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LABORATORIO INTEGRADO DE SISTEMAS INTELIGENTES Y TECNOLOGÍAS DE LA INFORMACIÓN EN TRÁFICO

Traffic Management with JBoss Rules University of Valencia LISITT

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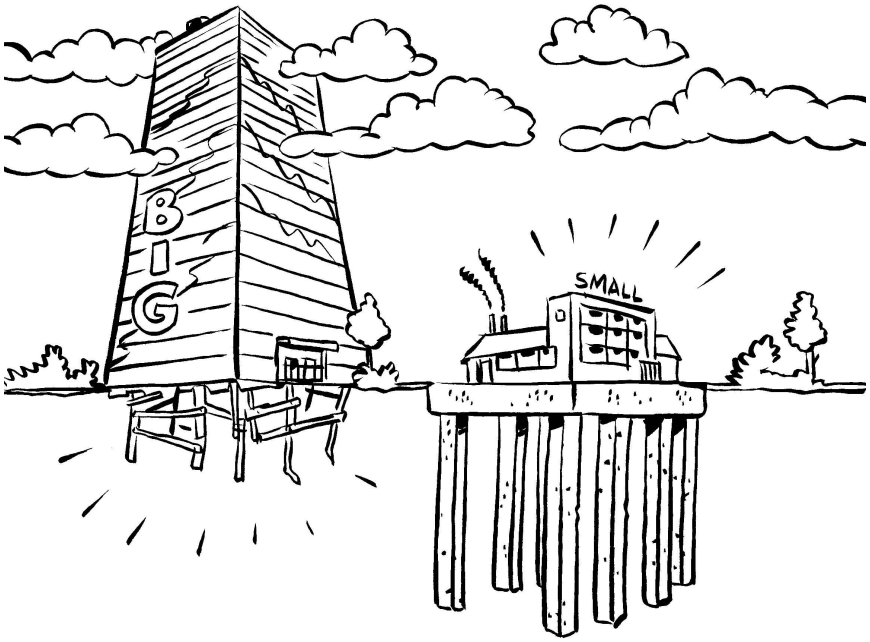
Introduction

- Traffic Management started in the early seventies with police officers managing the traffic on cross sections.
- In the last two decades the traffic has increased substantially creating a huge social, environmental and economical problem.
- In some countries it is not possible to keep increasing the road capacity so new IT-solutions had to be found.
- At the moment we have “infrastructure” based solutions such as information panels, ramp metering, tolling and information services via radio, television, internet etc.
- In the future we will have intelligent vehicles exchanging information about the traffic-, weather- and road conditions.
- There is a growing concern about *how* to integrate the different systems.
- The “world of Intelligent Transportation Systems” (ITS) is not dominated by technicians, most solutions are developed by civil engineers, mathematicians, behavioral experts etc.

Introduction

- ITS need the cooperation between individual ITS services to comply with present and future Transportation Policy Objectives (better, faster, cleaner…)
- The necessary Integration has not only strategic benefits but will prove "cheaper" on the long-term,
- An architecture helps with a solid fundament for development and integration.
- Already in the early nineties the benefits of an architecture for interurban traffic management was demonstrated in EU-funded research projects; first in the UROP-project and later in the Gerdien-project (in close cooperation with other projects such as ROSES, QUARTET etc.)
- The Dutch Ministry of Transport also investigated how to integrate the existing stuff → Paradigma



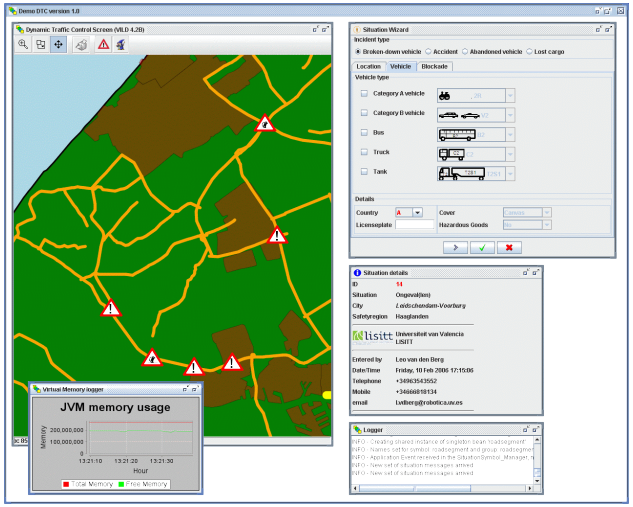
Introduction

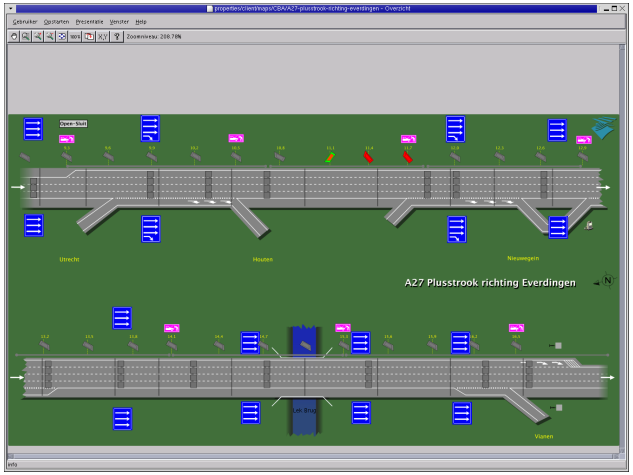
- **Paradigma was a low-budget [technology] R&D-project of the Transport Research Centre with apparently unrelated research objectives:**
  1. How can we create a sort of a “plug-and-play intelligent infrastructure for transportation applications?
  2. How can we create an extensible user interface for a traffic operator with existing Maps, but also with detailed views for object control?
  3. How can we seamlessly integrate the “old-stuff”
  4. How can we access statistic information [for research or evaluation purposes]
  5. How can we improve system maintenance?

- **Paradigma’s objective <u>was not</u> to create a system development blueprint, but to show and use state-of-the-art technology and possibilities to solve specific [User/technical] problems like:**
  - Legacy integration
  - Extensibility
  - Usability
  - Maintainability
  - Adaptability
  - Connectivity
  - Interoperability
  - Open source software use, performance and quality
  - And most important of all → <u>for and with real users</u>

Scalable Vector Graphics - SVG

- **Traffic Centre Operators need different kind of user-interfaces, depending on the task they need to perform and their experience.**
  - Traffic information type of applications use “geo-correct” maps, where only carriageways and/or road elements are shown. Different colours show the traffic status (red, yellow, green or unknown) Incidents are shown as symbols (warning, accident etc.)
  - Traffic Control applications need a more detailed or “schematic” view. Individual sensors and actuators are visible and the road is visualised as individual lanes. The road-geometry is distorted to maximise the number of points on a screen
  - The real “die-hards” use direct console input. Although decreasing, the operator likes this interface because of its efficiency (although very common nowadays, most ITS-systems don’t have an auto complete!)





* Ajax solved this problem partially

Postman Pat

- **Most ITS systems use a "store-and-retrieve" approach using a database Works great in "static environments" but is more complex in real-time environments with a very limited "data time window";**
- **Most dynamic ITS-applications have a ± 15 minute scope; "older" data is only necessary as "reminder" (so why should you store it first?) and new data types are likely to be added (meaning you must redesign the database…)**
- **Postman-Pat uses the concept of a Data Stream Management System which is more suitable for the dynamics of ITS-applications (however a DBMS will NEVER be obsolete, but should be used where appropriate)**
- **Postman Pat is used for the distribution of:**
  - Tuples, "flat" fixed length, time stamped numerical values transmitted as sequences (coming from a sensor network such as monitoring, or weather data),
  - Messages; information elements without a fixed length and containing complex data structures (complete list or trees of objects)
- **Postman Pat only delivers and is NOT interested in the content (just like most postmen)**
- **At present we use JBoss MQ (JMS) to implement Postman Pat,**

And the Business classes and rules ?

- **This was the most complex activity**
- **There is still no “common” vocabulary for the ITS-domain.**
- **Each project finds solutions for a specific sub-domain.**
- **There are no agreements on the way how to describe and design “things”, how they “interact” and what they “do”.**
- **Existing traffic models are complex and they need to be changed and tuned….. (again and again)**
- **The Ministry had some experience with fuzzy logic, expert systems, neural networks. Most of these projects failed because:**
  - The interaction with the “real world” is complex,
  - Specific (external) expertise was needed to program the models,

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ITS software framework

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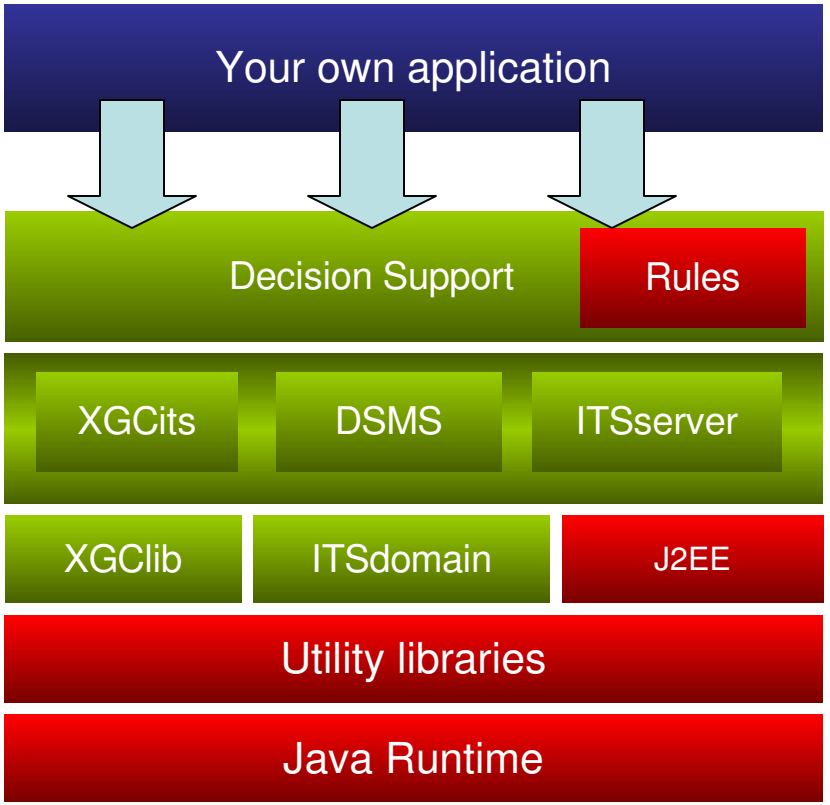
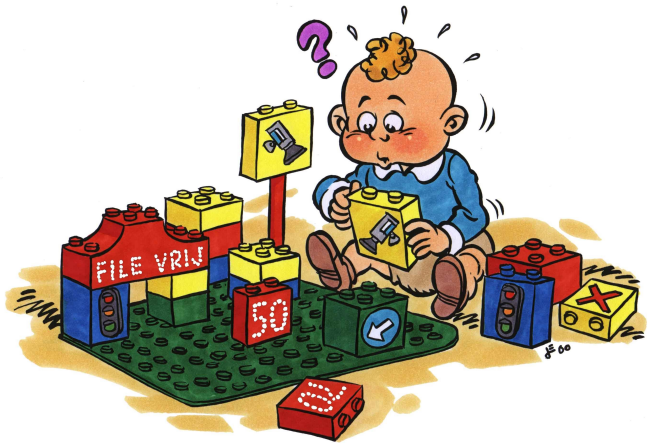
Functionality

- **Development started primarily focusing on the user interface with SVG**
- **The project got its present shape during the summer of 2005; a flexible and easily extensible [software] platform for all kind of ITS services**
- **The ITS software framework is "just" a set of components for the development of Interurban ITS and especially the graphic user interface. At the moment there are 6 libraries:**
  - ITSdomain provides all "domain" classes (road, datex, monitoring, weather, scenario's etc.)
  - DSMS, functionality for data distribution ("Postman Pat")
  - ITSserver, functionality for central storage ,access control, etc.
  - **Decision Support ; contains basic functions to use a "business rule engine" (Rules)**
  - XGCits, adds transportation functionality such as specific devices and traffic signals and the handling of specific traffic situations
  - XGClib: which contains basic components for a Map-based user-interface, Inter-process (IPC) and inter-person (P2P) communication (including messaging, email and SMS)



Functionality

- **The framework provides a Lego-like [java] toolbox from which applications can be build.**
- **It contains basic implementations for information elements based on a transportation information architecture:**
  - Speed, flow, traveltime, quality, incidents
  - Point and ProfileObservation, RoadElement, Roadsection, Route and Corridor ,
- **Triggers, Scenario, Measure and Action**
- **Provides functionality for data distribution (JMS), persistence (Hibernate) and rule based decision support (Rules),**
- **Provides basic user/role management authentication and authorization (user, organizations, groups and roles)**
- **Its objective is to prevent "re-inventing" the wheel over and over again; basic functionality can be re-used and extended**



Open-source

- **All components are developed as** open-source **as well as the used third party libraries**,
- **The libraries, sources and support documents will be available soon for download from SVN,**
- **The source code is given “as-is” without further guarantees.**
- **Professional support services will be available from early december 2006 (University Spin-off)**
- **Other Service providers can create the necessary configuration and may “sell” additional services.**
- **Service provision for “development and maintenance” in stead of “box-selling” and extremely expensive software development based on proprietary products;**

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Case 1:

The Incident Management Support System

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Incident Management Support System

The Dutch Incident Management guidelines provide:

- a clear view on the “why, with who and what” of handling specific traffic incidents.
- “Scenarios” which include the use of specific traffic management and –information tools and interaction with emergency services:
    - Regional and National Police,
    - Road administration,
    - Roadside assistance agencies,
    - Emergency services, such as police, fire brigade and ambulance,
    - Towing truck companies etc.

Problem:

- Still no organizational framework available; we have procedures for handling the incidents, but not for accessing and handling the related Incident Management information,
- No standardized localization and incident description available,
- Nobody allows full access to their information systems to other agencies for legal, organizational or technical reasons,
- The most important part of the management chain, interaction between organisations, is still a human operated task (telephone and fax are the most used means of communication)

Making all the information available to all “chain partners” could mean a next step in improving the incident management.chain

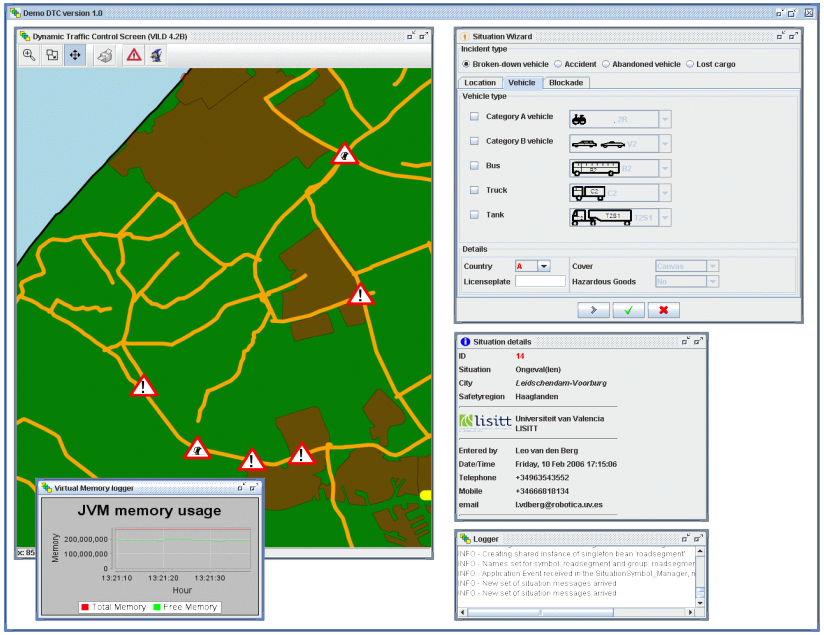
Incident Management Support System

The IM system includes functionality for:

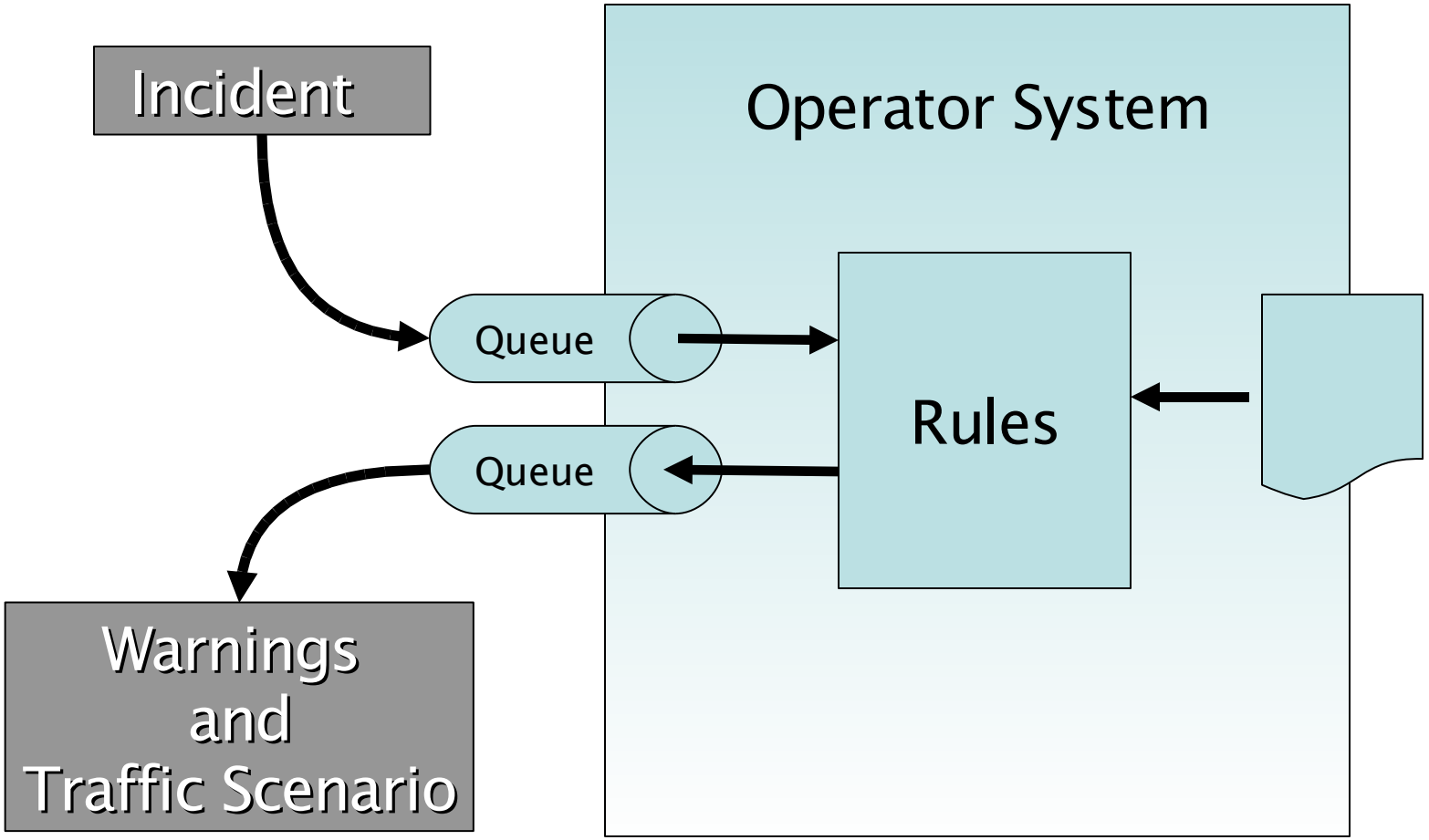
- **Acquisition of incident information based on the European Datex-standard,**
- **Persistence of all incidents and distribution of the incidents through a message mechanism,**
- **Displaying an accurate map of the Netherlands including city and province areas, road network and the visualisation of all incidents messages in a non-proprietary standard format,**
- **Real-time rule based decision making on each individual incident and semi-automatic handling of all resulting consequences based on the Traffic Management Plan concepts,**
- **Distribution platform for the dissemination of alert messages to the specific organisations and/or persons using traditional fax, email, SMS or XMPP based messaging**
- **Additional viewer for “external users” which displays a “situation overlay” on Google Maps.**

Incident Management Support System

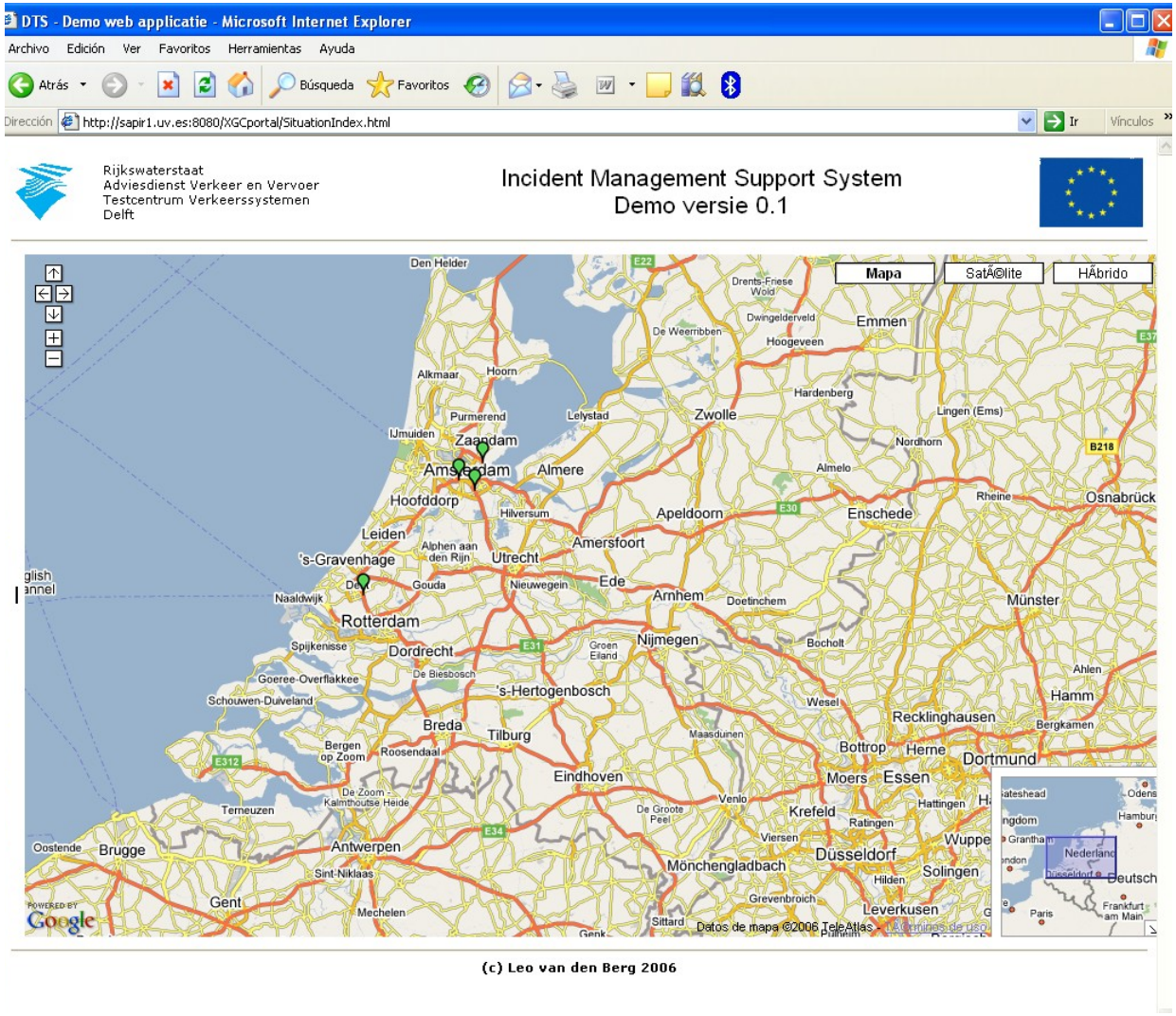
- The edit process is based on the “Incident Management Guidelines” (rood-blauwe boekje)
- After creating an incident, it is processed by a decision support module (operator expert system) which processes the incident using a set of user configurable rules.
- The rules can be extended and changed .
- Each rule can result in one or more actions such as sending an alert message to an emergency service or controlling a device such as a Variable Message Sign.
- These actions can be performed automatically or after the operator’s approval.
- traffic signal symbols are added to a “top-layer” and automatically displayed on the correct location,
- The map has support for real-time panning en zooming.
- The map and all the actual situations can be printed or send to other users via Fax, email or P2P-messaging,



Incident Management Support System



Incident Management Support System



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Incident Management Support System

Why Rules for operator support?

3. **Complex, hard to remember rules why and when to call emergency services,**
4. **Experienced operators can switch off support, but new operators will use it frequently,**
5. **Changes can be made relatively easily, the system can “learn” additional situations**

Problems

9. **Other users such as police still use their own legacy information systems, possibly we need to externalize the information system would and make it accessible through web services,**
10. **Traffic engineers need a more “domain specific” language, The University is working as a first step on a “traffic ontology”**

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Case 2:

The Traffic Flow Optimizer

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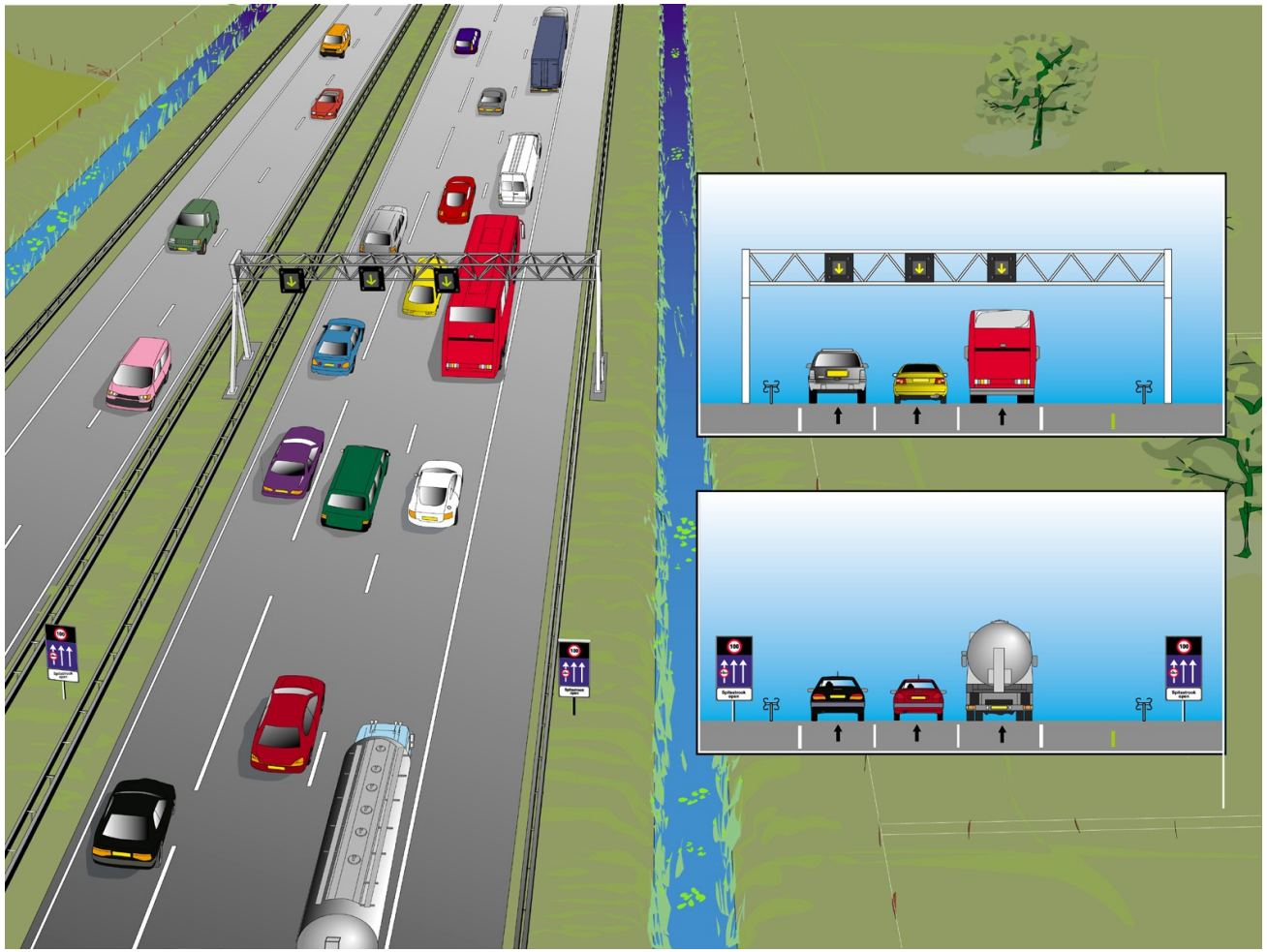
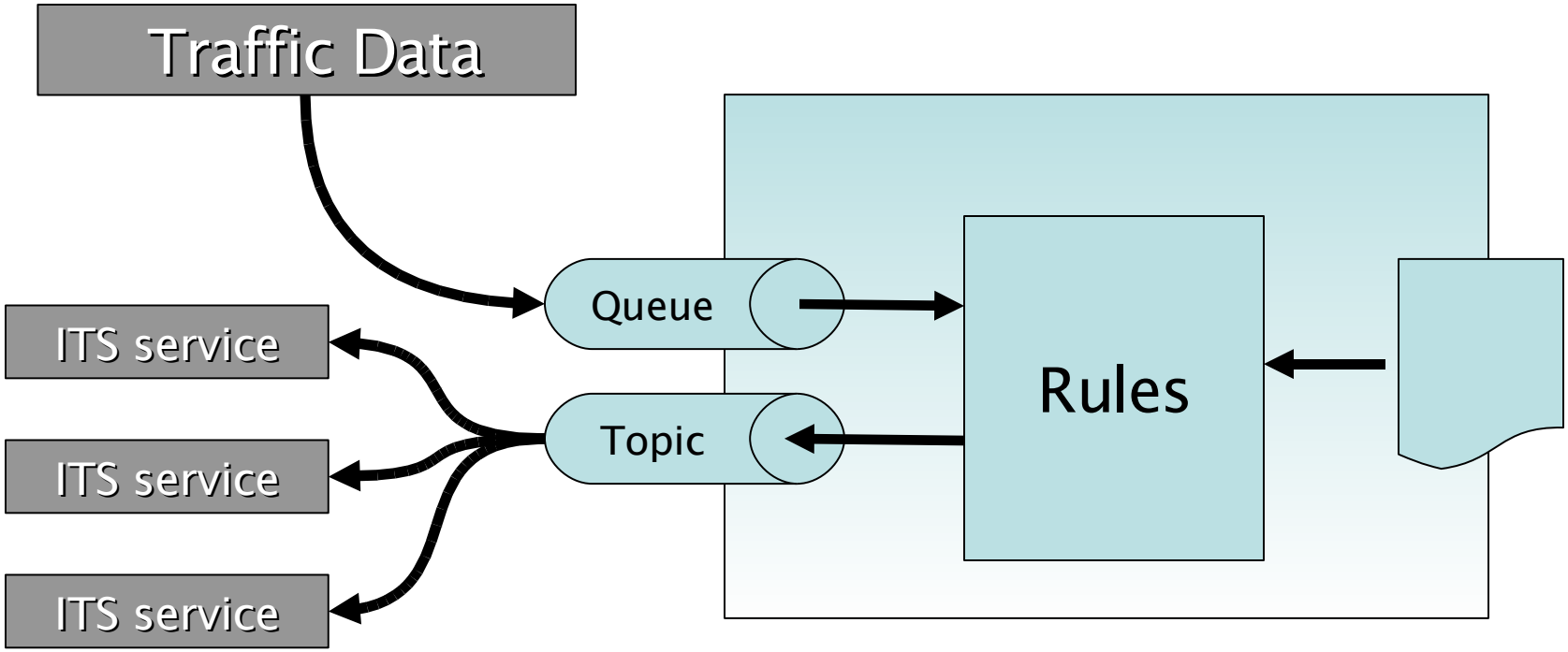
Traffic Flow Optimizer

- Actual traffic status in the Netherlands is measured every minute mainly with “electromagnetic” detection systems,
- Traffic congestion is detected automatically and a notification is send,
- All this data is send to 5 so-called “Monitoring Centers” in the Regional Traffic Control Centre,
- These Centers calculate basic information such as average speed, intensity and travel time for all road sections,
- There are also “prediction” models which intend to calculate these parameters for the next 15 minutes using the actual status and historical data,
- based on actual and the predicted traffic information we activate services such as information panels, ramp metering, radio traffic information etc.
- The latest addition is the “Plus” or “Rush-hour” lane; the use of the emergency lane during rush-hours.

Traffic Flow Optimizer



Incident Management Support System



Traffic Flow Optimizer

- **First attempt (very simple model): Throw in all measurements and try to find anomalies → *waste of time 95% of the time the system generates "no problem"* messages….**
- **Second attempt (with pre-filtering): Only throw in pre-triggered road section information ; define basic capacity and set the pre-trigger on 80% of the capacity all remaining is further processed → *Improved performance some 90% resulted in problem messages***
- **Third attempt: Trigger the plus-lane scenario → *resulted difficult because of the human-interaction***

Traffic Flow Optimizer

Why Rules for Traffic flow optimization?

3. **Can handle large amounts of information,**
4. **Centralized support service for all operators and possibly automating some services,**
5. **Changes can be made relatively easily, the system can "learn" additional traffic situations**

Problems

9. **We needed to "flatten" the model, first attempts used many "eval" statements to subtract objects**
10. **Combination with task management (through jBPM) is needed to solve the "process" part of some services**
11. **Traffic engineers need a more "domain specific" language, The University is working as a first step on a "traffic ontology"**

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Questions ?

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