

Towards multi-agency sensor information integration for disaster management

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Summary

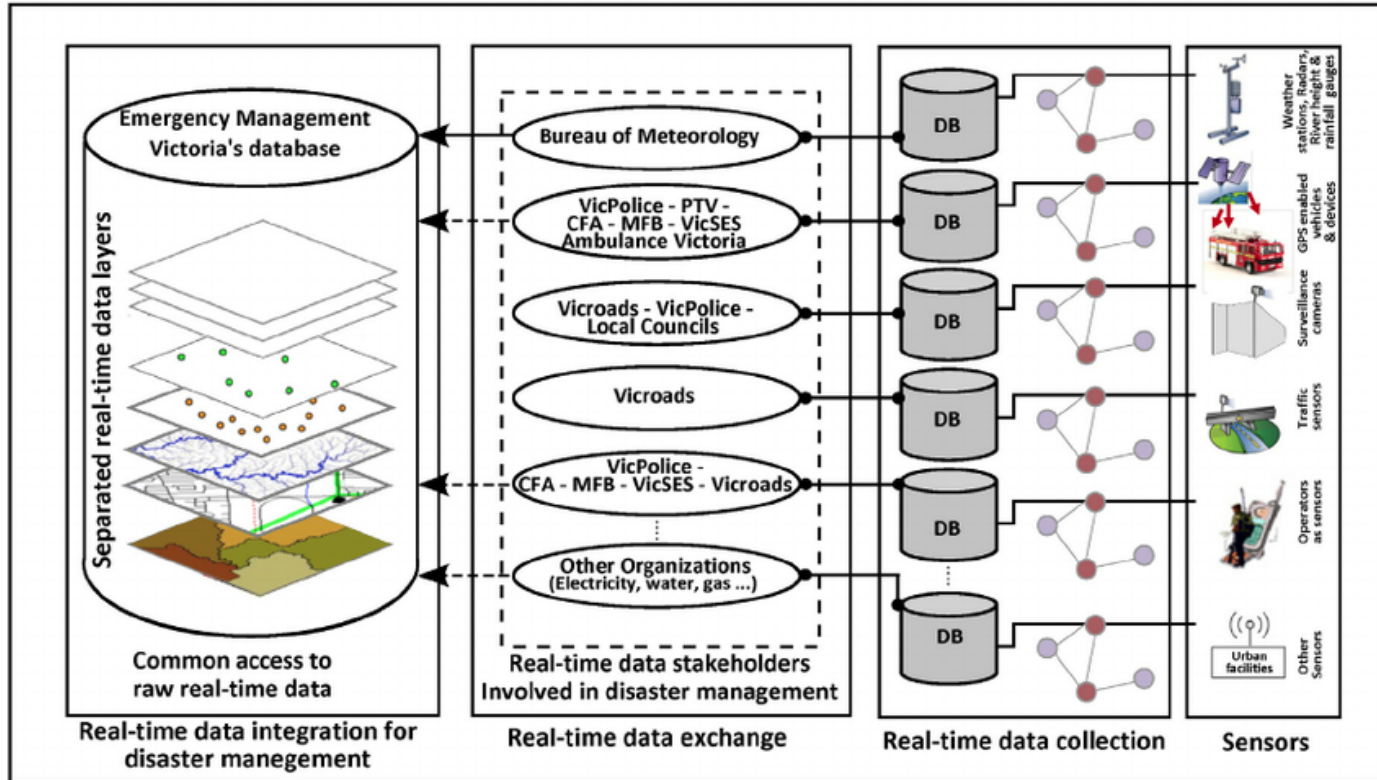
- “Improves real-time spatial information usage by integrated multi-agency(sensor data from many different sources) in a disaster management system.”
- Displayed as maps.

- Identifies current issues of multi-agency integration.
- Proposes a standardised approach to overcome current integration issues.
- Introduces Geographic Information System(GIS)-based software, and Intelligent Decision Support System-(IDDSS)Sensor to provide the functions of the standardised approach.

Background

- Victoria, Australia
- Aims at urban floods and water levels firstly
 - Wildfires etc
 - Large and small scales
- Geographical situation displayal(Maps)

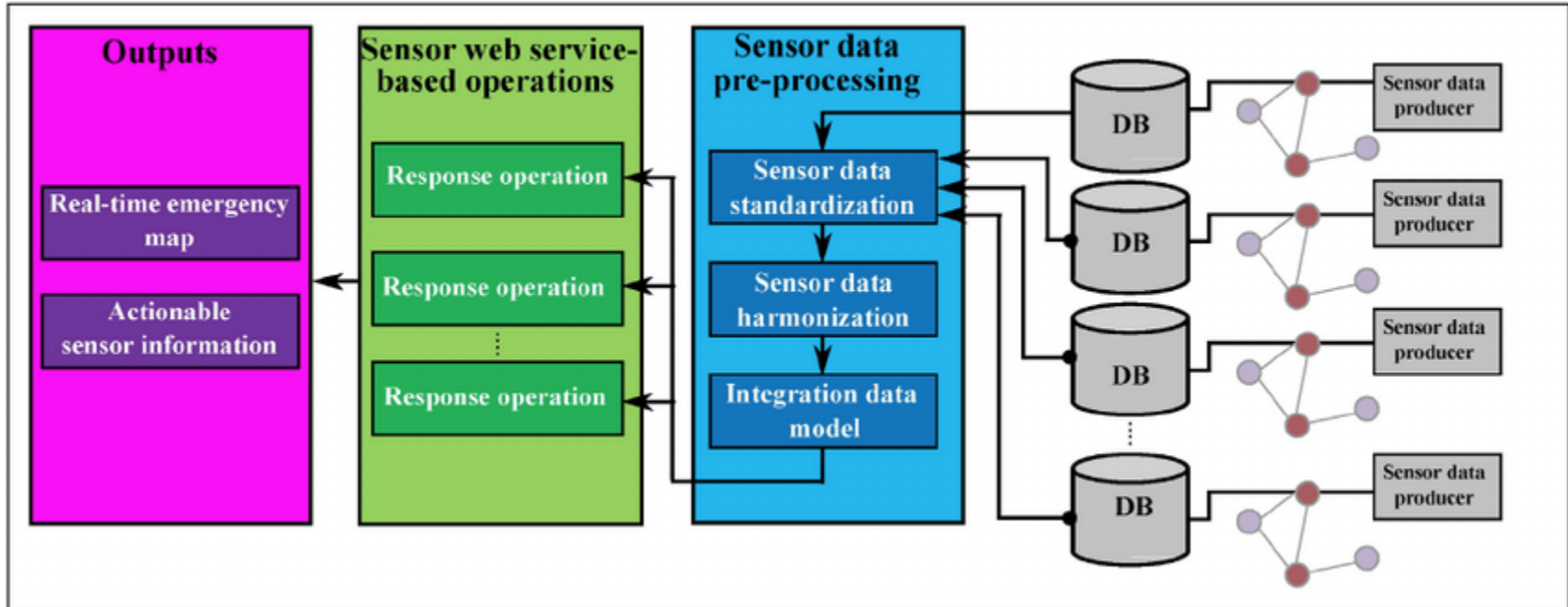
Current multi - agency sensor integration



Issues with the current process

- Lack of access to multi -agency sensor data
 - Mostly only road cluster, and meteorological observations
- Lack of interoperability in multi -agency sensor data exchange
 - Different data format(Raw text data, binary, different XML variants).
 - Different data access interfaces.
- Inconsistency in multi -agency sensor data
 - Many different sensor data stakeholders, leads to inconsistent or incomplete sensor data specifications.
- Lack of automated usage of multi -agency sensor data
 - Only raw realtime data feeds, which are not machine-readable.

The new proposed approach



Introduced steps

- Standardization
- Harmonization
- Integrate data model
- Sensor web service-based operations

Standardization

- Introduces OGC SWE framework of standards
 - Domain independence
 - Producer independence
 - Openness
 - Inter-organizational interoperability
- Especially for real-time management

Open Geospatial Consortium (OGC)
Sensor Web Enablement initiative (SWE)

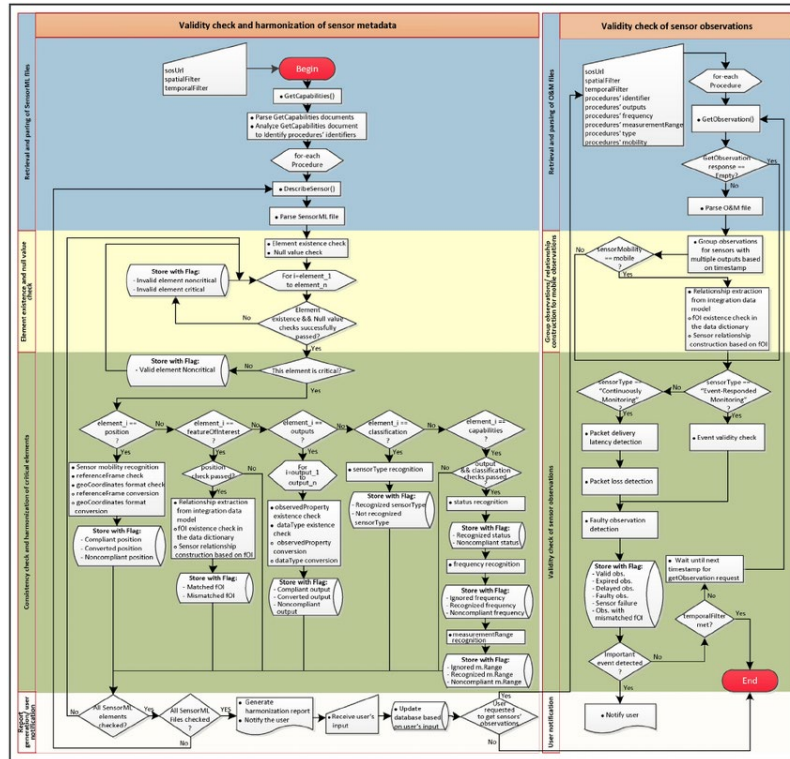
“Ensure consistency between sensor stakeholders
by providing a common agreement.”

Harmonization

“Automatically identify and resolve the remaining inconsistencies in the received data.”

- On-the-fly validation
 - Consistency checking
 - Validity checking
- Element existence
- Element null
- And more...

Harmonization process chain



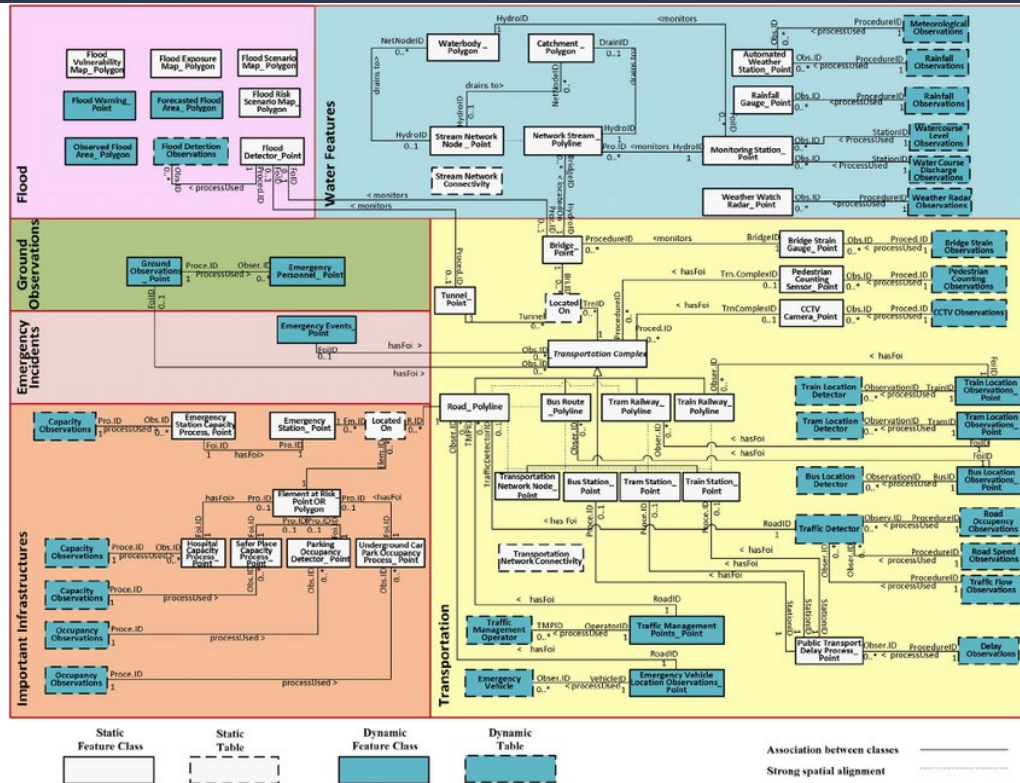
Data model integration

“Establish the relations between organizational sensor data that reach EMO with static spatial data stored in EMO's database.”

- Prevents separate and detached data layers
- A database model that provides linkage between the sensor and spatial data sources
 - Flood risk scenario maps
 - Flood forecasts, warnings and observations

Emergency Management Organization(EMO)

Integration class diagram



Sensor web service - based operations

“Consume the standardized, harmonized and connected sensor data and send back the value-added emergency information”

- Creates a Response operation

The GUI of IDDSS - Sensor client application

Case Area : Flash Flood - City of Melbourne

You are logged in as usr01 [logout](#)

Control Panel

Data Layers Services Query Management

Sensor Data Layers

LayerName	Num	Action
BOM:Rainfall	-1	🔍🔊🔄
BOM:Riverheight	-1	🔍🔊🔄
VicRoads:Traffic Flow	1204	🔍🔊🔄
COM:PedestrianCounting	-1	🔍🔊🔄
VicRoads:TMPoints	-1	🔍🔊🔄
COM:IngroundParkingBayOc...	-1	🔍🔊🔄
COM:UndergroundCarparkOc...	-1	🔍🔊🔄
VicSES:Personnel	-1	🔍🔊🔄
ESTA:EmergencyEvents	-1	🔍🔊🔄
VicRoads:CCTVs	-1	🔍🔊🔄

Static Data Layers

LayerName	Num	Action
Safer Places	-1	🔍🔊🔄
Hospitals	-1	🔍🔊🔄
Main Roads	-1	🔍🔊🔄
Local Roads	-1	🔍🔊🔄
UnderGroundCarParks	626	🔍🔊🔄
Stream Network Nodes	-1	🔍🔊🔄
Stream Network	-1	🔍🔊🔄
Catchments	-1	🔍🔊🔄
FloodScenarioMap_Parcel	-1	🔍🔊🔄
FloodScenarioMap_Waterways	-1	🔍🔊🔄
FloodScenarioMap_Drains	-1	🔍🔊🔄

180x
May 2, 2015
01:53:58 GMT+10

CESIUM

00:00GMT+10 May 2, 2015 00:00:00GMT+10 May 2, 2015 02:00:00GMT+10 May 2, 2015 04:00:00GMT+10

(144.90 -37.85 -144.99 -37.78)

Harmonization results

Harmonization Result for SOS: City of Melbourne

Sensor: **OM/PedestrianCounting/Col270**

Metadata element	Value	Result	Action
position	mobile=false	Recognized_mobility	NA
	referenceFrame=urn:ogc:def:crs:EPSG::4326	Compliant_position	NA
	sensorPosition=[-37.81573486328125, 144...	Compliant_position	NA
featureOfInterest	Road_Col1221	Mismatched_foI	CollinsStreet_1221 is selected
outputs	urn:x-ogc:def:phenomenon:OGC:PeopleCount	Compliant_output	NA
classification	sensorType= null	Invalid_element_critical	ContinuouslyMonitoring
capabilities	status= active	Recognized_status	NA
	frequency= 10 min	Recognized_frequency	NA
	measurementRange= [0, 10000]	Recognized_measurement...	NA
	observedBBOX= null	Invalid_element_noncritical	NA

Zoom to sensor Apply changes OK

Query management interface

- 2 layers
 - Define query condition for the first observation layer
 - Define query relation
 - relational query based on the relations defined in the integration data model
 - Proximity
 - Define query condition for the second observation layer

1) Define query condition for the first observation layer

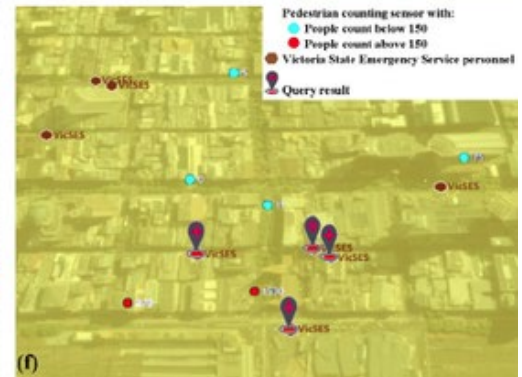
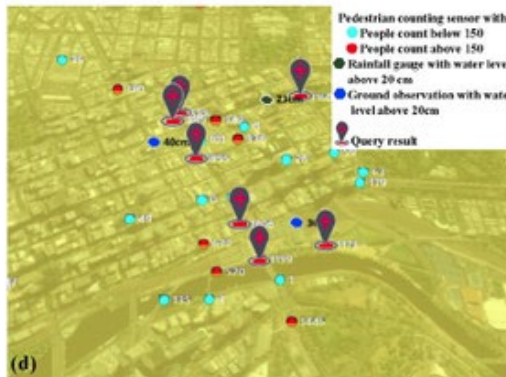
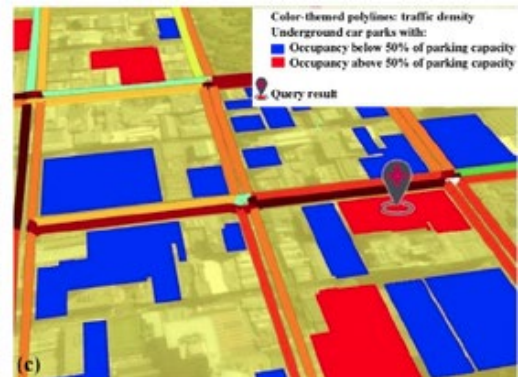
2) Define relation

3) Define query condition for the second observation layer

The screenshot displays a query management interface with two observation layers and a relation. The first observation layer is titled "Select Observations From" and includes fields for "Observation layer:" (COM:UndergroundCarparkOccupi), "Observed Properties:" (Occupancy:10min), "OutputType:" (Count: Vehicle), and "Condition:" (MeasurementRa >= 50%). The second observation layer is titled "With Observations From" and includes fields for "Observation layer:" (VicRoads:TrafficFlow), "Observed Properties:" (Density:10min), "OutputType:" (Numeric: veh/km), and "Condition:" (Greater than 200). A relation is defined as "In Which Has:" (Located on). Buttons for "Submit" and "Choose Second Offering" are visible.

Section	Field	Value
1) Define query condition for the first observation layer	Observation layer:	COM:UndergroundCarparkOccupi
	Observed Properties:	Occupancy:10min
	OutputType:	Count: Vehicle
	Condition:	MeasurementRa >= 50%
2) Define relation	In Which Has:	Located on
	Relation:	Located on
3) Define query condition for the second observation layer	Observation layer:	VicRoads:TrafficFlow
	Observed Properties:	Density:10min
	OutputType:	Numeric: veh/km
	Condition:	Greater than 200

Result of 6 different queries



Conclusion

“Multi-agency sensor data as a potential source for providing real-time spatial information for disaster management”

- GIS-based software IDDSS-Sensor is implemented to support the decision-making of emergency agencies by integrating multi-agency sensor information in real-time
- Particular useful during emergency events
- Improvement in inter-agency collaboration through providing more automation in the interaction between organizations

Geographic Information System(GIS)
Intelligent Decision Support System-(IDDSS)

Future work

- Expand to other disaster
- Evaluate by questionnaire of based survey of industry expert