5. Modelling and models

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Content

- Investigation of data used in Emergency response
- Operational data models
- Models for Navigation and Evacuation

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Existing data

- Very often they have a model (even UML)
- Maintained with the source
- Accessed via Web services, BPEL applications, Groove (MS collaboration software program)
- Standards for schema and data exchange (OGC)
- Initiatives for data harmonisation: INSPIRE, ..

Operational data

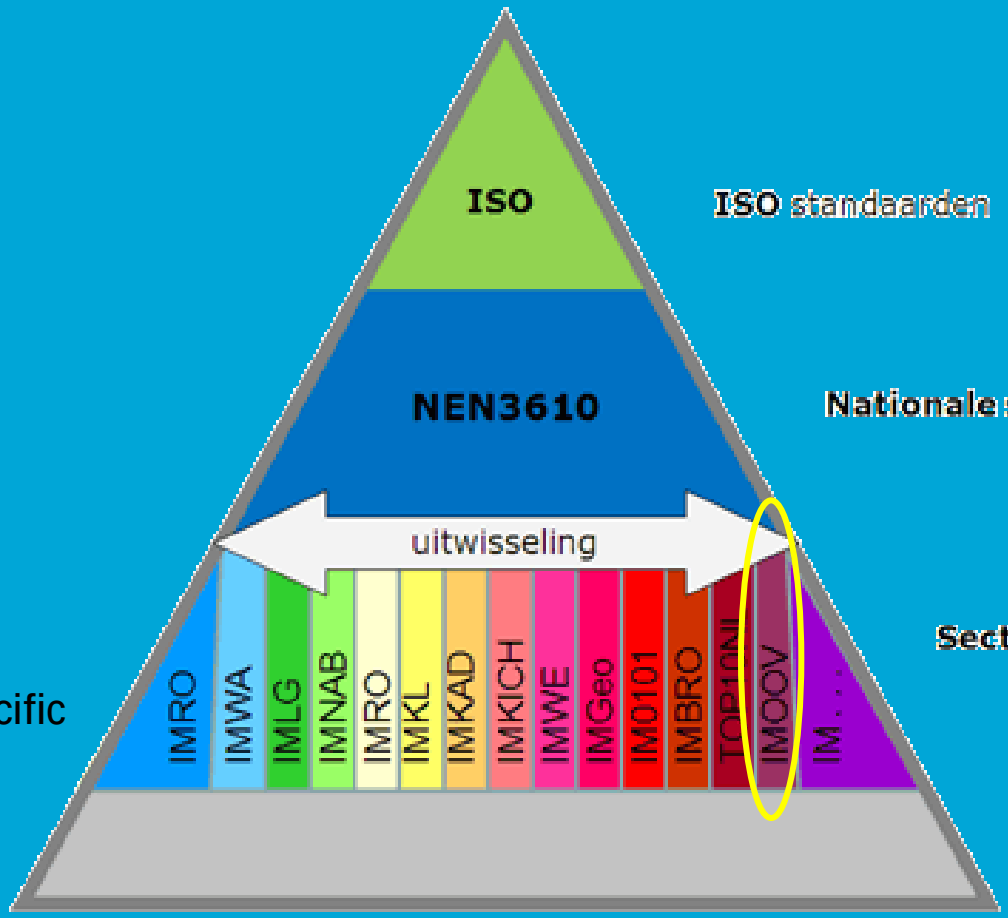
- No models (In large extends not structured data)
- Maintained by municipality, safety region, province, NCC
- Access: Web services, BPEL applications, Groove (MS collaboration software program)
- Initiatives for standards: Common Alert Protocol (CAP), several EU project
- Little initiatives for data harmonisation.

Information modelling in the Netherlands

Generic

Sector specific

Organisation specific



ISO standaarden

Nationale standaarden

Sector standaarden

Organisatie specifieke afspraken

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Operational (dynamic) data: steps to record data

1. Activities, Users, Tasks have to be defined (to be able to identify the information to be persistently stored)
2. Formal modelling (UML, ontology)
3. Spatio-temporal data model (approach to record information with respect to geometry and time)
4. Storage?: DBMS based vs. file-based approach, DBMS (commercial vs. open-source)

Modelling of process 5: Measurements and observations

1. Centralist receives location
2. Places sector template
3. Direction of the wind
4. Measuring teams
5. Creation of plume

Forms to perform measurements in the affected area

- **Measuring order leader-MPO** DTG: ___ ___ ___
- Measuring team **Whiskey** _____
- *Sectorenmal*
- Coordinates of incident **Oscar 1** _____
- Sectors **Oscar 2** _____
- measurement location (coordinates) **Mike** _____
- *Type measurement*
- Info about exclusivity **Echo** _____
- Measuring pipes **Bravo** _____
- Electrical instruments **Romeo** _____
- **Electrical instruments 2** **Romeo-sierra** _____
- Personal detectors **Delta** _____
- Personal protection **Ademlucht** _____
- Time order **Tango** _____

Formal modeling using UML: Activity, use case diagrams

Needed dynamic spatial information

Incident
- location of incident
- type of incident (?)
- scale of incident

Effects and consequences
- size of affected area
- development of the incident
- threatened area (+time/period)
- escalation possibility

Surroundings of the incident
- sectormal
- damaged infrastructure
- damaged utilities
- damaged special objects

current and predicted meteorological info
- wind direction
- wind speed
- precipitation (rain/snow)
- temperature
- humidity

Accessibility
- in- and out-routes
- traffic direction
- (possible) blocked roads

Victims
- number of casualties
- number of dead
- number of missing
- number of found people
- number of trapped

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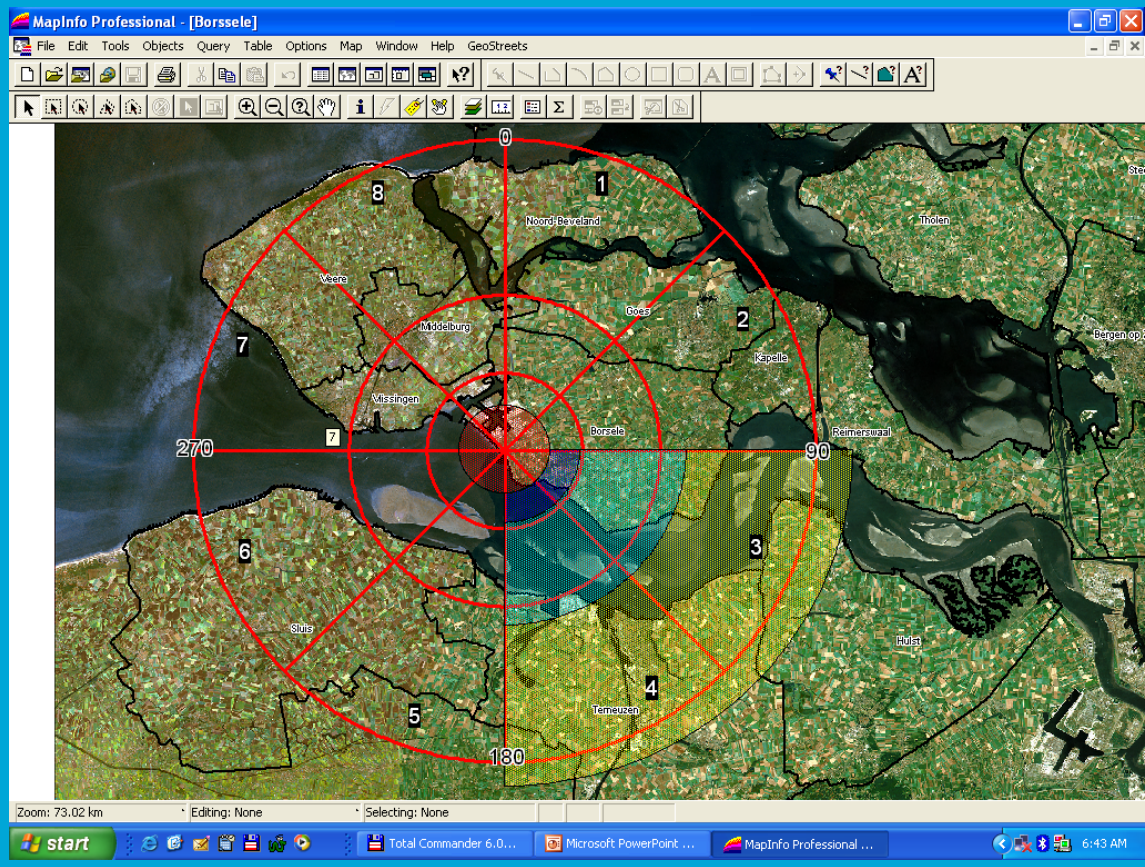
Spatial information created by Process 5

- Source location
- Affected area
- Threatened area
- Scale of incident
- Type of incident
- Development of incident

- Sector diagram
- Measurements (according to the specialised forms)
- Plume



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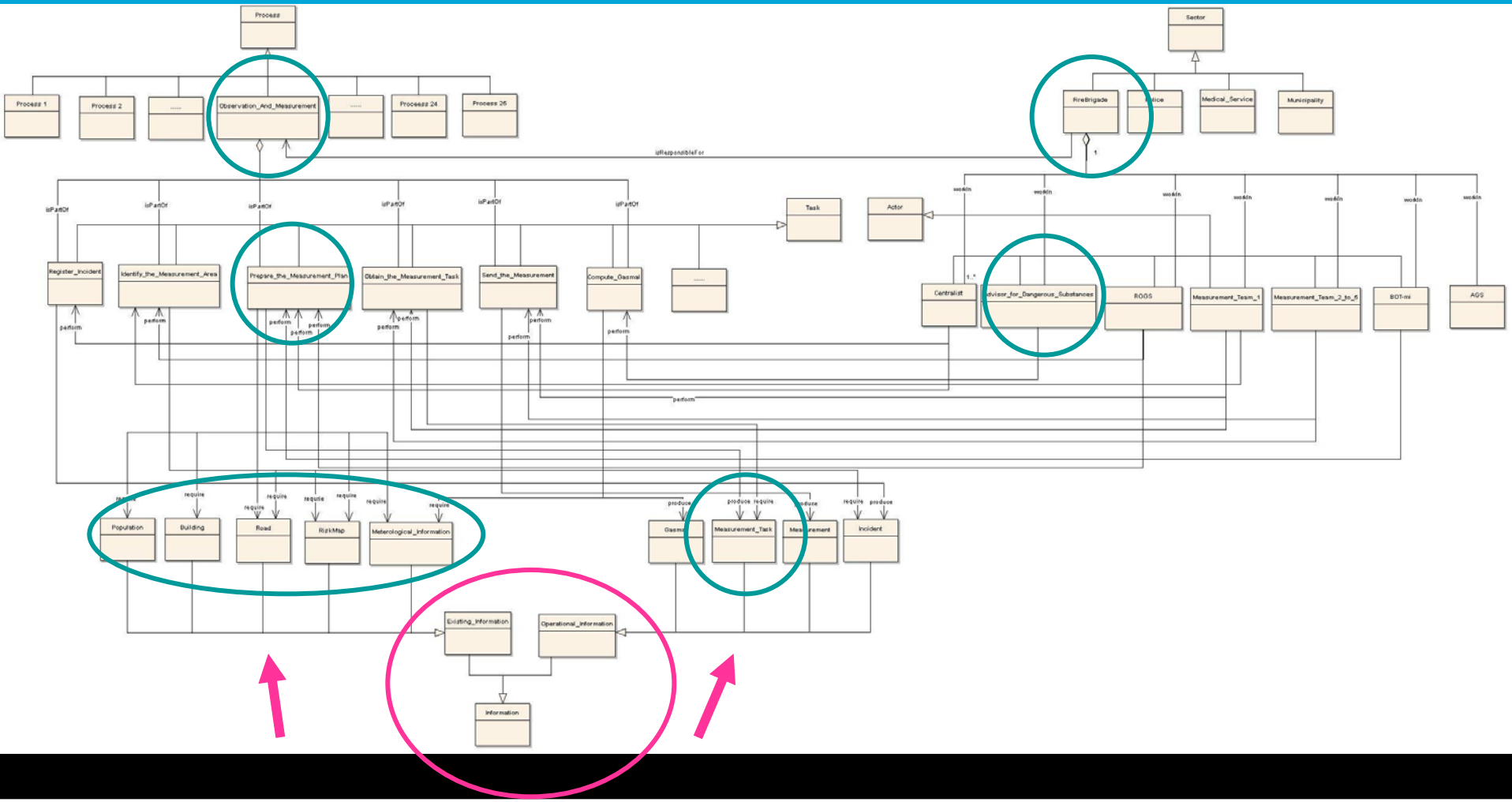
Processes, Units, Actors, Tasks



Needed and produced temporal data

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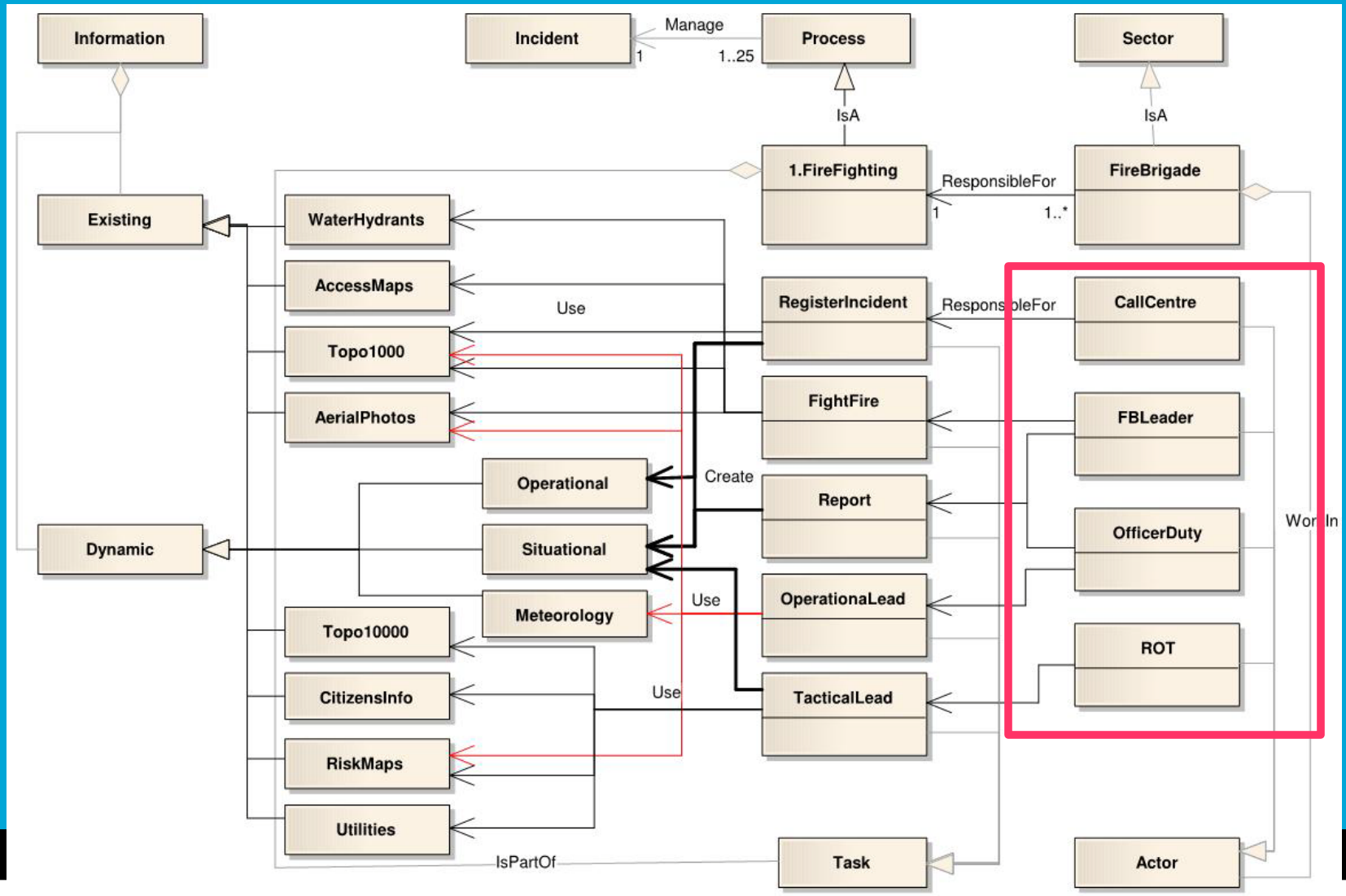
Process 1: fire fighting



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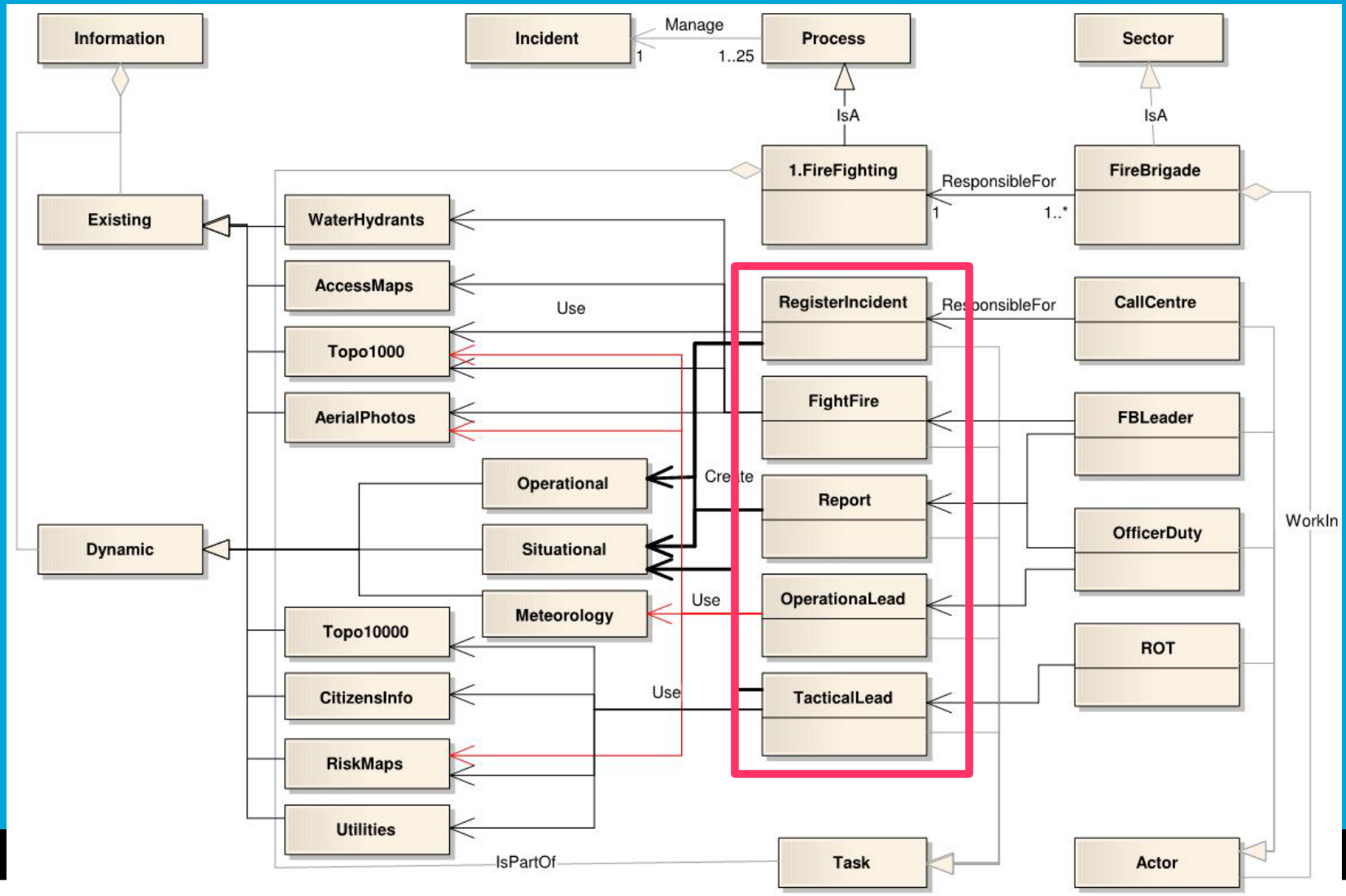
Process 1: fire fighting



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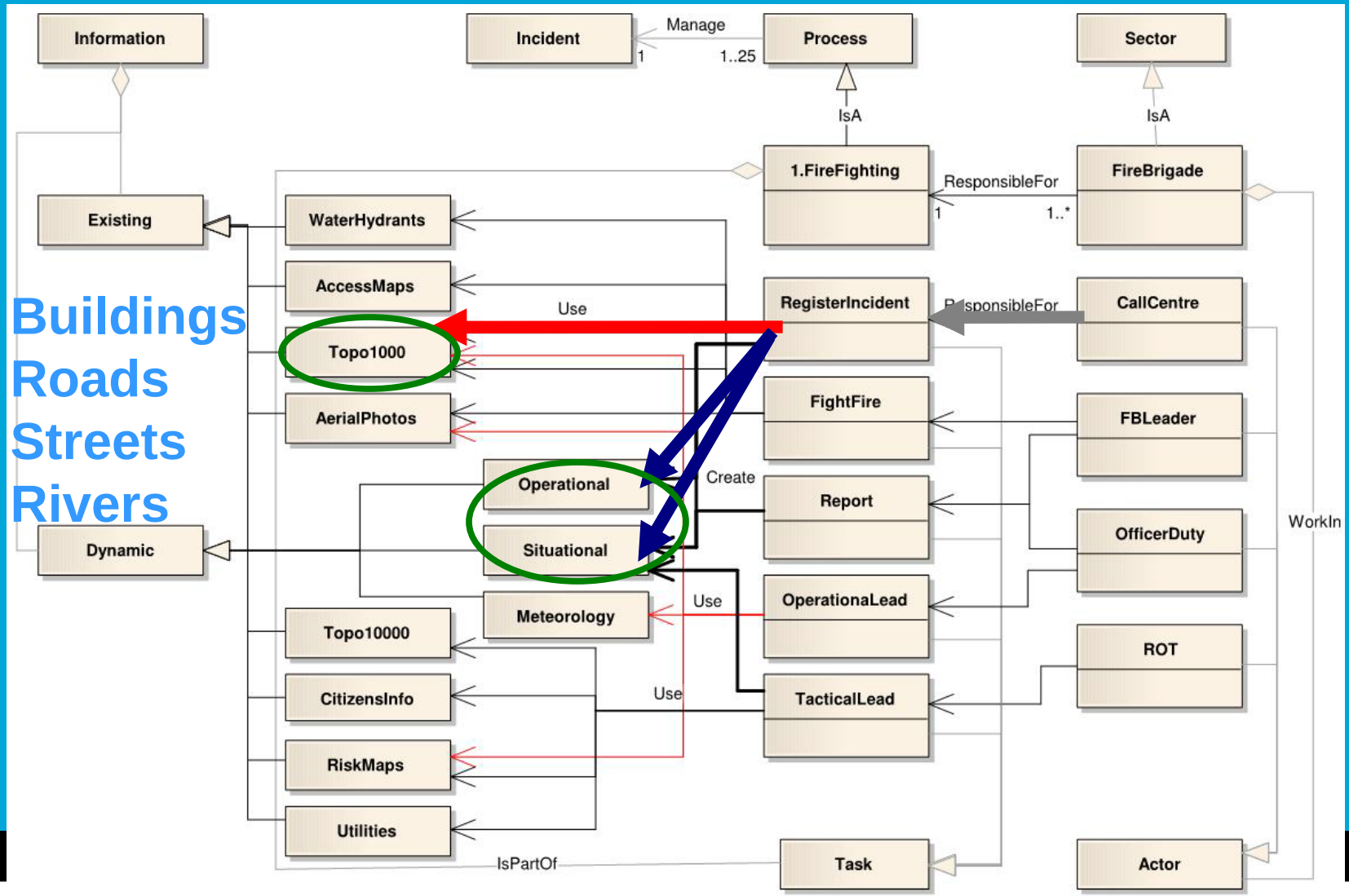
Process 1: fire fighting



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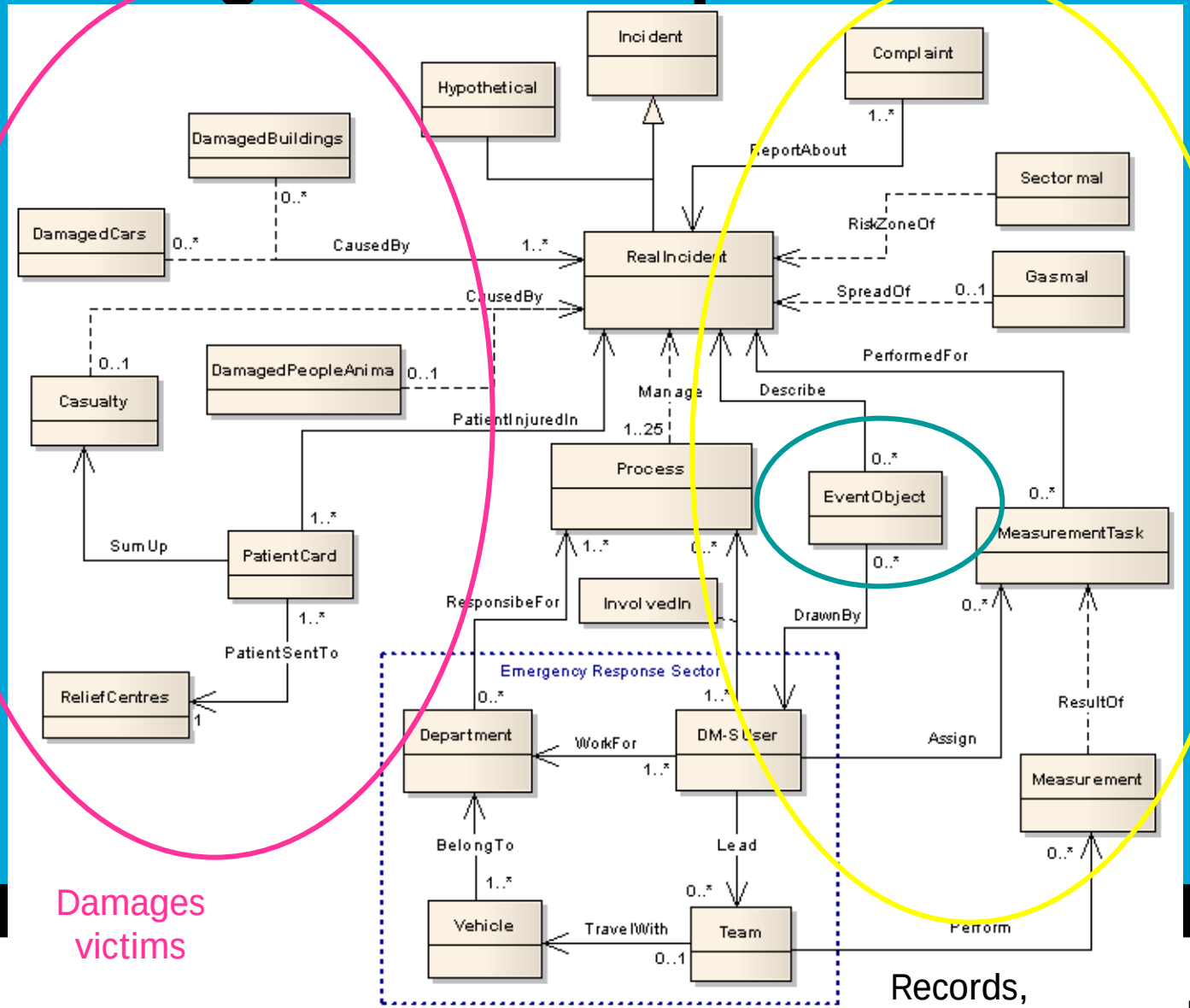
Integrated conceptual data model



Damages victims

Points, Lines, polygons, (video)

Records, measurements

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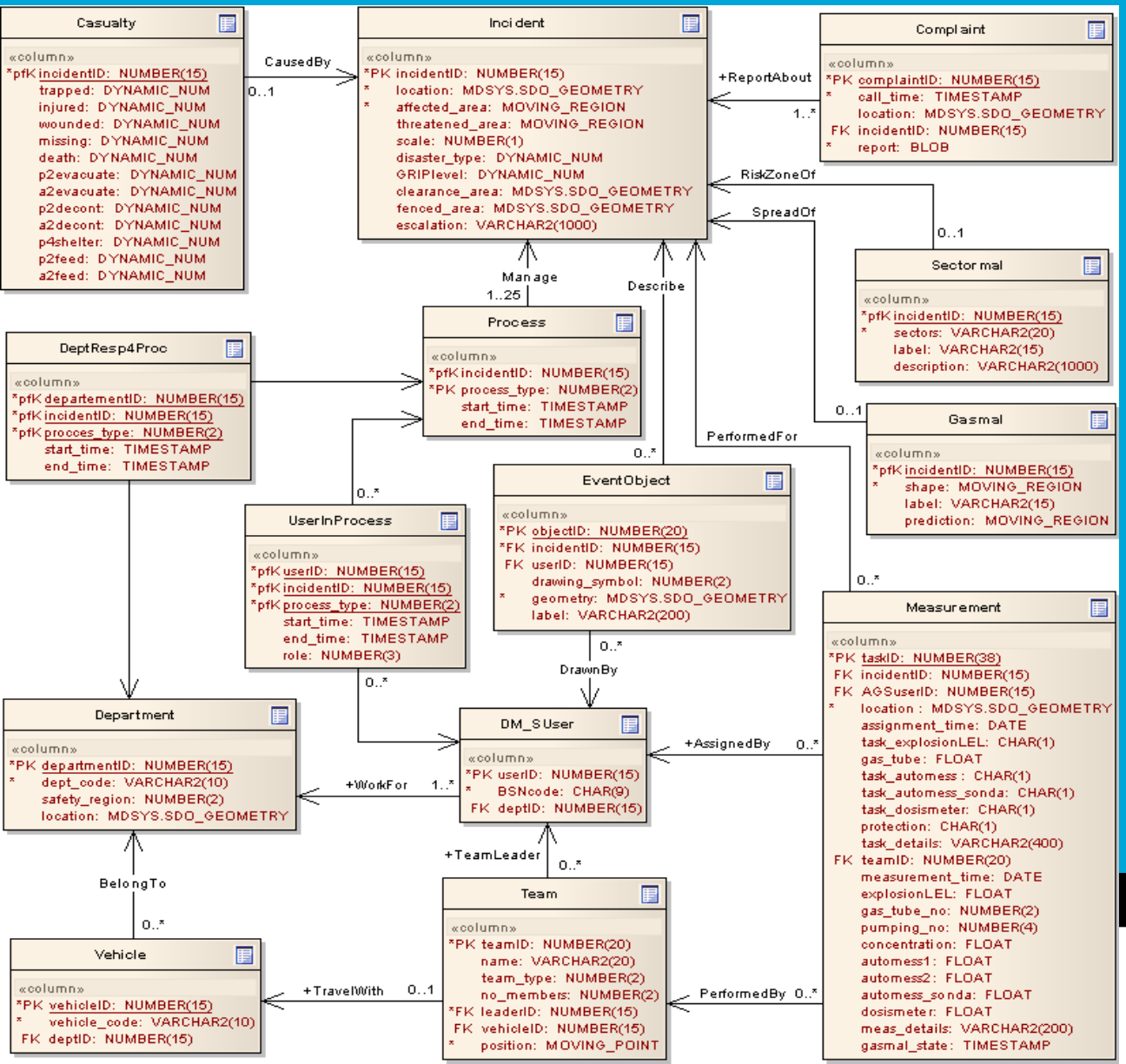
Class diagrams for the data model



Information is organised per incident
Centralized storage
DBMS

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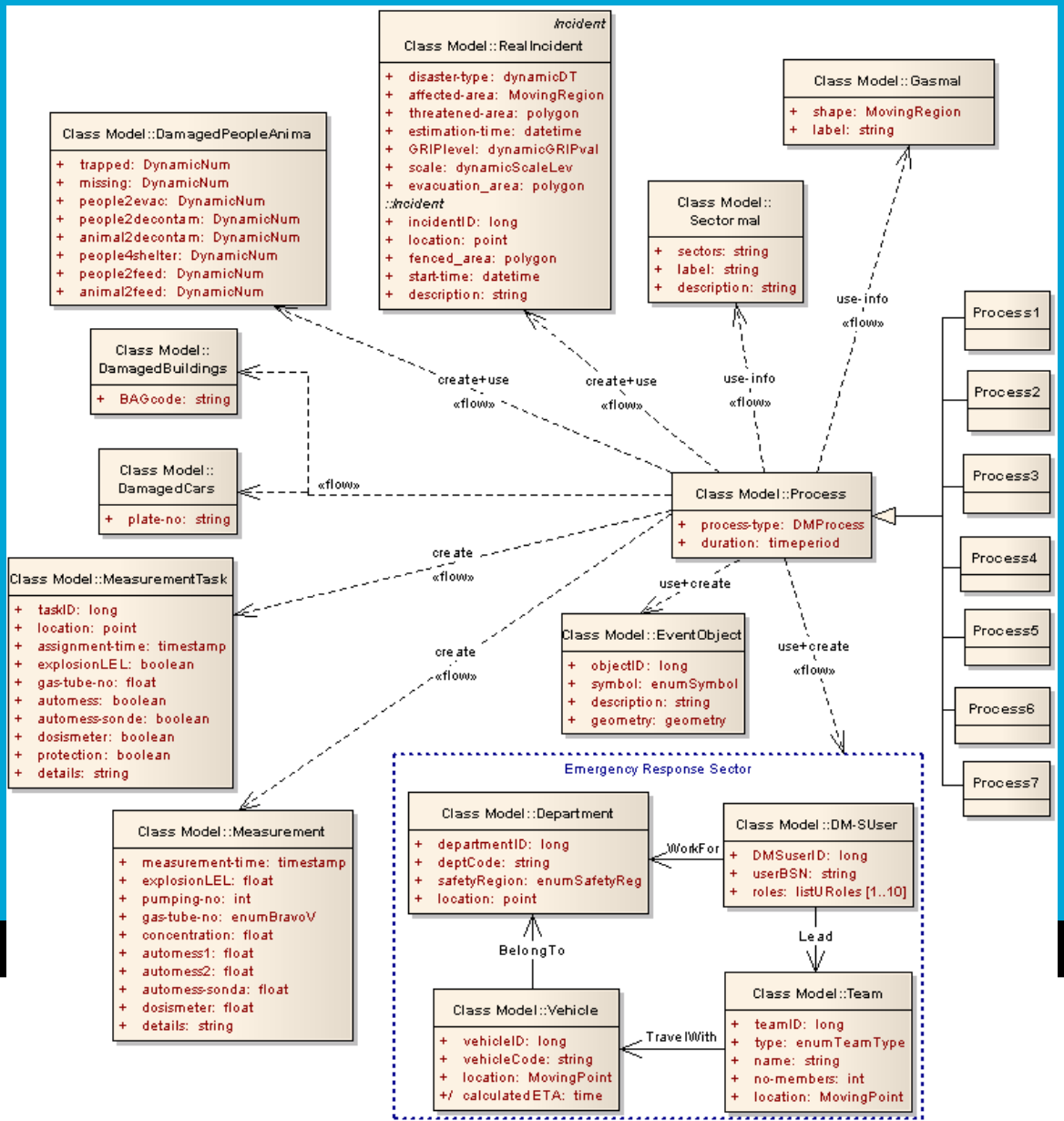
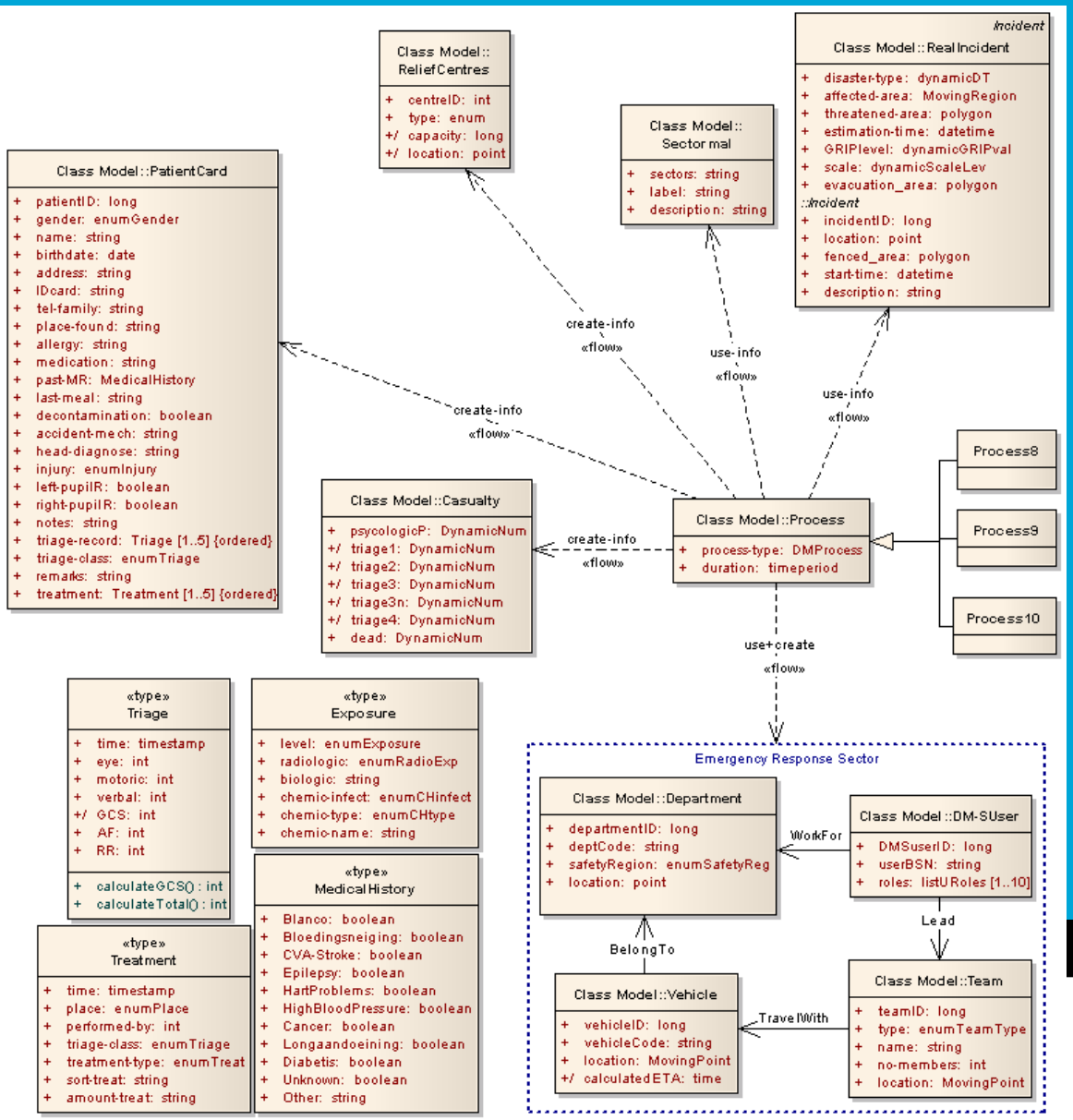
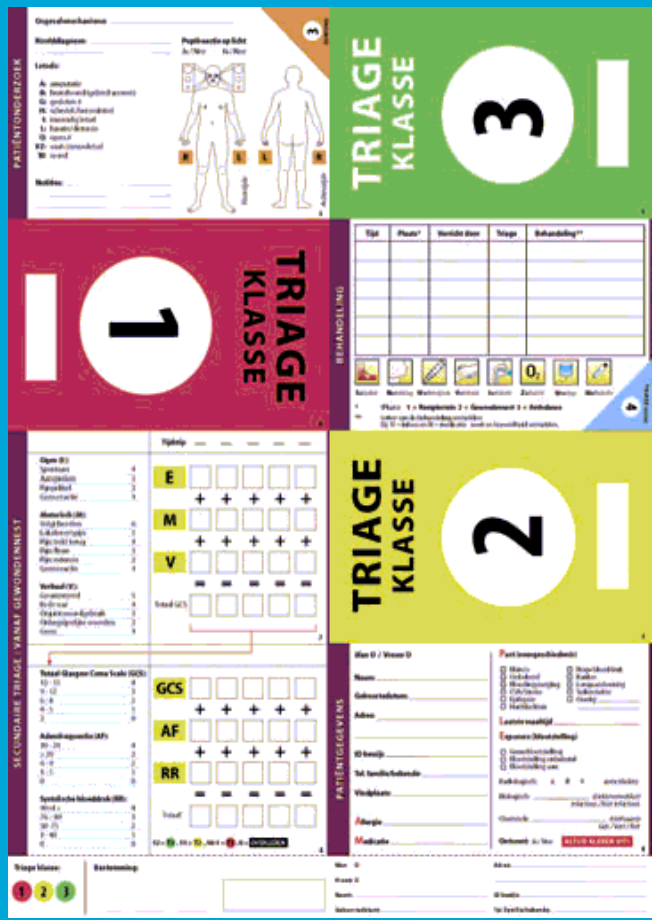
Information used by the fire brigade



Information used by medical help





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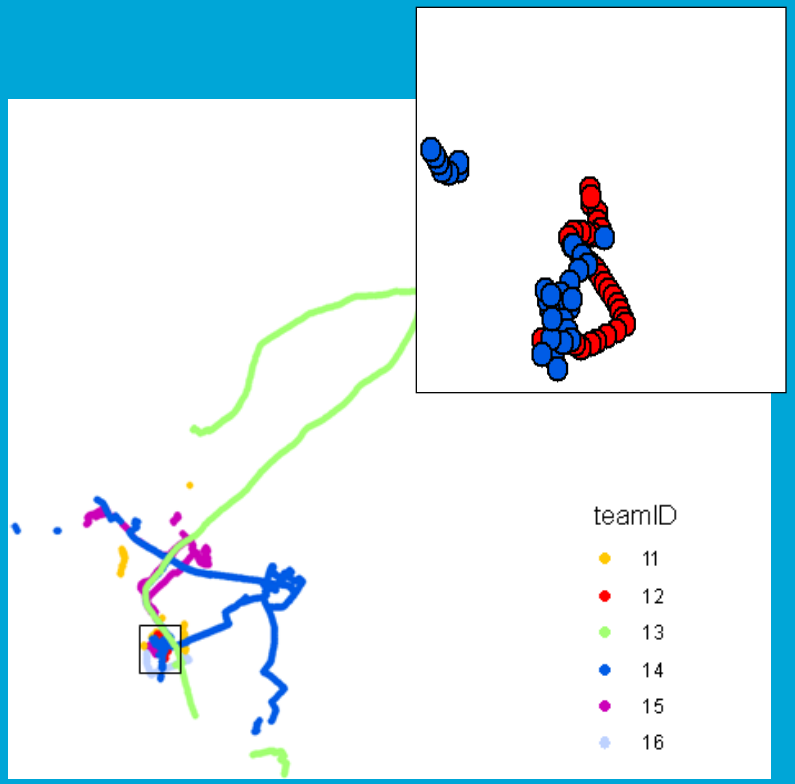
A large number of can be executed

- find police vehicles that are in a radius of 5km from the incident
- which car is the closest to the incident?
- calculate the speed of expansion of the gas plume;
- evaluate the evacuation area for the next 8 hours from the area covered by the current gas plume and the prediction;
- calculate a route, which does not overlap with the gas plume;
- find the location of all the fire brigade teams;
- give the locations of the measurement teams;
- give information that has been available 2 ours after the incident has taken place;
- when the fire brigade/ambulance arrived at the place of incident?;
- what is the size of the affected area?;
- give number of injuries/damages/... 4 hours after the incident has taken place;
- how many people of the police sector are involved? and so on.

Examples



- Show the trajectories of teams with ID11 to ID16
- Show the trajectories in the last 2 hours

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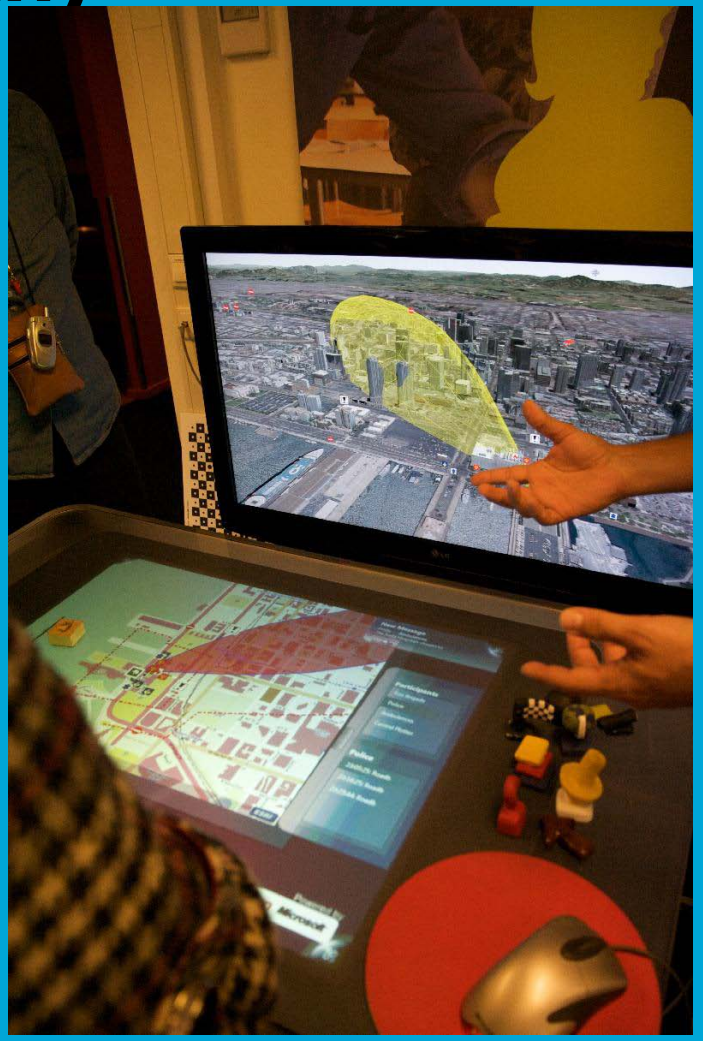
Visualisation (Geodan)



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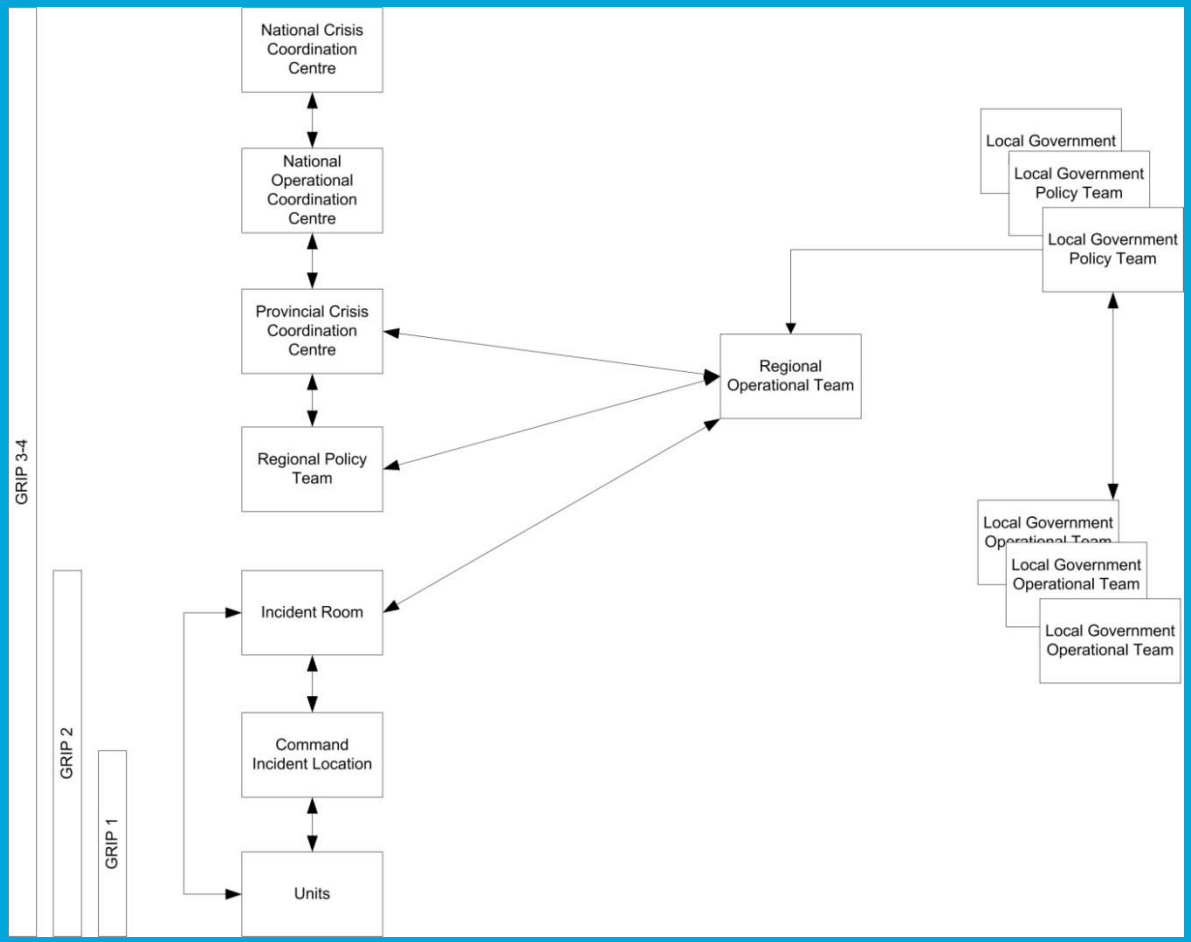
Not in the model:

- GRIP 3,4



Not in the model:

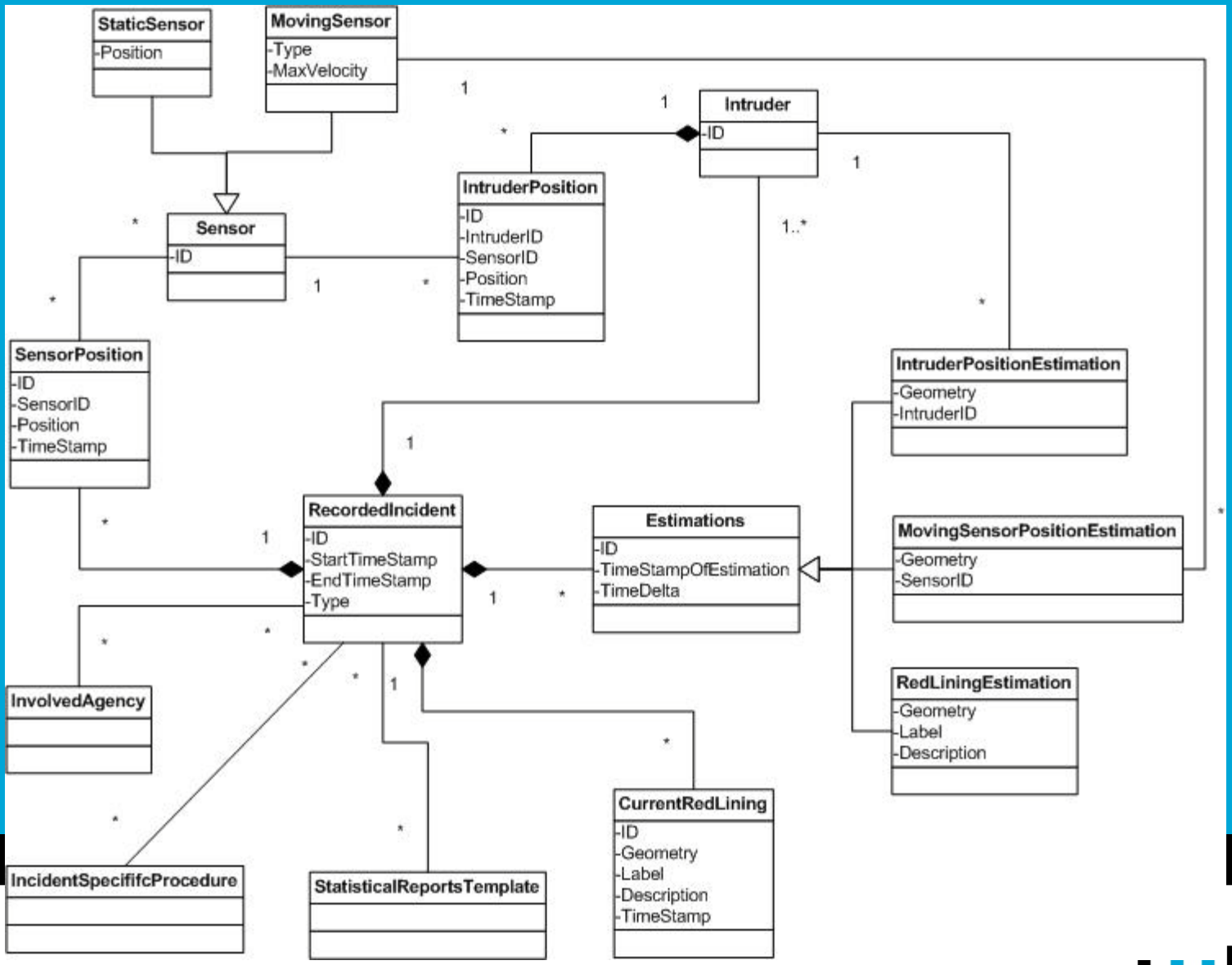
- Actors that are not primary emergency response units
- Information specific for a type of disaster (e.g. water level)
- Sensor information (any kinds of sensors)
- Physical models for prediction and simulation
- Moving objects

- ... some more limitations in geometry representations

Border security use case (illustration of moving objects)

- Intruder enter EU and is detected by a kind of sensor
- Police attempts to follow them
- Equipped with all kinds of sensors (GPS, camera, motion detectors

Formal modelling: UML class diagram



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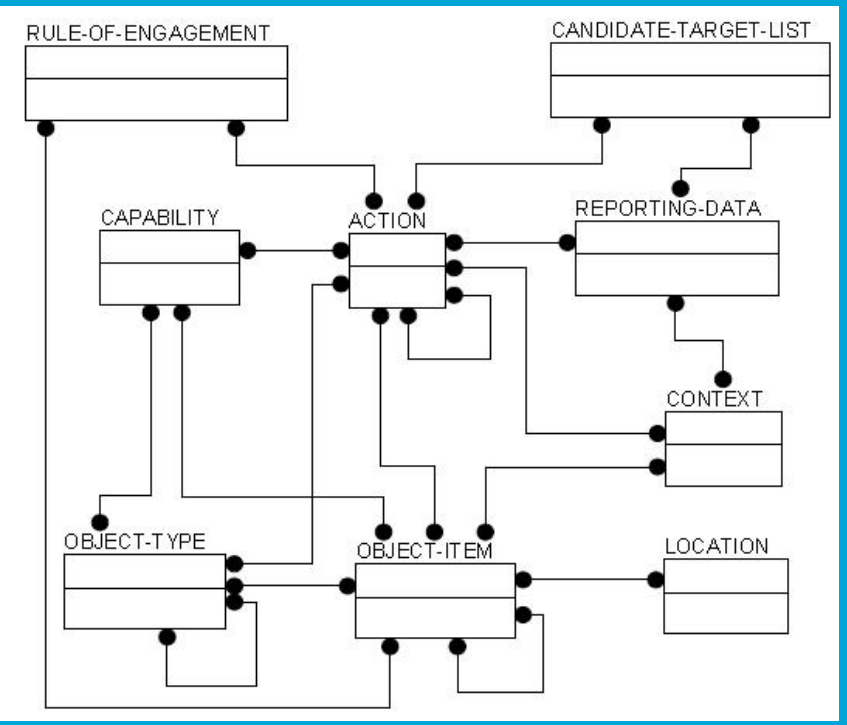
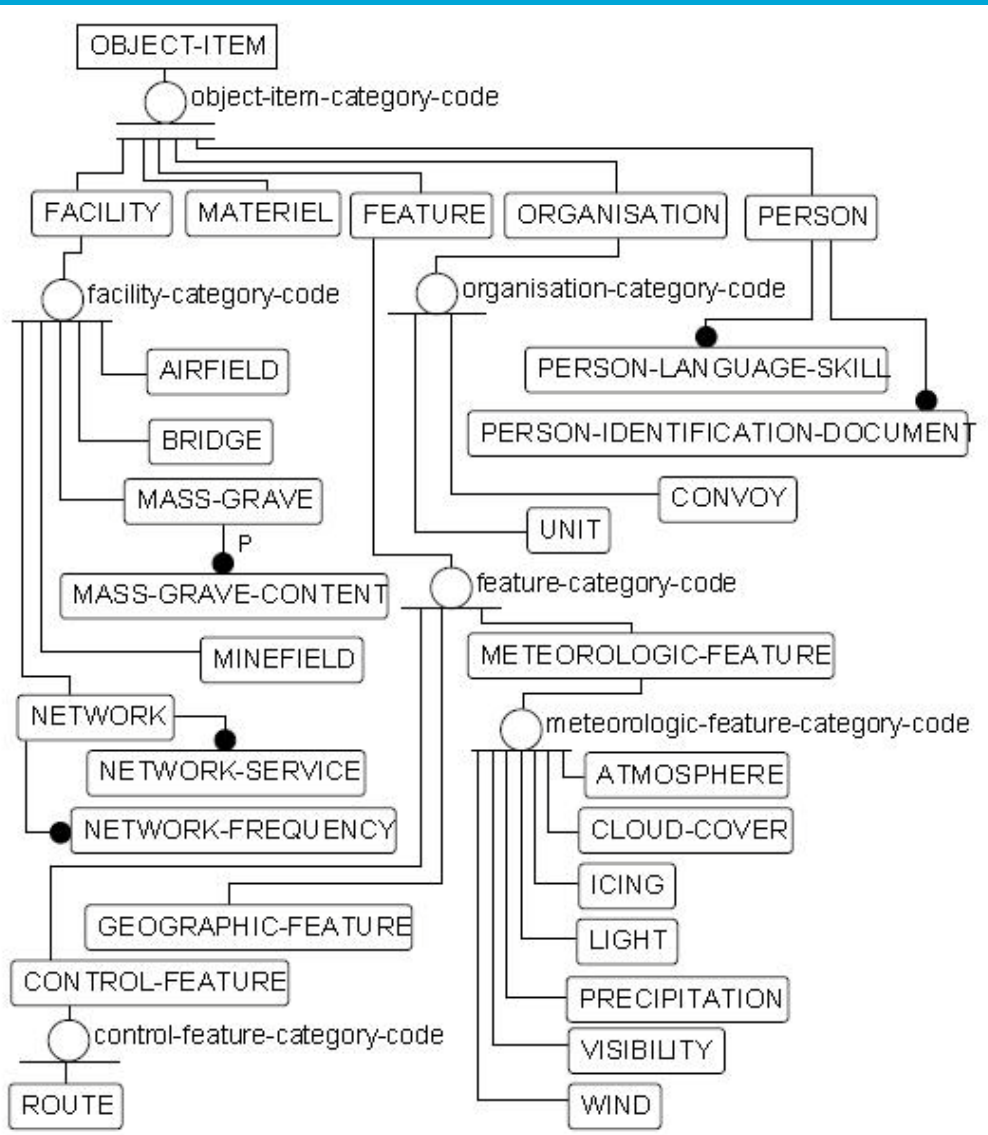
NATO: LAND C2 INFORMATION EXCHANGE DATA MODEL





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Operational models

- Many problems are expected:
  - Modelling just starts (many models already exist)
  - Needed information is not clear (like for example for topographic maps or cadastre)
  - Used information comes from many different sources (many formats)
  - Semantic differences (DM is practically a combination of several application domains)
  - ….

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- Investigation of data used in Emergency response
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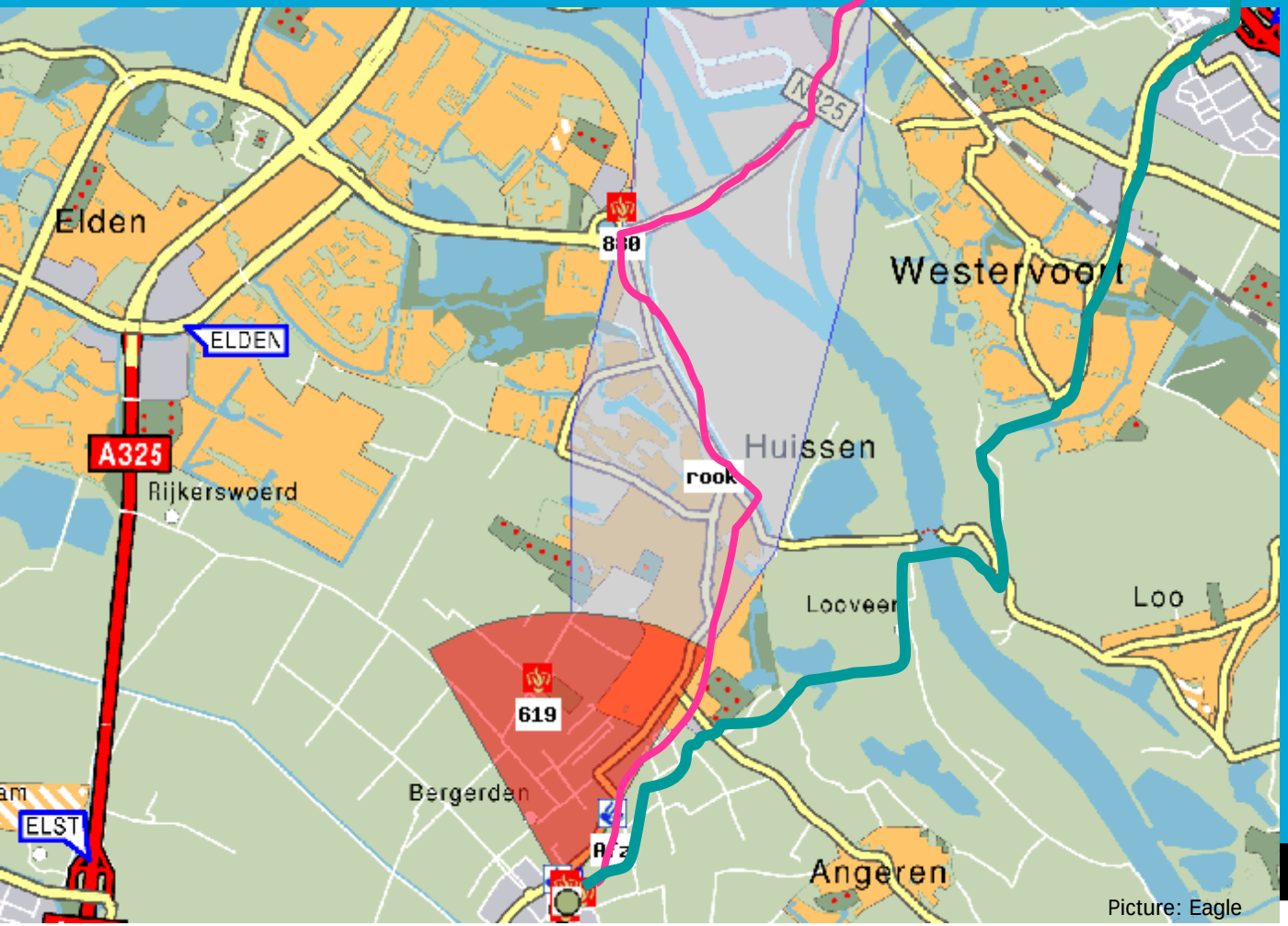
Existing navigation systems...

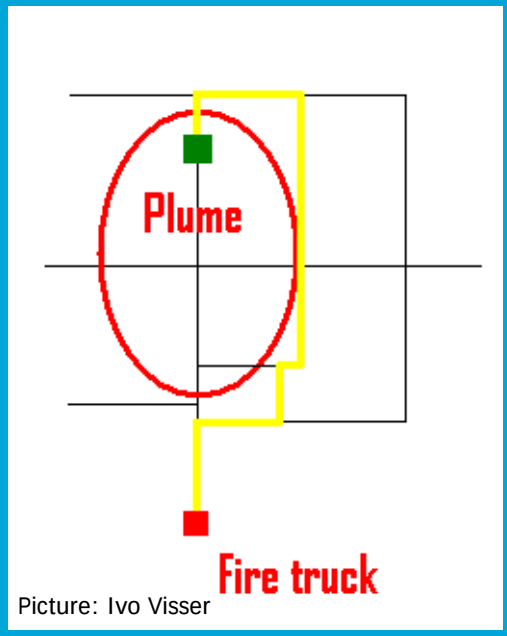
- Positions (and tasks) of other teams are unknown=>cooperation between them cannot be taken into consideration
- Accessibility of roads is unknown
- The road network is predefined
- Changing environment is not considered
- Tracking is possible (and done) but only monitored and not analysed

Factors influencing navigation in emergency response (1/2)

- Spatial information: roads, paths, pedestrian areas, etc…
- Users' information: task, personal data (age, gender, disabilities), equipment (personal devices) and location.
- Event (threat) information: information about development of disaster

Find the ‘optimal way’ considering the dynamic situation





How close?

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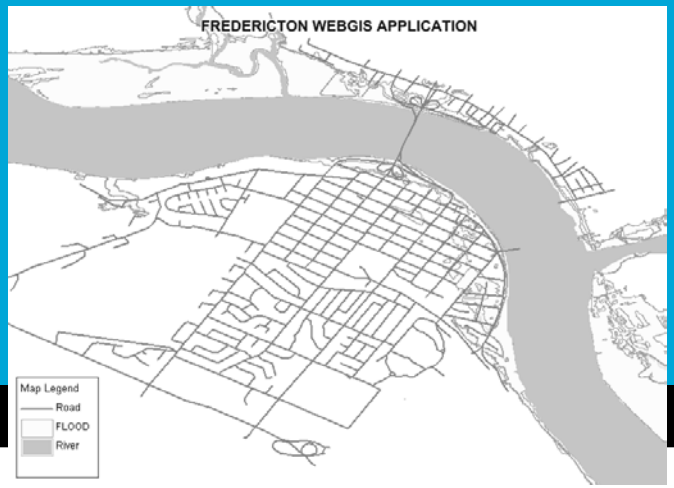
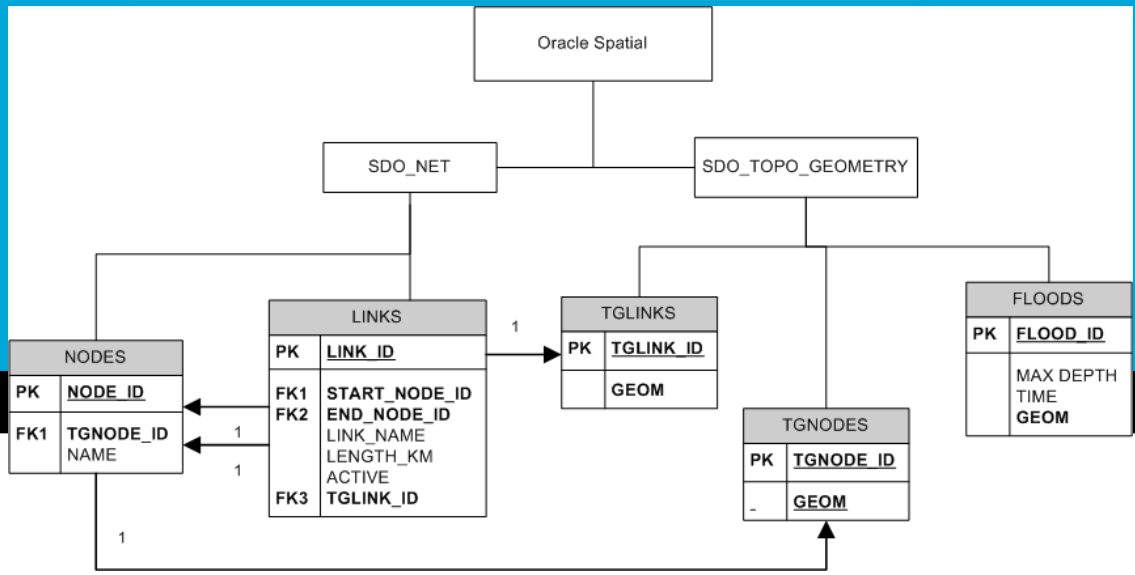
Find the ‘optimal way’ considering the dynamic situation





Mioc, Anton, Liang, 2008

Factors influencing navigation in emergency response (2/2)

- One or multiple moving objects
- One or multiple target points (which can be also moving objects)
- Cost function: 'optimal' path (shortest distance, fastest route, safe route, comfortable route)

Six navigation cases

- 1:1s, an ambulance to a hospital
  - 1:1s(?), an ambulance to the 'best' hospital
- 1:Ms, a truck carrying first aid supplement to many shelters
- M:1s, many fire trucks to one fire
- M:Ms, many ambulances to different hospitals
- M:1d, find a place for meeting of MO/catch criminals
- M:Md, evacuation of many responders to many moving places

s-static point; d-dynamic point

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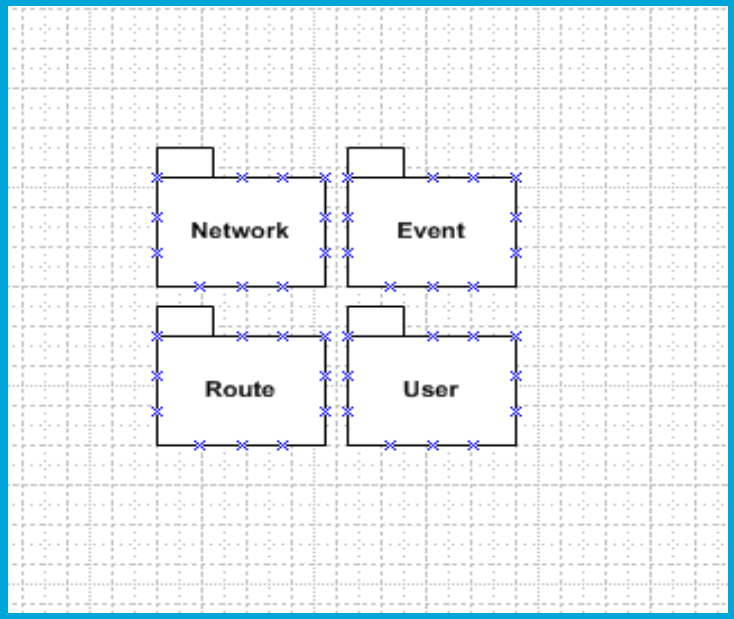
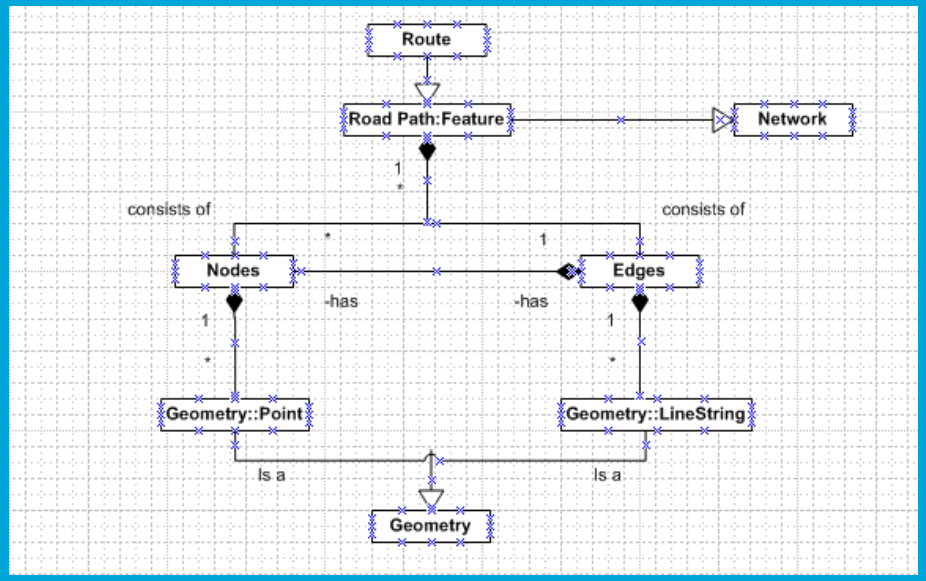
Spatio-temporal Model (1/2)



Four packages



Network (Route) class

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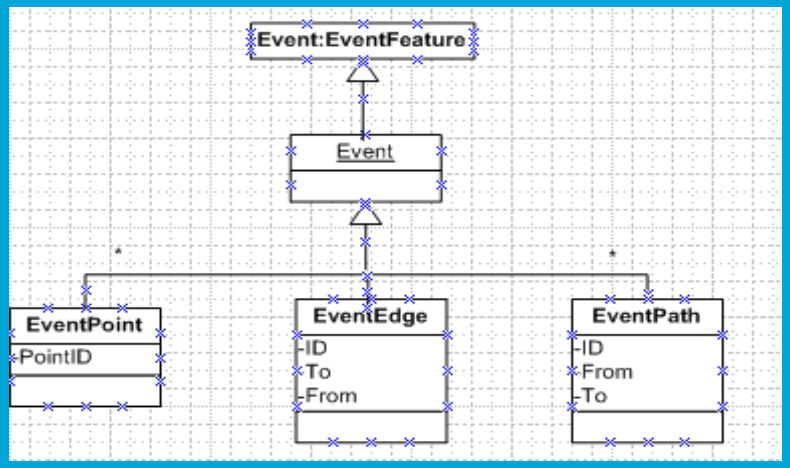
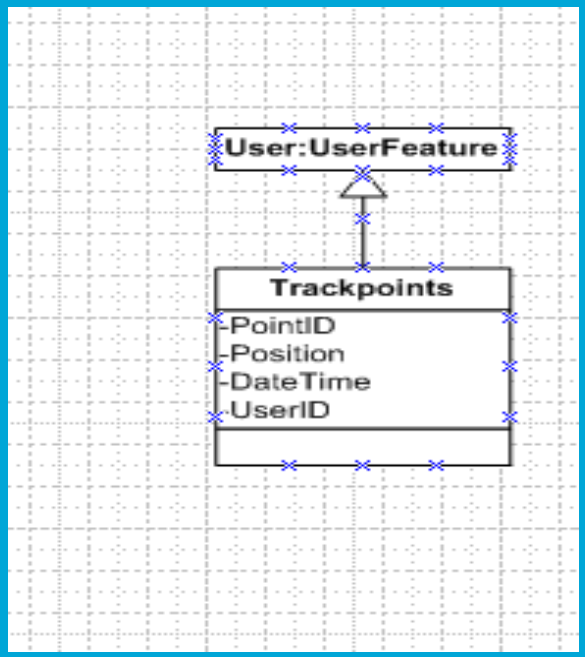
Spatio-temporal Model (2/2)





Event class

User class

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DBMS: 1:1s

```
select gid,the_geom from
  shortest_path_as_geometry('tudelft_street',981,1197);
```

Dijkstra algorithm

shortest distance

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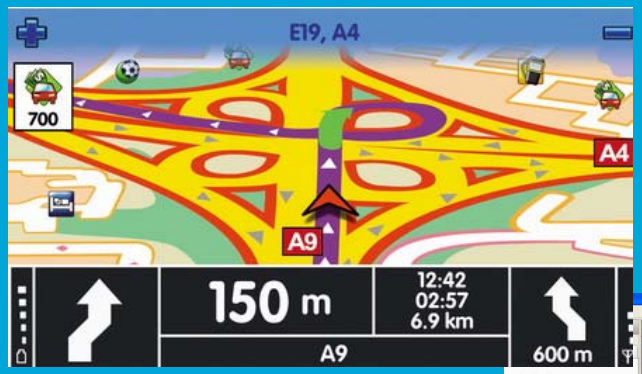
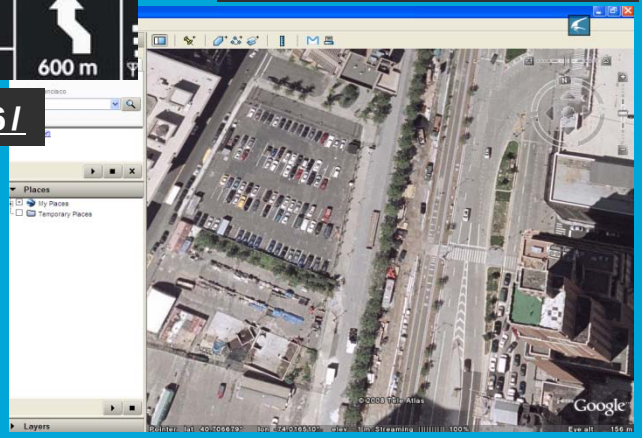
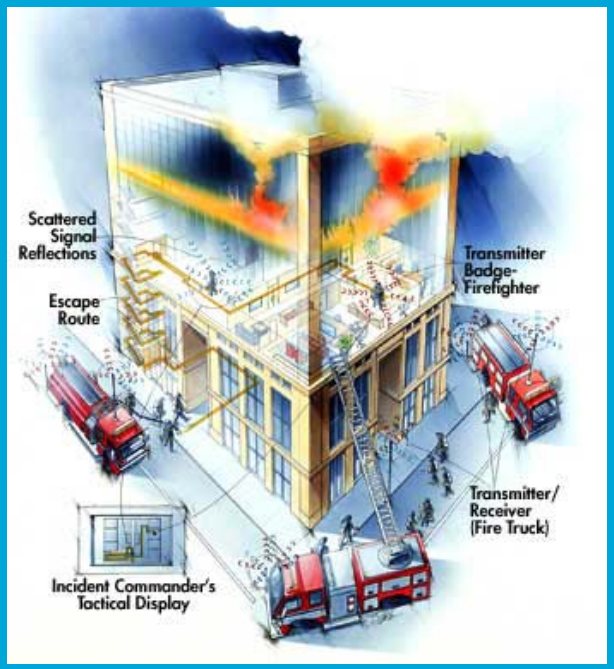
A Key Problem：3D Navigation



http://www.66.com/route66/

New York, Google Earth





http://www.ece.wpi.edu/Research/PPL/

- Integrated Indoor and Outdoor Navigation
- Personalized 3D Representation

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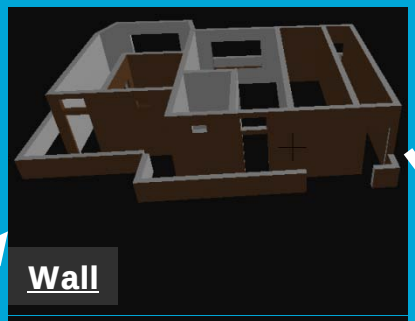
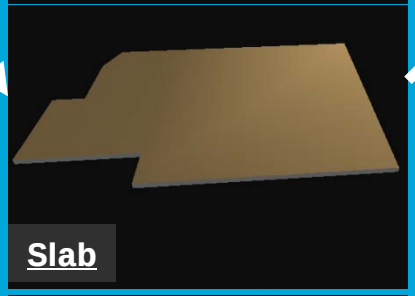
Indoor network model from Building Information Models

BIM Model



Wall

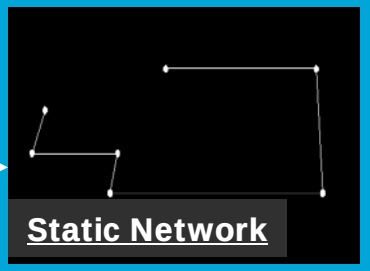


Slab

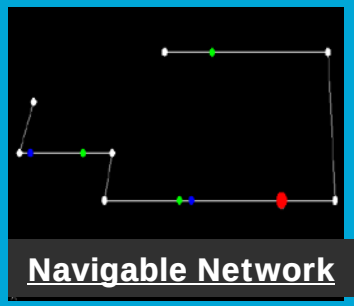
Doors & Windows

Stair

Corridor



Static Network



Navigable Network

Li Yuan, Xiamen University

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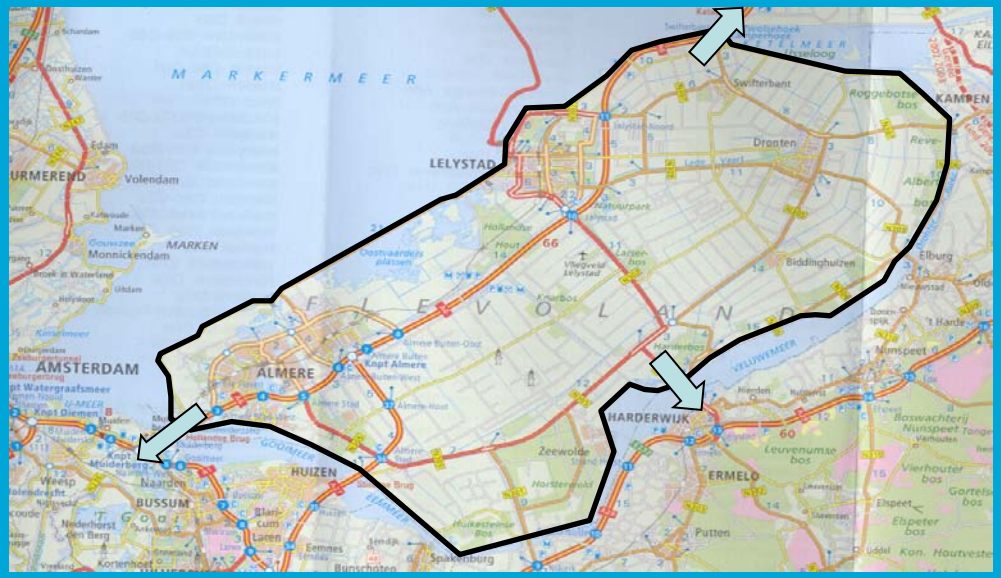
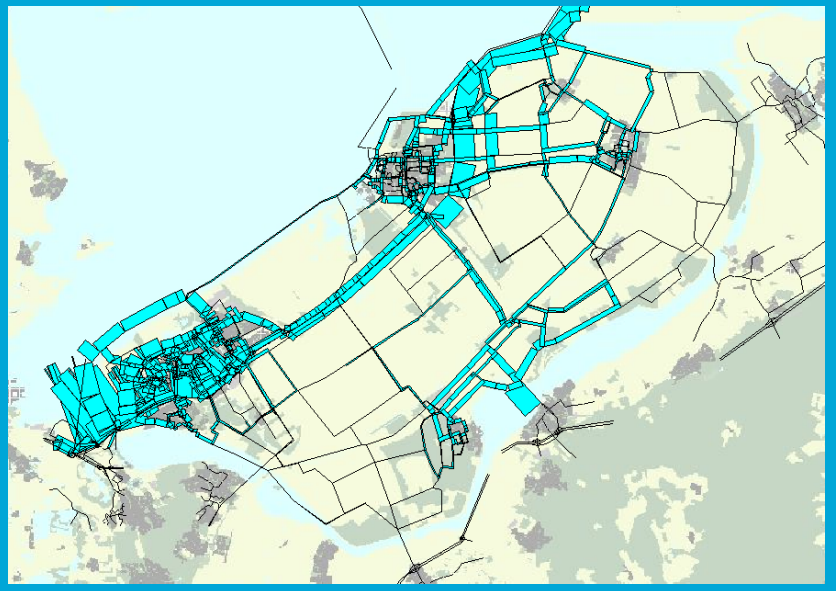
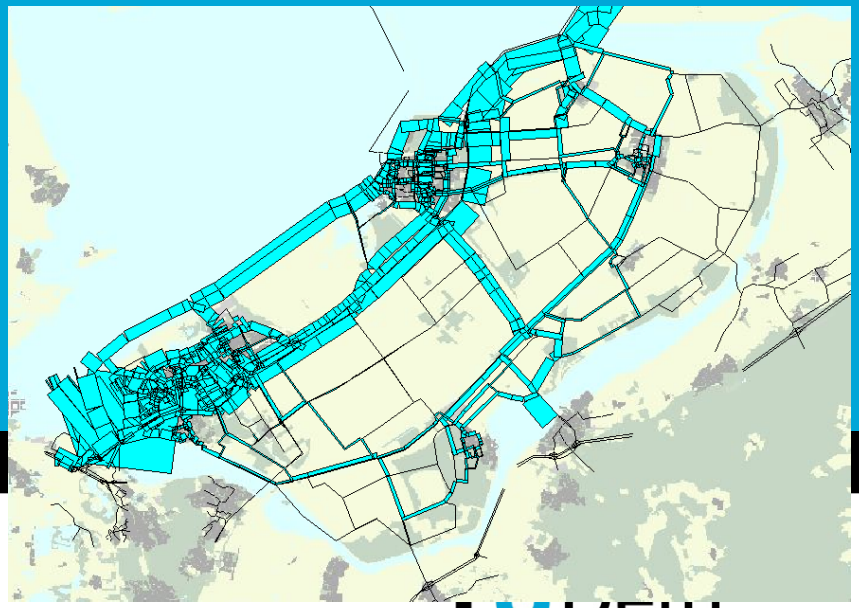
Evacuation models

26, 20, 17 hours







Zuilekom, Zuidgeest, 2008

Summary

- Modelling is critical for entire DM chain
  - Better understanding of data
  - Matching between different data set for integration (model-driven approach, match models and not data)
  - Exchange of information between different applications/users
  - Archiving of operation data for future analysis
  - Simulation and prediction
  - Modeling helps in developing context-aware applications.