



## Safety and Comfort Services for Intelligent Traffic Systems Based on 3GPP Femtocell Technology Connected to Locally Deployed Application Logic

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..... Alcatel-Lucent

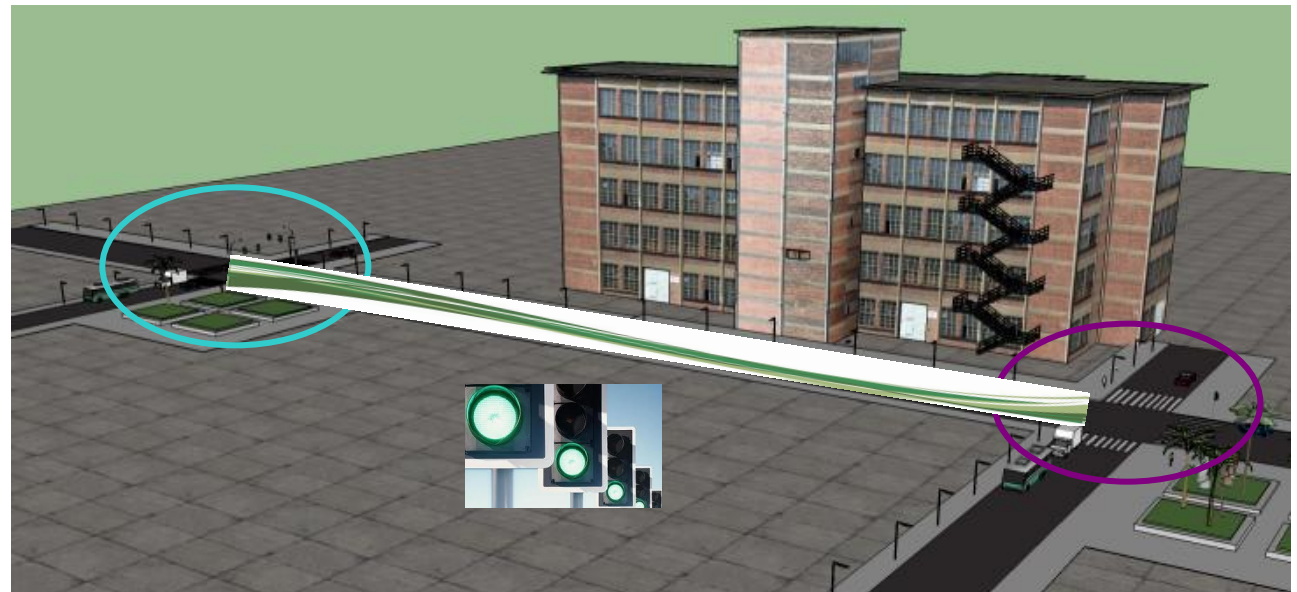
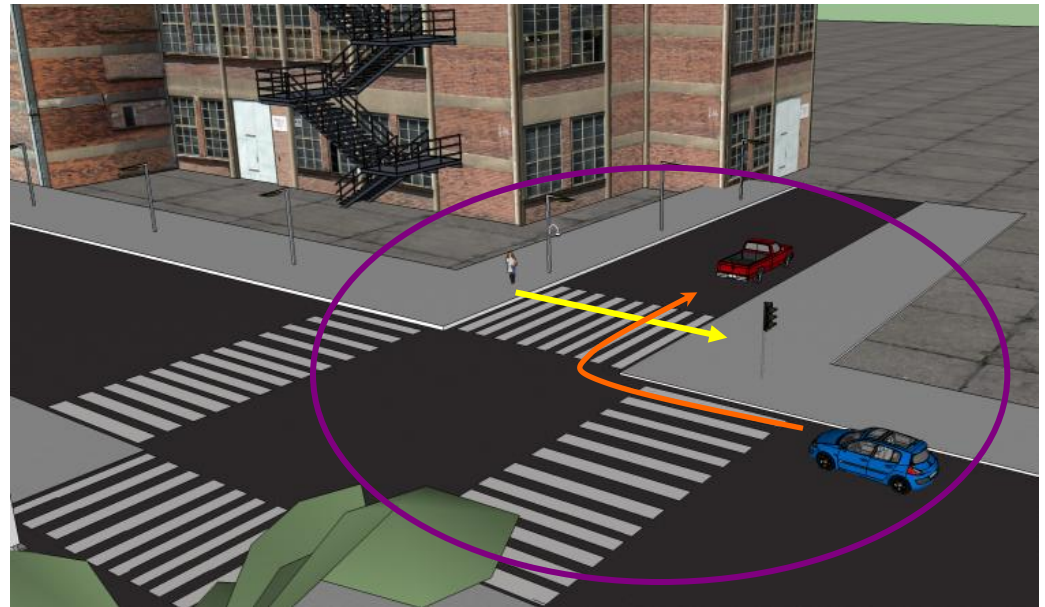
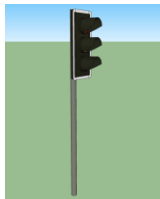
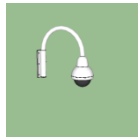


# AGENDA

1. Problem space
2. Challenges
3. Solution
4. Demonstrator at Lommel Proving Ground



# Problem space

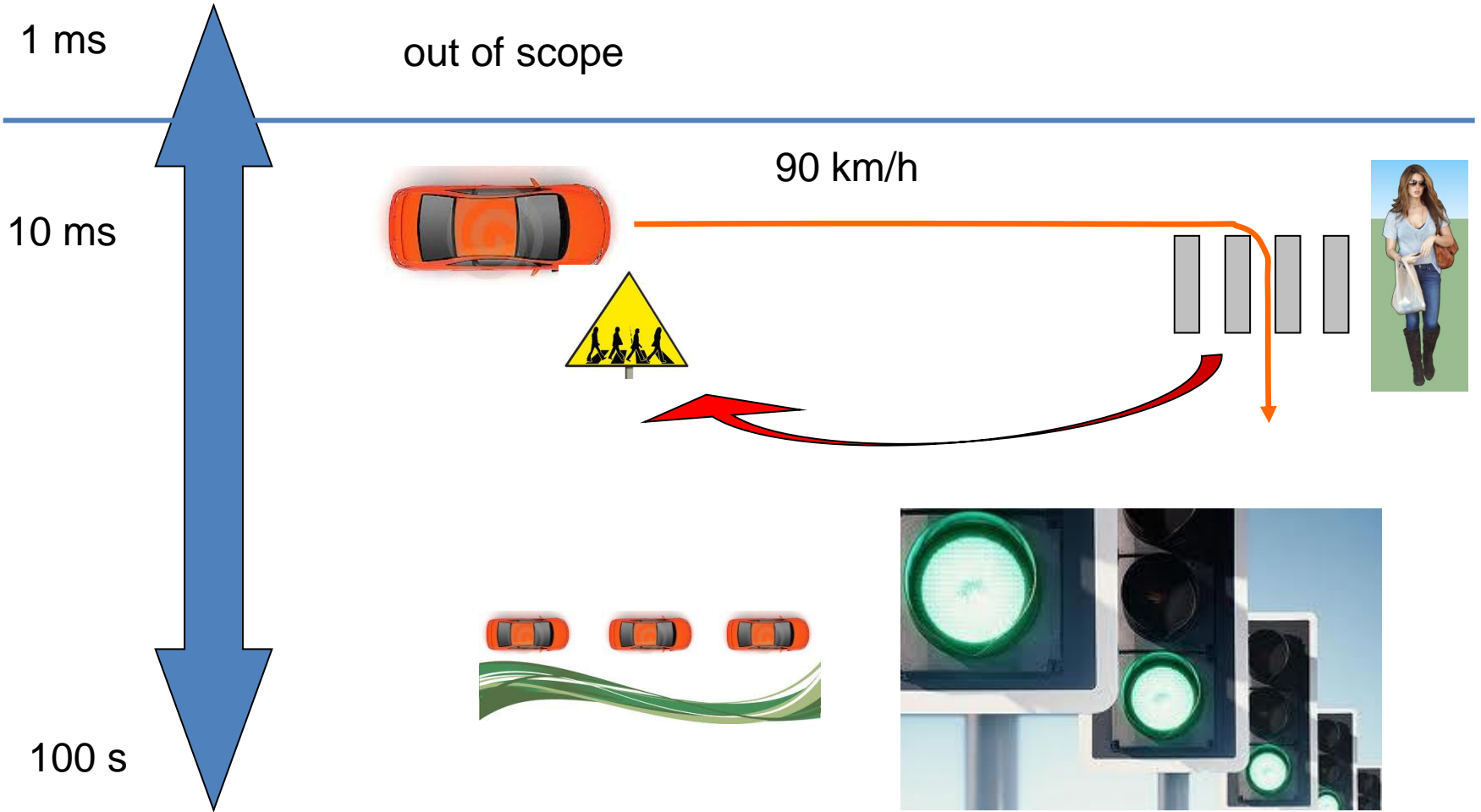


# Problem statement: Road infrastructure - car communication

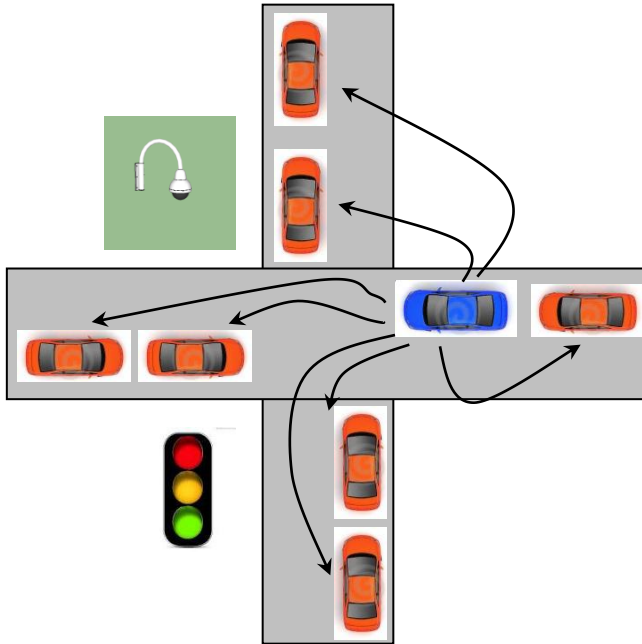


# Challenges (1)

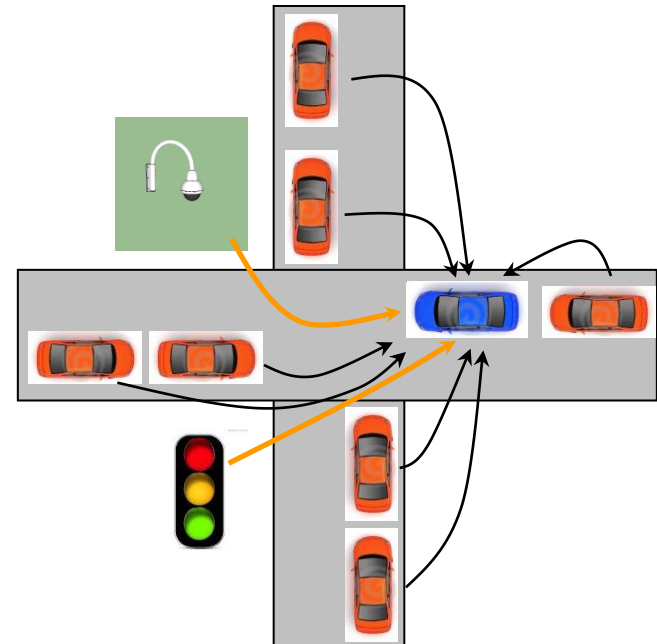
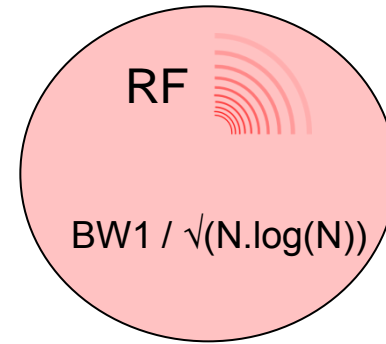
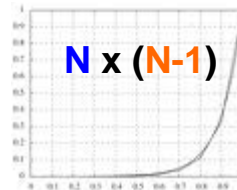
## real time aspects



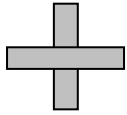
# Challenges (2) performance



	car1	...	carN
car1			
...			
carN			



# Challenges (3) scalability



# Challenges (4)

budget: **SW engineering** and **infrastructure deployment**

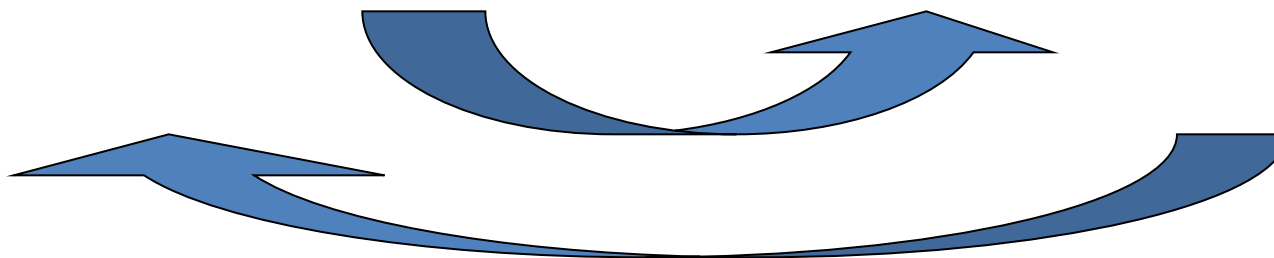
application 1		
reuse	Cost to consortium A	Gain to party x
<b>code reuse</b>	<b>code delta</b>	To society (safety)
<b>infrastructure reuse</b>	<b>infrastructure delta</b>	To GNP (traffic jams)
<b>test reuse</b>	<b>test delta</b>	To business (value added services)
<b>network reuse</b>	<b>network delta</b>	
~ 0	<b>cost &lt; gain ?</b>	

application 2		
reuse	Cost to consortium B	Gain to party y
<b>code reuse</b>	<b>code delta</b>	To society (safety, ...)
<b>infrastructure reuse</b>	<b>infrastructure delta</b>	To GNP (traffic jams, ...)
<b>test reuse</b>	<b>test delta</b>	To business (value added services)
<b>network reuse</b>	<b>network delta</b>	
~ 0	<b>cost &lt; gain ?</b>	

**time to market** →

**scalability** →

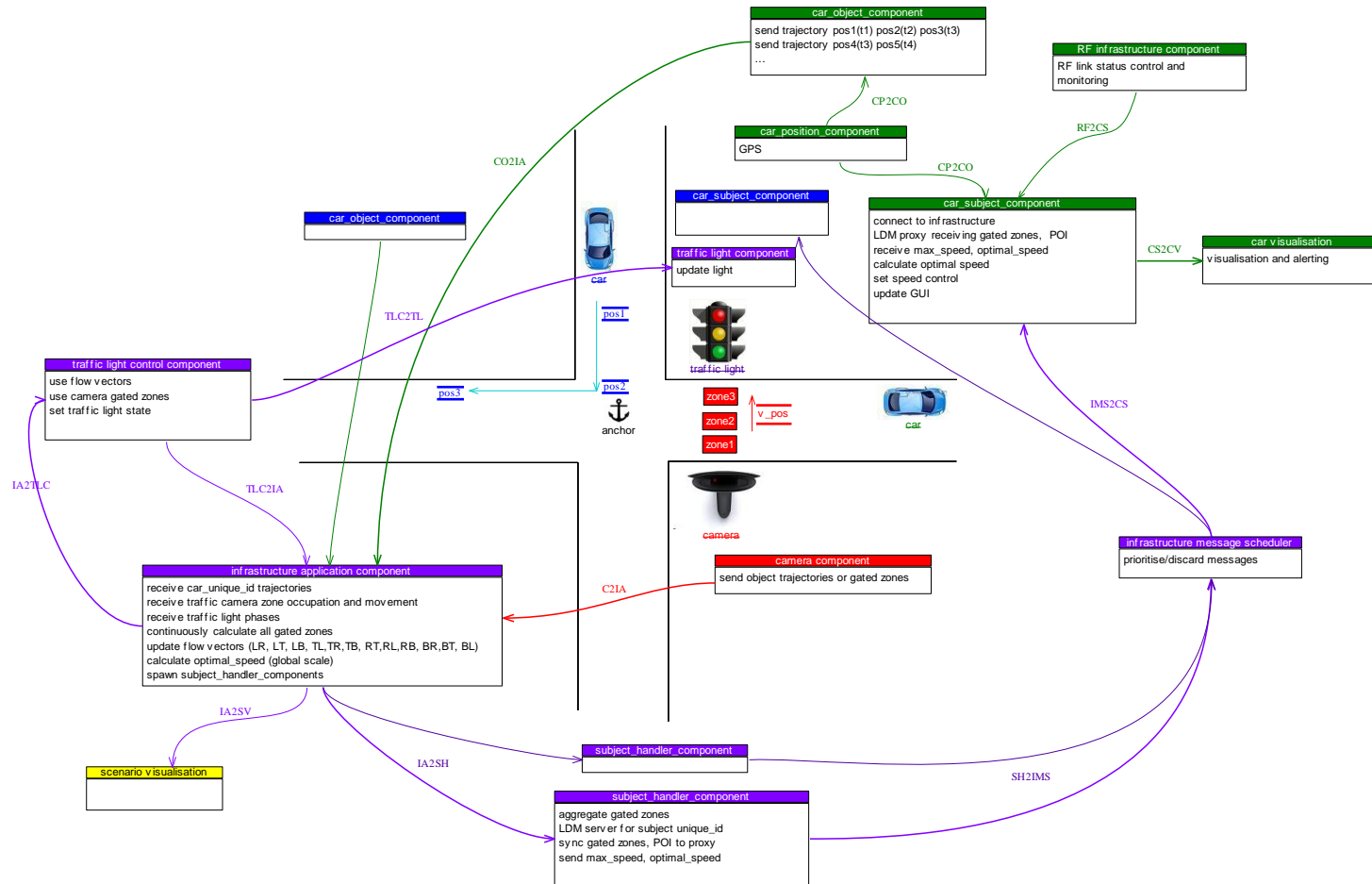
**time to market** →





# Solution

## single crossroads functional architecture



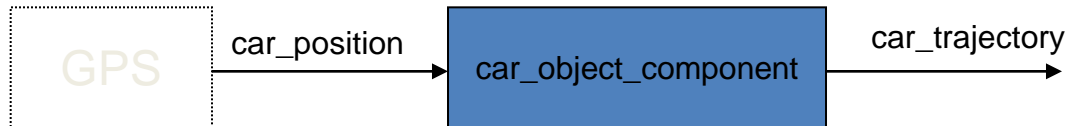
# Solution

## Component runtime – implementation concepts

Our application architecture supports modularity: **component** concept

A component can be individually designed, tested, deployed

A component runs code scheduled by timer or message callback



Components are interconnected by **channels**

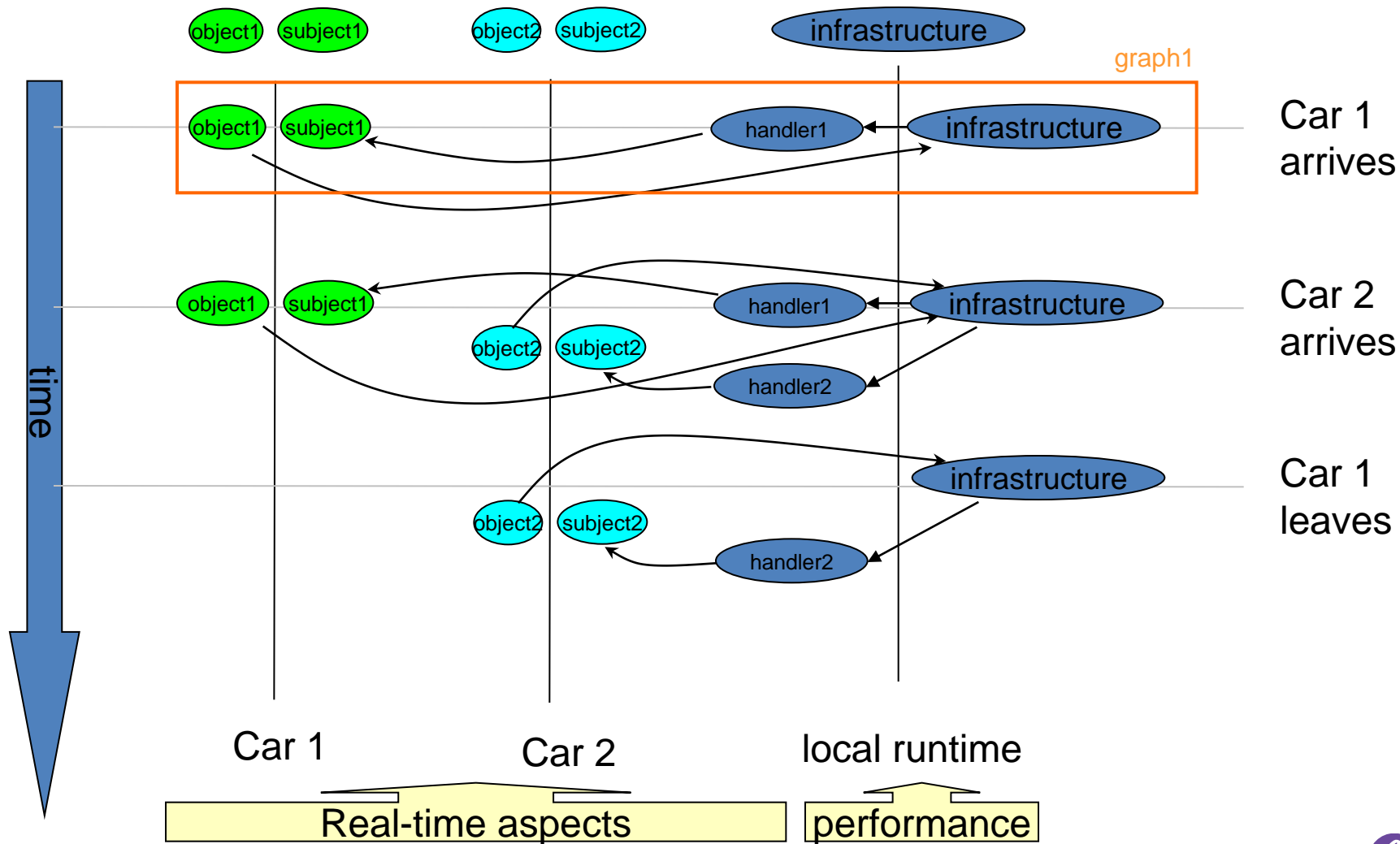
A channel carries messages that are strongly typed  
(Apache Hadoop AVRO)

The interconnection **graph** of {components, channels} defines an application

Applications can be deployed on the runtime by instantiating components and channels

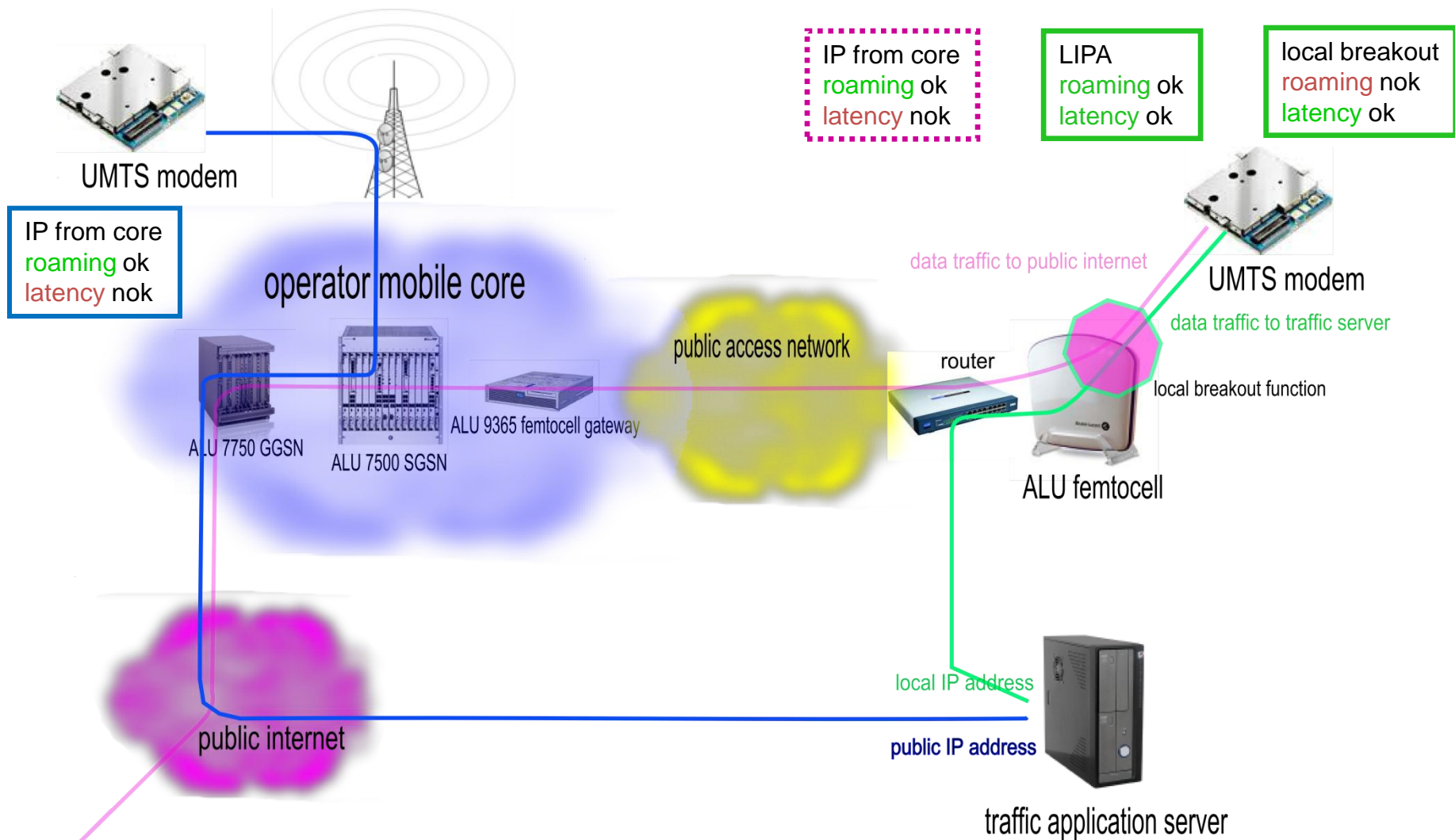
# Solution

## component runtime - deployment

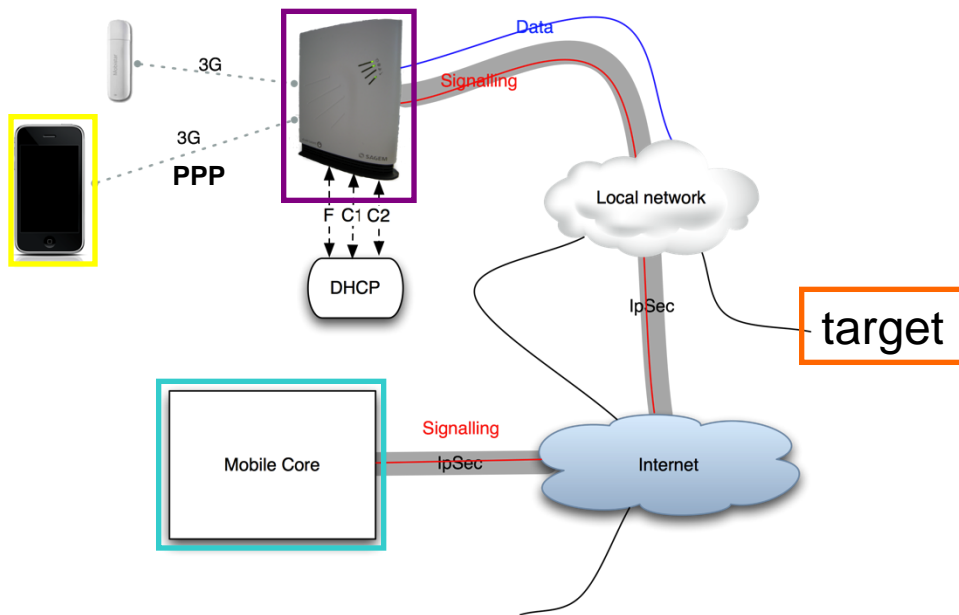


# Solution

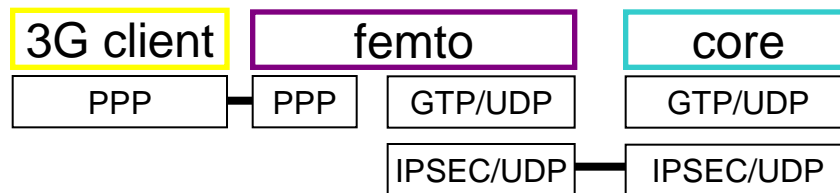
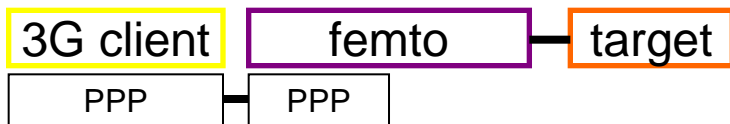
## single crossroads network architecture



# Solution network - 3GPP local breakout



- Femto obtains IP address from local DHCP server
- Femto sets up IpSec tunnel towards Mobile Core
- 3G client obtains IP address from local DHCP server, which will not support roaming
- target has local IP address



# Solution network - 3GPP(2) LIPA

## Solution 1

- terminal has 2 APN, separate GGSN and local IP address
- no NAT required
- femtocell needs to replicate some SGSN/GGSN functionality for local IP address allocation

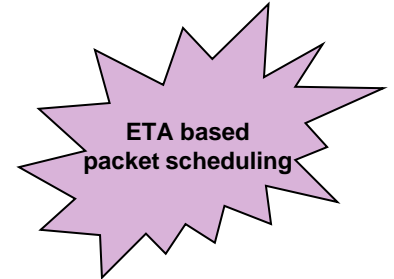
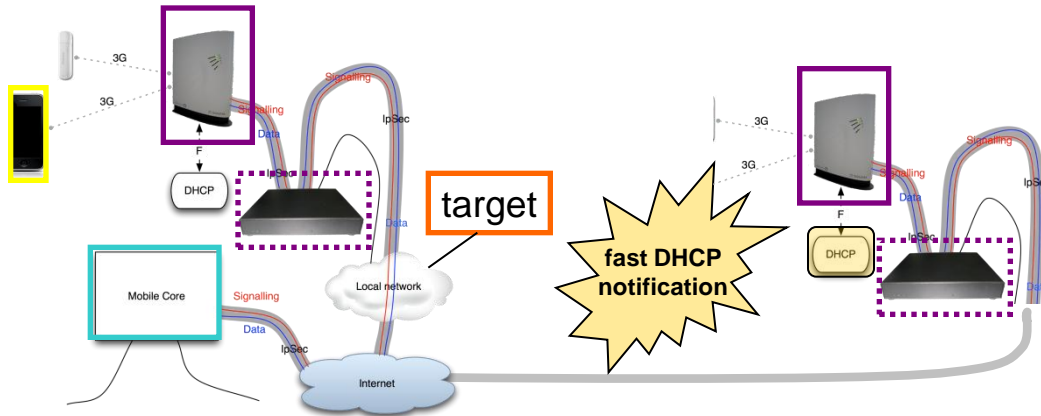
## Solution 2

- Femto obtains IP address from local DHCP server
- Femto sets up IpSec tunnel towards Mobile Core
- 3G client obtains IP address from GGSN, which supports roaming
- target has local IP address
- NAT functionality
- fully transparent, at the expense of some compute effort in the femtocell

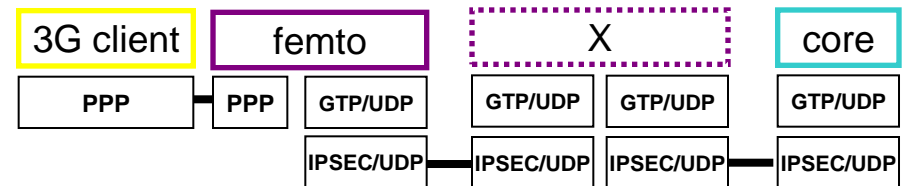
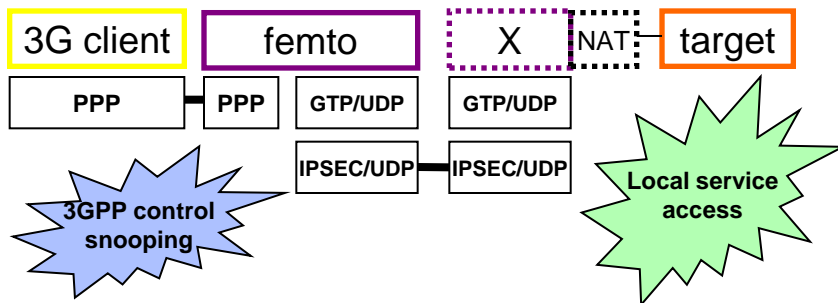
## Solution 3 (3GPP2)

- mobile IP foreign agent - home agent
- foreign agent needs to support local network access
- also requires modification to the home agent

# Solution network – LIPA in a 3GPP architecture



- Femto obtains IP address from local DHCP server
- Femto sets up IpSec tunnel towards Mobile Core
- 3G client obtains IP address from GGSN/Mobile Core (**roaming ok**)
- X implements NAT-like functionality (**latency ok** due to local access)
  - can be bidirectional, access controlled per service / client

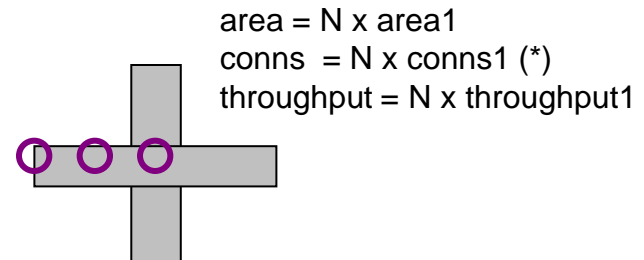
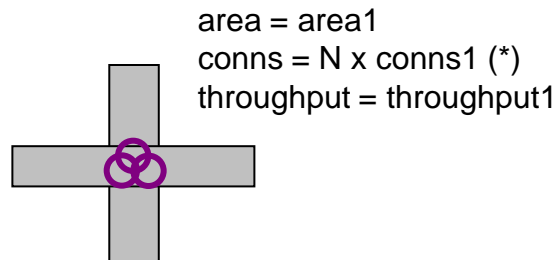


# Solution

## scaling at the local crossroads

- Network scaling

- $N_{\text{macrocell}} \rightarrow N_{\text{femtocell}}$ , throughput =  $BW1 / \sqrt{(N \cdot \log(N))}$
- femtocell + femtocell + ...

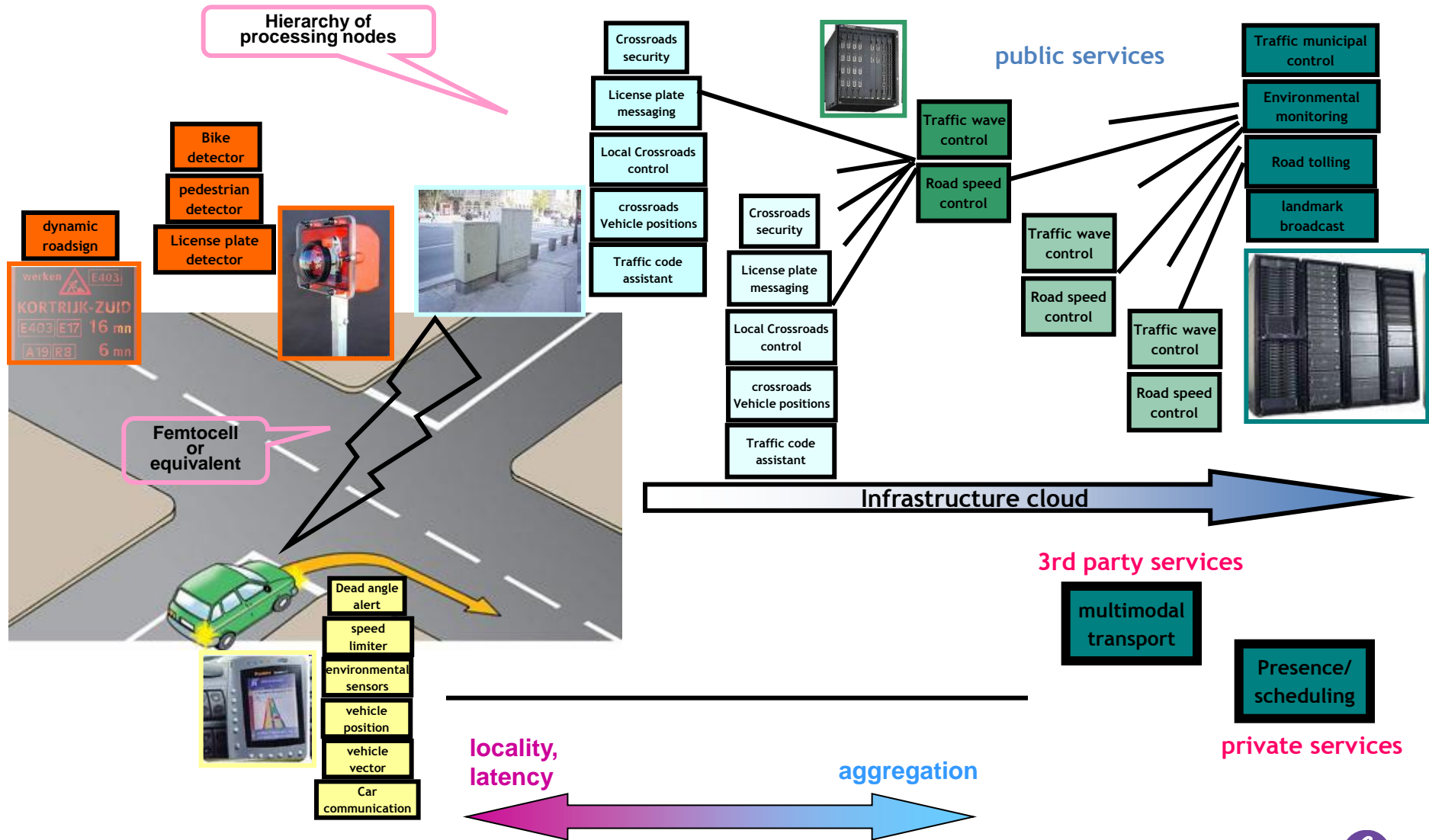


- Application scaling

- single runtime can handle hundredths of graphs
- data flow model allows easy aggregation of functionality at higher hierarchical layers of computing
- fine-grained elasticity within runtime (car arrival/departure)



# Solution scaling geographically



# Demonstrator



- local (Dutch language) TV coverage
  - <http://media.tv1.be/archief/20111013-008-2967.mp4>

# Deployment is feasible

- Cellular has established solutions for authentication, roaming,...
- Higher latency functions can be provided by existing macrocell cellular infrastructure (green wave, traffic flow management,...)
- Low latency functions or heavily increased traffic lead to additional investment in femtocell and access network assets (incremental cost, much smaller than typical road infrastructure deployment)
- Application can be deployed based on IaaS technology  
“you pay exactly for the compute cycles you need”
- Car client can be deployed on cheap handheld after market devices (including Android smart phones)

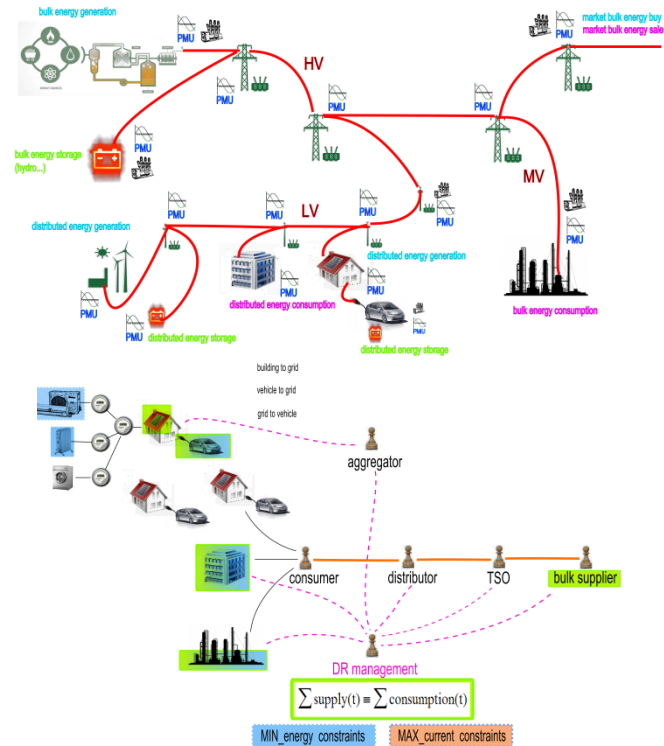
# Sensetale ADEP goes beyond ITS

[SmartIP Zwerm city game](http://www.europecommons.org/app/zwerm)

<http://www.europecommons.org/app/zwerm>



*Sensetale for Smart Energy Applications  
M2M Innovation World Congress Nice 2013*



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