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## Intelligent Information Access

# AUVS-Aust Board Meeting

## SemanticFusion™

**-Approach Overview**

**-Demonstrations**

# SemanticFusion –Situational Awareness for People & Autonomous Systems

*"...The SemanticFusion concept is based upon the idea that improved situational awareness requires improved high-level conceptual representations and reasoning capabilities.  It approaches data fusion from an agent, ontology & concept-modelling perspective, rather than a traditional data-analysis approach..."*

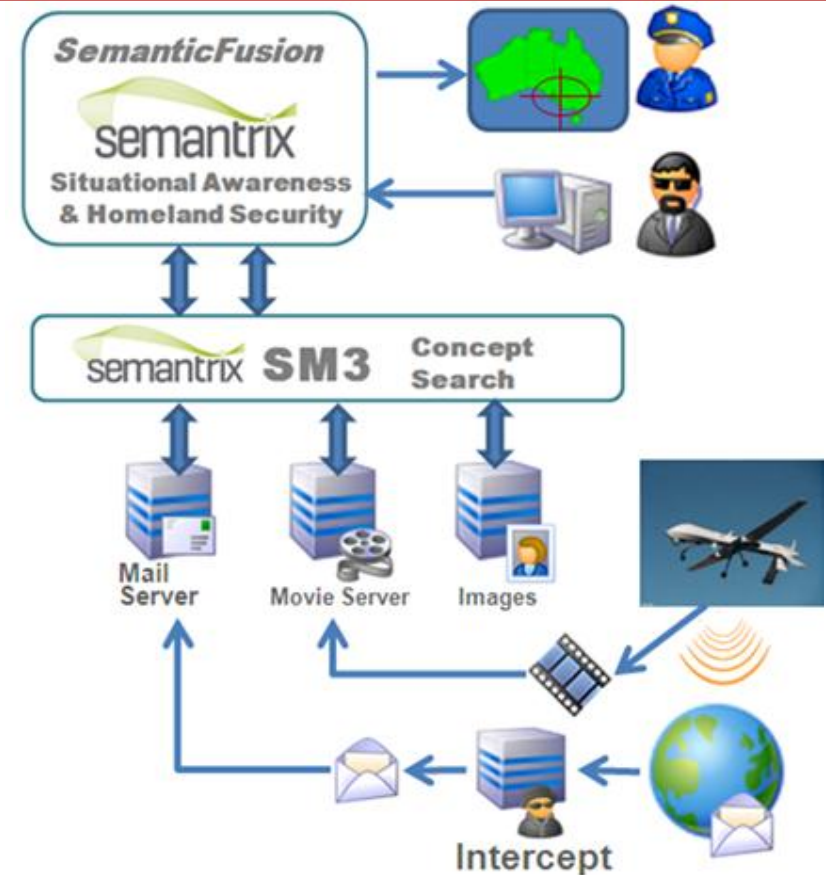Situational Awareness that is:

flexible, targeted, context-aware

distributed, extensible & easy to integrate

location, proximity, and time aware

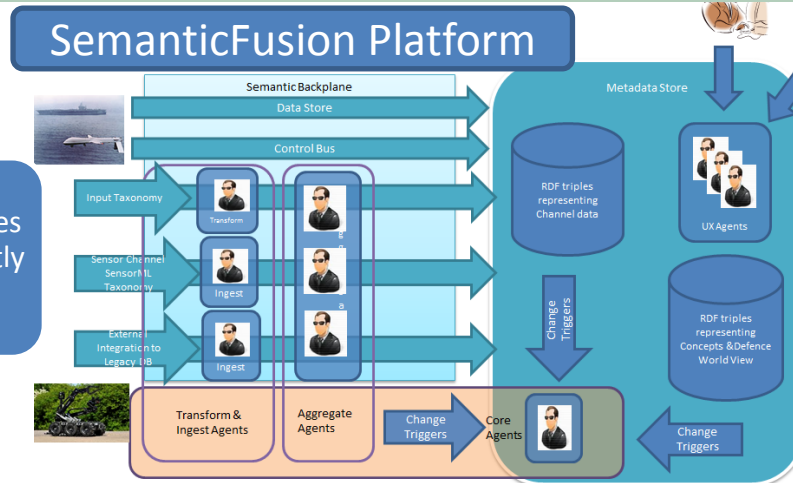real-time , contextual, decision support

operates at multiple levels

delivers Decision Support and  Open/Closed Loop control for Autonomous Systems & People



**SemanticFusion**

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**Situational Awareness & Homeland Security**

**semantrix SM3** Concept Search

Mail Server

Movie Server

Images

Intercept

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# *SemanticFusion™* :
# Situational Awareness Concept

## SemanticFusion Platform

So we designed a flexible, scalable, distributed, platform that incorporates proprietary, agent, semantic, text analysis technology to do just that!

Plus it does significantly more!

Semantic Backplane

Data Store

Control Bus

Metadata Store

Input Taxonomy

Transform

Sensor Channel SensorML Taxonomy

Ingest

External Integration to Legacy DB

Ingest

RDF triples representing Channel data

UX Agents

RDF triples representing Concepts &Defence World View

Change Triggers

Transform & Ingest Agents

Aggregate Agents

Change Triggers
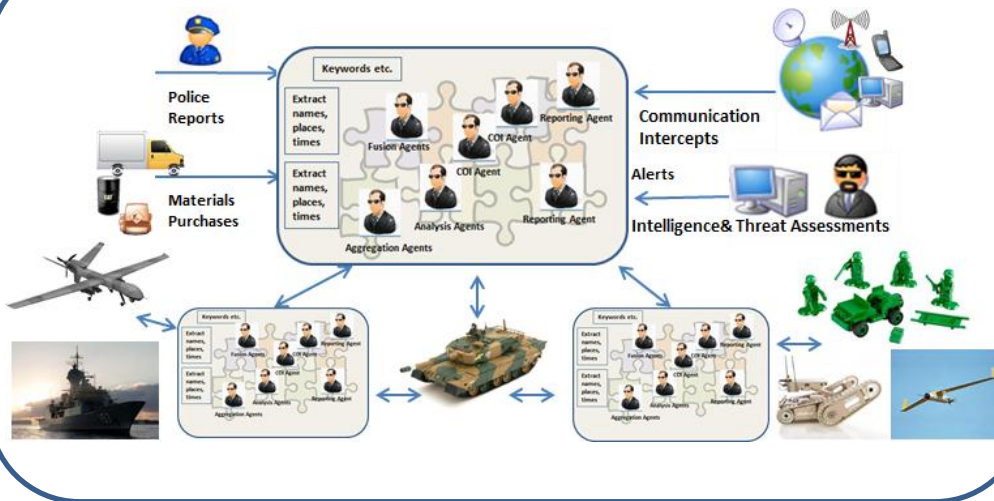
Core Agents

Change Triggers

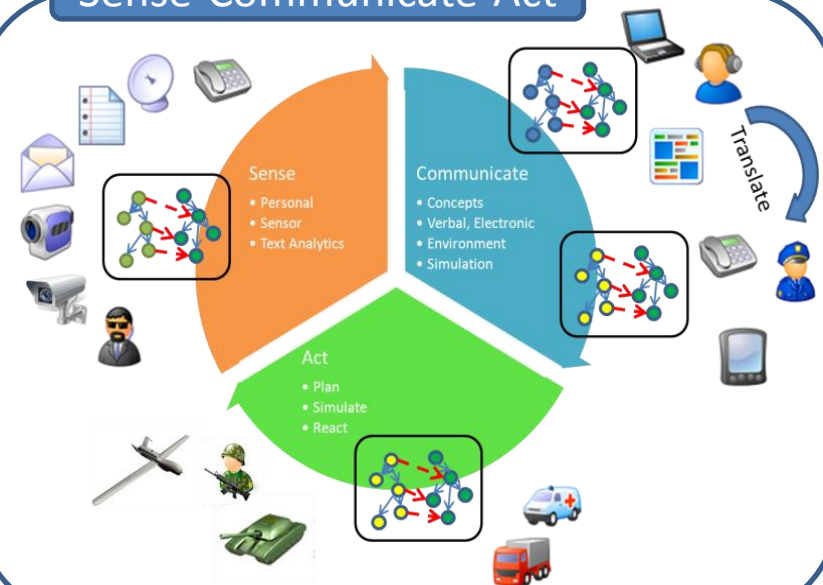SemanticFusion™ can integrate any information set in real-time

Works with concepts (not data) – that you understand and can describe scenarios and appropriate responses

Can Simulate, Predict, Monitor, Reacts, Plans , and is "Time- & Location Aware

## Real-Time & Distributed

Police Reports
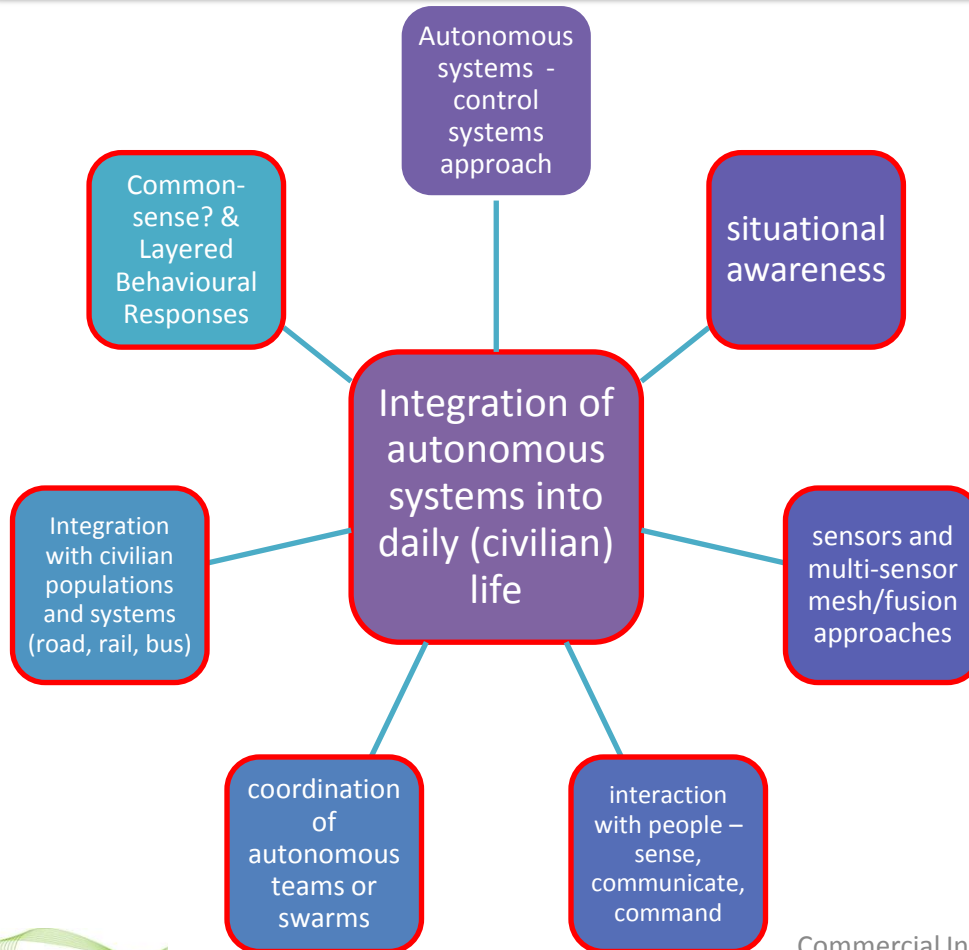
Materials Purchases

Keywords etc.

Extract names, places, times

Fusion Agents

COI Agent

Reporting Agent

COI Agent

Analysis Agents

Reporting Agent

Aggregation Agents

Extract names, places, times

Communication Intercepts

Alerts

Intelligence& Threat Assessments

Keywords etc.

Extract names, places, times

## Sense-Communicate-Act

Translate

Sense
• Personal
• Sensor
• Text Analytics

Communicate
• Concepts
• Verbal, Electronic
• Environment
• Simulation

Act
• Plan
• Simulate
• React

# *SemanticFusion*:
## Autonomous systems in the Real-world

**Red circled areas have proved difficult to achieve! Why?**

Autonomous systems - control systems approach

Common-sense? & Layered Behavioural Responses

situational awareness

Integration of autonomous systems into daily (civilian) life

Integration with civilian populations and systems (road, rail, bus)

sensors and multi-sensor mesh/fusion approaches

coordination of autonomous teams or swarms

interaction with people – sense, communicate, command

Difficult capabilities to achieve in the real-world - because we need machines to reason more like us

But traditional software development does not come close to delivering this

So we need to change the model for autonomous system development and integration

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# Existing Fundamental Issues

Existing issues with control and integration of Unmanned systems into common use in "everyday society"

Issues with planning and implementation - complex AUV's are effectively RPV's flown by pilots

Real-world situations typically too complex

Deployed systems "don't cope well with people, the unexpected, multiple coordination's, "Fate" – no common-sense

Don't understand uncertainty and non-sensor data sources

Combinatorial explosions as we move from lab to real-world environments

# Solutions to the real-world Issues

So we need to change the model for autonomous development and integration - to achieve solutions in the real-world

Reduce the amount of data – extract concepts and distribute, reason & plan with them

Support  real-time event-processing, reasoning & layered behaviors, and responses

Integrated "Situational awareness" -  requires integrating both local and external sensors with other information sources – at a concept level

Move beyond just vehicle sensors – integrate external sensor  & text elements  - use external information sources like commercial flight plans, bus and train time tables & signal systems, external maps and info assets  -  signs, schedules, and any indication of "potential interactions"

We need semantic agents monitoring, planning, and responding to sensor  & external events – with "integration agents " able to  also coordinate  & control "dumb" autonomous systems

# New Approaches

Work in a concept space – move from data centric to relevant concepts – cut back "volume" of info to process – just work with the "key elements" of relevance – move to a more abstract representation space  - facilitates "conceptual decision making" over  typical "algorithmic data processing"

Endow systems with "situational awareness" – flexibly integrate  and fuse multiple sensors – but move beyond just sensors to  integrate other relevant external sensor and information sources – police, traffic flows, timetables, maps and info assets, etc

New approach leverages Agents  representing entities in environment,  and Semantics to describe Relationships/Generalisation – relate concepts and allowed actions

High speed  scenario or "Condition Of Interest" (CoI) model – users describe "scenarios" in language they understand  - mapped to domain models machines understand

Agents & Planning  - R/T constrained & delegated hierarchial planning approaches – to achieve layered goals and handle exceptions (leverage embedded simulation capabilities)

Allows inference, logic & reasoning – easy integration and expansion of external data to use, validate against, or enhance local sensor and other info

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# Advantages & Benefits

Facilitates "smart" automation of processing for previously manual tasks .

Intelligently filters  out "irrelevant information" and only notifies the user based on their definition of "important" allowing users to maximise their time on tasks requiring "human cognition"

Semantic Agent technologies allow new information processing approaches based on concepts – compared to traditional data based fusion approaches

Agents support asynchronous real-time system monitoring of events & data & "Conditions of Interest" (COI), either  nominated by consumers, or by the system itself (network integrity and performance thresholds, etc)

Supports interacting decentralised SemanticFusion system elements  - each focused on specific input processing & concept extraction tasks – distributed across the network of participants

Allows complex information to be transferred as "concepts", described a Scenario/CoI's and semantically processed – used to create layered interacting  responses/behaviours or to relay information

Minimises data transfers and communications bandwidth required - as the system transmits  just "high-level concepts" and not the related raw data – to support  autonomous systems and operators

The SemanticFusion platform is continuously extensible, scalable, and applicable to a wide-range of problem domains, and can be adapted to work with almost any information source

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# *SemanticFusion*:
# Real-world Demonstrations Constructed & Planned

## Autonomous Vehicle Applications Demonstrator – Most Scenarios Complete

- Real-time Vehicle & Mission Management,
- Time-constrained real-time Plan/Re-plan, Collision Avoidance
- Integrating on-board and external sensors
- Planner Agents coordinating multiple UAV's to achieve objectives – including re-tasking

## Defence demonstrations – Initial Scenarios Complete

- Squad level demonstrations – integrating sensor feeds visualisation and personal situation awareness
- FCW examples combining soldiers and UAV sensor systems etc.
- Demonstrate bandwidth-limited communications – process & distribute concepts not raw-data

## Police demonstration & Home Detention Bracelet Monitoring- Detention scenarios complete

- Coordinate public reports, communications monitoring, large volumes of outstanding warrants / persons-of-interest etc. information to trigger appropriate responses (reducing operator information overload)
- Integrate GPS tracker bracelet sensor with automated monitoring of offender and their allowed areas, times, behaviours

## Homeland-security & Anti-terrorist demonstration

- Combination of people, facial recognition, public transport, terrorist acts and temporal correlation to determine appropriate responses/threat ratings
- Analysis of shipping manifest and vehicle locations to automatically alerts on dangerous goods combinations (oil-tanker and fertiliser shipments – proximity alarms in terms of proposed dock location or travel plan)

## Health – HSR: Health Sense & Respond - Initial Scenarios Complete

- Demonstrates real-time patient sensor monitoring, text analytics applied to patient tests, patient behavioural monitoring for falls detection and prevention, etc.
- Demonstrates extracting and presenting context-aware info tailored to specific staff roles

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# *SemanticFusion™*: Benefits

Ingest intelligence from sensors and integrates text analytics and external information sets

Understands and integrates location, proximity, sensors and text/ELINT

Distil data into concepts – describing scenarios or "Conditions of Interest"

Expressed as Reasons which people can understand and use

Responses – Alerts/Actions, Open/Closed loop, Automated Rules or C³, Layered Behaviours
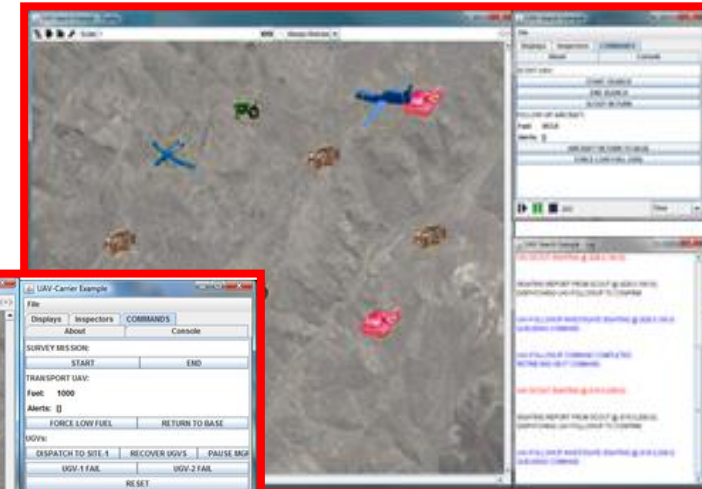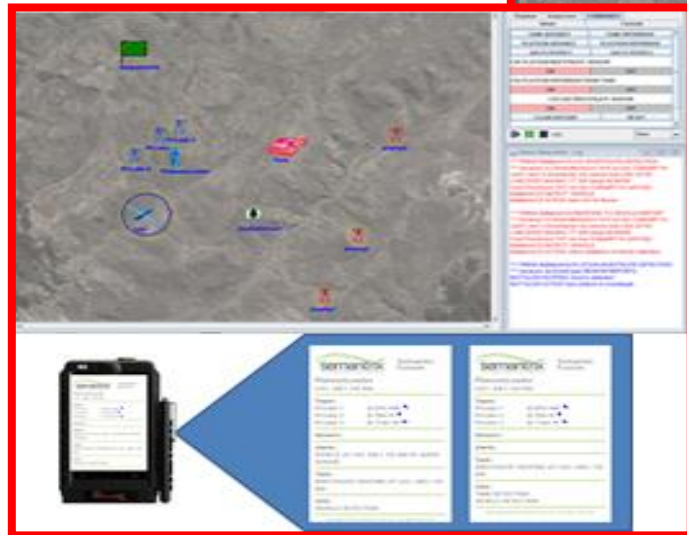
Communicate appropriately to all Levels  - AUV/Operator upwards

Low-Bandwidth - Distributed Model – from Man Portable upwards

Integrates Sensors, Man, & Machine. Bridges Legacy to Future Combat Warfare Models

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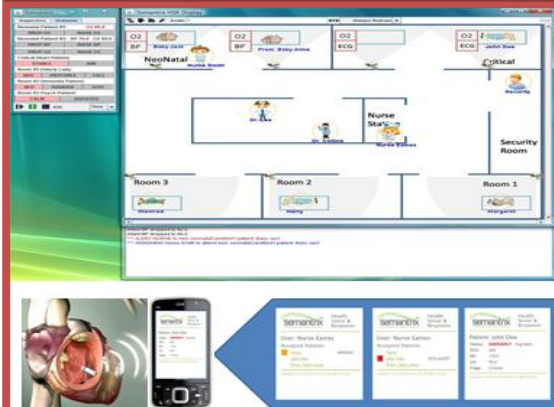# *SemanticFusion™*: Demonstrations

**Three Demonstrations:**

- **Semantic Agent management of Multiple UAV Search**
- **Multiple UAV – UGV Scout/Retrieval/Replenishment**
- **Integrated C&C, Soldier, UAV Situational Awareness**

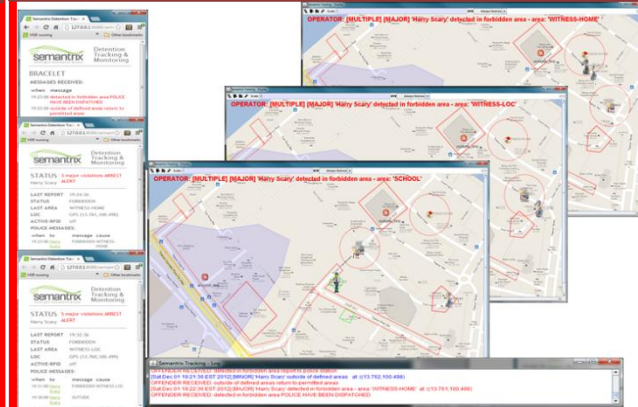# *SemanticFusion™*: Demonstrators


*HSR: Health - Sense & Respond*


*Conference Attendee RFID Tag Tracking*


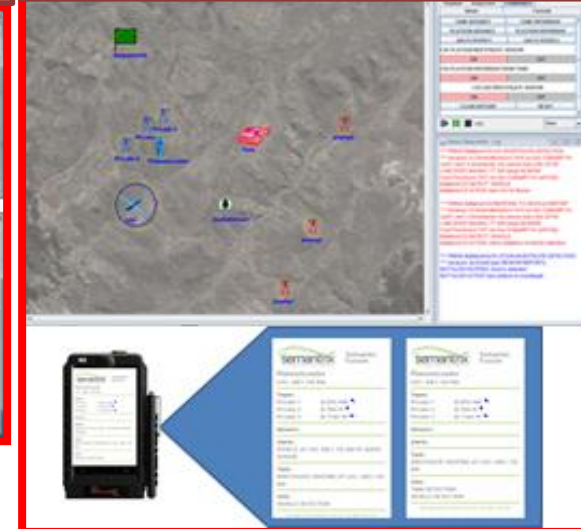*Home Detention Bracelet Tracking*


*Autonomous Vehicle Delivery/Retrieval*


*Multi-UAV Search*


*Situational Awareness*

# Semantrix: Skills & Technologies

## Key Technologies we can support include:

- Data and concept fusion – people work with concepts they understand
- Text analytics – extract who, what, why, & sentiment
- Semantic enrichment – extend content from new and legacy sources
- Concept-level Information representation, transformation, mapping and integration
- Complex real-time event processing and decision-making support
- Smart Reasoning and Search across multiple information types
- Integration of Artificial Intelligence, Knowledge—based systems, and Agent based technology approaches with Semantic and Text Analytic technologies – to provide leading-edge approaches to integrating, analyzing and interpreting structured and unstructured text and multimedia content

## Business process driven, Semantic web-services and integration approaches

- Our partner TopQuadrant has been heavily involved supporting various US Defence information modeling, and integration projects

## Semantic Web and Metadata related technologies and applications

- Enterprise or custom Search and indexing applications
- Catalogues and Online directories – ingest, transform, cross-ref, content enhancement and publish
- Contextual search & advertising – user personalisation
- Dynamic Semantic Publishing – smart analysis, cross-referencing, metadata tagging and automated publishing via our partner Ontotext

## Semantrix principles and partners have been involved in:

- High-performance information and event capture, processing, storage, fusion, processing and display. etc.
- Real-time decision support in power-plants, instrumentation & control-systems, expert and diagnostic systems, mine equipment, etc.
- Operator information displays and processing in complex scientific instrument networks, radar systems, mine equipment, etc.
- Enterprise scale search, index and recommendation systems, text analytics and content analysis and cross-referencing, etc.
- 3D virtual reality and information visualization environments - mine sites, radar and instrumentation information displays, etc.

## Situational Awareness and Network-centric warfare

- Combining a range of technologies and skills to deliver the information you need
- Integrating, analyzing, reasoning and presenting information in a way that makes sense to a warfighter role
- Information presentation in a form that meets users immediate needs – delivering superior situational awareness and decision making - without information overload.
- We can support Intelligence analysts through text analytics, conceptual search and information cross-referencing and automated filtering
- Semantic Fusion delivers enriched, targeted information to role-based analysts – assessing threats and supporting homeland security applications
- Integration of multiple sensors and disparate information sources, artificial intelligence approaches, and adds simulation/planning capabilities

## SemanticFusion™ - Next Generation Situational Awareness and Concept level data fusion

- Integrates, interprets and distributes the relevant information – on the ground, and tailored to each warfighter role
- SemanticFusion ™ provides enhanced situational awareness, emergency response, and simulation and planning capabilities
- SemanticFusion ™ can be dynamically extended, can integrate new sensors, information, & displays, and can dramatically enhance R/T decision support

## HSR: Health Sense & Respond™

- HSR provides the next-generation of medical decision support in the hospital or emergency or battlefield triage applications
- HSR is location and context-aware tying NFC/RFID tags, and smart information management together with real-time patient sensor & location monitoring, plus Text analysis of patient records, treatments , trends - to provide context aware "treater" decision support next to the patients bed on mobile devices.

## SM3: Social and Multimedia Metadata Manager™

- SM3 is an Enabler for the Next Generation of Social Network Aware Intelligent Media
- Recommendation, Personalisation, Conceptual Search, Semantic Advertising and UGC System Integration.
- SM3 enables capabilities not available to traditional DAMS/VMS systems and emerging User Content systems.
- Analyse, Cross-Reference, & metadata tag, multimedia, security/UAV video, images, documents, reports etc. Links media assets such as video to other relevant media or text assets

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