UNIVERSITY OF TWENTE.

Mobility-2.0

Mobility 2.0:

Co-operative ITS Systems for Enhanced Electric Vehicle Mobility

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* Thanks to Adras Kovacs (Broadbit) and Tiago Fioreze (UT)

for providing some of the slides

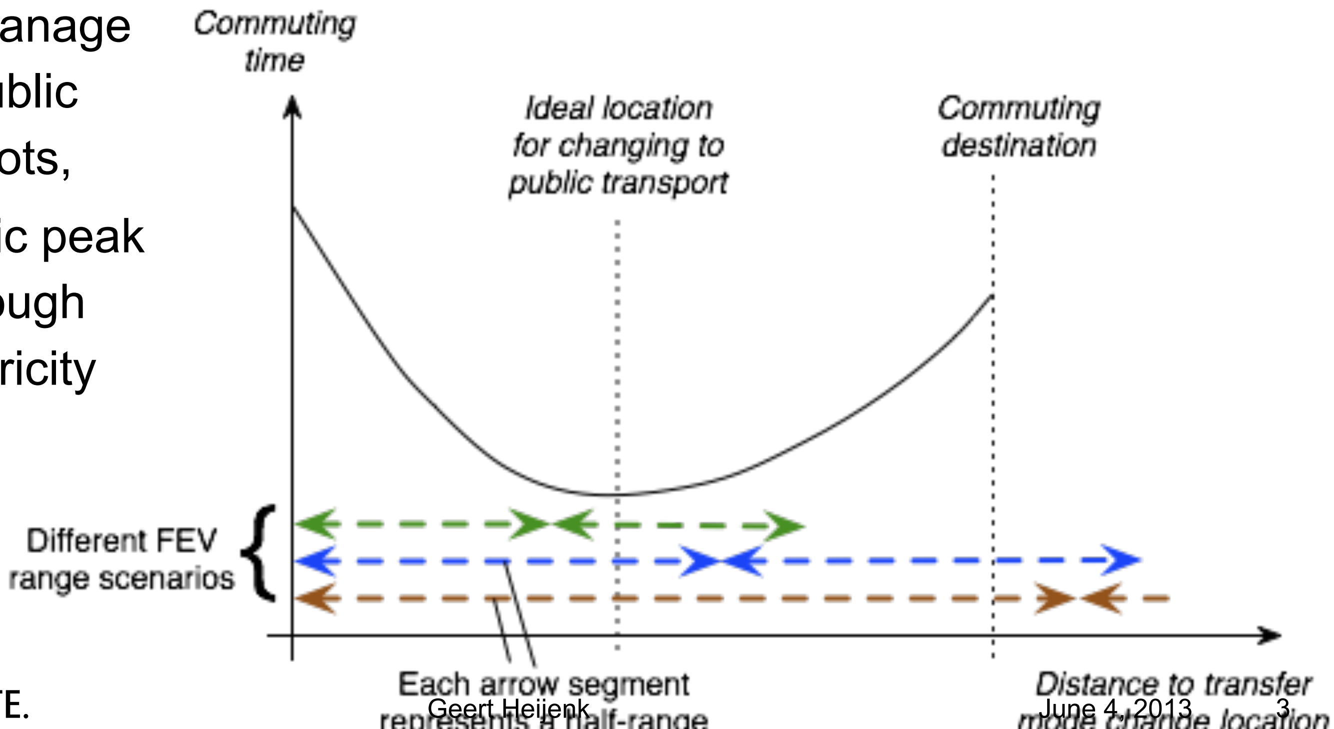
Outline

- Part 1: The Mobility 2.0 Project
- Part 2: (Virtual) Road Side Unit ((V)RSU) selection for GeoBroadcasting

Mobility 2.0 Main Project Objective

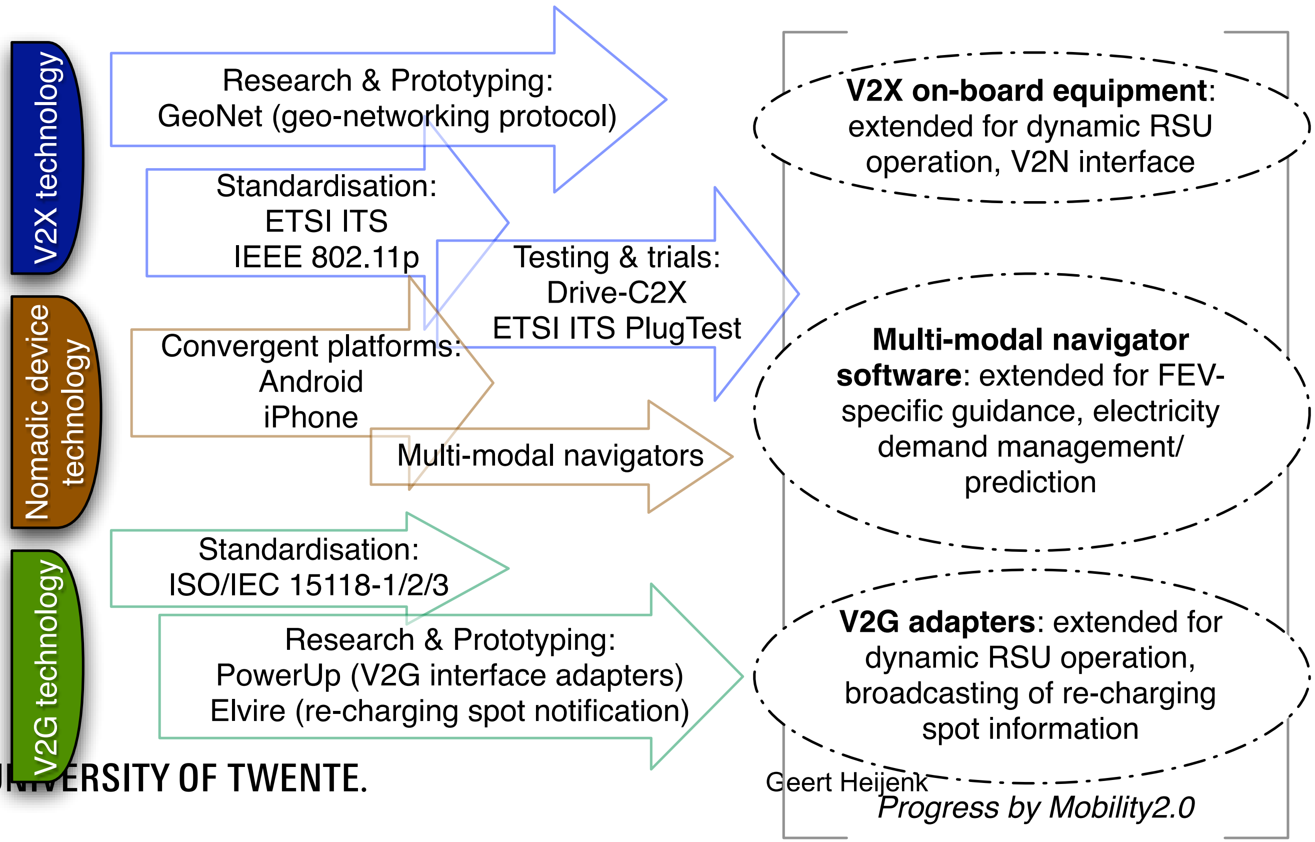
Mobility2.0 focuses primarily on the **development of co-operative commuting assistant for Fully Electrical Vehicles (FEVs)**. This guidance application shall:

- Optimize overall commute time,
- Intelligently manage priorities at public recharging spots,
- Facilitate traffic peak mitigation through dynamic electricity pricing.



Use of of Convergent Technologies

Mobility2.0 will extend standardised V2X and V2G technologies for its aims. The application layer and HMI will be based on nomadic devices, through the use of convergent device platforms.



Use of plugged-in FEVs
as Virtual Road-Side Units

A major deployment challenge for the realisation of large-scale 5.9 GHz co-operative vehicle-infrastructure systems is revolving around the effort and costs of deploying road-side communications units (RSUs).

- Plugged-in Fully Electrical Vehicles (FEVs) can serve as Virtual RSUs, resolving/mitigating this deployment challenge.

- Mobility2.0 will specify and prototype such solution

Mobility 2.0 Test Site Plans

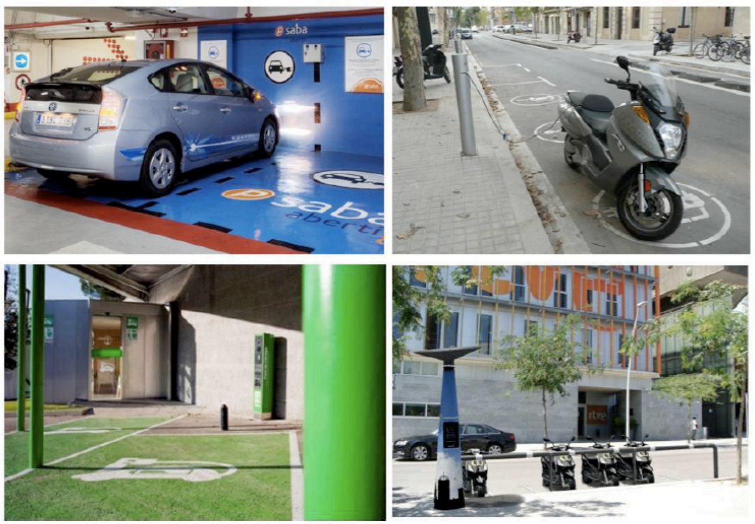
Two test site locations in Mobility2.0: Barcelona and Reggio Emilia.

Off-street

On-street
on-road

On-street
off-road

Exclusive
to E-Moto



Barcelona test site:

- about 6 municipal FEVs participate in the tests
- about 200 public re-charging spots available

Reggio Emilia test site:

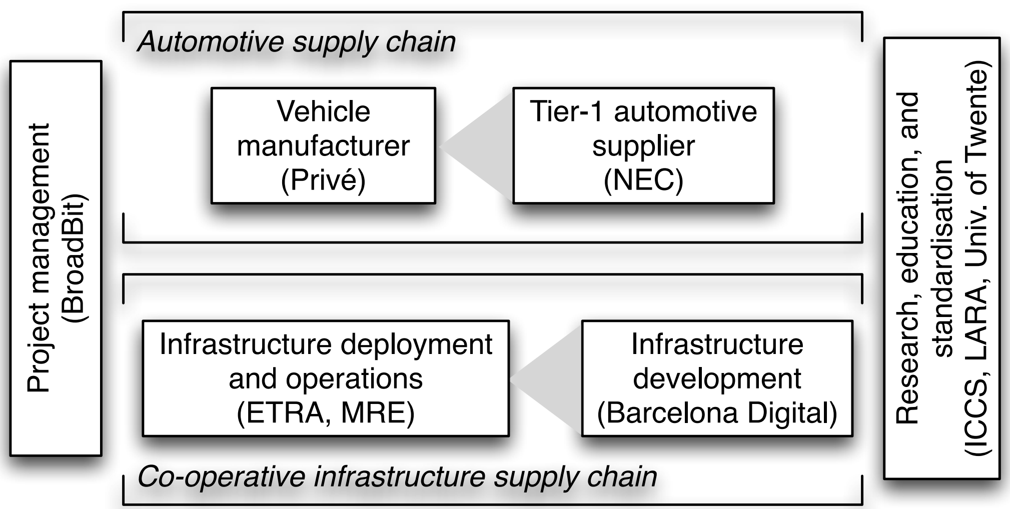
- about 5 municipal FEVs participate in the tests
- 2 FEVs will be used for testing integration of in-vehicle interfaces
- 6 re-charging spots will be installed

Mobility 2.0 Project Data

- EU FP7 - ICT for Green Cars-2012
- Project type: STREP
- Budget 2.7 M€
- 1/9/2012 – 1/3/2015 (30 Months)

Project Partners

Participant no.	Participant organisation name	Participant short name	Role
1 (Coordinator)	BroadBit Slovakia	BB	Coordinator
2	ETRA	ETRA	Infrastructure supplier
3	Fundació Privada Barcelona Digital Centre Tecnològic	BD	Transportation management SW supplier
4	ICCS	ICCS	Research institute
5	Municipality of Reggio-Emilia	MRE	Municipality
6	LaRA Joint Research Unit / Armines	ARM	Research institute
7	University of Twente	UT	Research institute
8	Privé	PR	Vehicle manufacturer
9	NEC Europe Ltd	NEC	Automotive supplier



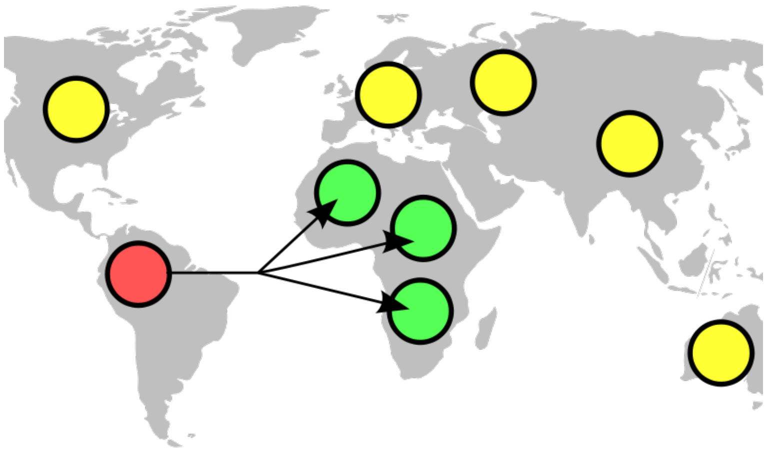
Outline

- Part 1: The Mobility 2.0 Project
- Part 2: (Virtual) Road Side Unit ((V)RSU) selection for GeoBroadcasting [1]

[1] Tiago Fioreze & Geert Heijenk, "Extending the Domain Name System (DNS) to provide geographical addressing towards Vehicular Ad-Hoc Networks(VANETs)", IEEE Vehicular Networking Conference (VNC 2011), Amsterdam, November 2011.

Introduction

- Geo(broad)cast is a location-aware service that enables messages to be sent to a set of nodes within specific areas defined by latitude and longitude coordinates.



- In Mobility 2.0, we need to find the IPv6 addresses associated with (V)RSUs, e.g., for sending charging spot notifications to On-board-units of vehicles

Problem description

- How to provide geo(broad)casting in the Internet
  - where the destination area is specified by the source (application)
  - where destination areas are not predefined
  - operating in a scalable way?

Geoaddressing in the Internet (Existing work)

- [Geonet project]: Geocasting is considered a form of multicasting, where nodes in a certain region explicitly join a predefined multicast group covering the region.

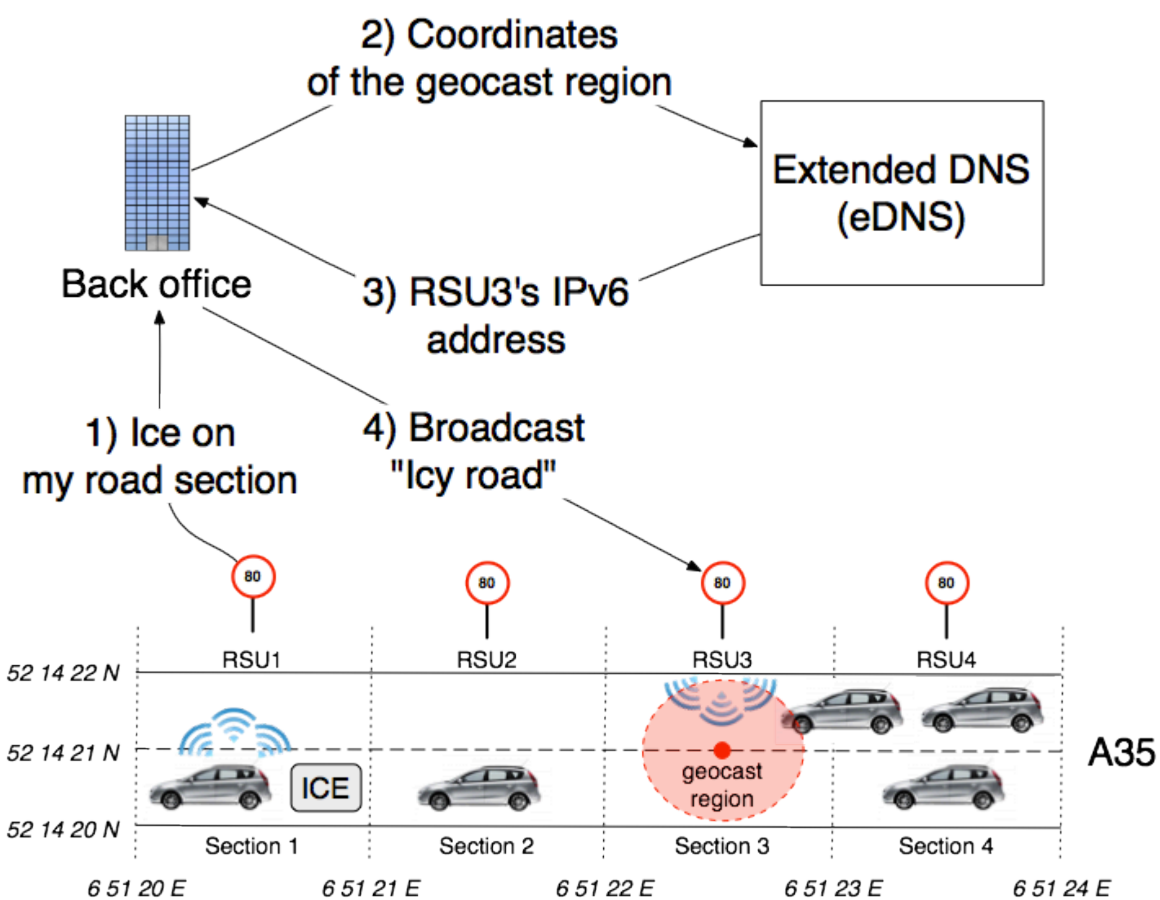
  Problems:
  - predefined regions / multicast groups
  - scalability
- [RFC 1876]: LOC records defined for the Internet Domain Name System (DNS) to specify location of a host

  Problems:
  - DNS Queries based on LOC records not possible
- [other]: see [1]

Our proposal: extended DNS (eDNS)

- DNS servers are extended (eDNS) with the capability to resolve geographical areas into IPv6 addresses of (V)RSUs.
- We base our proposal on LOC records defined in the RFC 1876 "*A Means for Expressing Location Information in the Domain Name System*".
- The application in a server wishing to perform a geocast resolves the intended geocast area into the IPv6 address(es) of the (V)RSU(s) using eDNS. It sends the message(s) to that IPv6 address(es), where it is forwarded to the nodes in the served area using geobroadcast over IEEE 802.11p.

Geocasting with eDNS



Example LOC records

```
$ORIGIN a35.highways.nl.
$TTL    86400

; Road domain
@    IN   SOA   ns.a35.highways.nl.   root.a35.highways.nl (
          2011032800 ; serial number
          3h         ; refresh time
          30m        ; retry time
          7d         ; expire time
          3h         ; negative caching ttl
)

; Nameservers
    IN   NS   ns.a35.highways.nl.

; A35 geographical coordinates
    IN   LOC (52 14 20 N 6 51 20 E 11m) (52 14 22 N 6 51 24 E 11m)

; RSUs
rsu1       IN   AAAA   3FFE:801:1000::2EF:6FFF:FE11:2222
                LOC 52 14 22 N 6 51 20.5 E 11m 400m
rsu2       IN   AAAA   3FFE:801:2000:100:280:9AFF:FE80:3333
                LOC 52 14 22 N 6 51 21.5 E 11m 400m
rsu3       IN   AAAA   3FFE:801:3000:1:270:9AFF:CH80:4444
                LOC 52 14 22 N 6 51 22.5 E 11m 400m
rsu4       IN   AAAA   3FFE:801:4000:100:2500:8AEF:FEHH:3542
                LOC 52 14 20 N 6 51 23.5 E 11m 400m
```

Querying the eDNS server

- In a normal forward DNS lookup, hostnames would be the primary key of a DNS query.
- In our eDNS proposal, we use instead LOC records as the primary key and the associated information (hostname and IPv6 address) can be returned.

```
; Request
QNAME = "(52 14 21 N 6 51 22.5 E 11m 200m).a35.highways.nl"
QTYPE = Host Address
;
; Answer
NAME = "(52 14 21 N 6 51 22.5 E 11m 200m).a35.highways.nl"
TYPE = Host Address
RDATA = Type AAAA, addr 3FFE:801:3000:1:270:9AFF:CH80:4444
```

- eDNS servers check their LOC records for all non-zero intersections between the issued geographical coordinates and the LOC records.

Distributing the eDNS database

- Bottom-up approach
- Hybrid approach
- Name servers higher in the logical hierarchy aggregate the areas of lower level name servers.
- Incoming queries for LOC records matching the aggregated area of these lower level name servers are then delegated to those name servers.

Prototype implementation: eDNS server side

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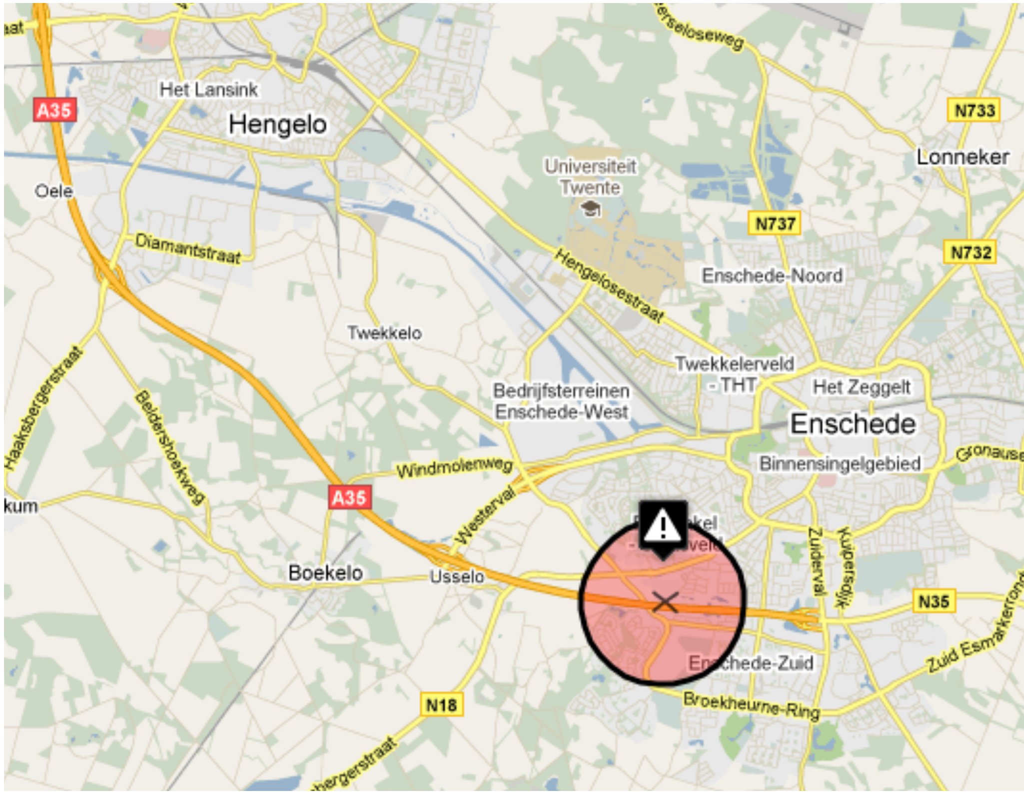
- Google Maps API has been used to graphically show the interaction between clients and our eDNS server prototype.
- The geographical locations of RSUs and their respective coverage areas are shown here as stored in the eDNS master file.

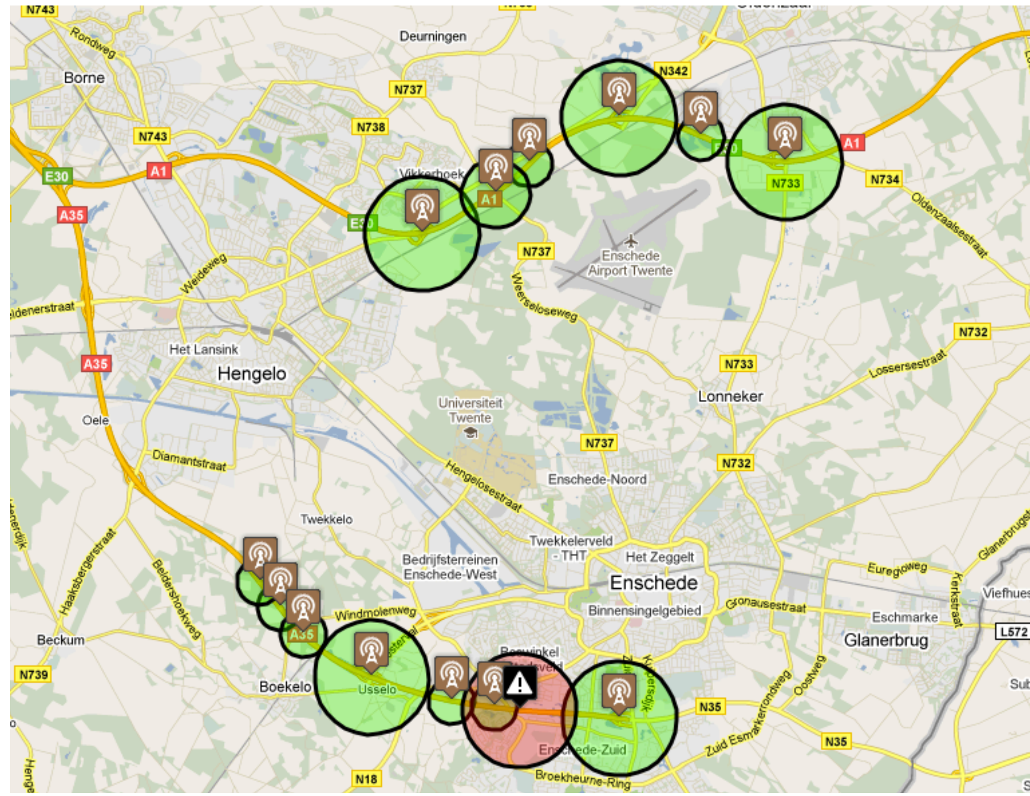
Prototype Implementation: eDNS client side

- The geocast region is defined as a circle with center point (specified by a latitude and longitude pair) and radius.
- Radius is defined in meters and it is adjustable. Therefore, a bigger or smaller geocast region can be defined.



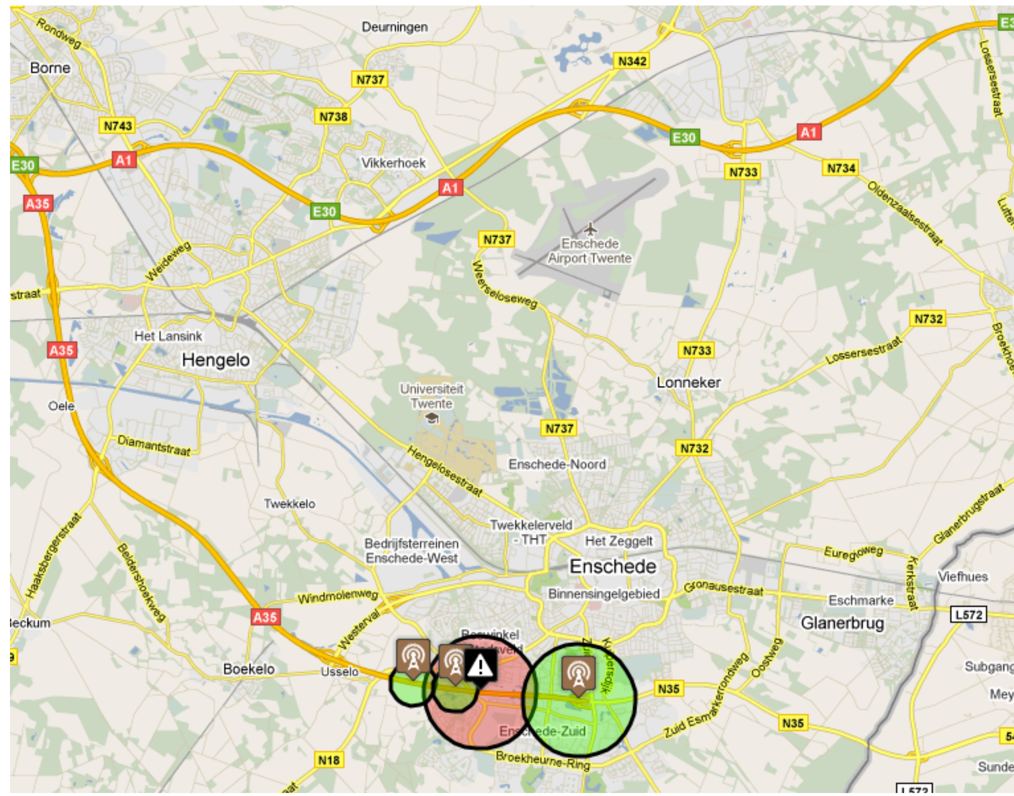
Prototype Implementation: Geoquery@eDNS server

- The geographical query (geocast region) is received by the eDNS server, which calculates whether the geocast region intersects with any RSU served under its authority.
- Here, three RSUs intersects the issued geographical query.



Prototype Implementation: Client gets the answer

- The client receives the answer from the eDNS server containing the IPv6 addresses and LOC records of the RSUs that intersect the geocast region.
- Here, geographical information on three RSUs that intersect the geocast region are returned and displayed at the client side.



Conclusions & Future Work

Conclusions

- DNS has been extended to support geographical queries
- eDNS enables geo(broad)casting in the Internet, where the destination area is not predefined, and specified by the source
- eDNS has been tested in a first prototype

Future Work

- eDNS:
  - Dynamic updating
  - Optimization of prototype
  - End-to-end geocast operation
- Mobility 2.0:
  - Complete Specifications
  - Implementation
  - Integration and Testing at Regio Emilia and Barcelona Test Sites

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Thank you for your attention!!

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