Autonomic Infrastructure Management

*For Smarter world*......

Dr Muna Hamdi

Intelligent Mobility: Future Vision (iMFV) Collaboration Group

[www.imfv-group.org](http://www.imfv-group.org)

@
Smarter World

Smart Services should be available for Cities, Regions, rural environments to improve the quality of life, providing social inclusion & economic prosperity. This will necessitate the integration of systems & data networks, by creating Scalable platform that provides ‘intelligent infrastructure functionality’ as a service & allows for optimal resource management.

Modern systems may be described as “technological giants with a child’s brain”. Would conventional management systems be able to cope with the current rate of systems’ expansion?

Overview

• Why iMFV?
• Smart World? Smart Infrastructure?
• Autonomic Approach
• Conclusion & Future work
Seamless Travel!
Commercially viable vision or just a dream?

Ref: The science fiction that turned into science fact – Teleportation As seen in: Star Trek
http://www.telegraph.co.uk/science/7911939/The-science-fiction-that-turned-into-science-fact.html
Why iMFV?

**Problem**

- Costly ineffective patched work
- Lack of
  - Supporting policies
  - Long term planning
  - Adaptive Planning,
  - condition monitoring & maintenance
- Technology Driven – true intelligence?

**Need**

- Multi-model,
- Dependable
- Real-Time…..On-demand
- Integrated,
- Interoperable,
- Dynamic & Proactive,
- Informative
- Adapts to new environment & technology
Technology
Travel Management

Safe
Reliable
Green
Comfortable
Journey

Markets:
- Infrastructure
- Personal
- Commercial

User Acceptance

Inform
Monitor
Control

Services

Inform
- Passenger Information
- Journey Information
- Traffic Information

Applications

Business Case?

Business Case?
New world of mobile technology

To understand the **Transport network behaviour** it is essential to transfer these data to **useful & reliable information**.

To **predict** systems behaviour, user & market acceptance, related social & economic changes..etc.

**SMART 2020 report** found that Information and Communications Technologies (ICT) could **save 15% of global emissions in 2020**

---

**We need to understand behaviour to influence change of behaviour**

- **Availability**
- **Accuracy**
- **Security**
- **Privacy**
- **Ownership**
- **Sharing**

- **Multi-Source/Modal**
  - **Weather**
  - **Events & Incidents**
  - **Trains**
  - **Roads**
  - **Flights**
  - **Ships**
  - **Collective Mobility (taxi, bus, tram, metro..)**

- **Information & Options**
  - **Relationships**
  - **Behaviour Models**
  - **Prediction**

---

14 Jan 2016

iMFV @ Sunshine Project Final Conference
I²TS

Smart living
- social
- economic
- environmental
- policies
- built environment
- land use
Facts

At the present
• Europe is dominated by the passenger cars (73.4% compared to just 1.4% combined for the tram and metro).
• According to the World Health Organization, about 40 million people in the 115 largest cities in the EU are exposed to air exceeding WHO air quality guideline values for at least one pollutant.
• Recent studies showed even in peak hours 98% of road segments in cities are underutilized

Autonomous vehicles,
• expected to enable the doubling of the highway capacity: in 2040-ies the autonomous vehicles are likely to represent approximately 50% of the new vehicles sales, 30% of the total vehicle fleet and 40% of the total vehicle travel.
• the big impact they will have on safety, mobility and the environment revealed by tests shows a range of fuel reduction between 4.5 and 25.1% in cars and 2.4-15.3% for trucks.

Real-Time Information Synthesis (USDoT AERIS) shows that the application itself can provide average fuel savings of 5-10% per vehicle (annual savings of 170 USD for cars and 280 USD for SUVs, based on vehicles driving 8000 miles per year on arterial roads).

Expectations & EU Priorities

Autonomous, Electric & Cooperative cars, collective mobility & car independent infrastructure

• The fourth priority area of the European ITS Directive is focused on linking the vehicles with the infrastructure

• The Autonomic Road Transport Systems (ARTS) an action was started by the approved COST, to explore the potential of embedding autonomic properties into the design of transportation systems (McCluskey, 2011). The goal is to encapsulate the intricate decision-making process under generic objectives inserted by the operators.

References
How to Solve the Congestion Problem?

Car-Independent Society
Audi Urban Future Award: Winner
For Audi’s Urban Future Initiative exhibition in 2012, we designed a cityscape model of what Sao Paulo could look like come the year 2030: foot bridges...
DesignApplause | Audi's urban future initiative. Höweler + yoon
...designapplause.com
Uber’s Rise Presses Taxi Lenders

The values of taxi medallions are plunging, as passengers and drivers increasingly turn to ride-sharing services including Uber and Lyft.
Smart cities

2 types of projects

• Brand new
• Modernisation & regeneration projects
iMFV Programmes

• Autonomic Wide Area Network (AWAN) Manager
• iMFV in the Arab Region
• iMFV in your region
WE Need

Scalable & Adaptive to change
- Environment
- Technology
- HW performance
- Needs and requirements

Adaptation e.g.
- Update policies/strategies
- Create new goals, processes
- Tune parameters
- Provide actions or advice on actions
- Update & configure

Examples of Integration
- People with special needs Pedestrians Cyclist
  - Technologists
  - Urban designer
  - Policy makers
  - Medical
  - behaviour/social, human factors-Man/Machine interaction
- Mobile health
  - Location base delivery Medicine
- Condition Monitoring and Supply chain
  - Maintenance & Supply Chain
  - Weather > demand > product delivery > work load > traffic & logistics
Intelligent Infrastructure Platform
The Problem

Road Transport Management

Complex Systems in unpredictable, dynamic environments
Autonomic Management Systems

From human biology..................ability to manage itself & dynamically adapt to change in accordance with business policies & objectives (IBM, 2005)
System Autonomy

**Automatic**: system carries out a process itself generally humans create the process to achieve certain goals

**Autonomous 1**: system carries out a process involving situations where it makes decisions itself, possibly based on data from a dynamic unpredictable environment generally humans create the process to achieve certain goals

**Autonomous 2**: system creates a process to achieve certain goals, system carries out process itself, possibly based on data from a dynamic unpredictable environment generally humans create goals for the system

**Autonomic**: system creates its goals according to its self-management properties, system creates a process to achieve these goals, and system carries out the process itself humans create the system and embed it with self-management properties
Benefits .... more for less

Adaptable requiring less:
Ownership costs, human management, change & maintenance

ARTS
Increasing:
Capacity, Capability, Dependability & ease of management

Autonomic Management of Limited Resources (Time, Roads, Energy, Money,..) provides

- Expertise
- Efficient energy management
- Save time
- Reduce pollution
- Save money
- Aid limited human capacity towards rising costs

Autonomic Management should be able to inform us of

- the benefits of implementing a policy
- Disadvantage of a policy
- conflict
- Provide alternatives
Properties of Autonomic Systems

“**Self-configure:** to adapt dynamically to changes in the environment, using policies provided by operators”.

“**Self-optimise:** automatic monitoring & control of resources & balance workloads to ensure the optimal functioning with respect to the defined requirements”

“**Self-heal:** to discover, diagnose & act by correction of faults to prevent disruptions”

“**Self-protect:** to anticipate, detect, identify, protect against threats”

<table>
<thead>
<tr>
<th>Concept</th>
<th>Current computing</th>
<th>Autonomic computing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-configuration</td>
<td>Corporate data centers have multiple vendors and platforms. Installing, configuring, and integrating systems is time consuming and error prone.</td>
<td>Automated configuration of components and systems follows high-level policies. Rest of system adjusts automatically and seamlessly.</td>
</tr>
<tr>
<td>Self-optimization</td>
<td>Systems have hundreds of manually set, nonlinear tuning parameters, and their number increases with each release.</td>
<td>Components and systems continually seek opportunities to improve their own performance and efficiency.</td>
</tr>
<tr>
<td>Self-healing</td>
<td>Problem determination in large, complex systems can take a team of programmers weeks.</td>
<td>System automatically detects, diagnoses, and repairs localized software and hardware problems.</td>
</tr>
<tr>
<td>Self-protection</td>
<td>Detection of and recovery from attacks and cascading failures is manual.</td>
<td>System automatically defends against malicious attacks or cascading failures. It uses early warning to anticipate and prevent systemwide failures.</td>
</tr>
</tbody>
</table>

Ref: Kephart and Chess - 2003 - *The vision of autonomic computing (IBM)*
Dependable System Attribute:
- Reliability
- Availability
- Safety
- Security
- Robustness

20 Year Transport Vision (20TV)
Intelligent systems are adaptive to change with the ability to perceive, learn, optimise, predict, plan, manage, detect conflicts & advise on or take a corrective action.

Traveller decision making is highly dependent on higher levels of decision making. ‘Intelligent’ systems are adaptive to change with the ability to perceive, learn, optimise, predict, plan, manage, detect conflicts & advise on or take a corrective action.

Higher Level Planning allowing management intervention capabilities to
- meet policy objectives
- evolve in response to change in policy,
- identifying conflicts
- saving in costs

Plans execution deals with planned disruptions, & predicted regular flows

Unplanned incidents, operators:
- interpret data & make a judgment of the nature of the incident
- record the details of the incident, and communicate the details to road stakeholders
- execute & monitor appropriate pre-formed plans

Current coverage of Technological Support

Future coverage with Autonomic Systems Approach

Adapted from Ref. http://compeng.hud.ac.uk/scomtlm/cost.html
Conventional & Autonomic Systems, illustrating the capability to “deliberate” (reason) and to optimise outcomes for declared “goals”, policy directives, operational environment and available control.

Conventional: reactive systems

Autonomic: “deliberative (aka self-aware) systems

Goals, States, Actions, Service Levels, ...

Autonomic Systems, illustrating the capability to solve the crisis of large software-intensive systems: their configuration, management, maintenance, evolution ....
DISTRIBUTED ARTS Architecture

Our focus is on developing an ARTS that would scale to manage wider regional networks, adaptable to change in environment and traffic demands, have ability to anticipation behaviour, predict consequences, and collaborate in a distributed environment using knowledge of a mixture of “goals” and intervention capabilities (which may be conflicting) of the various stakeholders.

Currently working on implementing autonomic properties for multi-objective, real-time, dynamic planning & scheduling tools.

Reference:
ARTS Cost/Benefit analyses & Business Model On-going Study that aims to

To Build a collaborative base that supports the development & deployment of ARTS - To explore progress within ARTS addressing:

• Cost/Benefit analysis. building a business model for change

• Current and future applications: for example, how ITS application would contribute to improving safety, behaviour change & law enforcement?

• Current and future infrastructure: for example – exploring Autonomic Cooperative Systems & issues of privacy & security

• Current and future standards – current work on standards will shape future outlook as standards takes years to develop and approve – how can we involve standard bodies?
Conclusion

Thinking of I²TS as part of a Smart Infrastructure

allow us to reach out for solutions that are beyond the capacity provided by the current transport networks
ARTS Cost/Benefit analyses & a Business Model Study

For operators/stakeholders to believe in a new management approach building ‘trust’ is the key.

focuses on:

• To build up for market acceptance ensuring long term deployment of solutions that will interoperate and interwork.

• Ensuring future stakeholders involvement: Creating an ongoing dissemination & engagement programme that aim to build stakeholders trust. Thereby, securing future funding for further research and testing the technology demonstrators developed by the ART Network.
Future Collaboration on

• ARTS BM & Stakeholders Engagement Programme
• ARTS Demonstrators – Testing it in the Real-World
• Funding Allocations for Smart Infrastructure Project Collaboration
Submit a short article for iMFV @ Google+ & Follow our news on iMFV discussion boards in LinkedIn
Thank You

Autonomic Infrastructure Management

For Smarter world....... 

Dr Muna Hamdi
Intelligent Mobility: Future Vision (iMFV) Collaboration Group
muna.hamdi@imfv-group.org

www.imfv-group.org
iMFV @ Google+