whether it is caused by a terrorist act or an accident.

The objectives of WP5 are to develop, integrate and test a complete toolbox for first responders, decision makers and the public, including innovative components developed during the project to provide an improved and integrated preparedness and response to CBRN events.

The tools will be organized in 6 categories:

1. Recommendations
2. Standards
3. Protocols / procedures
4. Equipment and systems (eventually simulated): hardware, software, with performances, Technology Readiness Levels (TRLs), validation/certification status
5. Simulated environment (with 3D databases)
6. Real equipment and system emulation capabilities.

These tools will fulfil functions as defined in WP3, organized in line with the ESRAB/Staccato taxonomy functions, completed and detailed when needed for PRACTICE. The toolbox should be considered as living system gathering “bricks” into an integrated solution to manage a CBRN crisis. It will include actual tools and equipment and ICT simulated environments including hardware and software. This will allow plugging and playing new components and guarantee their interoperability.

The toolbox will be developed and integrated in two steps:

- A V0 version integrating in an innovative way existing validated capabilities (fed from WP 2 and WP 3) i.e., tools, methods and procedures that will be put together into an information system, with specified standard interfaces.

- A V1 version integrating innovative tools, methods and procedures and supporting future standards to improve interoperability and consistency without impeding the existing operational systems.

Developing V0 and new CBR tools for V1 will be an iterative process with all the stakeholders in the loop. Focus will be put on specifying simple interfaces for any supplier to describe and present its "bricks" in order to "index / reference" them in our PRACTICE Toolbox Information System. Any new tool that satisfies the "standards" interfaces should be easily added to build new solutions ("buildings").

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Contents

1. Executive Summary

This document will describe the Modelling Software that should be considered for inclusion in and supported by the PRACTICE Toolbox. This document is part of the work package 5 in the FP7 **PRACTICE** project.

The software must satisfy the key features of PRACTICE that are at least :

- European scope to guarantee interoperability within Europe
- Non-proprietary unless this is a De-facto standard
- Prone to be widely deployed in the future

This report:

- Examines the main software solutions that should be considered for use in the PRACTICE Toolbox
- Describes features with advantages and limitations
- Identifies how we plan to implement and handle them in the Toolbox.

Providers in this arena tend to be used to working in military circles as the main uses for this type of technology over recent times has been for battlefield prediction and simulation. However, organizations are now starting to move into the civilian homeland security arena due to the increased threat of international terrorism.

2. Introduction

This document will describe the modelling software recommended for inclusion within the PRACTICE Toolbox. The purpose of this paper document is threefold:

1. List the relevant software
2. Justify the inclusion of the software in the PRACTICE Toolbox
3. Identify how the software should be utilised in the Toolbox

2.1 Context

The software described in this document will be utilised by WP5 of the PRACTICE project. The software recommended within the document has been highlighted due to the potential to assist first responders and emergency services deal with the immediate aftermath of a CBRN incident.

Astrium is a consortium partner leading the WP5 work package, responsible for the implementation of the Toolbox. Furthermore Astrium as a service provider in a number of fields including Telecommunications and Public Safety can bring the expertise to identify the software to be used in the future.

2.2 Problem Definition

When a CBRN incident occurs the first hours are the most critical. First responders need information fast in order to make the correct decisions not only on dealing with the incident itself but also on dealing with the risk to critical infrastructure and the general public. Observations and information from sensors can provide up to date information on what is happening but just as important is the need to know what will happen. Accurate prediction of the state of the hazard in the coming hours / days could prevent significant loss of life and critical infrastructure as well as decreasing the likelihood of major disruption to the general public.

For many years hazard prediction of this type has been mainly in the military domain and dominated by manual processes specified within NATO standards. In recent years, mainly due to the increasing power of mobile computers used on the battlefield, the military have been able to leverage software that has been able to assist with these predictions (known as Plume Modelling) to a level of detail that is unattainable manually. However, these software packages are reliant on the use of complex computer models, all of which are based on complex mathematical solutions that rely on a complex array of data. Each model will produce different results and therefore operators need in-depth training in order to be able to interpret the vast array of outputs from these models.

The main problem is that historically the software used has been different on a country by country basis and there has been no de-facto modelling standard in place.

The PRACTICE project therefore faces a number of challenges in this area:

- **Utilization of Military Technologies:** Plume Modelling has come from a military background and is still firmly situated in that arena. The PRACTICE project needs to recommend software that suits use in a civilian capacity across Europe.

- **Modelling Standards:** A de-facto modelling standard or set of standards needs to be agreed upon for use by the software.
- **Integration:** The software to be utilized needs to be able to integrate with other functions provided by the PRACTICE Toolbox. Integration with existing and new sensors is a must have to be able to create accurate predictions.

2.3 Project Scope

In order to address the problems outlined in section 2.2 this document will focus on the following areas that require attention. These are as follows:

- Currently Available Software: This document will investigate the Plume Modelling software currently available on the market as its suitability for use in a civilian context
- Integration: This document will also look into the integration capabilities of the software in order to ascertain the suitability for inclusion in the PRACTICE Toolbox.

2.4 End-users

While the key facet of the PRACTICE Toolbox is one of simplicity it should be noted that it is highly likely that end users will require some form of specialist training in order to utilize Plume Modelling capabilities provided by the PRACTICE Toolbox. However that is not to say that the goal of simplicity can not be partly achieved. If the software in question is modular enough then custom simplified user interfaces and functionality could be achieved by utilizing standard SOA techniques.

This document will attempt to briefly outline the possibilities in this area.

2.5 Document Contents

This document will be divided into three major sections. Section 3 describes the software currently available. Section 4 evaluates the various offerings laid out in section 3 while the Section 5 concludes the document with high level recommendations.

3. Modelling Software / Services

3.1 Available Software

The following table lists the software that is currently available:

ST-1 **TigerIM** by Bruhn Newtech

- Web Based Command & Control Solution
- Direct Access to Weather Feeds
- Can produce Toxic Industrial Material / WMD hazard areas, Plume Modelling and IED Blast Templates
- Supports changing modelling standards
- Geofencing capability
- Sensor support for numerous sensors (CBRN, GPS, Video / Audio Feeds)

ST-2 **HazResponse** by Bruhn Newtech

- Thick Client Incident Command Solution
- Can be used standalone 'on the ground'
- Can produce CBRN Templates
- Sensor support for numerous sensors (CBRN, GPS)

ST-3 **HazCore** by Bruhn Newtech

- Calculation Engine and Web Service Wrapper to allow third party / bespoke applications to access the modelling calculations directly.
- Can produce WMD calculations based on NATO standards, Toxic Industrial Material and Toxic Industrial Chemical calculations.

ST-4 **LynxIM** by Bruhn Newtech

- Web Based Command & Control Solution
- Direct access to Weather Feeds
- Provides ALOHA Plume Modelling Tool, Explosives Calculator
- Provides Logistics Management Capability
- Incident Replay Functionality

ST-5 **SCIM** by Bruhn Newtech

- Sensor Integration Technology for plugging into multiple different branded sensors

ST-6 **CBRN-Sim** by Bruhn Newtech

- CBRN Incident Simulation software

ST-7 **EOD-Frontline** by Bruhn Newtech

- Incident Managemenent for Explosive Ordnance Disposal Operations (EOD)
- Hazard Area Prediction for CBRN and conventional incidents
- Sensor support for CBRN, GPS, explosive and weather sensors

ST-8 **HazKey** by Bruhn Newtech

- Mobile Incident Management software designed for personnel who are working within CBRN and toxic environments.
- Integrates with EOD-Frontline, HazResponse or LynxIM
- Has fitted GPS and Weather sensors

ST-9 **CBRN Analysis** by Bruhn Newtech

- CBRN Risk Management Solution for Military Commanders
- CBRN Risk Calculation based on NATO Standards
- Can be integrated into existing systems as Web Services

ST-10 **OMEGA** by SAIC's Center for Atmospheric Physics (CAP)

- OMEGA provides multiscale atmospheric simulation system for advanced, high-resolution weather forecasting and forecasting dosage and hazard levels due to the atmospheric release of aerosols and gases.

ST-11 **Prometheus** by Alberta Sustainable Resource Development and others

- A deterministic wildland fire growth simulation model based
- Provides a number of APIs which expose various areas of functionality

ST-12 **NBCWaRN** by OptiMetrics

- Enables the operator to rapidly gather, correlate and assess CBRN reports
- Generates real-time hazard predictions and warnings

ST-13 **FireFamilyPlus** from Missoula Fire Labs

- Used for summarizing and analyzing daily weather observations and computing fire danger indices

ST-14 **WindNinja** from Missoula Fire Labs

- Computes spatially varying wind fields for wildland fire application.

ST-15 **CAMEO** from US Environmental Protection Agency

- software applications used widely to plan for and respond to chemical emergencies

ST-16 **Atlas Ops**

- Provide software for a range of defence/security functions, including CBRN downwind hazard prediction

ST-17 **SAFER Systems**

- Provide solutions and support for situational awareness and chemical emergency response

ST-18 **CATS** by SAIC's Center for Atmospheric Physics (CAP)

- Assesses the consequences of technological disasters on population, resources, and infrastructure

ST-19 **ICWater** by SAIC's Center for Atmospheric Physics (CAP)

- Generates downstream and upstream traces of the release of CBRN materials in rivers

ST-20 **NBCWaRN**

gather, correlate and assess CBRN reports from the battlefield, and generate real-time hazard predictions and warnings

4. Technology and Service Evaluation

4.1 Software Providers (1)

This section provides more detailed information on software providers which it is believed are worth further investigation as part of the development of the PRACTICE CBRN Toolkit.

4.1.1 Bruhn Newtech

As can be seen from section 3 Bruhn Newtech is the dominant supplier of COTS Plume Modelling software within Europe. Indeed for military use they claim 8000 plus users and a presence in 85% of NATO countries. This experience, combined with the support for NATO standards and the US DoD models makes them an extremely strong force in military circles. However PRACTICE is about civilian resilience and in this area the experience is nowhere near as strong.

Bruhn Newtech has however invested in producing a suite of products aimed directly at the civilian market. Of the suite of products available there are a number which at first glance appear to fit with the requirements of the PRACTICE project. **TigerIM** is Web Based and is intended to provide a Common Operating Picture to the different agencies involved in tackling a CBRN incident. It comes packaged with an impressive array of functionality including modules to allow integration of CBRN sensors, including military sensors, as well as modules to generate plume models for toxic agents, WMDs and IEDs utilising JEM, HPAC and ALOHA Models. **HazCore** is also of interest due to the fact it has been designed to provide the ability to integrate the various prediction models into existing systems via the use of a web services. Alongside the systems above the **SCIM** module could provide a wealth of added value due its ability to quickly integrate numerous existing CBRN standards directly into the hazard calculation services.

4.1.2 OMEGA

SAIC's Center for Atmospheric Physics (CAP) has developed a novel multiscale atmospheric simulation system for advanced, high-resolution weather forecasting and forecasting dosage and hazard levels due to the atmospheric release of aerosols and gases. The Operational Multiscale Environment model with Grid Adaptivity (OMEGA), has a horizontal grid resolution that ranges from 100 km to 1 km and a vertical resolution that ranges from a few meters to 1 km. OMEGA is more than an atmospheric forecasting and dispersion model; it is a complete forecasting and dispersion system. The OMEGA system consists of:

- Routines to maintain and manage real-time weather data feeds from the NOAA National Centers for Environmental Prediction or from the US Navy Fleet Numerical Meteorology and Oceanography Center;
- World-wide surface elevation and land/water datasets at 30 arc-second and 5 arc-minute resolution, and additional terrain information (vegetation, soil type, albedo, land use, etc. at varying resolutions);

- An integrated Graphical User Interface (GUI), XOMEGA, that provides a user-friendly method for the rapid re-configuration of the model;
- The automated OMEGA Grid Generator that accesses the surface datasets and creates the required terrain files for the OMEGA model;
- A meteorological data pre-processor that ingests gridded terrain, gridded meteorological analyses and forecasts, and raw observations, and performs a detailed Quality Control (QC) of the ingested data, followed by an Optimum Interpolation (OI) data assimilation to produce Initial and Boundary Condition files for OMEGA;
- The OMEGA atmospheric simulation and dispersion model;
- XGRID, the OMEGA graphical post-processing tool that enables the user to display OMEGA output as two-dimensional slices (horizontal slices overlaid on mapping information from the Digital Chart of the World or vertical slices), skewT-logP profiles for any location, and animations of various sequences;
- Additional post-processors to provide for data extraction and re-formatting for external applications;

It should be noted that in the time available to prepare this document, it has not been possible to obtain sufficient detail regarding how OMEGA may be deployed (e.g. thick-client versus web-based, available APIs, etc.)

4.2 Software Providers (2)

This section provides more detailed information on software providers which have products which could be potentially useful as part of the PRACTICE CBRN Toolkit, but it is believed may not be as well-suited as those listed in the previous section.

4.2.1 Prometheus

Prometheus is a deterministic wild land fire growth simulation model based on the Fire Weather Index (FWI) and Fire Behaviour Prediction (FBP) sub-systems of the Canadian Forest Fire Danger Rating System (CFFDRS). It produces a GIS model that contains spatially explicit fire behaviour and spread outputs given heterogeneous forest fuel, topography and weather conditions. Fuel types and weather can be modified by users to evaluate a variety of scenarios and the data inputs can be imported from files or created manually.

Although this is a thick-client application, it should be noted that Prometheus provides a number of COM interfaces. It may be possible to develop web-based services which use these interfaces to provide functionality from Prometheus. However, it should be noted that COM is a legacy technology, for Windows only, and requires the use of wrappers to support integration with current .NET-based languages such as C#.

4.2.2 FireFamilyPlus (FFP)

FireFamilyPlus (FFP) is used for summarizing and analyzing daily weather observations and computing fire danger indices based on the United States National Fire Danger Rating System (NFDRS). However, as it is a standalone Windows application, rather than a web-based application, and so may present some obstacles to integration and interoperability.

4.2.3 WindNinja

WindNinja is a computer program that computes spatially varying wind fields for wild land fire application. However, as it is a standalone Windows application, rather than a web-based application, and so may present some obstacles to integration and interoperability.

4.2.4 CAMEO (Computer Aided Management of Emergency Operations)

This may not lend itself well to interoperability. The presence of a dedicated in-built GIS would make it difficult to adapt for PRACTICE. Also, it is highly focussed on the American market.

4.2.5 Atlas Ops

This is a less desirable option because of its complex to use and because it is not well suited to support remote / web operation.

4.2.6 SAFER Systems

Applications from SAFER Systems appear to be entirely bespoke and thus less suitable for use as the basis of a international standard.

4.2.7 CATS

CATS, from SAIC, assesses the consequences of technological disasters on population, resources, and infrastructure. CATS analyzes the damage to the environment, the risk to the well-being of the exposed population, and provides real-time resource allocation information to mitigate the consequences.

However, this runs either as a standalone application or as a plug-in for ArcGIS, and so may present some obstacles to integration and interoperability.

4.2.8 ICWater

ICWater from SAIC is available is available in conjunction with CATS. It generates downstream and upstream traces of the release of CBRN materials in rivers using the RiverSpill model. However, it appears that may be focussed on the American market.

4.2.9 NBCWaRN

NBCWaRN enables the operator to rapidly gather, correlate and assess CBRN reports from the battlefield, and generate real-time hazard predictions and warnings. NBCWaRN effectively replaces a complex, time-consuming, and error-prone manual process.

This is primarily advertised as a standalone application, although some of the advertising material indicates that it provides an API.

However, it is also noted that this product appears to be more focussed on the American market.

4.3 Integration into the PRACTICE Toolbox

The PRACTICE toolbox will be built around the concept of so-called 'functions'. Functions are the tools and procedures used to handle incidents, which will be included and integrated in the PRACTICE toolbox. The toolbox will be a web based Information system ("database") fed with a catalogue of existing and innovative components provided and developed during the project.

The PRACTICE Toolbox is meant to be an integrated solution to manage CBRN incidents. One of the bigger challenges in the PRACTICE project will, in fact, be this integration of all functions and components in one large package: an integrated toolbox.

Detailed decisions on how the technologies discussed in this document should be integrated into the toolbox are not possible until the toolbox architecture is defined in more detail. However, it is safe to assume that Service Oriented Architecture techniques utilising Web Services will form the core of the integration.

5. Conclusion

As can be seen from earlier sections of this document the area of CBRN Prediction / Simulation and Plume Modelling is a very specialist one containing very few organizations. In military circles, especially in Europe, Bruhn Newtech's suite of applications appears to be the dominant presence in the CBRN Prediction area. This experience should not be underestimated and as such the Homeland Security options which they provide should be investigated thoroughly and considered for inclusion in the PRACTICE Toolbox. The fact that they can provide components to integrate existing systems utilising a Service Oriented approach makes the Bruhn Newtech offering even more attractive. This ability could ease the effort of inclusion in the PRACTICE Toolbox. The above is also relevant for SAIC's product OMEGA and although OMEGA has a much greater focus on the US market it should not be discounted for addition to the toolbox as this stage.

Appendix A – Glossary

ALOHA	Aerial Locations of Hazardous Atmospheres
CAP	Centre for Atmospheric Physics
CBRN	Chemical Biological Radiological Nuclear
CBRNIAC	Chemical, Biological, Radiological & Nuclear Defense Information Analysis Center
COTS	Commercial Off The Shelf
DoD	Department of Defense
EOD	Explosive Ordnance Disposal
ESRAB	European Security Research Advisory Board
FBP	Fire Behaviour Pattern
FWI	Fire Weather Index
GPS	Global Positioning System
HPAC	Hazard Prediction and Assessment Capability
IED	Improvised Explosive Device
JEM	Joint Effects Model
NATO	North Atlantic Treaty Organisation
NOAA	National Oceanic and Atmospheric Administration
OMEGA	Operational Multiscale Environment model with Grid Adaptivity
PRACTICE	Preparedness and Resilience Against CBRN Terrorism using Integrated Concepts and Equipment
SAIC	Science Applications International Corporation
SOA	Service Orientated Architecture
WMD	Weapon of Mass Destruction
WP	Work Package
XML	Extensible Markup Language

Appendix B – Sources And References

This section lists a number of sources of information which were used in the production of this document..

Source	Notes
Atlas OPS website http://ww.atlasops.com/	Information on Atlas OPS products
Bruhn Newtech website http://www.bruhn-newtech.com/homeland-security/products/	Information on CBRN products
CBRNIAC website https://www.cbrniac.apgea.army.mil/	Information services from CBRNIAC
Fire Models website http://www.firemodels.org	Information on FireFamilyPlus and WindNinja
NAOO website http://weather.noaa.gov/pub/data/observations/metar/stations/	Information on provision of METAR data
NBCWaRN website http://www.nbcwarn.com/	Information on NBCWaRN product
Promethius website http://firegrowthmodel.ca/	Information on Promethius
SAFER Systems website http://www.safersystem.com/solutions/	Information on SAFER Systems products
SAIC website http://www.saic.com/products/	Information on OMEGA, CATS and ICWater