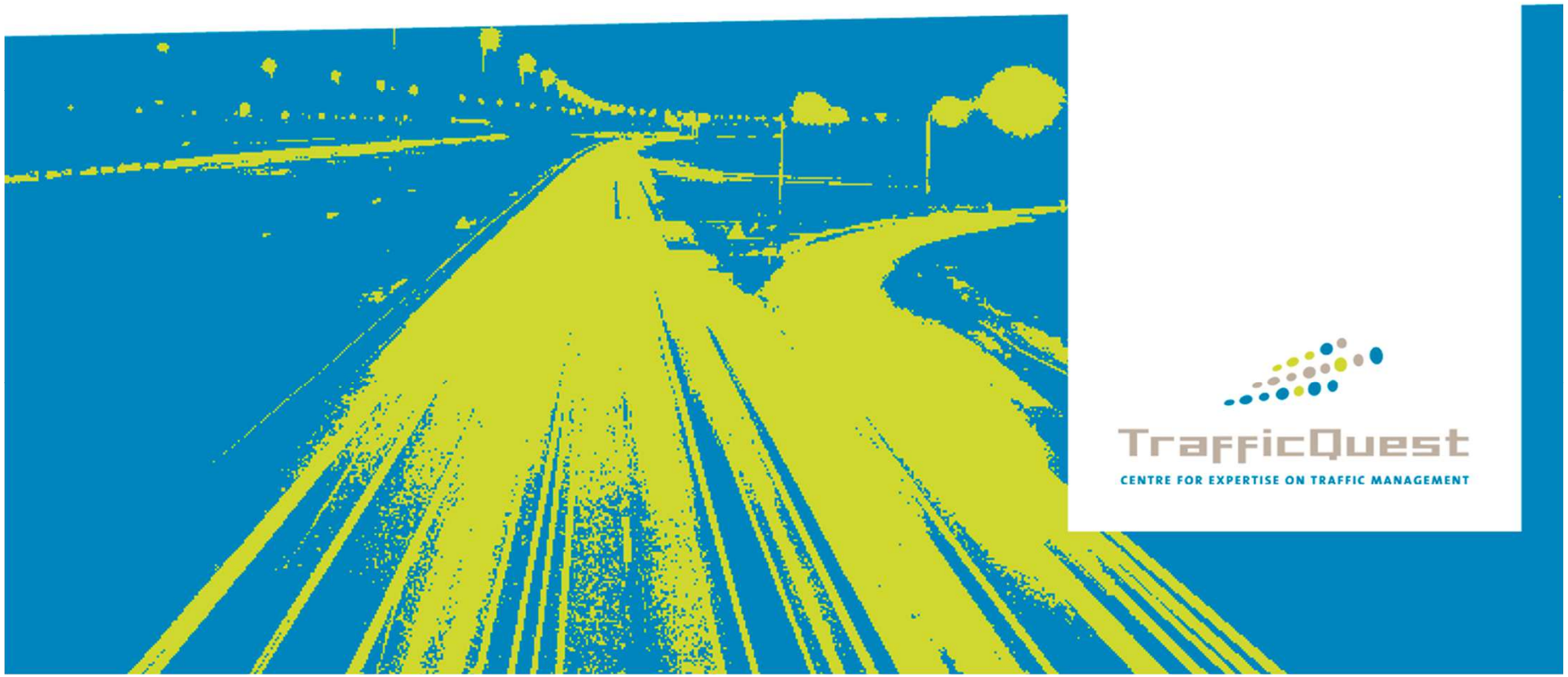
Innovative solutions and field trials

Cerema visit, 5/6 October 2016



Contents

- Background
- Field trials with innovative solutions
- Programs and collaborations

The Netherlands as testsite

- The Netherlands has a very heavily used road network
- Not much room (or budget) to widen roads, so other solutions needed
- Emphasis on smart mobility (C-ITS and automated driving)
- Experiments have always been done, first only road-side and now also with in-vehicle component
- These days: experiments are joint efforts from government, industry and knowledge institutes

The Netherlands as testsite

- Testsites: from laboratory conditions to testing on the road
  - In Helmond: VEHiL lab, N270/A270, intelligent crossing, Innovation Lab
  - On many other roads in various field trials
- Also much effort put into monitoring and evaluation
  - Methods
  - Data

Recent field trials

- A58 Shockwave damping
- European Truck Platooning Challenge
- Grand Cooperative Driving Challenge
- Practical Trial Amsterdam
- ITS Corridor / Intercor

A58 Shockwave damping

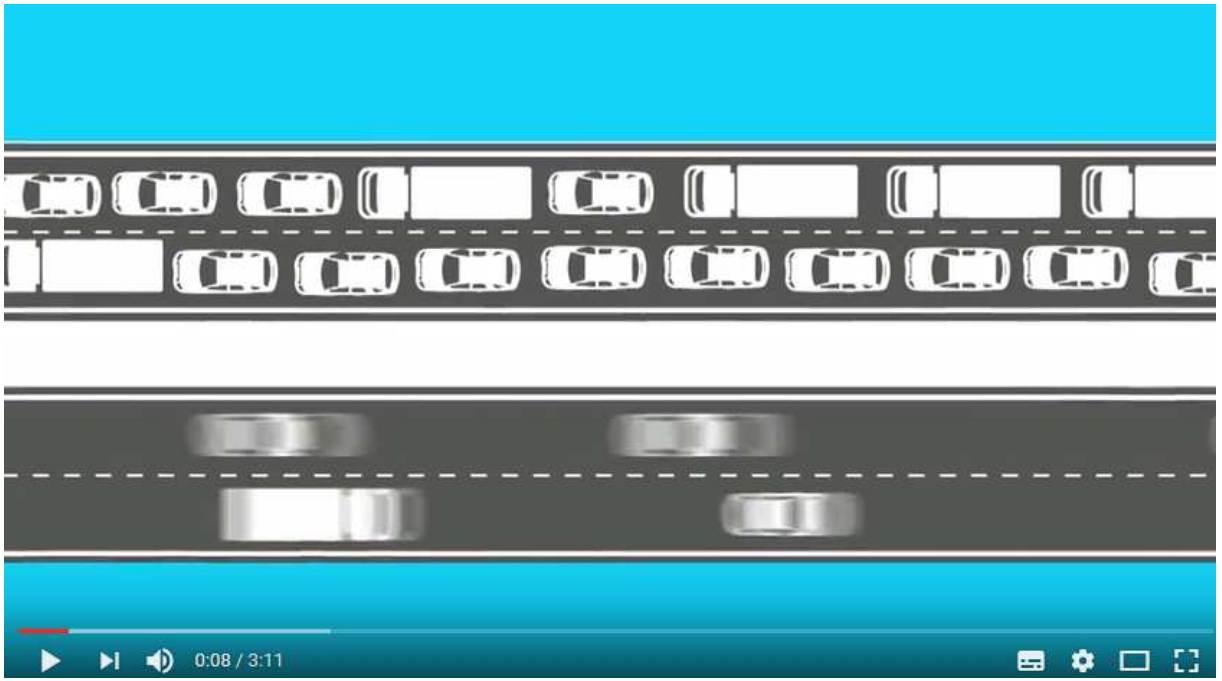
- Shockwaves cause substantial part of delay on motorways
  - ~ 20% of vehicle hours lost
- Shockwave damping was first tested in 2010 on the A12 between The Hague and Utrecht
  - Using automated incident detection / variable speed limits system
- Results and subsequent simulations showed that:
  - It is possible to resolve shockwaves with road-side systems
  - Potential of using (in addition) in-vehicle systems is higher
  - Advantage: more detailed information about speeds of vehicles, compliance expected to be higher

A58 Shockwave damping

- How to resolve shockwaves?
  - Reduce inflow into queue by reducing speeds upstream
- Current test: shockwave damping with in-vehicle systems
  - Smartphone apps and dedicated device
  - Communication: short-range (wifi-P) and 3/4G
  - Data obtained from loop detector (vehicle passages) and FCD
  - Back-office determines speed advice
- Apps: ZOOF and FlowPatrol

A58 Shockwave damping

- Movie: https://youtu.be/X8X8A9pIdvQ

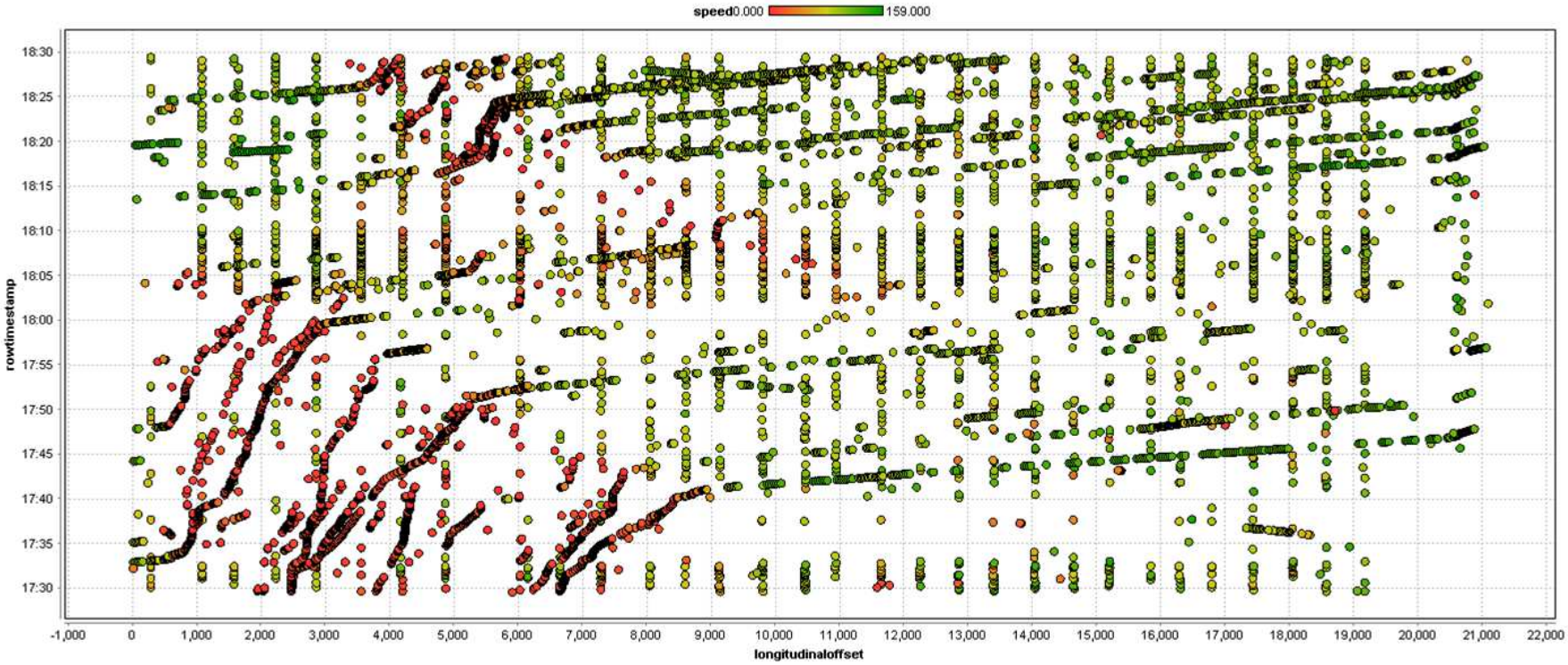


A58 Shockwave damping

- Various versions in one field trial
  - Smartphone app using 3/4G
  - Application on other device using DSRC (DSRC)
  - Input varies: 1-minute aggregated data, or individual vehicle passages plus FCD
  - Various HMIs

- Lessons can be learned from testing different versions
  - Accuracy of advice based on different data qualities, user preferences

Data fusion: loop detector passages and FCD



Additional test: using automated vehicles

- May 2016: test with self-driving cars, automatically complying with speed advice
- 3-car platoon
- First vehicle received the advice from road-side and complied
- The 2 following vehicles adapted their speed in the same way
- Also advice given to increase speed at the head of the queue
- Test completed succesfully

A58 & automated vehicles

- Movie: https://www.youtube.com/watch?v=Sl5zSqusHWo&feature=youtu.be

Activities during Dutch EU presidency

- Truck platooning challenge
- Ministers transport in automated cars (of various manufacturers, all succesfully negotiating the Amsterdam road network)
- Informal Transport Council meeting: Declaration of Amsterdam signed
- Declaration of Amsterdam lays down agreements on the steps necessary for the development of self-driving technology in the EU
- Message: Automation and cooperation should come together

Automated vehicles on display during the Innovation Expo…

European Truck Platooning Challenge

- April 2016: 6 truck platoons (of 6 European truck manufacturers) drove to the Port of Rotterdam
- Low level of automation (C-ACC)
- First cross-border test
- Much work needed to obtain the necessary 19 (!) exemptions

European Truck Platooning Challenge

- Movie:
  https://www.youtube.com/watch?v=R08mg0XmbS0
  https://www.youtube.com/watch?v=aP-B7Iq-GTc

Grand Cooperative Driving Challenge

- May 2016: 2nd Grand Cooperative Driving Challenge
- Demonstrations with cooperative and automated driving on the A270
- 10 teams came to Helmond with their own automated vehicles
- Competion:
  - Merging scenario
  - Crossing scenario
  - Emergency services scenario

Grand Cooperative Driving Challenge

- Movie: https://vimeo.com/168583504

Practical Trial Amsterdam

- Goal: reducing delays and increasing travel time reliability on Amsterdam network (motorways and urban roads)

- Three phases – we're in phase 2 now

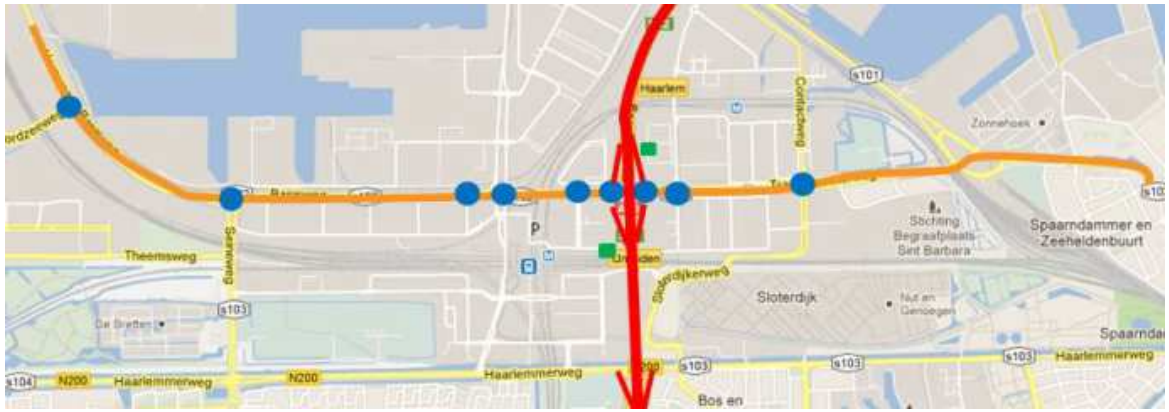
- Phase 1: separate road-side and in-car tracks
- Phase 2: road-side and in-car partly integrated
- Phase 3: full integration of road-side and in-car systtems

Practical Trial Amsterdam

- Movie: https://www.youtube.com/watch?v=e73eyS-lPXY

Road-side trial results

- Evaluation based on small sample of days
  - Days with the system on vs. days with the system off
  - Data from motorways and urban roads
- Travel time east of the A10: -13%
- Travel time west of the A10: -11%



Road-side trial results: conclusions

- Throughput on A10 motorway was improved (at Coentunnel)
- Throughput on nearby A5 also improved
- However, the coordinated ramp metering and buffering on urban roads resulted in longer waiting times
  - Total delay motorways: -15% (is about 190 hrs less for an average evening peak)
  - Total delay urban network: +30% (is about 250 hrs more for an average evening peak)
- Net results: little bit more delay overall
- Concept is sound, but algorithms need more tuning
  - Ramp metering started too early
  - Too much buffering of traffic upstream of the bottleneck

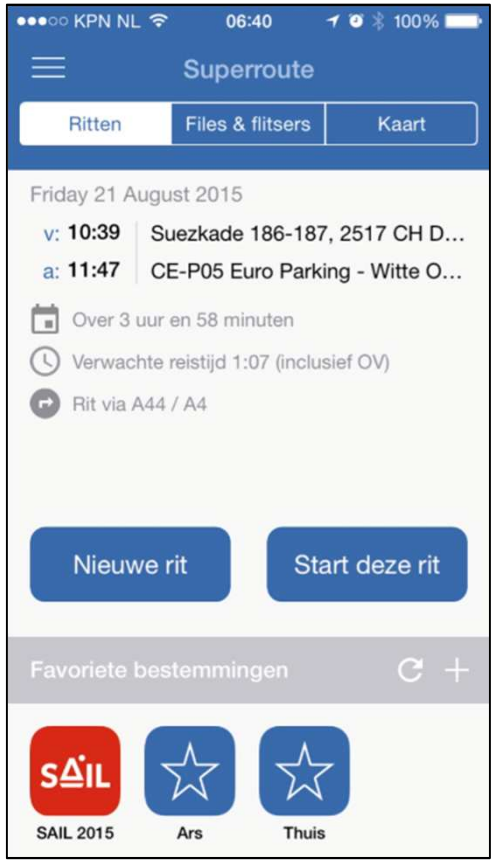
Phase 1 In-Car

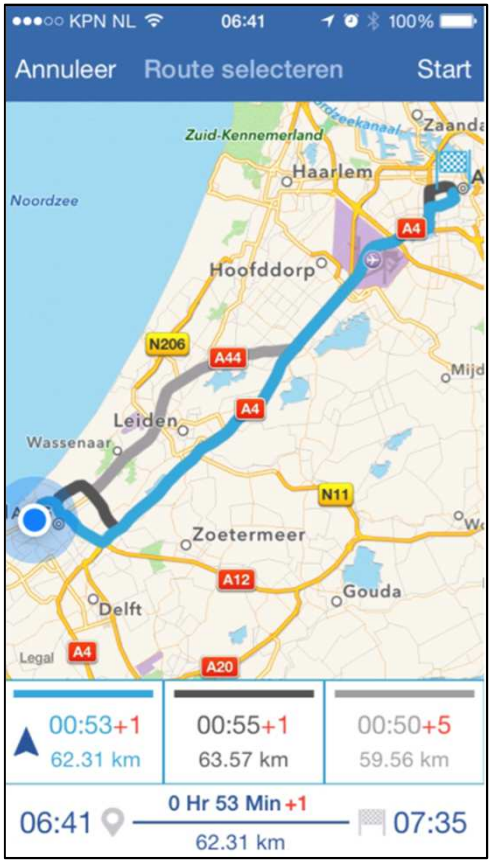
- Two consortia, each doing one trial for everyday traffic and one for event traffic
- On-trip and pre-trip advice

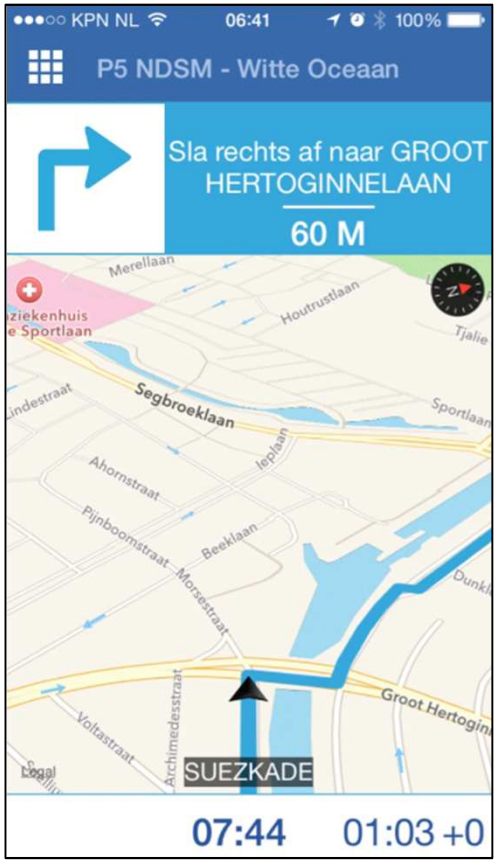
- ARS-TNO consortium:
  - Over 28,000 participants
  - 1,000,000 trips
  - 10 months trial period, 10 events (in in 2015)
  - Final event (SAIL Amsterdam) also with public transport advice

- Close cooperation with road authorities and three traffic management centres
  - Data going back and forth, automated and semi-automated

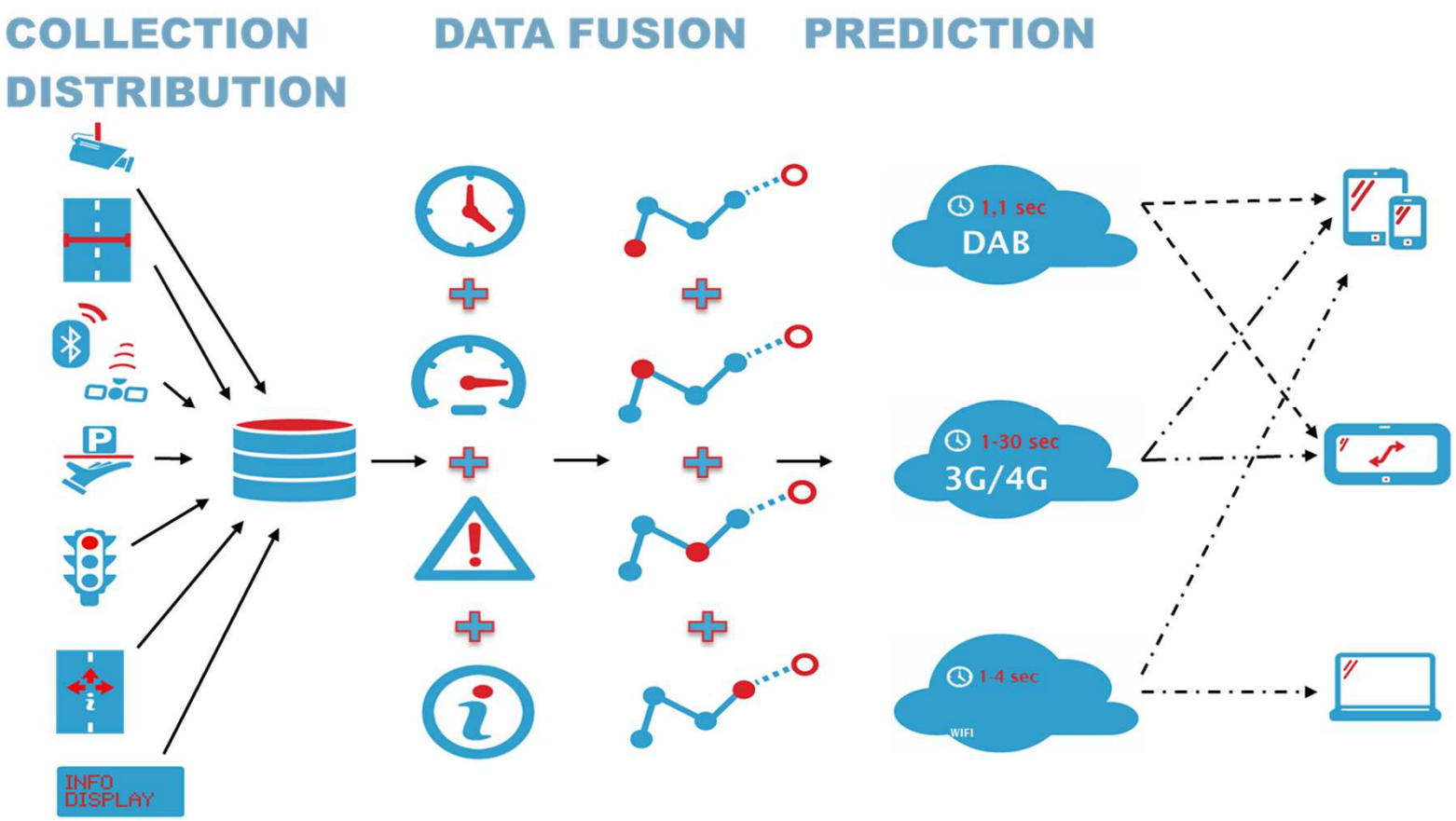
Screenshots of the app





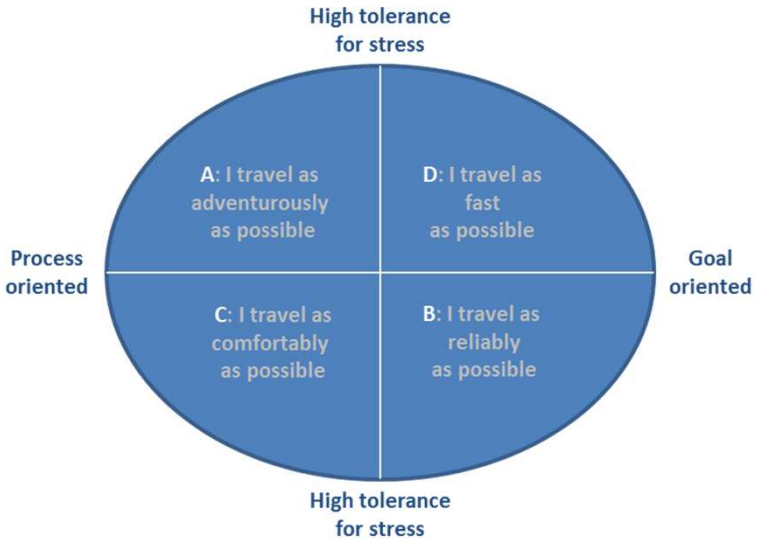


How it worked



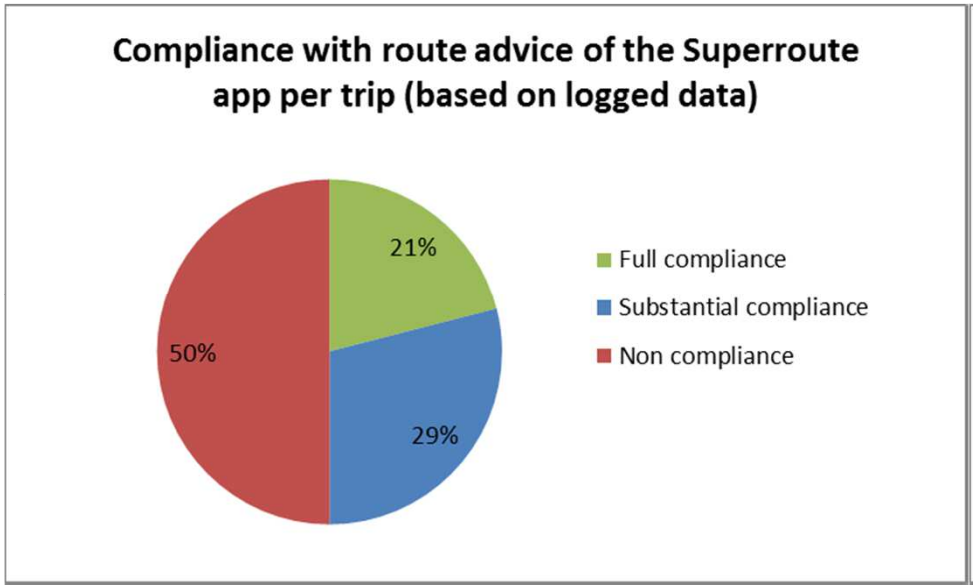
Smart routing

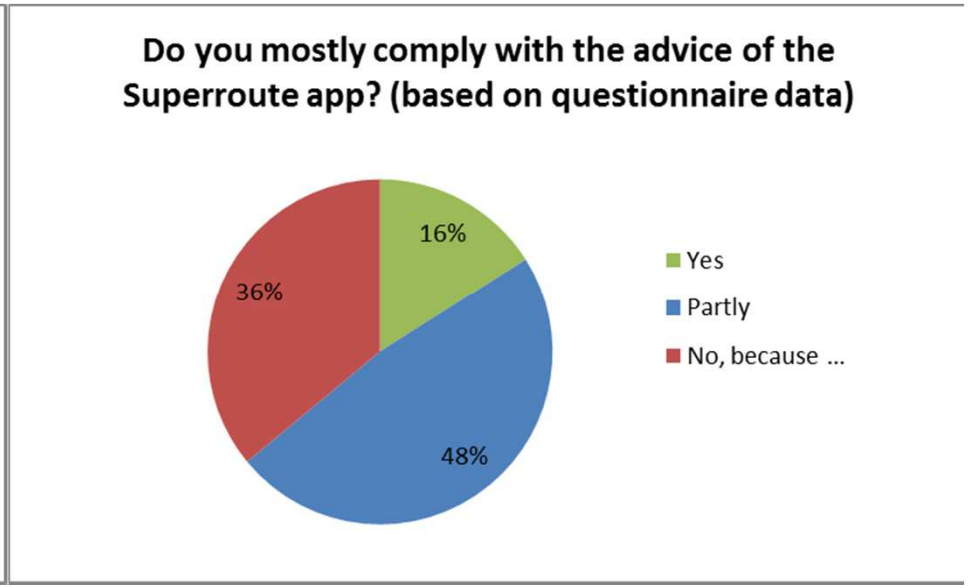
- Takes into account:
  - Current and predicted travel times
  - Previous advices and advices given to others (load balancing)
  - Personal preferences



Some results from the evaluation

- People are willing to comply with advice
- But sometimes have reasons not to comply (personal or traffic-related)
- Higher usage was associated with higher compliance





Some results from the evaluation

- Approx. 1 in 12 participants adapted their departure time
- Approx. 50% compliance with on-trip advice
- During events, an effect on travel times was shown, resulting from better distribution of traffic over routes to event venues / parking locations
- Travellers seem to want pre-trip information more than on-trip information
- This reveals:
  - A need to explain what they can gain by using such apps all the time (e.g. when incidents cause delays)
  - A need to improve the user interface

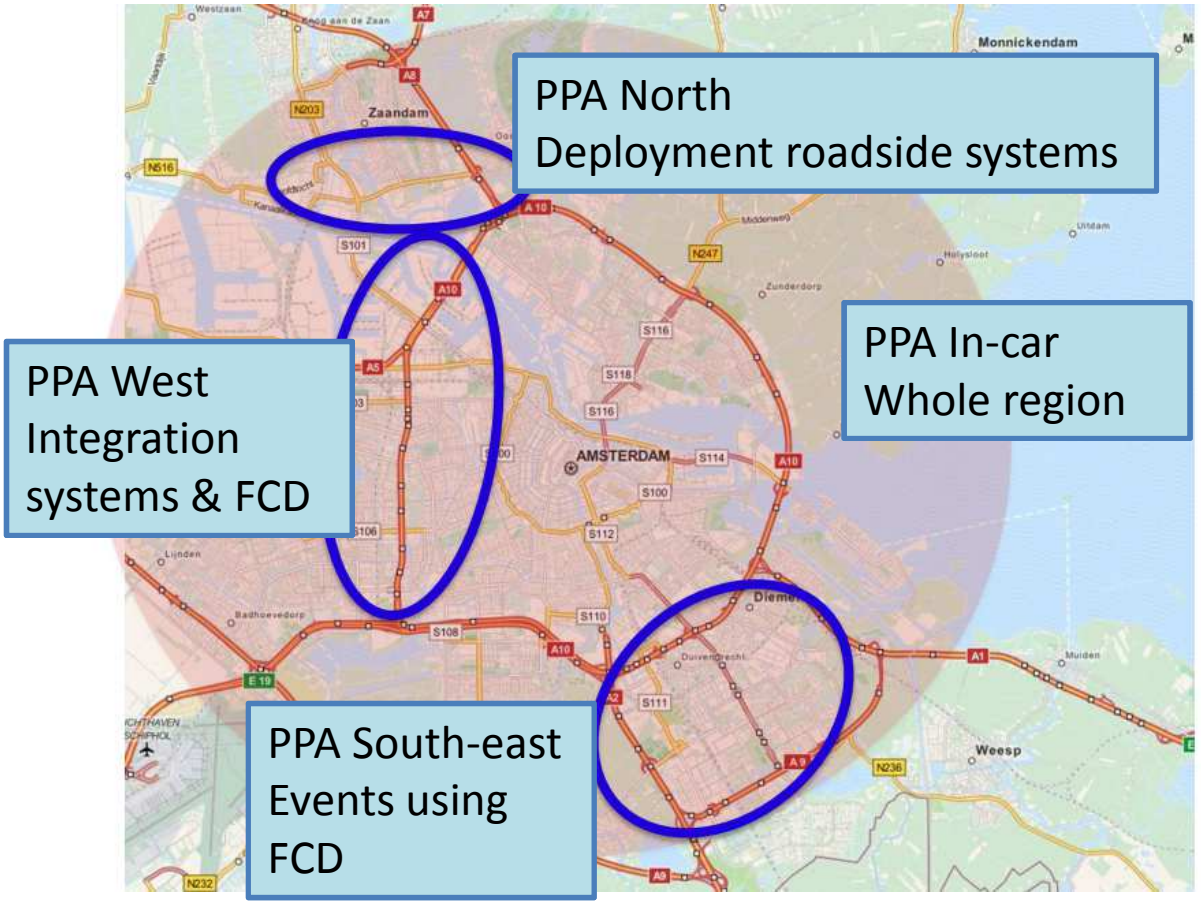
Some conclusions of the phase 1 in-car trial

- The app was downloaded and used by a lot of travellers
- Travellers appreciated the integration of the main function (on-trip route advice) with other functions
- App and mindset of users could be ‘improved’ to make advice more effective:
  - Pre-trip advice was used much more than on-trip advice (with navigation function)
  - No clear correlation between usage and adverse traffic/weather conditions (although users claimed that’s when they would use the app)
  - Both positive and negative user reviews
- Only positive opinions about collaboration between road authorities and consortium
- A lot of extra data were made available, but unfortunately no (extra/real-time) data about road works and incidents

Phase 2 of the Amsterdam Practical Trial

- Strengthening the combination of in-car and road-side information/measures
- Mainly for event-related traffic
- More research into public-private partnerships for traffic management (in order to increase cost-effectiveness)
  - Functional
  - Technical
  - Organisational

Phase 2 of the trial

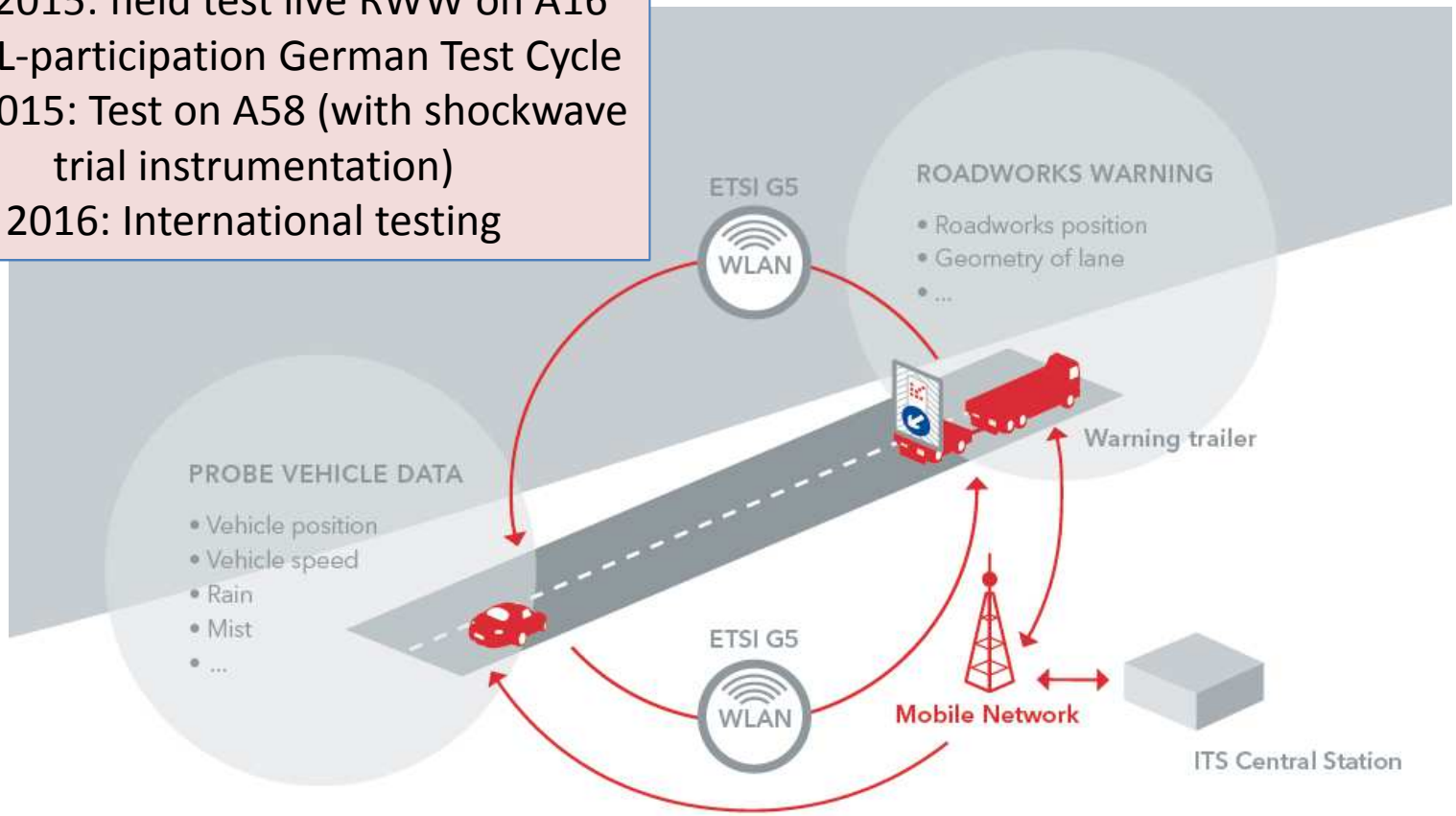


C-ITS Corridor

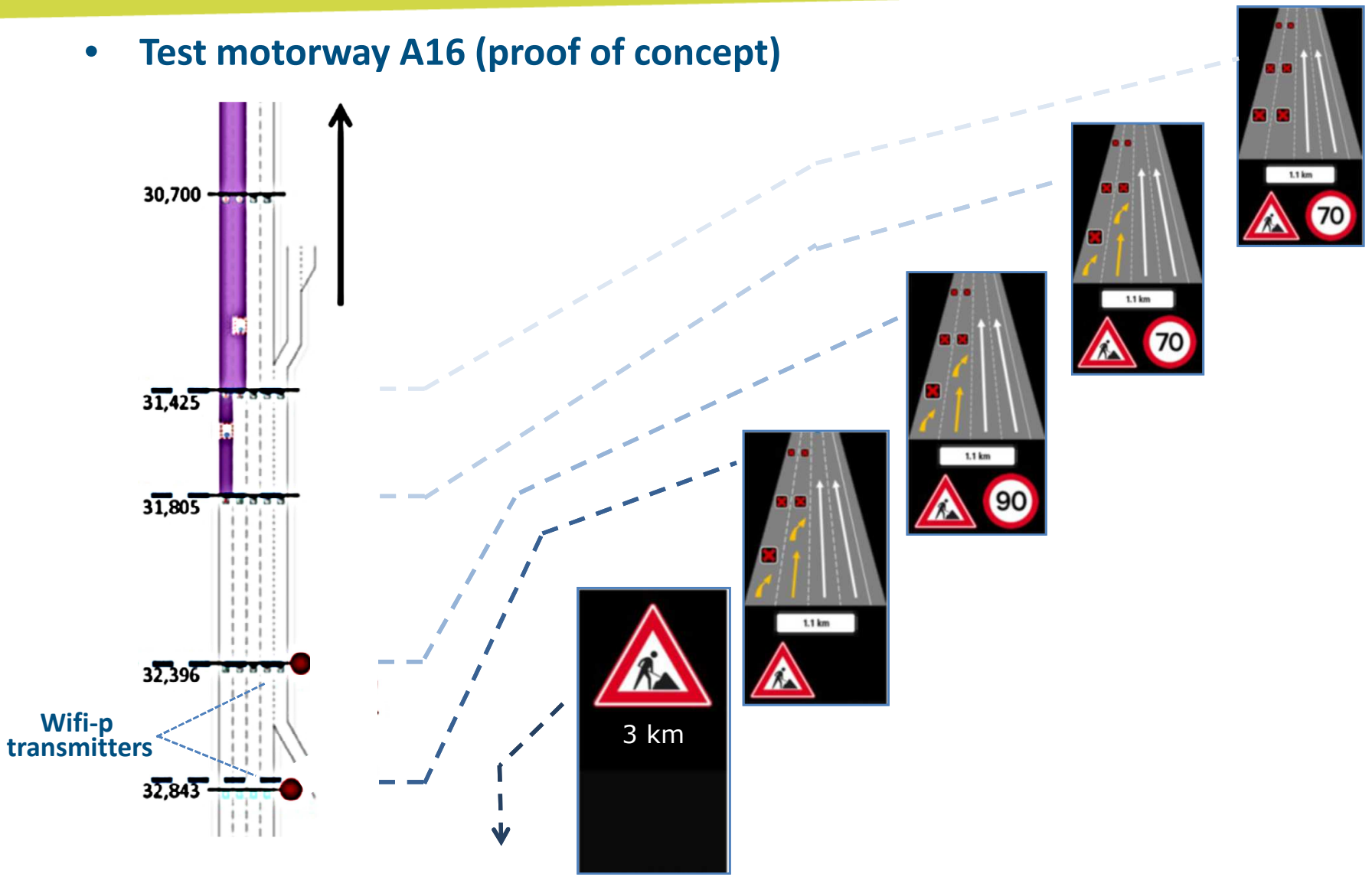
- Objective: Provide a basis for standardized, international, future-oriented C-ITS services:
  - A joint road map for the introduction of the initial C-ITS services
  - Common functional descriptions of the initial C-ITS services and technical specifications
  - Start of the actual implementation of the initial C-ITS services
- Pre-development and proof-of-concept
- Deployment of Road Works Warning and Probe Vehicle Data in the Cooperative ITS Corridor (NL – DE – AT)

C-ITS Corridor - Initial services

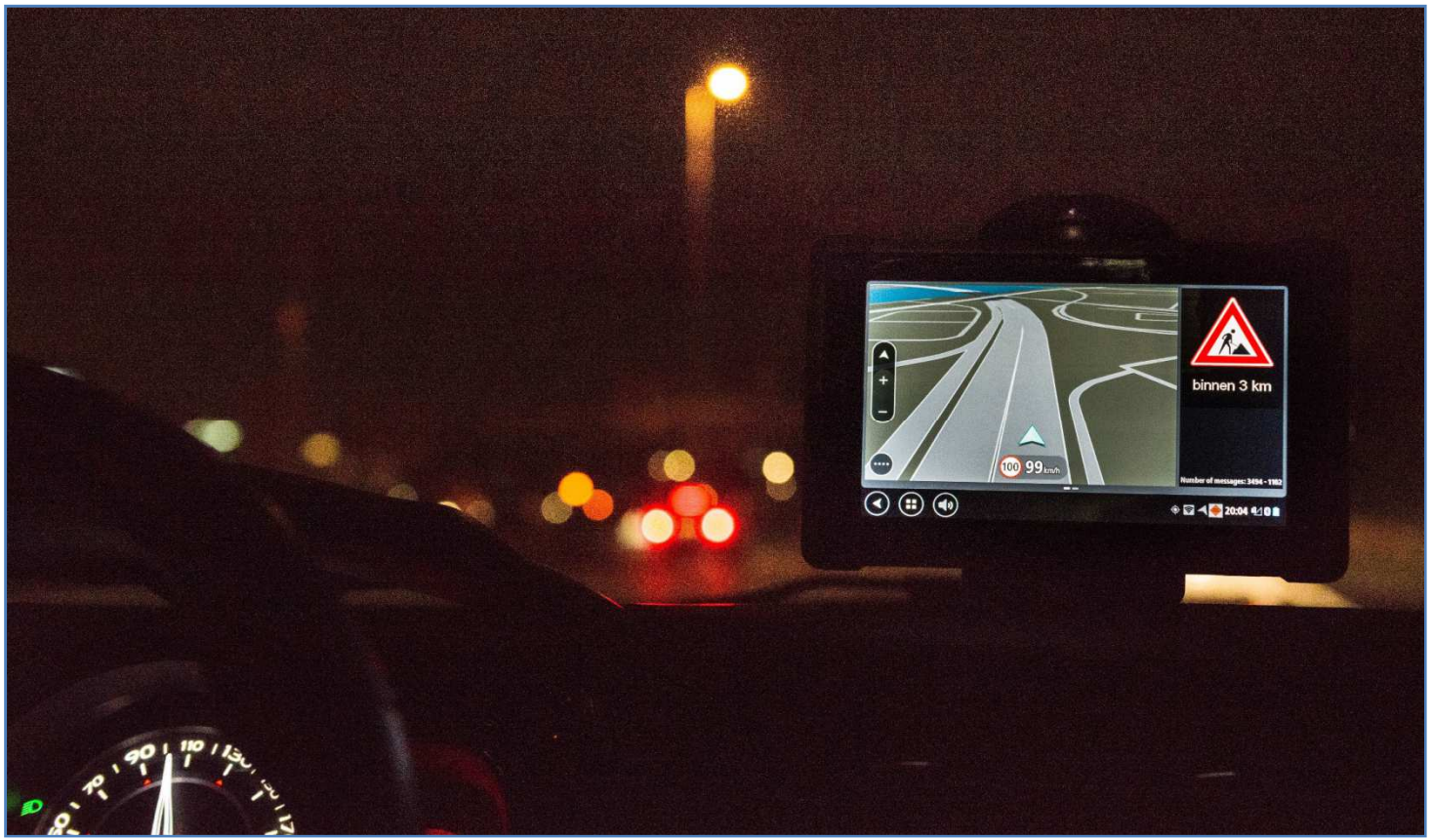
Testing:
Nov. 2015: field test live RWW on A16 and NL-participation German Test Cycle
Dec. 2015: Test on A58 (with shockwave trial instrumentation)
2016: International testing



- **Test motorway A16 (proof of concept)**



- **Test motorway A16 (proof of concept)**
  - First message, at a big distance, cellular communication

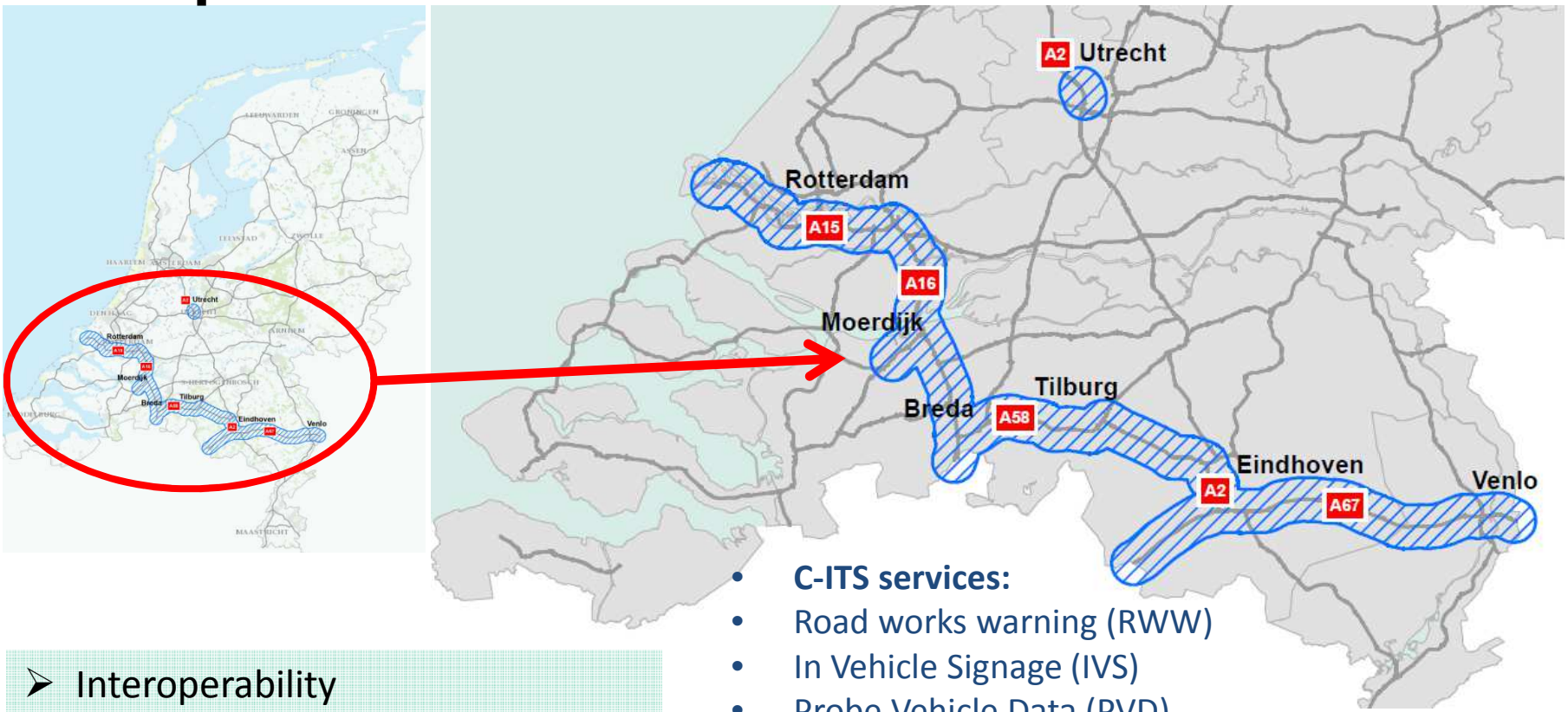


- **Test motorway A16 (proof of concept)**
  - Second message, more detail about lay-out roadworks, Wifi-p communication

- **Test motorway A16 (proof of concept)**
  - Fourth message, speed limit 70 km/h, Wifi-p communication

Intercor – ‘extension’ of C-ITS corridor

Dutch part of InterCor



- Interoperability
- Hybrid communication
- Logistics
- Security

- **C-ITS services:**
- Road works warning (RWW)
- In Vehicle Signage (IVS)
- Probe Vehicle Data (PVD)
- GLOSA
- Freight services
  - Tunnelmanagement information
  - Parking information on corridor
  - Optimizing cargo goods delivery Rotterdam area

Collaborations and programs

- DITCM
- Connecting Mobility
- Round tables
- Beter Benutten
- CEDR
- SmartwayZ.NL

- These collaborations and programs support the development of innovative solutions

DITCM

- Dutch Integrated Testsite for Cooperative Mobility
  - DITCM Innovations and DITCM facilities
- 4 ‘Programme Lines’: Human factors, Cooperative technologies, Effect studies, International policies
- DITCM Innovations:
  - Cooperation between governments, market parties, knowledge institutes and interest organizations
  - Encourages partnerships, coordinates (PCP) projects
  - Acceleration of new mobility concepts
  - Shared vision and shared innovation program
- http://www.ditcm.eu

Connecting Mobility

- Part of Ministry of Transport / Rijkswaterstaat
- Acts as a catalyst, creates necessary conditions and preconditions, and orchestrates the cooperation between government and market players
- Monitors (C-)ITS activities
- Connects developments and parties
- Facilitates national rollout of successful innovations
- Project: SimSmartMobility tool
- http://connectingmobility.nl/EN+Home/default.aspx
- https://youtu.be/fhq37_xGZRw

Round tables

Facilitated by DITCM, Connecting Mobility

- Stakeholders get together to exchange information, discuss, occasionally write memos and guidelines
- Five themes:
  - Architecture & Interoperability
  - Security
  - Human Behaviour
  - Effects
  - Legal aspects

Connekt / Dutch Roads for Self-Driving Vehicles

- Connekt = ITS Netherlands
- Brings together stakeholders, organises study tours
- New task force: Dutch Roads for Self-Driving Vehicles
  - Developed knowledge agenda
  - Stimulating and facilitating tests with automated vehicles on the Dutch road network
  - Providing information about suitable test sites
  - Developed procedure for obtaining exemptions needed for testing
  - Made checklist for ensuring safe and legal tests

‘Optimising use’ program (Beter Benutten)

- Large program in which the national and regional authorities and industry work together to improve traffic efficiency (throughput, accessibility)
- Phase 1: over 350 measures implemented and evaluated
  - 149 infrastructural measures (roads, bicycle paths, (bicycle) parking)
  - 122 demand management measures
  - 83 traffic management and ITS measures
  - Public transport measures
  - Data-oriented measures
  - Lean & Green measures for sustainable mobility

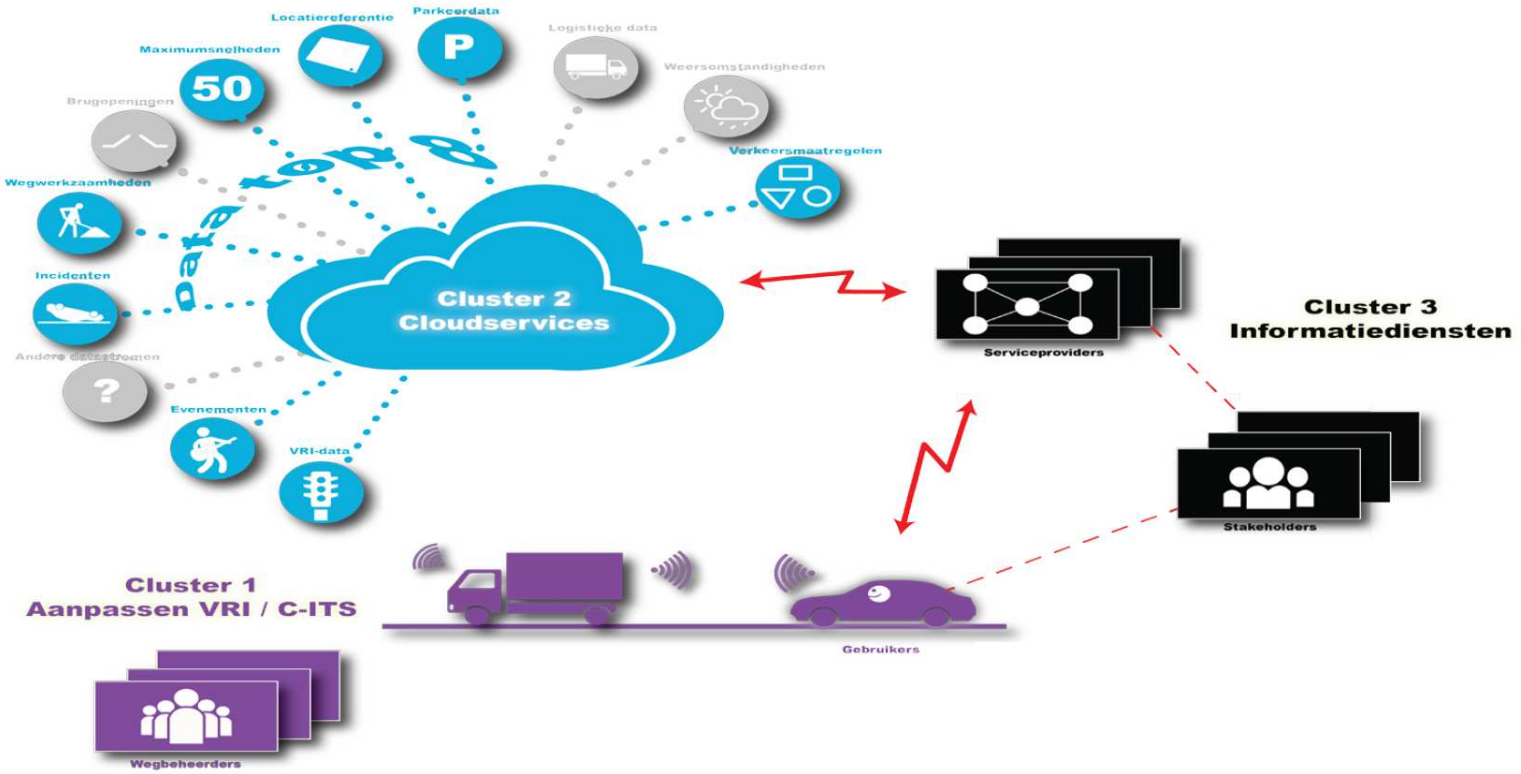
Results Beter Benutten phase 1

- 19% less delay on specific corridors
- 48.000 ‘avoided peak hour trips’ per day
- Reduction of emissions
  - 70,000 tons of CO_2 (plus 45,000 tons from Lean & Green approach)
  - 150 tons of NO_x
  - 15 ton PM_{10}

Beter Benutten – Phase 2

- Emphasis on smart mobility
- Call for projects: ‘Talking Traffic’
  - Collaboration between road authorities and industry
  - Several ‘innovation partnerships’ will work together to provide in-vehicle services
    - Cluster 1: adaptation of traffic control installations
    - Cluster 2: Cloud services (data exchange)
    - Cluster 3: Information services
- Service will be available on in-vehicle devices (e.g. smartphone), everywhere in the Netherlands
- Implementation in stages, between now and end of 2017

The 3 clusters (each with several innovation partnerships)



‘Use cases’

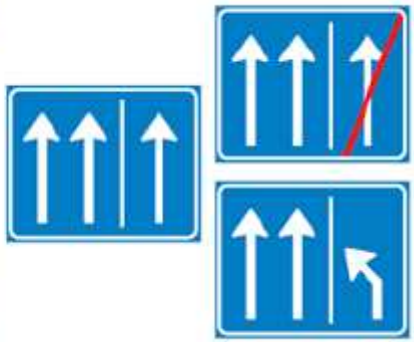
1. In-vehicle signage and speed advice
2. In-vehicle information on (potentially) hazardous situations and roadworks
3. Priority requests to TLI’s (Traffic Light Installations)
4. In-vehicle information from TLI’s
5. Optimalization of TLI arrangements
6. In-vehicle parking information

In-vehicle signage and speed advice

- Static
- Semi-static (with time windows)
- Dynamic
- At roadworks
- With speed advice for e.g.:
  - Approaching and leaving a traffic jam
  - Hazardous weather conditions
  - Condition of pavement, slippery road
  - Approaching emergency vehicle

In-vehicle signage

- Locally applicable obligations and prohibitions
- Other locally relevant information (such as a lane drop), based on traffic signs



In-vehicle info on hazardous situations and roadworks

In-vehicle info on potentially hazardous situations ahead:

a) (soon to be) opened bridge
b) traffic jam tail ahead
c) hazardous weather conditions
d) accident, incident or calamity
e) event
f) approaching emergency vehicle
g) road inspector (‘s vehicle) on the road (or hard shoulder) ahead
h) broken down vehicle on the road (or hard shoulder) ahead
i) objects on the road ahead
j) dense traffic ahead (when needing to merge further ahead)

Traffic control systems

- Conditional priority (e.g. based on vehicle characteristics)
- Extension of green light (also based on vehicle characteristics)
- Absolute priority (e.g. emergency services)

- Lot of work on preparing traffic control systems for provision of traffic light data (via National Data Warehouse – NDW)
- Information to be delivered to vehicles
  - Time-to-green, time-to-red, reason for waiting
- Optimisation of traffic control algorithms and settings

In-vehicle parking information

- (Current / expected) availability of parking spaces
- Routes to parking facilities
- Parking information at events
- Bicycle parking

Data sources

- Mainly Open Data
- Service providers can add proprietary data
- For public data sources, feedback on quality and latency is appreciated
- Service providers to use data and add value – creating commercial data

Monitoring & Evaluation

- TNO is currently developing plans for monitoring and evaluation of the in-vehicle services
  - Using FESTA-V approach
- Evaluation while doing
  - interaction with innovation partnerships – what are they building?
- Using questionnaires, GPS traces, counts of events triggering alerts and advices
- Clusters 1-3 required to provide necessary data

CEDR projects with Dutch participation

- ANACONDA
  - Assessment of user Needs for Adapting Cobra including Online Database
  - Impact assessment and cost-benefit analysis of C-ITS
- DRAGON
  - Driving Automated Vehicle Growth on National Roads
  - Impacts of automated vehicles for national road authorities (NRAs)
  - Actions for NRAs to maximise positive impacts

SmartwayZ.NL

- Large innovative mobility program for the south-eastern part of the Netherlands (approx. 1 billion euros)
- Is being set up; no actual measures decided on or implemented yet
- Objectives:
  - Stimulation of innovations
  - Improvement of throughput
  - Well-functioning process
  - Strengthening the economy

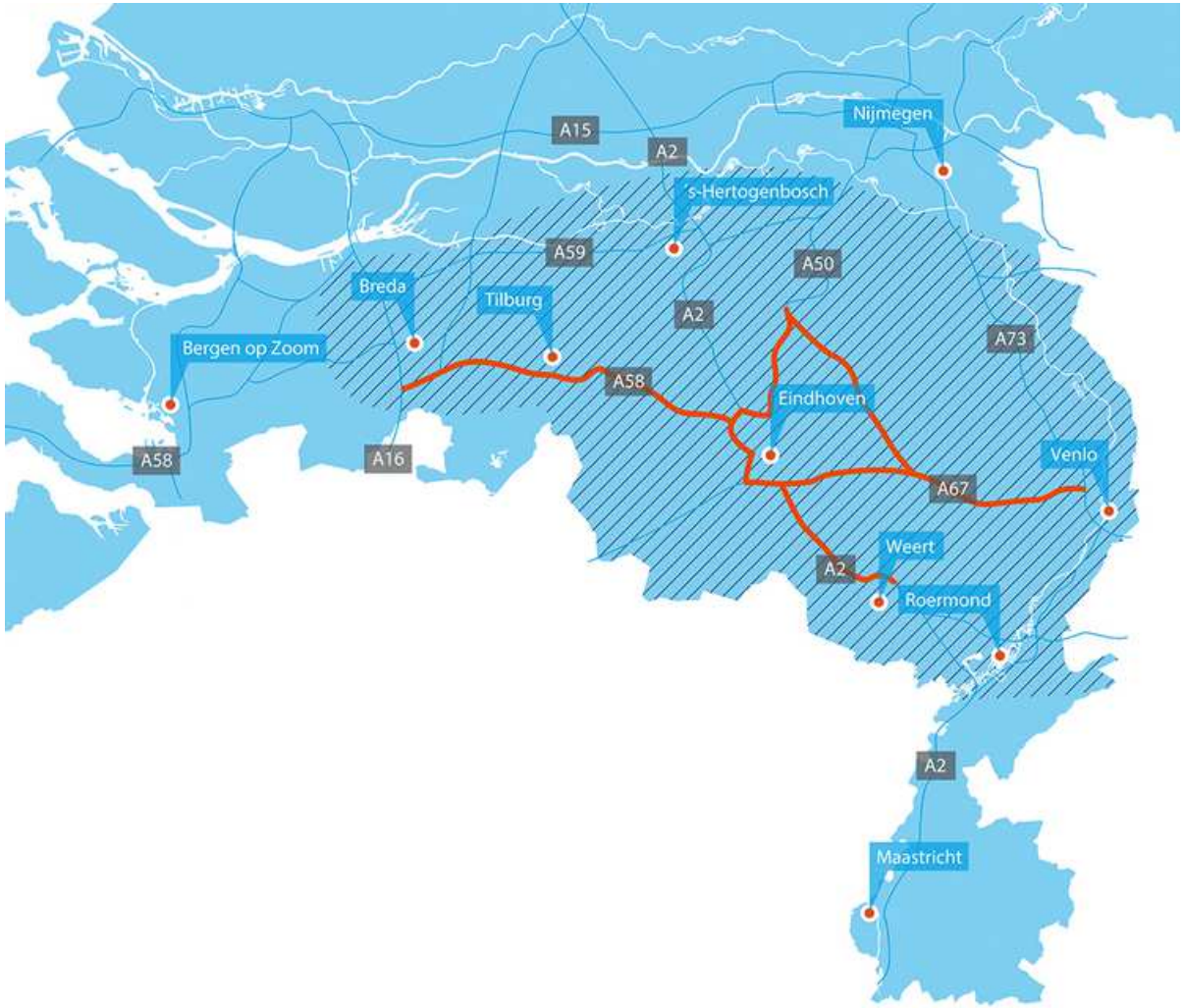
SmartwayZ.NL

- Keywords:
  - Together
  - Sustainable
  - Learning by doing
  - Adaptive (planning, budget, scope/solutions)
  - Smart mobility where possible
- Smart mobility aspects:
  - Developing (generic) smart solutions for bottlenecks
  - Smart mobility solutions get priority over infrastructure upgrades
  - Promising results to be used in other tasks (tasks on next slide)

SmartwayZ.NL

- Z.NL stands for Zuid-Nederland (South-Netherlands)

- 8 tasks:
  - Smart Mobility
  - InnovA58
  - A58 Tilburg – Breda
  - A2 Randweg Eindhoven
  - A2 Weert – Eindhoven
  - A67 Leenderheide – Zaarderheiken,
  - N279 Veghel – Asten
  - Bereikbaarheids-akkoord Zuidoost-Brabant



Smart mobility in SmartwayZ.NL

- Living lab
- Monitoring and evaluation
- Scaling up local findings to impacts at e.g. national level

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TrafficQuest is een samenwerkingsverband van

TNO innovation for life

TU Delft

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