Towards Collaborative Mobility: 
Elastic Transport Infrastructure & 
Research Challenges
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Elastic infrastructure

Concept – TEAM Collaborative network
Elastic infrastructure

Objectives (1/2)

• **Elastic traffic infrastructures** - let infrastructures start to be flexible and change based on citizens’ or cities’ demand and interactions with them.

• Provide “on demand” services for mobility to offer a maximum of flexibility in the usage of different transport modes (multi-modal mobility) and easy access modalities allowing an affordable and environmental friendly mobility.

• Development of **collaborative applications** which are focusing on the infrastructure side targeting mainly the enhancement of energy efficiency and environmental friendly mobility, without neglecting also the safety and comfort benefits, taking into account basic system components from EMPOWER.
Elastic infrastructure

Objectives (2/2)

• Make flexible use of available mobility facilities (i.e. road lanes, parking places etc.) by making a **sustainable dynamic planning**.

• Provision of **cooperative control sensing and optimization algorithms** which are able to:
  - *evaluate mobility decisions or behaviour* in regard to other stakeholder’s needs and behaviour,
  - *orchestrate different user alternatives* in a way, that they are adjusted to increase traffic efficiency and optimize mobility.

• Development of a set of **enablers** (i.e. data, aggregated data, algorithms or tools) which together with the horizontal technologies and subsystems to be developed at the EMPOWER sub-project will be the key components used by the TEAM applications.
Elastic infrastructure

Applications – Outcome of stakeholders survey

• Collaborative pro-active urban/inter-urban monitoring and ad-hoc control (CMC)
• Collaborative co-modal route planning (COPLAN)
• Co-modal coaching with support from virtual/avatar users (CCA)
• Collaborative smart intersection for intelligent priorities (CSI)
• Collaborative public transport optimization (CPTO)
• Dynamic collaborative corridors (DC)
## Stakeholders preferences and constraints

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Preferences and constraints / Main targets</th>
</tr>
</thead>
</table>
| Users                        | Egoists: fastest, smoothest, most convenient route  
• Congestion avoidance     
• Improved bus services      
• En-trip information        
• Decision support etc.    
They don’t want to be monitored by the “system” |
| Road operators               | • Safety (human and cost reasons)  
• Sustainability of the road infrastructure | |
| Public transport operators   | Maximise quality of service and minimise their costs (conflicting)  
• Priority scheduling / Green wave  
• Dynamic bus lines, bus lines synchronisation etc. |
| Local authorities            | Focused on their residents’ preferences  
• Congestion reduction       
• Modal split               
• Access control            |
### Stakeholders preferences and constraints

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| **Traffic management centres** | Efficiently manage the traffic to keep other stakeholders satisfied  
  • Current traffic state & forecast, historic data  
  • Reaction to incidents  
  • Flow maximisation  
  • Provide data to third party companies                                                                                                                                                                                                                                                                      |
| **Automotive OEMs and suppliers** | Real-time (traffic) information to the driver – competitive advantage  
  • Equipment for gathering (traffic) information, providing this information to the TMC and receiving traffic information gathered by others                                                                                                                                                          |
| **Others**                   | Logistics providers: interested in post processed data from the TMCs for providing good services to their customers  
  Emergency vehicles: they want to be as fast as possible while disregarding all constraints and preferences of all other stakeholders                                                                                                                                                                      |
Users, stakeholders, and use cases

Stakeholder survey

**Business Case**

<table>
<thead>
<tr>
<th>CMC</th>
<th>COPLAN</th>
<th>CCA</th>
<th>CSI</th>
<th>CPTO</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.92</td>
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<td>6.40</td>
<td>7.79</td>
<td>8.30</td>
<td>7.61</td>
</tr>
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</table>

**End User Acceptance**

<table>
<thead>
<tr>
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<th>CPTO</th>
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<td>7.17</td>
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<td>6.84</td>
<td>8.07</td>
<td>8.48</td>
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</table>

**Mobility of Travelers**

<table>
<thead>
<tr>
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<th>CSI</th>
<th>CPTO</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
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<td>8.74</td>
<td>7.45</td>
<td>8.52</td>
<td>8.70</td>
<td>8.00</td>
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</table>

**Traffic Throughput Benefit**

<table>
<thead>
<tr>
<th>CMC</th>
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<th>CPTO</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.20</td>
<td>8.67</td>
<td>6.24</td>
<td>8.90</td>
<td>7.60</td>
<td>7.74</td>
</tr>
</tbody>
</table>
Users, stakeholders, and use cases

Stakeholder survey

Environmental Benefit

Safety Benefit

Community Benefit

Technology Challenge
Research Challenges

Technical related challenges

- Mobile communications convergence for ITS
  - 802.11p
  - LTE
- Local Dynamic Map++ (LDM++) and Data cloud
  - Flexible/layered mobility information management
  - Local level (e.g. vehicle/mobile) & system level (e.g. cloud) real-time operation
- Increased position accuracy (cooperative GPS)
  - Exchange of raw GNSS data
  - Different communication protocols & technologies
- Privacy and security
Collaborative optimisation & control algorithms

- Designed for large scale systems exploiting infrastructure information and mobile data
- **Key innovations:**
  - Considering all road users and their interactions (not only the needs of an individual driver or traveller)
  - Regulate the system in a decentralized best-effort manner
  - Elastically respond to the changing needs of the participating actors
- Different **algorithmic approaches** under examination:
  - Game theory
  - Control theory
  - Optimisation
  - AI/Machine learning
Conclusion & outlook

Conclusion

• Elastic infrastructure – A key concept for addressing transport problems of modern cities
• Promising results from the stakeholders survey for future deployment and exploitation
• Innovative applications selected (stakeholders survey)
• Several research challenges to be addressed: technology related & algorithms related (optimisation & control)

Outlook

• Design & architecture of elastic transport infrastructure
• Implementation and integration
This project is co-funded by the European Union
Thank you!

Dr. Angelos Amditis  
*Research Director*  
ICCS

**Contact**

9 Iroon Polytechniou str,  
Polytechnic Campus, Athens, GR-15773  
Phone: +30 210 7722398  
Fax: +30 210 7722291  
Email: *[a.amditis@iccs.gr](mailto:a.amditis@iccs.gr)*  
Website: [http://i-sense.iccs.gr/](http://i-sense.iccs.gr/)