Transport Network ITS Spatial Data Deployment Platform

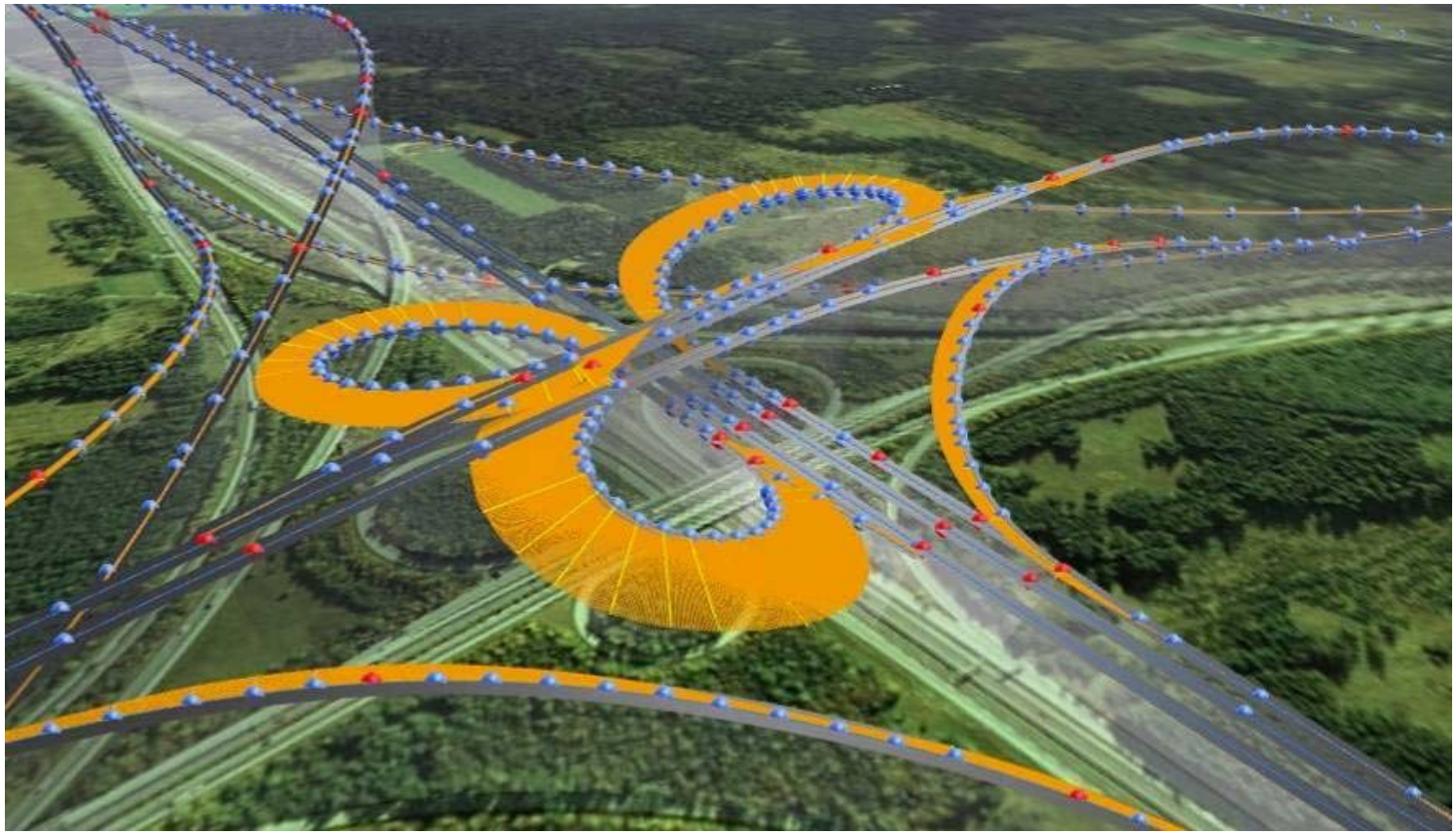
Standardisation in the TN-ITS arena

Kees Wevers, President TN-TS

CEN/TC 287 - workshop on standardisation of geographic information
15 October 2014, Delft

Source of image: ROSATTE web site (ertico.com/rosatte/)

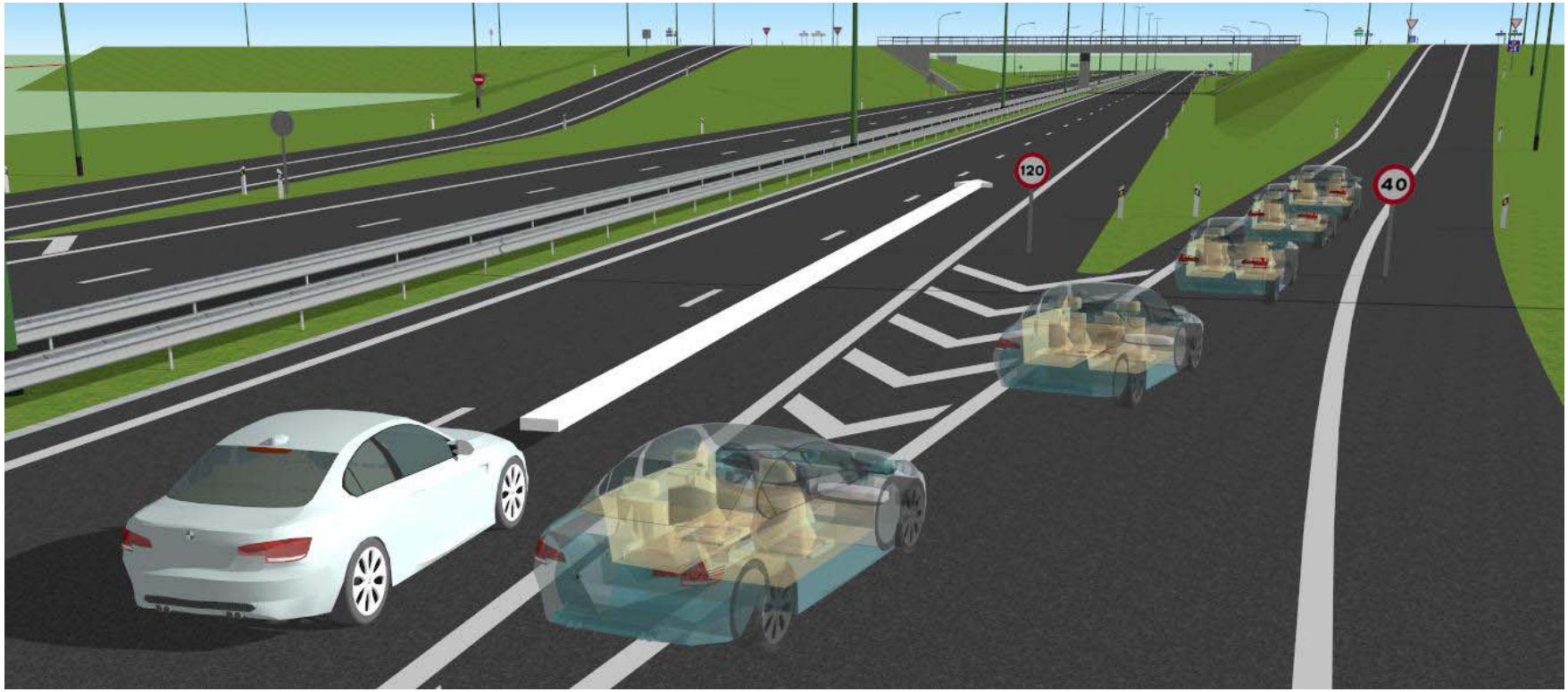
ITS digital maps: navigation drives the technology



- routing for vehicles has been driving the technology for some 20 years
- basics of vehicle navigation:
  - search/destination selection/routing/positioning/guidance/map display
  - road-centreline structure of the data underneath

Image: NAVTEQ (Nokia/HERE) / presentation, B. Denaro, 18th ITS World Congress, Special Session 45, Orlando, USA, October 2011

navigation → ADAS → cooperative → automated



- advanced automotive applications require more accurate positioning and thus accurate/precise maps:
  - ADAS Geometry, more detailed lane level modelling
- safety, efficiency and comfort need look-ahead capability
- timeliness of updates

Image: R. Streiter et al., GALILEO for Interactive Driving - The GAIN Project, in: Proc., 19th ITS World Congress, Vienna, October 2012

30 years evolution of the digital map for ITS

1984	foundation of Tele Atlas, Belgium
1985	foundation of Navigation Technologies (NavTech), USA
1985	start of GDF development (Demeter project)
1986	start of the development of the Carin navigation system (Philips)
1991	foundation of European Geographic Technologies (EGT), The Netherlands
1995	(around this time) first use of term ADAS and gradual start of development (from ~1999 real take-off)
1996	first factory-installed vehicle navigations system (Carin, BMW)
1996	Philips merges EGT into NavTech, headquarters Chicago
1996	completion of CEN GDF 3.0 as ENV14825:1996
1999	IN-ARTE project, on integration of ADAS applications
2000	Tele Atlas acquires Etak (USA) from Sony
2001	foundation of the ADASIS Forum
2004	start of EU-funded PReVENT/MAPS&ADAS project (Feb 2004/Jan 2007) - developed ADASIS v1
2004	start of the work on the Navigation Data Standard (NDS)
2004	Navigation Technologies renamed to NAVTEQ & NYSE IPO
2004	completion of ISO GDF 4.0 as ISO14825:2004
2006	start of SAFESPOT (01/2006-12/2009) and CVIS (06/2009-06/2010) projects on cooperative systems
2007	TomTom acquires Tele Atlas
2008	Nokia acquires NAVTEQ
2011	Nokia integrates NAVTEQ as a division
2011	completion of ISO GDF 5.0 as ISO14825:2011
2012	gradually increasing interest in automated driving, start WG Automation of iMobility Forum
2013	NAVTEQ renamed to HERE
2013	foundation of the Transport Network ITS Spatial Data Deployment Platform

Increasing requirements for the map

- turn-by-turn navigation
  - road centrelines, turn restrictions, speed limits, address ranges, POIs
  - connected networks
  - accuracy 5-20 m
- ADAS (advanced) driver assistance systems (autonomous ADAS)
  - curvature, slope, banking, traffic signs, splines
  - accuracy 1-5 m
- cooperative systems (cooperative ADAS - local dynamic map)
  - lane centrelines, intersection paths, stop lines, traffic lights
  - accuracy ~1 m (in which lane)
- highly automated1 driving (HAD): driving still requires limited human input as not all driving situations/environments are supported
  - infrastructure objects for positioning (e.g. light poles)
  - accuracy < 1 m (where in lane)
- automated1 driving (AD): vehicle drives by sensing its environment and navigates without human input

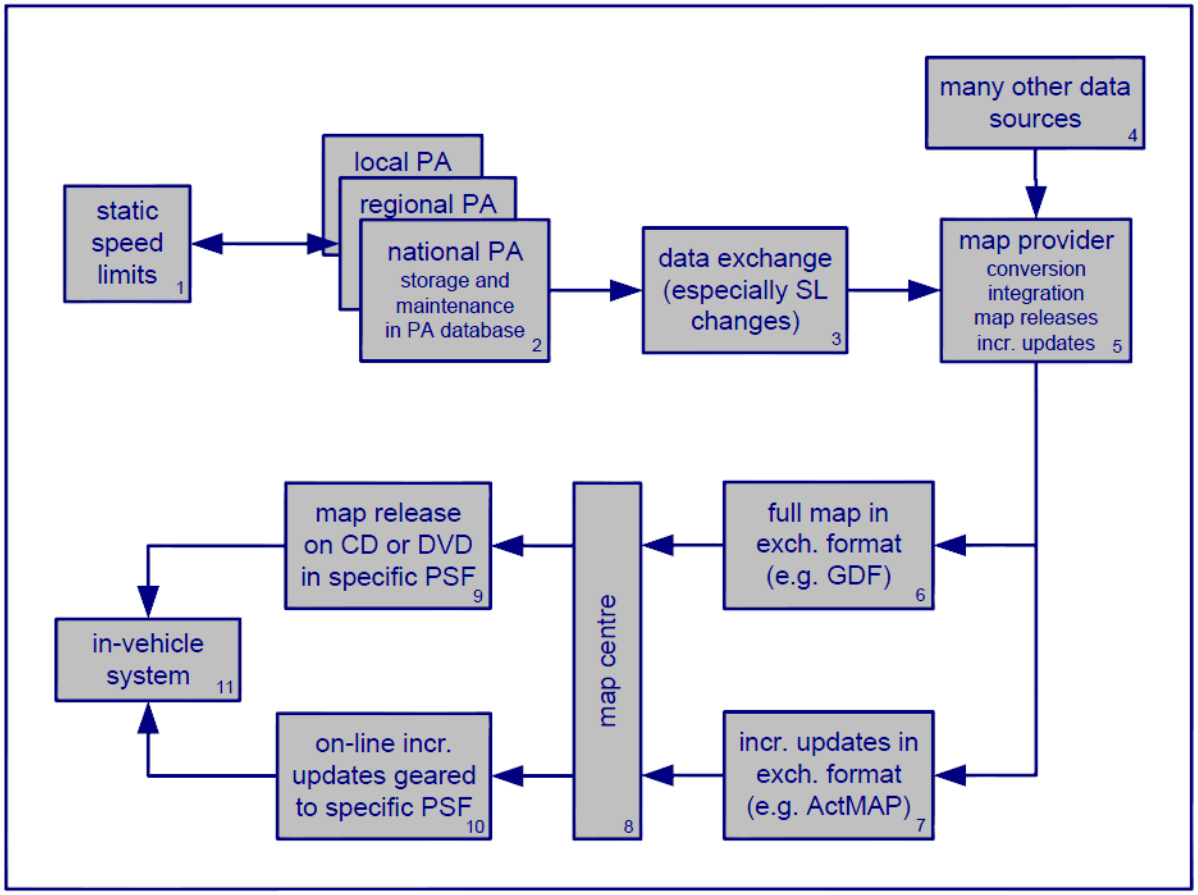
[1] alternative term: (highly) autonomous driving (as used in source)

Source HAD/AD definitions: TomTom, presentation, Filip Ballegeer, 20th ITS World Congress, Special Interest Session 56, Tokyo, Japan, October 2013

TN-ITS as result of EU-funded ITS map projects

- PReVENT/MAPS&ADAS project (Feb 2004/Jan 2007)
  - apart from the important work on the ADAS Interface Specification, this project extensively addressed safety-related road attributes for ADAS applications
- SpeedAlert project (May 2004/Jun 2005)
  - work on speed limit information in digital maps
- ROSATTE project (Jan 2008/Jun 2010)
  - aimed at establishing an efficient and quality-ensured supply chain for information on safety-related road attributes, from public authorities to commercial map providers and other road data users, with a focus on changes in the concerned attributes rather than full data sets
- Digital Maps Working Group of the iMobility Forum (Sep 2011/May 2013) and eMaPS project (same period)
  - prepared the creation of TN-ITS (as a deployment platform for roll-out across Europe)
- TN-TS founded on 5 June 2013 at European ITS Congress, Dublin
  - members association under ERTICO (ITS Europe)

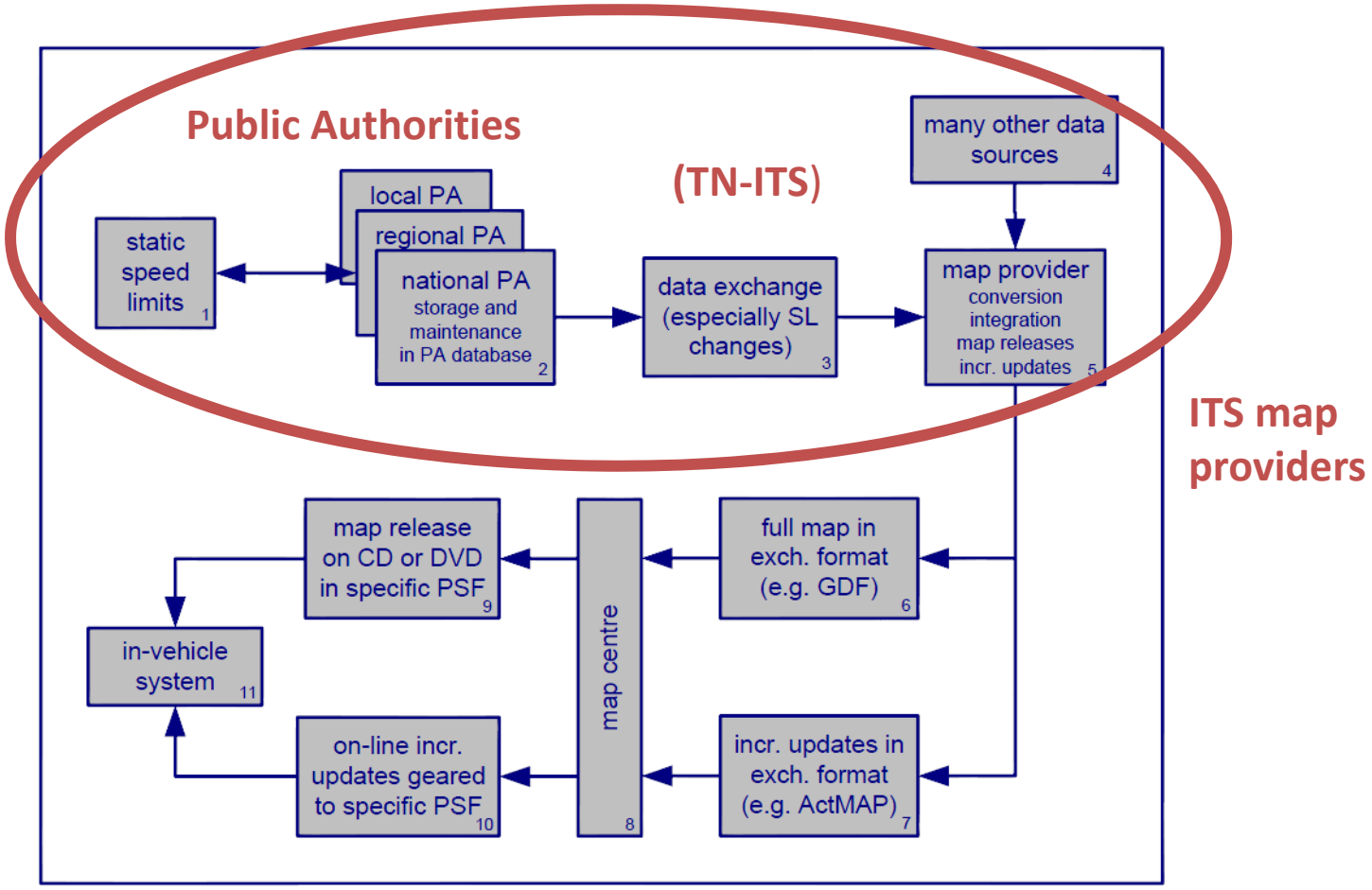
The vision of the data chain: 2005



Overview of the data chain for static speed limits

Source: Wevers, K., Lu, M. "Provision of in-vehicle speed limit information", ITS World Congress, San Francisco, November 2005 (with acknowledgement of the EU-funded SpeedAlert project)

The vision of the data chain: 2005



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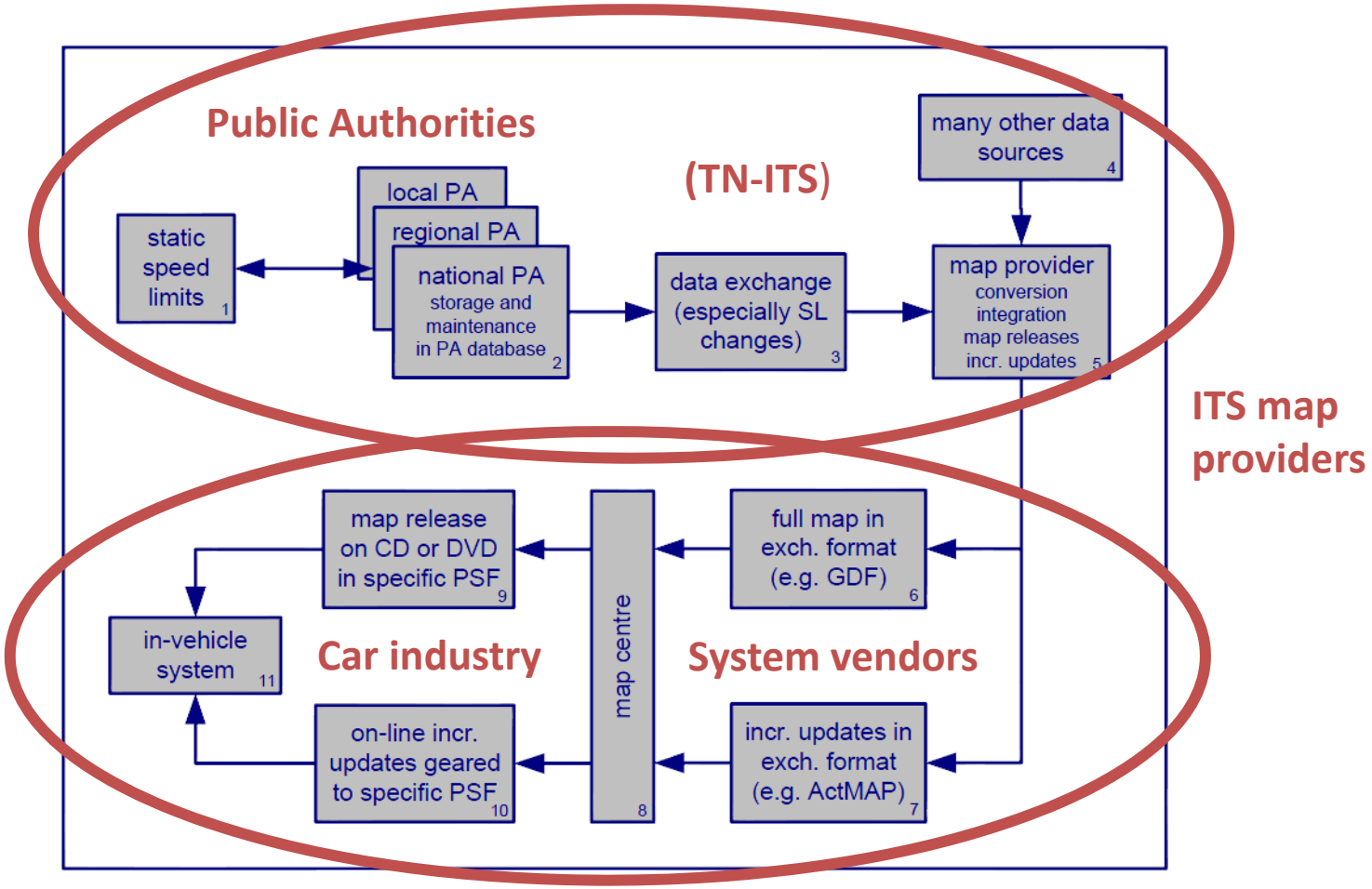

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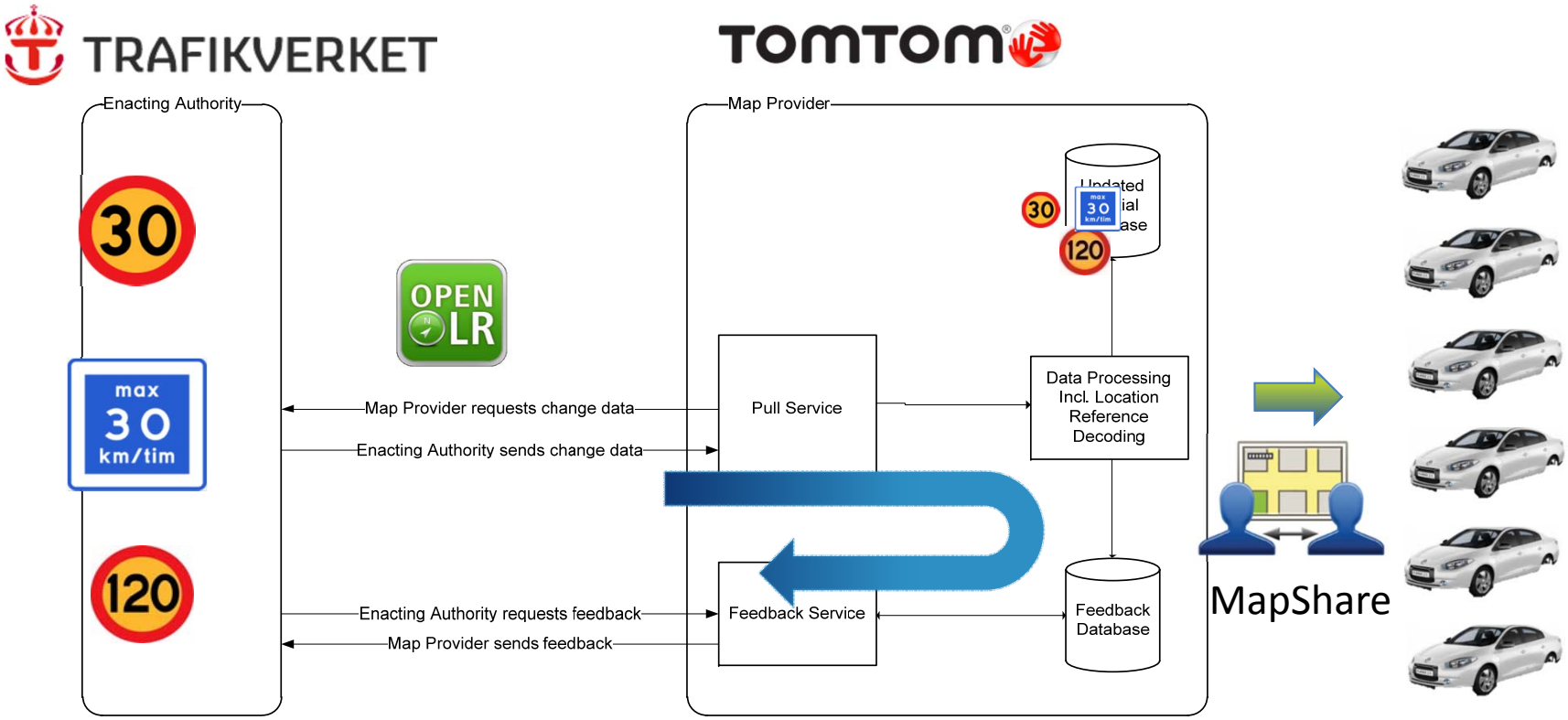
The concept: exchange of updates for ITS maps

- important that ITS digital maps are highly up to date for critical attributes (ADAS, cooperative systems, automated driving, as well as for other applications, e.g. public transport/multimodal)
- the ITS map providers cannot easily keep immediate track of changes
- a solution is to retrieve the information on changes from the most efficient source: road authorities, who make the changes
- can establish an additional trusted source for ITS map providers
- this approach requires digital storage and maintenance on the side of road authorities, and some kind of flagging of changes
- concern is road attributes based on regulations, but may extend to other map features, like public transport, and even geometry
- focus on updates concerning information that will go into the map
- multitude of solutions at governments that are different in terms of GIS and data models applied
- hence a common agreed exchange infrastructure is needed

ROSATTE infrastructure still in place



Source: TomTom / presentation M. Flament 15-04-2013

TN-ITS - basis, objective and mission

- ITS Action Plan (16 Dec 2008) priority actions
  - (1.2) optimisation of the collection and provision of road data
  - (1.3) procedures for ensuring the availability of accurate public data for digital maps and their timely updating through cooperation between the relevant public bodies and digital map providers
- ITS Directive (7 July 2010) specification (b) items
  - (3) National access points
  - (4) Accessibility, publication, exchange and re-use of static road data
  - (8) Updating static road data
- INSPIRE
  - Transport Networks (TN) specification
- TN-ITS objective
  - to give support, on a permanent basis, for the implementation of priority actions 1.2 and 1.3 of the ITS Action Plan of 16 December 2008
- TN-ITS mission
  - to facilitate and foster, throughout Europe, the exchange of ITS-related spatial data between public road authorities as data providers, and map makers and other parties as data users

TN-ITS working groups

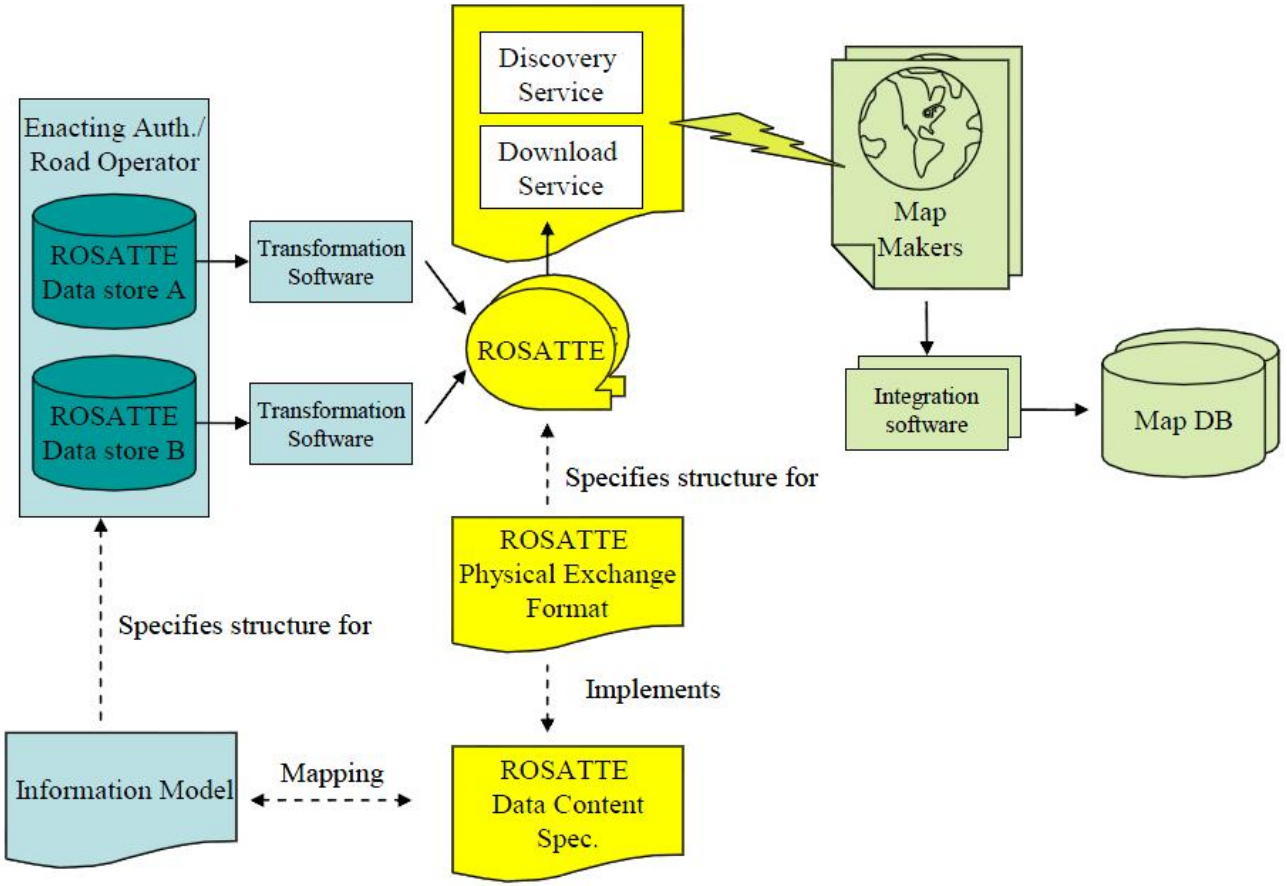
- WG 1 - Location referencing
  - dynamic methods not (always) sufficiently accurate for road data exchange
  - improve performance using current methods, additional attributes and elements of linear referencing
- WG 2 - Specifications and standardisation
  - bring the TN-ITS specification to a formal status
  - close cooperation with CEN/TC 278/WG 7
- WG 3 - Implementation support
  - provide guidelines, best practices and Q&A
  - support new implementation of road data maintenance and the TN-ITS framework
  - produce quality process for TN-ITS data suppliers (certification)
- WG 4 - Generic tools and reference implementation
  - provision of generic tools (interoperability testing, quality control and location referencing conversion) and a reference implementation
- WG 5 - Policy, awareness and dissemination
  - policy contributions along the current EU Directives: ITS, INSPIRE, PSI
  - promotion and dissemination actions

ROSATTE exchange specification

- The ROSATTE project developed and tested specification for exchange infrastructure for static road data
- Components of the ROSATTE specification:
  - a conceptual specification of the data content (information model). This is done using UML (packages, class diagrams, attributes, associations and OCL constraints). The data content specification is organized in a number of packages where each package corresponds to a separate subset of the ROSATTE domain.
  - a physical exchange format (structure and coding using GML schema) to specify a coding for the various types of data listed under the conceptual model.
  - a service specification is implemented using UML (class diagrams), in order to facilitate the actual data flow between the various actors within ROSATTE. This service specification is inspired by INSPIRE network services architecture.

Source: Wikström, L. (ed.), et al., "Specification of data exchange methods", ROSATTE Consortium, deliverable D31, version 16 (final), 31 August 2009.

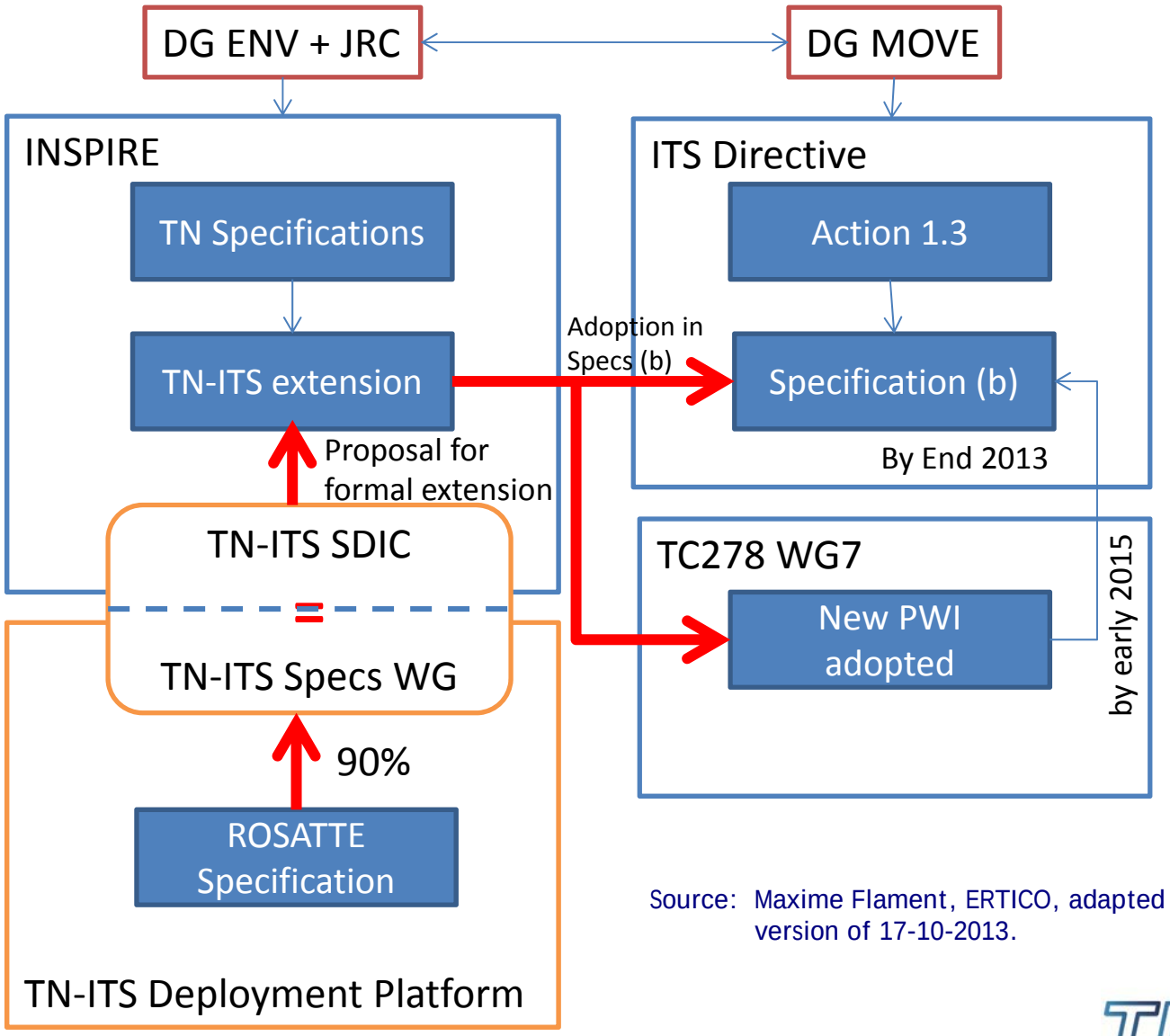
The ROSATTE exchange framework: 2009



Conceptual and concrete levels of the ROSATTE data exchange framework

Source: Wikström, L. (ed.), et al., "Specification of data exchange methods", ROSATTE Consortium, deliverable D31, version 16 (final), 31 August 2009.

TN-ITS: flow of specifications



Source: Maxime Flament, ERTICO, adapted version of 17-10-2013.

Transportation Pilot - driver for implementation

- Joint collaborative effort of the JRC (through their EULF project), TN-ITS and the ELF project, to test the usability of INSPIRE for the transport sector
  - EULF: European Union Location Framework, a concept for an EU-wide, cross-sector interoperability framework for the exchange and sharing of location data and services; mission of the EULF project is to test this concept, inter alia by bringing INSPIRE to other sectors
  - ELF: European Location Framework, three-year EU-funded project aiming at delivering a pan-European cloud platform and web services building on INSPIRE to enable access to harmonised data in cross-border applications
- Phase 1: September 2014/March 2015
- Phase 2: March 2015/ December 2015
- Benefits for TN-ITS in Phase 1
  - Boost for implementation: NO/SE, HERE/TomTom
  - Enabling of linear referencing, testing of dynamic linear referencing
  - Quick progress with the TN-ITS specification
  - One or two other (less advanced) countries in Phase 2

The Transportation Pilot in one slide

Phase 1 – test in Norway and Sweden - by March 2015

Phase 2 – test in one other country – by December 2015

EULF Blueprint

ITS map providers – application providers to businesses/citizens

TN-ITS (enhanced ROSATTE) feed

Attributes

INSPIRE based

ELF (INSPIRE) TN information as WFS, WMS

Integrated data

pan-European seamless platform

TN-ITS specifications/service

ELF platform

NO SE FI ... xx

Statens vegvesen TRAFIKVERKET

NO SE FI ... xx

Kartverket LANTMÄTERIET

TN Data coming from national road administrations

TN data coming from mapping agencies and road administrations - combined

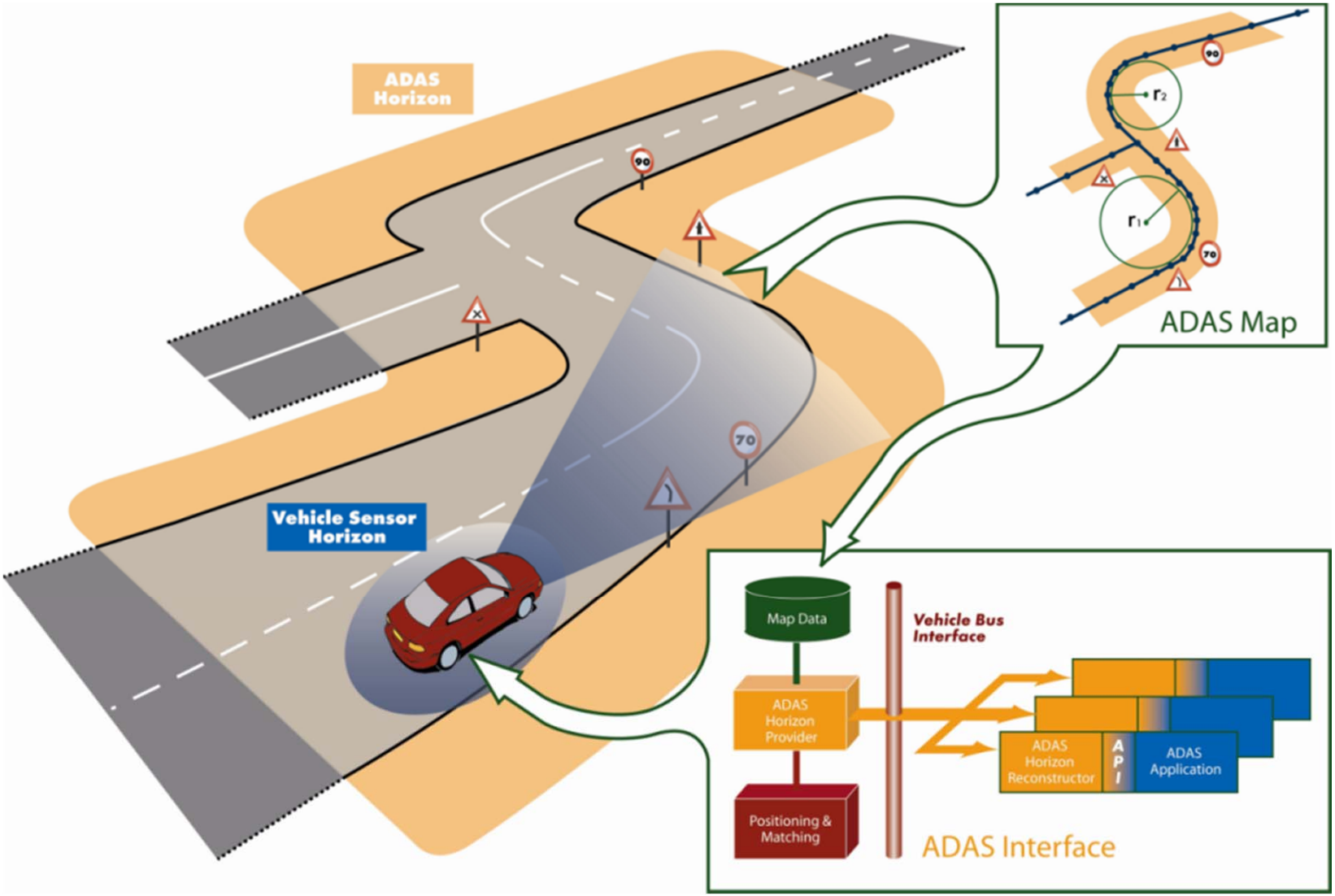
EULF Blueprint

Source: Maria Teresa Borzacchiello, JRC, 13 October 2014

ADAS Interface Specification (ADASIS)

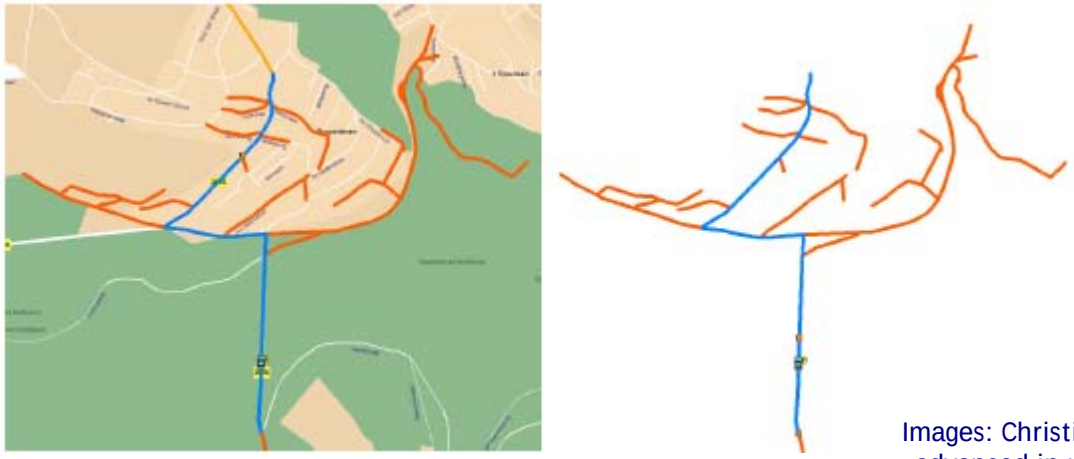
- ADASIS Forum established May 2001
- from June 2002 a forum under ERTICO
- goal: develop standardised map data interface between stored map data and distributed ADAS applications
- two parts:
  - open standardised data model and structure to represent map data in the vicinity of the vehicle position
  - open standardised interface specification to provide ADAS horizon data (especially on a vehicle CAN bus) and to enable ADAS applications to access the ADAS Horizon and position-related data of the vehicle
- key concept: ADAS Horizon or Electronic Horizon
  - a small moving map window in front of (or around) the vehicle
  - geometry, vehicle position, relevant attributes, most probable path
- MAPS&ADAS project (2004/2007) in support of development ADASIS v1
- updated CAN protocol specification was developed by a Task Force of the Forum and published 2008 (ADASIS v2) - industry standard

Electronic or ADAS Horizon



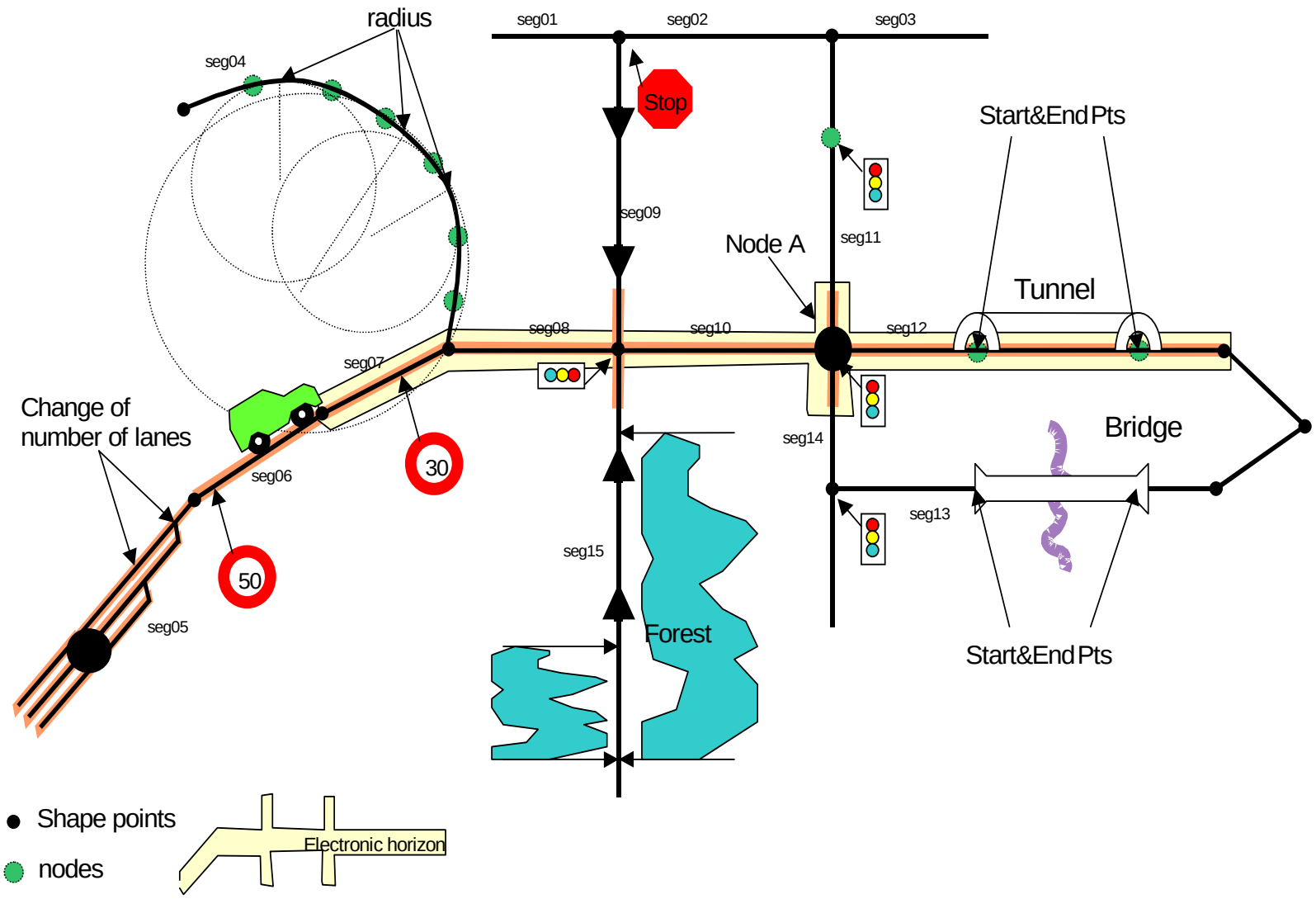
ADAS Horizon: the map as an additional sensor

- vehicle sensors observe the environment, but are limited in range
- the map data have a larger range and permit to look ahead on the path of the vehicle
- for this the most probable path is important
  - calculated based on the probability for each segment that it will be traversed
  - part of the ADASIS Horizon
- the map is in this way used as an additional sensor
- attributes like 3D geometry (curvature, slope), number of lanes, speed limits, and traffic signs can be observed in advance



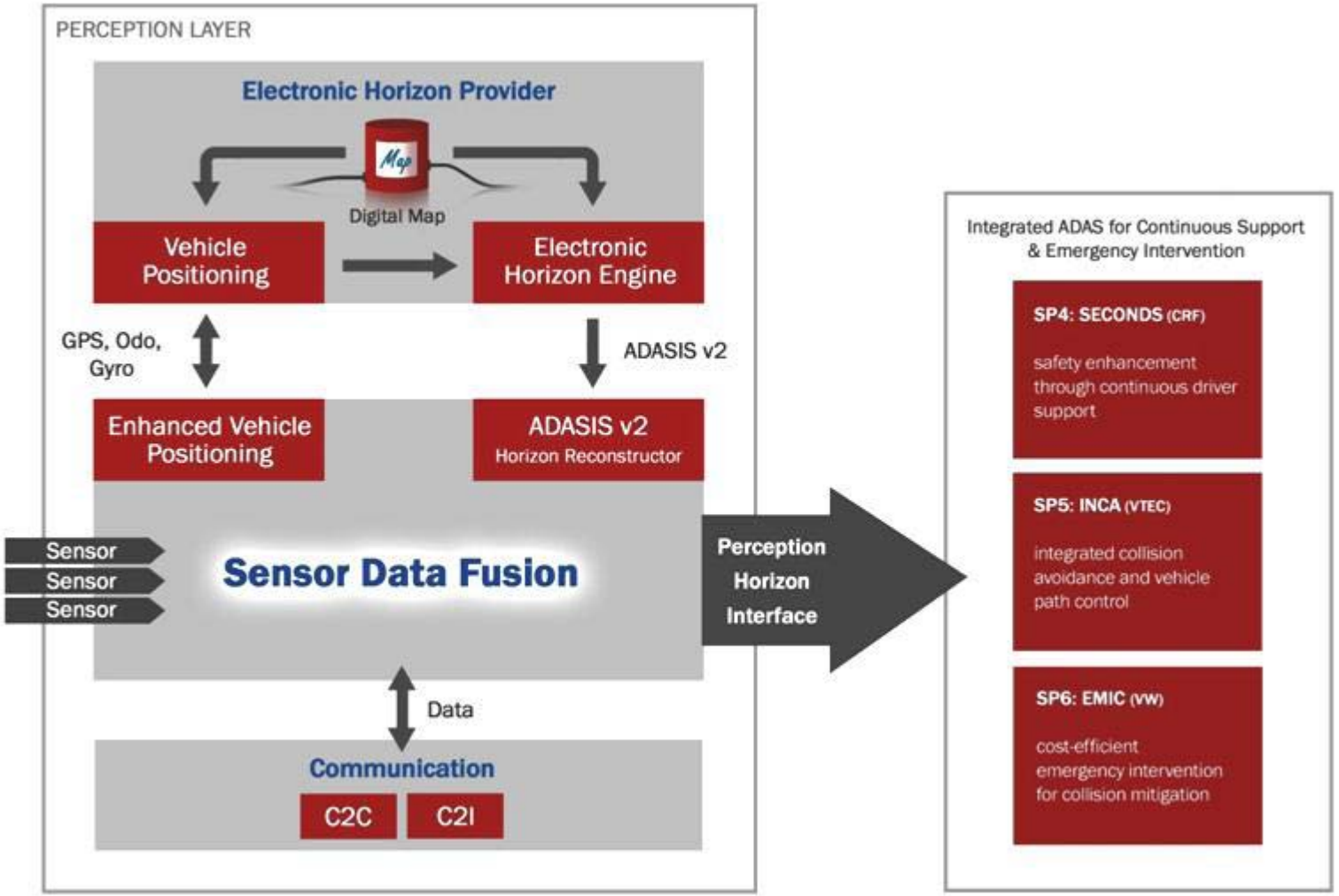
Images: Christian Ress et al., "ADASIS protocol for advanced in-vehicle applications", in Proc., 15th ITS World Congress, New York, USA, November 2008

Electronic or ADAS Horizon



Source: NAVTEQ (Nokia/HERE) / Maxime Flament (ERTICO), presentation, DG MOVE MS Experts meeting, 15-04-2013

ADASIS v2 as part of Sensor Data Fusion



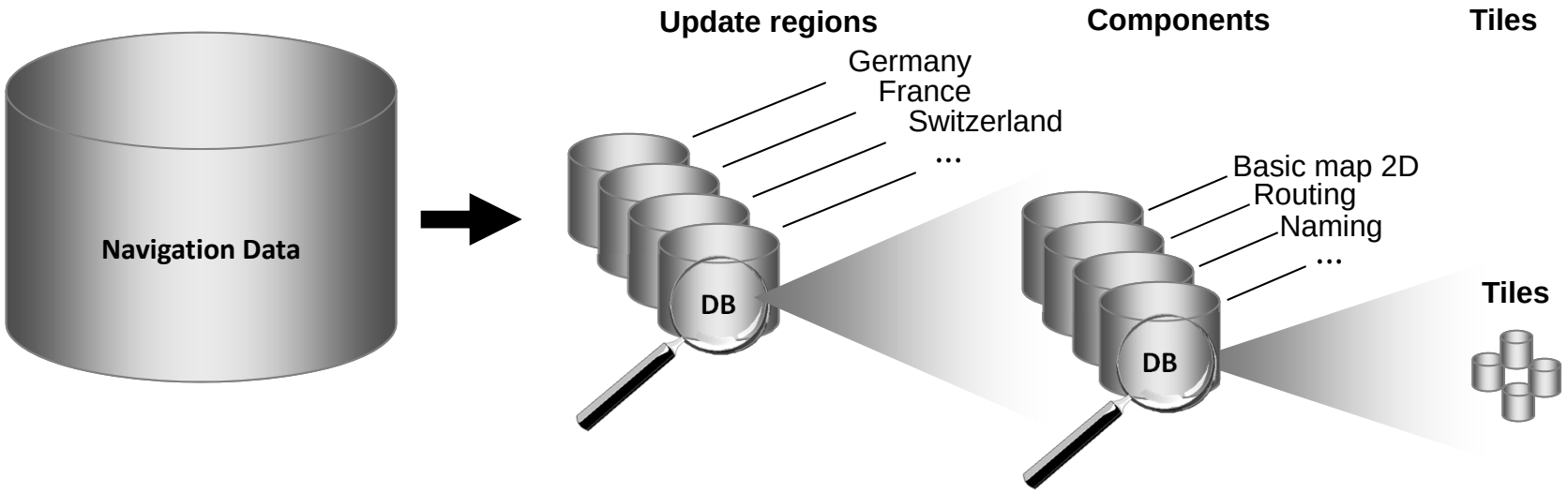
Source: interactIVe project / Aria Etemad (VW), presentation, 20th ITS World Congress, Special Interest Session 63, Tokyo, Japan, October 2013

Physical Storage Format

- the run-time format for the map db that is used in the navigation system
- each system vendor used its own proprietary PSF
- disadvantages:
  - for each different PSF a specific compilation process is needed
  - map data can only be used in the specific system, no interchangeability
  - many different PSFs, therefore small series per vendor (CDs, DVDs)
  - even worse if incremental updating becomes a must
  - ERTICO "Committee for Global Standardisation of Digital Map Databases for ITS" looked into this topic (second half 1990s)
- in 1999 NavTech released its SDAL format for PSF
  - this format was not widely adopted and did not become an industry standard

Navigation Data Standard

- industry initiative, started 2004, to develop a new standardised Navigation Map Format (or PSF)
- now a registered association with paying members
- will overcome the disadvantages mentioned
- will especially allow for incremental updating (tiled layers)
- each NDS db consists of different components stored in separate files



Source: Alexander Bracht (Daimler), presentation, 20th ITS World Congress, Special Interest Session 06, Tokyo, Japan, October 2013

Navigation Data Standard

Important features

- efficient mechanism for incremental updating
- use of SQLite database allows fast data access at small memory footprint
- digital rights management to prevent illegal copying
- sophisticated versioning for on-demand online updates
- building blocks allow flexible product configuration
- compatibility and interoperability

However

- not a public standard, but an industry standard
- substantial admission and annual membership fees (EUR 60,000)
- map providers cannot deliver NDS formatted data to non-NDS members
  - it is permitted that navigation system vendors deliver NDS-based systems to non-NDS OEMs, and this does happen already

Source: Alexander Bracht (Daimler), presentation, 20th ITS World Congress, Special Interest Session 06, Tokyo, Japan, October 2013

The local dynamic map for cooperative systems

- from the Description of Work of the SAFESPOT project:
  - to construct an LDM, road geometry from a standard digital map will be integrated with the information collected by the infrastructure or the vehicles (road status, obstacle presence, etc.)
  - the LDM is a dynamically updated world model representing the vehicle's (and infrastructure's) knowledge of the surrounding environment, with (fused) sensor data and static data (e.g. from digital maps) as inputs
  - this world model is a generic component that is needed for cooperative applications and it fills the gap between sensors, data fusion, static data and applications
- the well-know four layer model for the local dynamic map (LDM), from bottom to top:
  1. the static (and preferably ADAS enhanced) in-vehicle map database
  2. additional static information not present in the standard map database
  3. temporary and dynamic information (e.g. weather and traffic conditions)
  4. dynamic and highly dynamic objects

Source: Kees Wevers, Stéphane Dreher, "Cooperative systems and the concept of the local dynamic map", in Proc., 14th ITS World Congress, Beijing, China, October 2007

SAFESPOT - Helmond test site

Source: Stéphane Dreher (NAVTEQ/Nokia/HERE), presentation "The Local Dynamic Map from a Map makers point of view", CVIS workshop, 09-12-2008

The LDM is a construct

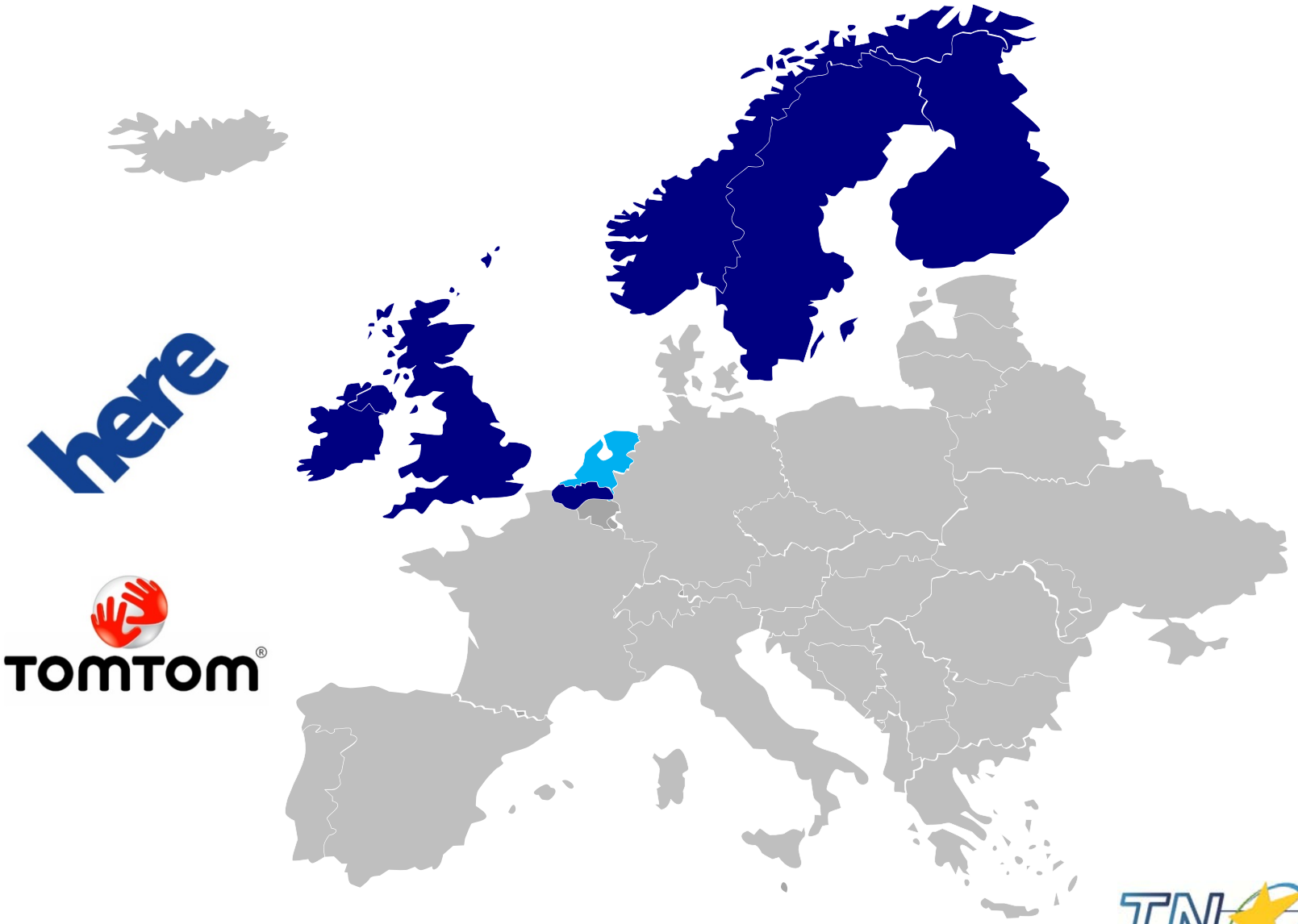
- from the map provider perspective the LDM is just a database on top of the static digital map, with (mainly) dynamic information linked to the static map
- in a virtual sense the LDM is a construct, a local moving extract from the static map combined with the dynamic information from the database on top of it (or attached to it)
- as a moving local extract it has some similarity with the ADAS Horizon, and great similarity with the Perception Horizon
- instead of in a database the dynamic information may also be stored in a data structure in the cache
  - this was the approach in EcoMove: the EcoMap
- just dynamic information temporarily attached to the static map
  - must like traffic information in a navigation system
- certainly for the static map different data structures are needed
  - lane centrelines and reference tracks don't build a connected network
  - locally reference geometry may be needed, preferably in the static map

Drivers for TN-ITS

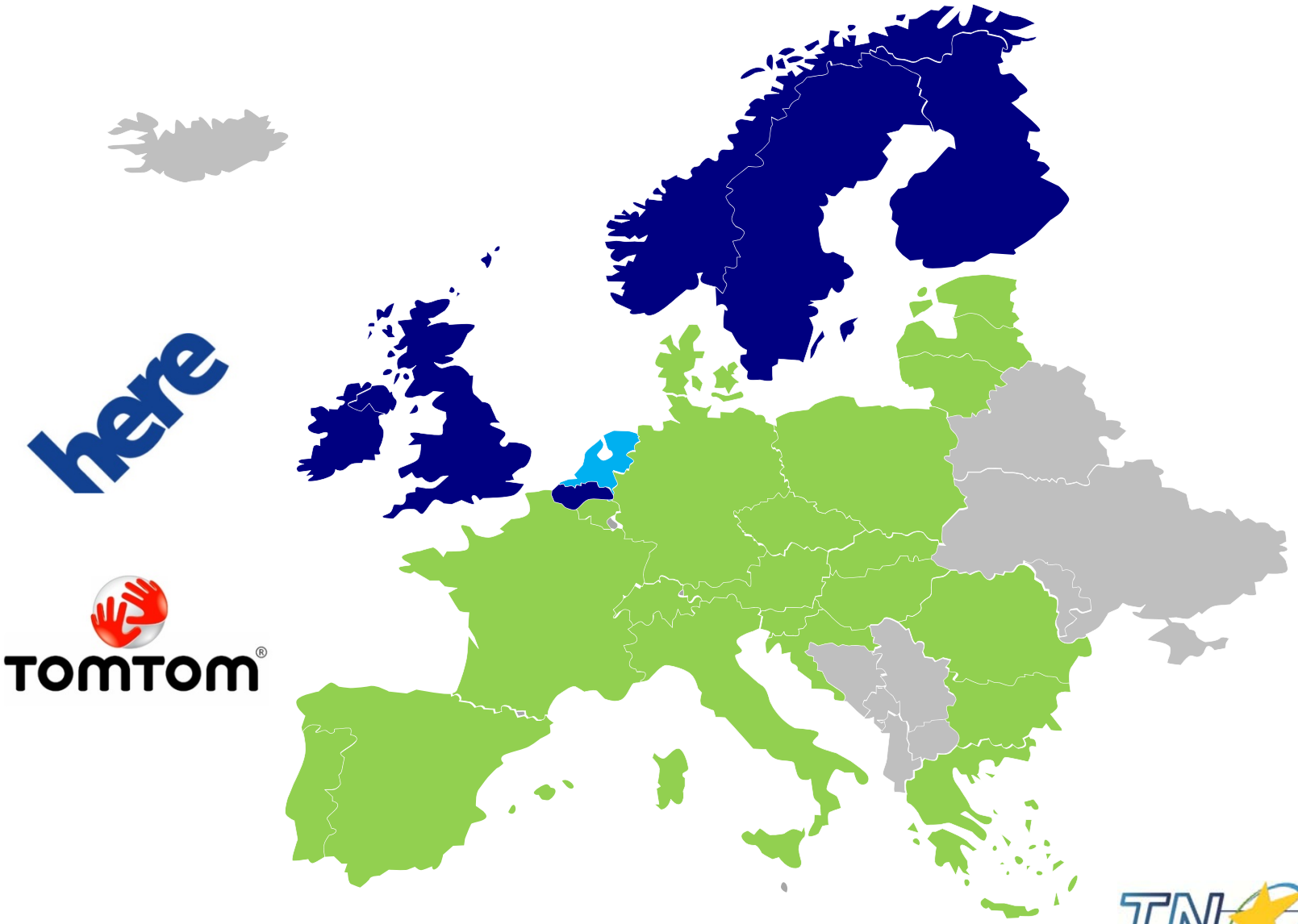
- Speed Assistance Systems in Euro NCAP protocol
  - map-based, camera-based or combination
  - may be a driver for accelerated introduction of such systems
  - this in turn may be a driver for the TN-ITS activities
- Transportation Pilot
  - showcase that INSPIRE (environmental) can be used in other sectors
  - JRC (EULF project) teams up with TN-ITS and ELF project
  - promising activity in terms of:
    - strengthening the links with the European Commission and INSPIRE
    - doing some actual roll-out of TN-ITS services
- In general: ADAS, cooperative ITS, (Highly) Automated Driving
- Strong involvement of and support from the ITS map providers

  However,
- Increased involvement of public road authorities of countries across Europe is a must

TN-ITS membership - current members



TN-ITS membership - prospects



In conclusion

- Status of TN-ITS, membership and activities
  - substantial progress was made in starting up and establishing the platform, and in initiating its core activities
  - to make TN-ITS sufficiently interesting for members to be part of it, a significant increase of the membership is required
  - more involvement in the working groups is needed
  - especially membership of the other "big four" is a must (DE/FR/IT/ES)
  - this is a long-term effort with substantial potential benefits for public authorities and society in general, to enable highly up-to-date ITS digital maps for advanced mobility applications
  - TN-ITS exists primarily to facilitate member states in implementation of an important part of specification (b)
  - standardisation is progressing

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