Ministerie van Infrastructuur en Milieu

ITS in the Netherlands

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In opdracht van het Ministerie van Infrastructuur en Milieu

ITS Netherlands connekt

Contents

Preface

This report contains the 2011 National Inventory of ITS for roads in the Netherlands in response to the demand formulated in EC Directive 2010/40/EU.

This report contains an overview of the current status of ITS in the Netherlands (the installed base) and provides a (non-exhaustive) list of past and present actions. This report is issued by the Ministry of Infrastructure and the Environment and is written by Connekt ITS Netherlands.

The inventory started with four workshops involving a selection of public and private parties that are involved in ITS. Additional information was collected with assistance from the national road operator Rijkswaterstaat, which helped complete the inventory of the development of ITS and identify major trends.

The Ministry of Infrastructure and the Environment's review group added policy aspects to the final version.

With 16.6 million inhabitants, a surface area of just over 33,000 square kilometres and approximately 9[1] million vehicles, the Netherlands is densely populated and very mobile. The primary road network, with a total length of about 5,500 km, is highly utilized and this leads to an average of 200 kms of traffic jams per working day. Many measures are taken to facilitate this high level of mobility and many more are needed as traffic is expected to grow between 10 and 35%[2] between now and 2020. Next to commuters, freight transporters are one of the major users of the road network. With its 750,000 jobs and 8.5% of GDP, this is one of the larger sectors in the Netherlands.

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Introduction

The ITS Directive (2010/40/EU Article 17), the scope of which encompasses ITS for roads with interfaces to other modalities, demands that Member States *submit to the Commission, by 27 August 2011, a report on their national activities and projects regarding the priority areas.* The ITS Directive defines a number of priority areas and actions for the next 7 years.

This report contains an overview of the status of ITS in the Netherlands and provides a (relevant) list of current systems and actions. As this inventory shows, there has been substantial deployment of Intelligent Transportation Systems (ITS) in the Netherlands in the last few decades.

Chapter 2 describes the development of ITS in the Netherlands. It highlights the relationship between the public and the private sectors in deploying a large ITS installed base.

Chapter 3 focuses on the current main topics of ITS in the Netherlands. As stand-alone systems get more connected shared standards for information exchange and shared databases are vital for the development of more advanced ITS services.

Chapter 4 looks at the generic trends in connectivity and mobile computing in society that will have a profound impact on the ITS actions in the Netherlands in the near future. The potential of a networked society where most individuals, vehicles and goods can communicate about their location and destination cannot be underestimated.

Chapter 5 describes general observations and links these with the ITS Directive's guidelines.

Annex A lists the most relevant activities in the Netherlands as well as their relationship to the priority actions and activities as described in article 2 and 3 of the ITS Directive. Annex B provides an inventory of the installed base in the Netherlands.


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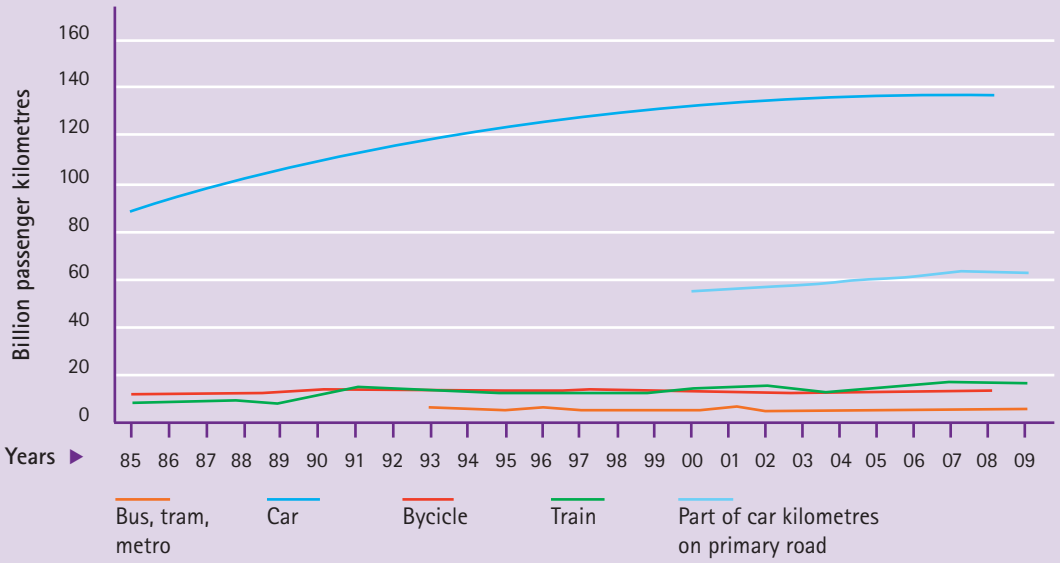
The development of ITS in the Netherlands

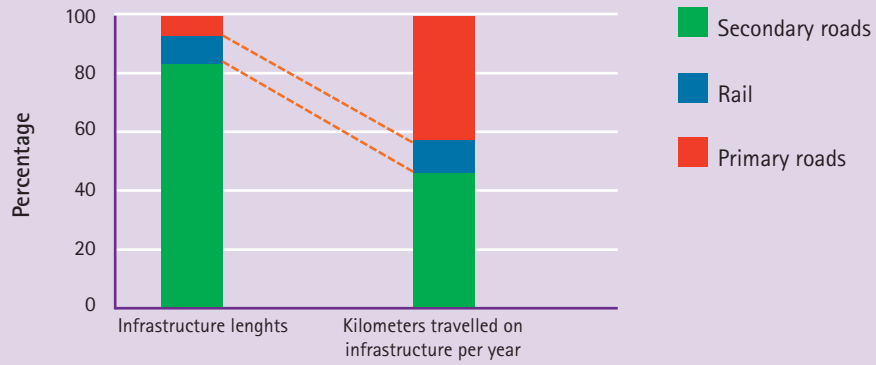
2.1 ITS as a solution to the growth in traffic

Utilisation of the Dutch transportation network has grown constantly, showing a significant rise in the number of passenger car kilometres (31% from 1995 - 2009[3]), a steady growth in numbers of train passengers (27% from 1995 - 2009[4]) and constant growth in the transportation of goods (13% in ton kilometres from 1995 – 2009[5]).

There was a sharp drop due to the crisis; 31% growth was realized until 2008. This growth exceeded the additional network capacity and increased congestion (61.9 million vehicle-hours lost in 2010[6]). Improved utilisation of the existing infrastructure has been a policy priority requiring more intelligent traffic management and information with ITS as a tool.

Figure 2.1 Passenger kilometres for different modalities and per type of infrastructure (Source: Mobiliteitsbalans 2010, KiM). It shows the development of usage of the main infrastructures (primary road systems, secondary road systems, trains) and the levels of primary road network utilisation.





Traffic Management

The first traffic lights (which can be seen as the first ITS measures on the Dutch road network) were deployed in the 1930's in cities such as Eindhoven, Amsterdam and The Hague. In the early 70's and 80's, the first Automatic Incident Detection Systems (based on detection loops and on Variable Message Signs (lane signalling) on gantries above the road) as part of the Motorway Traffic Management system were deployed in the Netherlands. The main goals were to:

1 Prevent rear-end traffic jam accidents;
2 Improve traffic safety by closing a lane when an incident occurs.

Due to the further foreseen growth of mobility in the 1990's the Ministry of Transport, Public Works and Water management created the Traffic Management programme for primary roads[7], which was produced in 1994. This policy document instigated the intensified implementation of Traffic Management measures *(Making better use)*: more monitoring and detection systems, including weather monitoring and warning systems, a communication network along all motorways and ramp metering on the ring roads of large cities in the Netherlands. New technological developments, such as RDS-TMC (Radio Data System - Traffic Message Channel), Traffic Control Centres and the implementation of Incident Management on the Dutch road network were also part of this policy.

Almost all motorways are now monitored with ITS. 980 Km (41% out of 2,346 km) of the motorways are equipped with lane control and there are over 15,000 speed limit matrix signs. Dynamic Traffic Management displays real-time travel information[8] on one of the 200 Dynamic Route Information Panels (Variable Message Sign) to advise the road user. This has resulted in a reduction in lost vehicle hours of between 5 and 10%[9]. ITS is also applied to reduce environmental impact. For example, reduced speed limits are enforced near inhabited areas by measuring average speeds per car/per section using Automatic Number Plate Recognition. Well over 3 billion Euro[10] has been invested in Traffic Management Systems since 1995, resulting in a reduction of vehicle hours lost and fewer accidents and casualties.

For example, VMS's have been estimated to reduce the number of accidents by 5 - 10%[11] (effects often depend on specific local conditions). Maintenance costs are estimated to be approximately 60 million Euro a year. In the coming years, further investments will rise to 200 million per year until 2020[12].
For reasons of economy, safety and better serving the road user, international standards, such as DATEX and recommendations for the use of VMS, are applied when applicable. EASYWAY is an important platform for harmonization and cooperation with neighboring networks. The development of the Deployment Guidelines within EasyWay will be a major step towards achieving European harmonization.

Traffic Information

The need to communicate real-time information on the state of the transportation network became apparent in the late 1980's. Next to regular congestion information broadcasted by FM-radio channels, the monitoring equipment for traffic management allowed the national road operator, Rijkswaterstaat to offer more precise traffic information to the end-user. Since most major roads are equipped with DRIPs these VMS allow quick, localized traffic information to be disseminated to the end-user. It is estimated that on-trip route information can reduce congestion by 5-10%[13] at the specific equipped locations. Research on pre-trip travel information has shown that up to 35% of travellers is willing to change their schedule (modality, time or route) if traffic information is real-time, reliable and easily accessible.

Private parties have also become prominent in the provision of traffic information. One of the first private parties, ANWB, started in 1993 with the provision of traffic information to end-users. Since 1998 a private company (called VID) has been specializing in gathering and disseminating traffic information. TomTom introduced the next step (2007 - 2008) by providing real-time personal traffic information on navigation devices. This information is more accurate and route-specific, since it is based on real-time feedback from the navigation systems in cars (using, for example GPRS connections) creating a second source of real-time data.

Cross Border Management

Within the context of EasyWay, neighbouring countries have developed cross border management (CBM) to inform drivers about enduring incidents or accidents and advise them about alternative routes to reduce time losses and nuisance. In the Netherlands, CBM rerouting is applied between Rotterdam-Antwerp, Eindhoven-Cologne and Arnheim-Oberhausen. Unofficial CBMs are applied between the North of the Netherlands and Lower Saxony.

Road pricing

The policy option to influence demand by changing fixed vehicle purchase tax and road use tax into a road use toll, variable on the basis of time, place and environmental class has been under serious investigation since the 90's with different focus areas. From 2007 onwards, the architecture incorporated individual GPS-enabled devices (on-board-units) per car, measuring position, location and time of day and calculating a variable road price.

The objective of the important *Anders Betalen voor Mobiliteit* (*Pay Differently for Mobility*) project (2005 – 2010) was twofold. First of all, it aimed to introduce a pricing mechanism which would discourage drivers from driving during peak hours or consider alternatives, secondly it set out to reorganise the funding mechanism for infrastructure and transport. There has been extensive involvement of the private sector in relation to specifying and developing the first system of this size.

Many parties recognised an opportunity, on the basis of the introduction of this standard, to monetize new value-added services for mobility; the government spent approximately 100 million Euro on preparations with respect to the introduction of this system.

The project was aborted in 2010 after the government had to resign and the political support to take this unprecedented step faltered. In 2011 the law will be changed to allow for new roads to be tolled as a financing mechanism.

Mobility management

The desire to gain some real life technological and social experience with variable taxation, reward systems and on-board units, was realised on the back of a number of projects aiming to reduce congestion in specific areas. This was often prompted by large, planned road-works which would temporarily reduce the capacity of the road. This created multiple opportunities to see if congestion could be reduced during the construction period (often years) via a combination of ITS and incentive systems (e.g. *financially rewarding for not driving*, eliminating 3-10% of traffic during rush hours).

For example: on the A15-corridor the ITS reward system has been implemented with great success. The average reduction of peak-hour trips for the 2,041 participants compared to the original situation is 59%[14].

The responsible authorities have established an organisation called *De Verkeersonderneming* to decrease traffic congestion during road construction on the A15. These construction works are the first step in the expansion of the port of Rotterdam into the sea with *Maasvlakte 2* (adding 12 kms of additional quays and 2,000 hectares of land).

2.2 Public-private cooperation – The private sector, unless...

Since the 1990's, ITS in the Netherlands has been based on a cooperation between the government and the private sector. ITS Netherlands was founded as a public-private institution in 1996[15]. The main goals of ITS Netherlands, now part of CONNEKT, are:

1 Creating support for ITS among a larger audience by disseminating knowledge;
2 Facilitating a network of experts on the basis of contacts with international ITS-oriented organisations and organising coordination meetings;
3 Stimulating the development of new expertise by means of supporting the development of architecture, standardisation and protocols.

Good traffic management requires the collection of accurate road data, real-time traffic data and the dissemination of traffic information and predictions to end-users. The growth of the private sector, collecting their own (elements of) data and delivering services commercially, required the establishment of *rules of engagement* between the government and the private sector. Discussions about these rules of engagement led to the establishment of a strategic board for traffic information and traffic management in 2009. This board's main goal is to formulate a joint vision in relation to the development of traffic information and traffic management between public authorities and private parties. On the practical side, a so-called National Data Warehouse is now also operational.

The main focus for ITS in the most recent policy document *Vision for Infrastructure and Land use* and the letter to Parliament *Programme Improved Utilisation*[16], is the involvement of the private sector in assisting with the deployment of intelligent end-to-end solutions, for both passenger and freight transport. Traffic management and traffic information are geared towards *peak shaving*, i.e. exploiting the fact that reducing vehicles during peak hours by a relatively small number means a much greater impact on congestion reduction can be realised. The policy is to help the private sector realise these kinds of services and restrict interventions to cases where a greater goal or ambition would not be served.

In 2010, the Netherlands handled 3.7% of global trade, leading to large amounts of freight traffic. The Task Force *Topteam* Logistics recently published their recommendations for increasing the competitiveness of the sector. One of the main recommendations is to create an industry-wide IT-platform (public and private) to facilitate seamless integration of the logistics network: a Single Window for Trade and Transport.

Incident Management

Incident Management has a high priority in the Netherlands, as any small disturbance creates substantial secondary effects on the highly utilised and interconnected roads. Getting rid of these disturbances quickly and allowing the traffic to flow at maximum capacity was (and still is) one of the major policy goals of Incident Management in the Netherlands.

In 2009 13% of vehicle hours lost were directly related to incidents. Whilst 80% of the incidents are small and can be solved by road users, the other 20% tend to last longer and heavily influence the throughput of traffic, increasing congestion levels considerably. For larger incidents a reduction in handling time of between 5 and 120 minutes can be realised if Incident Management is applied, reducing congestion by up to 30%. These savings can, for example, be gained by alerting a salvage company as soon as the notice comes in and rewarding these companies for delivering good quality. ITS provides tools at several steps in this process, including: incident detection (e.g. with cameras), communication between emergency services and the provision of traffic information to the end-user.

A high level of expertise has been gained on how to implement Incident Management efficiently and cost-effectively. The organisational challenge is the creation of cooperation between the different stakeholders that must be involved in the Incident Management process. This level of cooperation was established by setting a common goal: free and available roads for drivers. The proactive role of the Dutch road operator, Rijkswaterstaat also created an extra stimulus for obtaining this cooperation. Within EasyWay, Incident Management is dedicated as a service for the road user throughout Europe.

The next step for Incident Management is further integration with Traffic Management because these two heavily influence each other. Technological improvements, such as a common communication system as well as the virtual integration of the traffic management centres with emergency services operation rooms, have signified the first steps in this process for the primary road network. Also, e-call is currently being integrated within the incident management process and is expected to deliver even more societal benefits. Initial estimates claim a further reduction in vehicle hours lost of 5% for eCall alone.

3

From stand alone to connected systems

3.1 Increasing value by interconnecting stand alone systems

The next step, beyond individual road management of the highways, is network management and the interaction between different types of roads to manage the interoperability to facilitate road-user consistency. Not only should information be shared within modalities (e.g. real-time travel information on public transport stops) but also between modalities (e.g. by means of Park & Ride signs with multi-modal travel information). The traffic management systems for primary and secondary roads are being connected, allowing for better interaction between the two. Connecting multiple systems allows for improved door-to-door information and route guidance for the end user. The same type of connectivity is needed for trade and transport in order to reap the benefits of real-time track & trace data. Policymakers recognised that both the private and public sectors would benefit from the development of standardised protocols, interfaces and data models. Secondly it became clear that the creation of data exchanges for all types of modality and data-user was inevitable for the next step. Thirdly, adding interconnection increases the complexity of the total ITS system, making it even more necessary to create pilot projects and real-life tests to gain experience in practice.
Networks, traffic or transport do not stop at the borders, certainly not for our own or foreign drivers and travellers. Economic, mobility and safety benefits are at stake. The aspects of international harmonisation and continuity of services, therefore, must be taken seriously, not just in research but also in implementation and in operations. the Netherlands is an active partner in the unique European cooperation between road authorities for implementing harmonised EasyWay ITS services.

3.2 ITS Standards

The Netherlands actively participates in existing global and European standardisation platforms such as ETSI, CEN and ISO. Prominent areas include tolling and security, data exchange and cooperative systems. Within EasyWay, the Netherlands participate in the development and further improvement of the Deployment Guidelines for ITS implementations in Europe. The Netherlands has the principle intention that future implementations will be done according to the EasyWay Deployment Guidelines. Specific standardisation aspects need to be elaborated for and applied to the Netherlands. Three of those Dutch standardization efforts are:

- BISON - A platform on which standards on the exchange of data on public transport services are developed, harmonised and guarded. BISON is also used as a knowledge centre for the public transport concessions and related IT-policies. Within BISON, both public and private stakeholders are represented in addition to transportation providers and travellers. Activities include the development and maintenance of information standards which are applied to information exchange within the public transport arena, e.g. a standard for static and dynamic information on public transport stops. The stimulation of continuity and private practice in relation to public transport information exchange and the provision of advice with respect to dynamic travel information in public transport are also aspects of BISON. Furthermore, expansion and integration with existing European and international standards is also one of the goals.

- GROUN - Organisation for the exchange of data between map-makers and road authorities. In this project, paid for by the Ministry of Infrastructure & the Environment, road authorities and private parties collaborate to enhance the exchange of relevant static route information, facilitating route planners and navigation devices and optimising route planning for their users. This initiative started in the province of Zeeland as a central road information desk bringing together all available digital road information. The importance of such an initiative was recognised to such an extent that it became part of the National Data Warehouse database, meaning easy involvement of more public and private parties. The follow-up to GROUN is the legal obligation to make digital standardised traffic notifications from public authorities available in one location. These notifications are to be shared with navigation service providers and can include specific information for trucks, such as bridge and tunnel heights and weight limitations, and preferred route alternatives.

- MOGIN is the Dutch platform where technical operational aspects for sharing mobility information between public and private parties are addressed. The stakeholders involved, for example, have indicated that there is need to reach an agreement on the standardisation of mobility information and location referencing. These agreements, of course, also can be used between private parties to facilitate the exchange of data. These results will be used as input for the European standardisation.

Both public and private parties are represented in all platforms.

Connected public transport

First steps are taken by the public transport service provider 9292ov[17] to connect their network to the EU Spirit initiative. EU Spirit is a European travel information service offering the calculation of itineraries between European cities and regions with regard to public transport. EU Spirit itself is not a travel planner but a compilation of already existing internet based informationservice systems for short and long distance traffic. EU Spirit is used in such cases when a customer, not only wants to travel inside one city or region but is in need of an itinerary between different European regions.

3.3 Databases

Strongly related to the discussion on standardisation, is the establishment of databases which are required in order to make information widely available.

The main traffic information database for traffic management in the Netherlands is the Nationale Databank Wegverkeersgegevens (National Data Warehouse for the road network and Traffic Information or NDW for short), which became operational in 2010. The main objective of the NDW is to establish an operational National Data Warehouse for Traffic Information on a basic network of at least 5,500 kilometres of national, provincial and municipal roads within 5 years (from 2008-2013). NDW will become the databank that will collect, process, store and distribute all relevant traffic data using the European DATEX II standard. NDW is more than just a Data Warehouse, however, it is also a collaboration between 15 road operators covering approximately 60% of total Dutch traffic.

NDW has set the goal to collect traffic information for their measured road network once a minute and send an update to their users every 75 seconds.[18] Total costs for the NDW are estimated to be 67 million Euro's between 2008 and 2013.

The information that is collected in the database is provided to road authorities as well as service providers of traffic information, allowing them to create a complete overview of both primary and secondary roads. The information is both static and dynamic, containing all the relevant information which allows for more efficient traffic management as well as more effective route guidance.

Three other shared data exchange initiatives are currently under development:

- Two initiatives are being combined in public transport: the National Data office for Public Transport (NDOV) serves as a high-level standardisation and quality control group while GOVI (Borderless Public Transport Information) establishes a governance model covering the two major existing databases on public transport. This data can be used for multi-modal journey planning systems provided by service providers. GOVI is using the BISON standard that was mentioned in the previous paragraph.

- NDPV – a dataoffice holding first static[19] and later dynamic data on parking facilities (first off-street later on-street), making it possible to provide customised parking services to drivers. In the Netherlands, 9 million parking places are available, 500,000 of which are paid parking spots, 2% of which are in car parks.

The 34,000 or so parking spaces close to public transport hubs are of particular interest in order to support the flexible use of modalities.

3.4 ITS system tests, pilots and demonstration projects

As part of the Mobility management test site in the province of Noord-Brabant, a number of Value Added Services are tested. These will include the Intelligent Speed Information application near schools which involves reducing the maximum speed near schools during opening hours. Other services include parking information and information about road works. The speed information application is based on a static map and the opening hours of schools and provides time-related Speed Advice[20].

In the province of Noord- & Zuid-Holland a large Intelligent Speed Adaptation test has started in which participants are divided into two groups. One group of drivers only receives feedback about their driving speed behaviour (with the option to intervene when the limit is not respected for a specific time) while the other group cannot drive above the limit at all as they have a so-called active SpeedAlert system. This test started in April 2011 and will last for 7 months. One of the remaining questions, besides the technical aspects, involves the issues of liability and this must be thoroughly investigated[21].

The safety of vulnerable road users has a high priority in the Netherlands as cycling is a very popular activity. The development of an airbag mounted on the outside (windshield or bonnet) of cars (as a potential safety measure), specifically to protect cyclists that are hit by a car, is a prominent example of that priority.

Another example is the *Blind Spot Detection and Signalling Systems* project. Its aim was to improve our knowledge about the role that active detection and signalling systems for trucks can play in reducing blind-spot accidents where a pedestrian or cyclist is run over by a truck taking a corner. Modelling and tests have shown how quickly the situation can become dangerous and how hard it is for current sensor technology to detect imminent danger in time to prevent accidents[22].
In EasyWay initiatives are developed to increase the safety and security of Intelligent Truck Parking throughout Europe and special attention is given to the transport of hazardous and dangerous goods.

The Fileproof programme's main goal was to increase accessibility and improve the efficiency of traffic. Interesting ideas that were put forward were tested in practice to identify potential benefits. A total of 60 projects were run, resulting in a reduction of 3.4 million vehicle hours lost in 2008, creating a societal benefit of approximately 50 million Euro.

The *Accident Prevention Systems for trucks* project (part of the *Fileproof* programme) tested whether the various ITS systems that are available for trucks actually increase safety. A total of 2,400 lorries with Advanced Driver Assistance systems were monitored for close to 100 million kilometres. The systems tested were Headway monitoring and Frontal collision warning, Lane Departure Warning Assist, Adaptive Cruise Control, Directional control and Black Box Feed Back. A side-effect of the test is that many of the trucks in the Netherlands are now using accident prevention systems.

Mobility management is seen as one of the most important successes of the last decade in the Netherlands. More than 10 sizeable projects have been tendered and are operational, with a great deal of success. Key successes include: an area with heavy congestion, an easy explanatory project for the end-user and national and regional authorities and cooperation from the private sector.

Following the positive example of the Green Wave project (part of the *Fileproof* programme), where average waiting times at traffic regulated intersections were reduced by 30%, two other pilots were also started. The adaptive regulation of traffic lights, which can be attuned specifically to trucks (*Magic Green*) or normal cars, to obtain a smooth flow of traffic is currently under investigation. The ODYSA system, for example, provides speed advice to drivers to prevent them from needing to stop for red traffic lights. Furthermore, as part of the Brabant in-car II research programme, a project called RDSA (Radio Dynamic Speed Advise) focuses on providing traffic light information to the driver by means of RDS-TMC.

Transport and trading are very important economic activities for the Netherlands. The main focus of the concept of *Synchromodality* is to attain a better match between transport volumes, time available and the mix of modalities. It is basically the next step after intermodality where modalities and connections are fixed in advance. Synchromodality, in turn, allows for a growth in transport volume with lower costs for the environment and surroundings. The available capacity of transportation means and infrastructure together determine the choice of modality (road, waterway, air or rail) depending on the type of freight. ITS is vital within this concept.

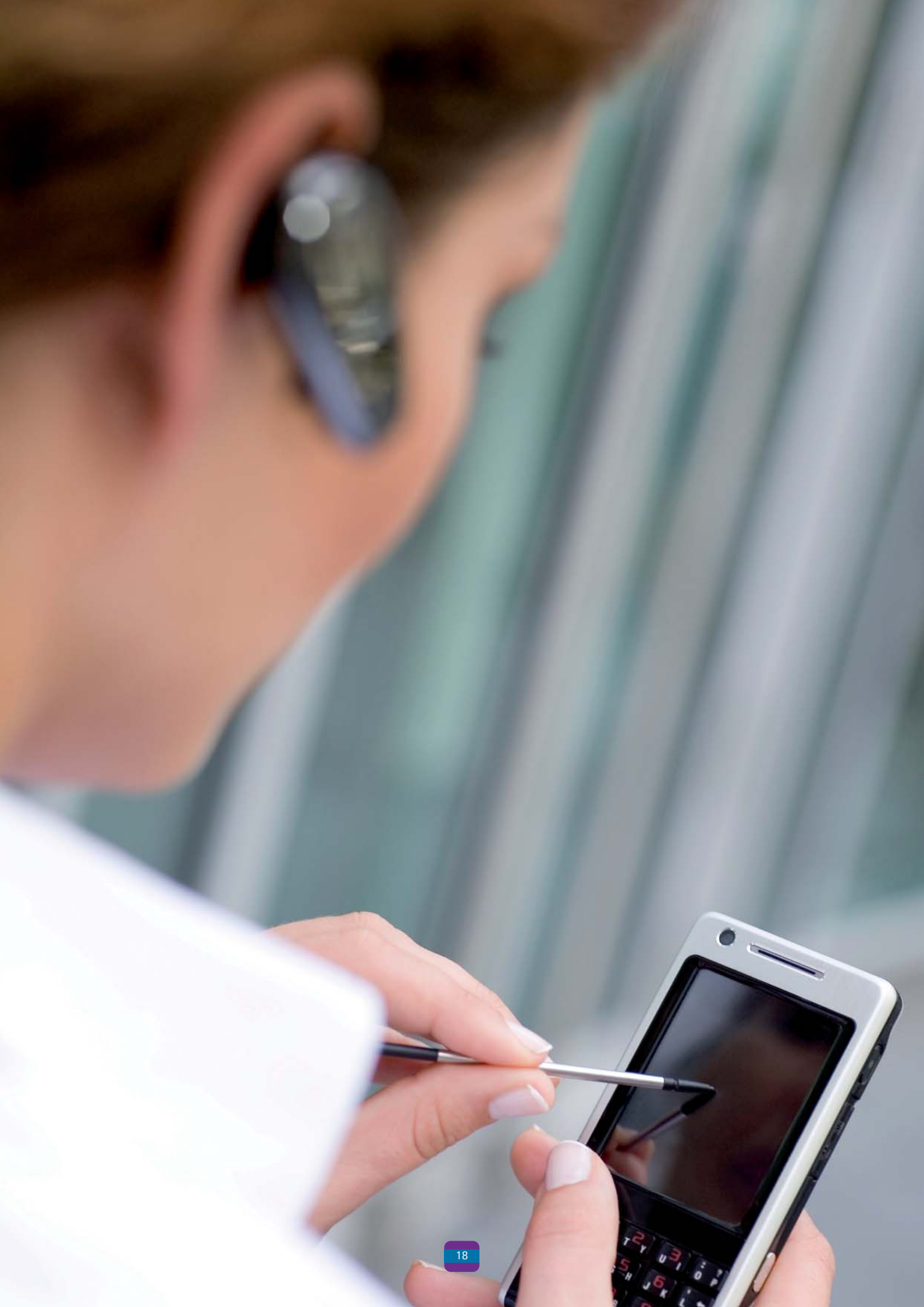
The expected threefold increase in the number of containers arriving at the port of Rotterdam in the coming decades has increased the need to improve the logistic performance of the transport facilities from the harbour to its final destination. A large programme (100 M€) called Impulse Dynamic Traffic Management for Waterways has been started in order to improve (mainly through ITS) the logistic integration of barge shipping within the waterways. The three main aspects of the programme are:

- Aspect 1: Further optimisation of the internal organisation of the public authorities as waterway operator;
- Aspect 2: A Single Window (sharing information between public and private parties);
- Aspect 3: Expanding knowledge base (providing information on how to take the waterways to the *next level*).

A specific initiative that is currently underway in the Netherlands is the development of the new roadside equipment for highways which will be required for the coming improvements. These monitoring and data-acquisition terminals collect and process traffic data and play a crucial role in lane control signalling and monitoring. The need to upgrade the current equipment as it nears the end of its technical lifecycle (15 years) creates an opportunity to introduce a new generation of roadside equipment that is flexible, fast, adaptable and future-proof. This will enable:

- Market conditions to be improved;
- Specific services to be offered;
- Commercial innovations to be supported;
- Open standards to be used as a base for opening up the upgrade path to cooperative systems.

All of the road authorities in Easyway in Europe, both public and private, are working together to collectively try to develop and deploy cooperative systems.



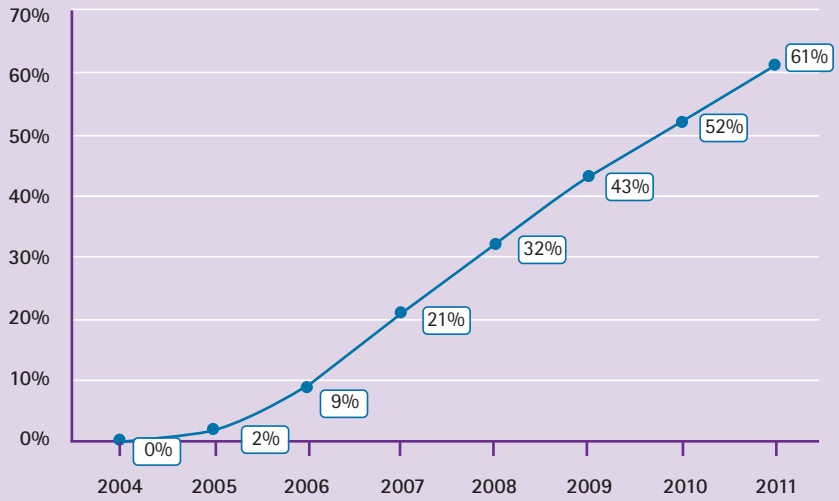
4

Networking: end-to-end solutions

4.1 Informed anytime anywhere

In the previous decade the level of data connectivity for computing devices, machines and (mobile) persons rose to unprecedented levels. As a result, new ITS options that were unthinkable some years ago have now become available.

Figure 4.1 Penetration of navigation devices per household in the Netherlands (2011 is a forecast) (Gesellschaft für Konsumforschung - GfK, 2011)

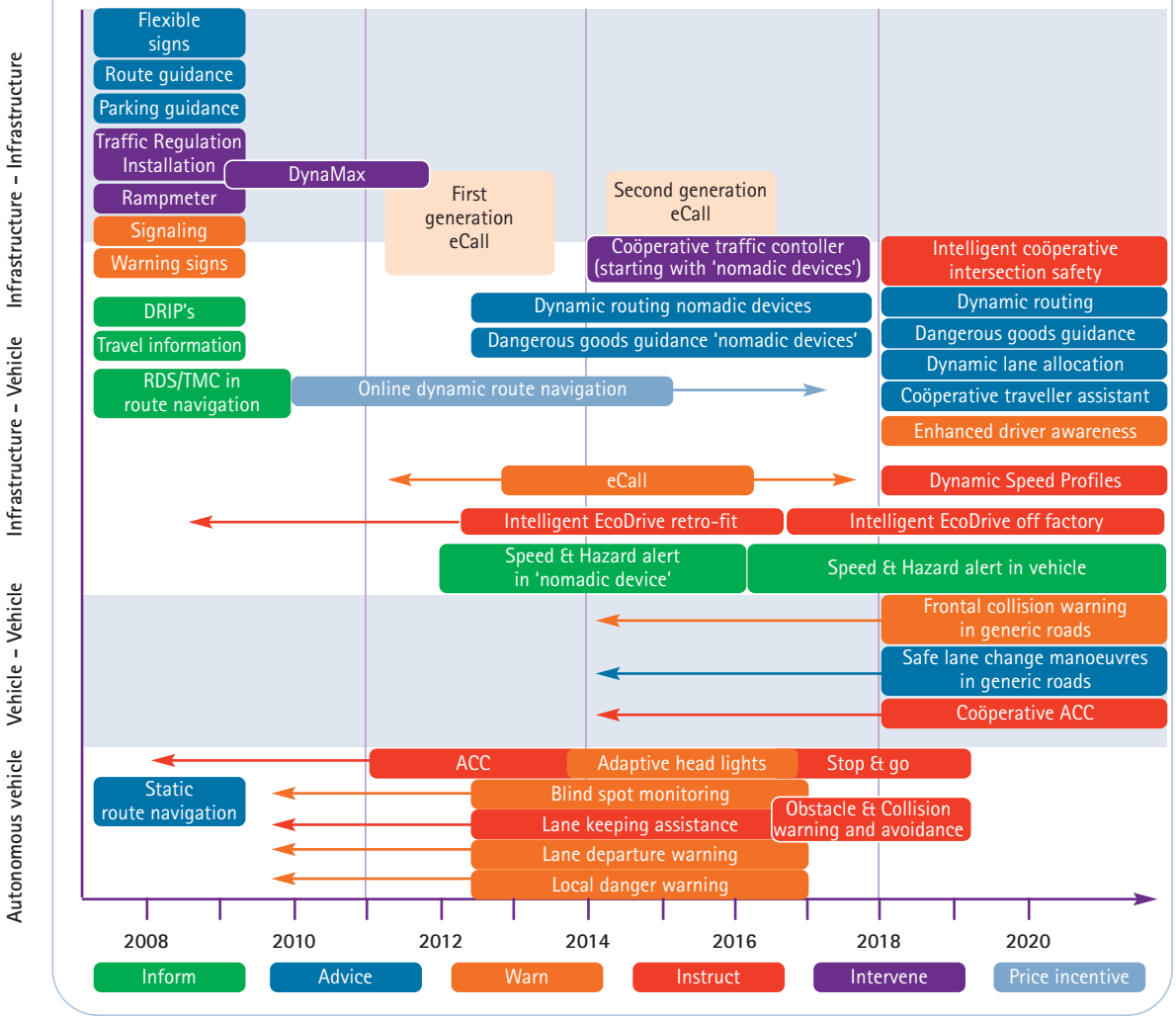


The widespread availability of navigation devices in combination with cheap mobile connectivity allowed navigation system producers to introduce systems that collect real-time traffic flow data from many thousands of drivers simultaneously. The aggregated flow data in relation to the movement of many mobile phones adds *floating phone data* as another layer of real time traffic information. The most recent development is the spectacular adoption rate of GPS-enabled smart phones, triggering many application developers to monetize location-aware services and mobility services. Experiments such as the fully integrated Personal Travel Assistant (Amsterdam, 2010) have demonstrated the potential of smart phones with mobile internet for Mobility Service Providers that provide end-to-end/door-to-door mobility services. The major challenge in realising door-to-door mobility services is to make data available to connect road traffic information with public transport information, especially at the locations where a transfer between modalities is possible (e.g. parking). The market is expected to start delivering this type of mobilityservices when the business case is positive.

As already shown in the previous chapter, the government's policy is to facilitate private initiatives by setting standards and making data accessible. As a result, multiple initiatives are being proposed. These initiatives include NIO, a plan claiming a 15% more efficient use of the road network and a reduction of 20% of vehicle hours lost in 2014 by applying a combination of new and existing technologies (see website for more information)[23].

The *Reference architecture for traffic management* shown below is one of the roadmaps that have been developed in the Netherlands in the past few years. It shows just how active the Netherlands is in developing concepts and innovations for ITS.

Figure 4.2 Reference Architecture Traffic Management



In the freight sector tracking-and-tracing systems have become commonplace and approximately 30% of trucks are equipped with specific on-board computers[24]. This allows activities to be planned more efficiently, data on transport to be shared and combined rides to be organised. The next step is to actually share this data amongst (competing) stakeholders in order to facilitate cross-chain control centres to increase benefits. The increased level of networked systems has identified a key issue in the development of ITS systems, i.e. the ownership, use and re-use of data.

When data is seen as input for creating a single value added service, it is clear that more complex services require many inputs from multiple sources. The economic cost of having to negotiate every bilateral agreement on how data can be licensed, paid for, used, what quality can be expected, what liabilities can be expected and so on from scratch is impeding growth. This is an aspect that needs to be addressed in the coming years and the steering committee for traffic information is currently preparing a plan focusing on solving these issues.

4.2 Developing and testing hyper-connected and cooperative systems

An important development project is the open platform for in-car systems called SPITS (Strategic Platform for Intelligent Traffic Systems). SPITS is based on the three large 6th Framework Integrated Projects that were finished in 2010, CVIS, SAFESPOT and COOPERS. SPITS focuses on three areas: traffic management, in-vehicle solutions and service download and management solutions. SPITS has defined an open, affordable, and scalable in-car platform for future systems, and explored new techniques in cooperative driving and mobility.

By utilising existing standards and creating pragmatic solutions and architectures, as well as a complete set of reference applications, the SPITS partners have delivered a toolkit that can easily be built upon by innovators. Impact studies will quantify the effects of the applications on throughput, comfort, safety and the environment[25]. One of the promising applications that has been developed is Cooperative Adaptive Cruise Control. CACC provides an opportunity for congestion (and more specifically shockwaves) to be tackled and showed a potential reduction of 30% in current congestion.

Complex systems need a good test environment, a test in near real-life situations with normal drivers where the environment is as controlled as possible. The Netherlands has identified the need for these tests to be conducted permanently and initiated, with a collective of public and private parties, the Dutch Integrated Test site for Cooperative Mobility (DITCM). The goal of the test site is to enable all system producers to test their systems and identify the potential effects these systems have on traffic, the environment and safety. Several large scale tests (A270 tests) were conducted with volunteer drivers in 2010 and 2011.

4.3 Pilots

One of the major and very specific developments with respect to traffic safety is the deployment of eCall. The Dutch government (and other involved parties) are actively participating in the pre-deployment pilot that is currently running in Europe. This pilot is performed together with other involved stakeholders such as the national police and the national road worthiness institute, but also involves private parties who will function as service providers when real deployment is taking place.

A development from the private sector is to identify Value Added Services for the eCall technology, viz. bCall (breakdown call), where the driver can request road side assistance when his car breaks down.

Besides the already available ITS applications on the highways, ITS can also be used as an instrument to overcome environmental problems such as air quality and noise nuisance within urban areas. One of the initiatives running in Europe, but also tested in the Netherlands, is the FREILOT project. FREILOT aims at increasing the energy efficiency of urban freight through the deployment of ITS (Intelligent Transport Systems) services.

The pilot area in the Netherlands includes a main route near Eindhoven, with 11 intersections, all connected in an adaptive urban traffic control system. The urban traffic control system will be augmented with fleet-specific sensors at strategic locations to detect the pilot fleet and existing detectors will be upgraded to selectively detect long vehicles. Additionally, the network can be used to calculate actual real-time travel times and the predicted number of stops for the two routes by which the trial fleet can exit the city[26].

The throughput on highways can be further optimised by making use of Dynamic Speed limits. This so-called Dynamax system has been tested in the Netherlands at four locations (57 kilometres) and in relation to various objectives (AID, speed harmonisation, bad weather speed reduction, environment). The next step is to set up tests where the dynamic speed limit is actually brought into the vehicle and is the recommended speed for that specific vehicle. For large scale deployment European Standards are needed.

Another large field operational test focusing on traffic management is the large scale test in Amsterdam, where the proof of concept was delivered last year. The goal of the test is demonstrating the effect of actively performing network-wide traffic management on the ring road as well as the main urban arterials and incoming highways. Operationally this means that the traffic on the ring road stays fluid. If results are promising this will lead to more reliable and robust travel times, an increase in traffic safety to homogenise the traffic flow, no deterioration of the environmental impact and happier road users.

Sensor City (partly EC funded) is an ambitious project which has been initiated by the province of Drenthe and the city of Assen. The main goal of this unique project is to realise a large measuring network which will allow the application of various ITS services. Sensor City will serve as a pilot project and display for the adaptation of sensor systems and allow for further deployment of such systems within the region. Sensor City aims to create visibility for the practical applications of different sensor technologies. The use of various concrete applications which are being formed in sub-projects, means that actual services or products can be provided to companies or other interested parties.

5

Observations

5.1 General

The growth in traffic on an already intensively used primary road network, creating problems of congestion, safety and the environment, has been one of the triggers for the early deployment of ITS in the Netherlands. ITS has been adopted quite successfully as a tool to solve practical problems in the mobility system. This approach has resulted in a focus on traffic management, on end-to-end solutions (door-to-door) over multiple modalities and on safety. The large number of cyclists in the Netherlands has led to an additional focus on ITS systems that protect vulnerable road users. The importance of transport and trade for the Dutch economy is clear from the use of ITS to support the complete supply chain.

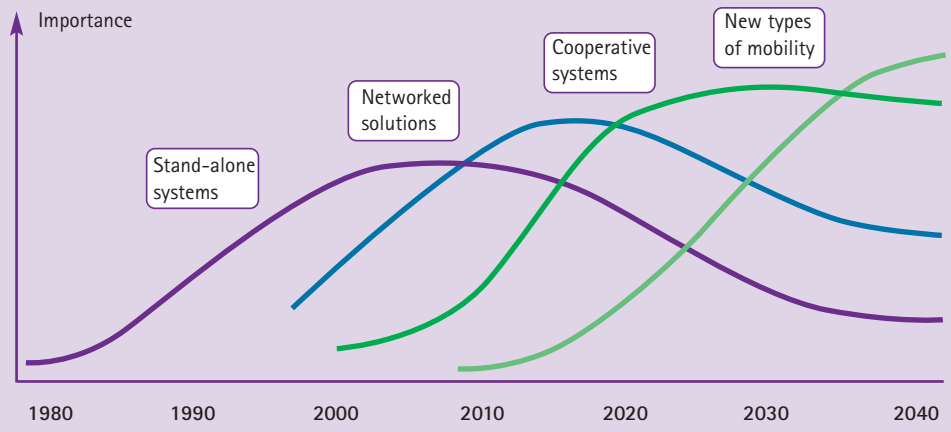
The Netherlands is known for its high degree of mobile and fixed data connectivity and the fast adoption of IT-tools such as smartphones (>40% halfway to 2011). This high level of connectivity is one of the key factors in current developments and may well become the lynchpin between infrastructure, vehicle and traveller. In the Netherlands it is believed that ITS (and more specifically cooperative systems) are on the verge of a breakthrough. Figure 5.1 indicates a vision of the expected importance of different mobility solutions. Connecting the various stand-alone systems has already proven to be very effective, but creating a network using these connections is the next step.

The emphasis has been on *Door to door* travel information and travel services since the last century, both for passengers and also freight. This applies to car travel and public transport. Travel information is already widely available and offered by a limited number of service providers. The next step is to enable the service providers to offer all this real-time information to the end-user in an integrated and personalised manner. The Dutch policy with respect to multimodal travel information is to provide reliable, actual and countrywide information for all modalities at any time and place before 2015. The government policy is to enable private parties to provide personalised traffic information services to end-users, starting by providing access to relevant data.

Synchromodality is the driving concept for freight. It allows for growth in transport volume with lower costs for the environment and surroundings. The available capacity of transportation means and infrastructure determine the choice of modality (road, waterway, air or rail) depending on the type of freight.

ITS is vital within this concept: new coordination centres need to be established which take care of different freight flows, the synchronisation of services and the harmonisation of transportation means. The organisation of the development and deployment of ITS has a history of cooperation between the public and private sector. The private sector is involved in development and is encouraged to innovate in the early stages of developments. This has created the need for regular discussions between public and private parties regarding roles and responsibilities. Platforms for these discussions have now been established.

Figure 5.1 Source: Policy framework Utilization – One of the pillars for a better accessibility (Beleidskader Benutten – Één van de pijlers voor een betere bereikbaarheid) (2008) Ministry of Transport, Public Works and Water Management.



5.2 In relation to the ITS Directive

Technical and legal framework

There are two main laws influencing traffic and travelling in the Netherlands. The first is the law on on passenger transport 2000 which focuses on public transportation and regulates (amongst other things) the way in which concessions need to be organised. Within this law, the public authority demandig the concession is obliged (from 2011 onwards) to organise real-time travel information from the concession operator. The second law (Road Traffic Act 1994) governs roads and traffic and sets out general arrangements concerning roads. A more specific regulation within this law governs aspects of experiments that are conducted at *road level*. This arrangement allows the Minister to appoint a specific section of road as an experimental area in which different road regulations can be applied.

As already shown in paragraph 3.2, The Netherlands is involved in and is initiating standardisation activities on both a national and international level. The national activities mainly consist of adapting international standards to the Dutch situation.

Dutch measures versus European areas

An overview of the installed base of ITS can be found in Annex B. This provides a first insight into the available technology for the Dutch road network. A list of existing important activities in the Netherlands can be found in Annex A. This list does not cover the large number of European research activities in which Dutch parties are participating.

Directive 2010/40/EC – Article 2

Priority areas

1 For the purpose of this Directive the following shall constitute priority areas for the development and use of specifications and standards:

- I. Optimal use of road, traffic and travel data,
- II. Continuity of traffic and freight management ITS services,
- III. ITS road safety and security applications,
- IV. Linking the vehicle with the transport infrastructure.

2 The scope of the priority areas is specified in Annex I of the Directive.

Annex A reveals that the Netherlands has a wider focuses compared to the priority areas. The development of road, traffic and travel data is of major importance. This again reveals the next step towards a networking era for which preparatory work is currently being performed. A number of specific projects and initiatives within Area III are being undertaken with respect to the specific Dutch situation. This creates the focus that is needed and confirms the conclusion that ITS is a pragmatic solution for the Netherlands.

Area IV is the preparation for the next step. Although the number of activities appears to be small, the focus of the activities in the inventory is strong and the foundation for the connection between vehicle and infrastructure is built with initiatives like SPITS and DITCM.

Directive 2010/40/EC – Article 3

Priority actions

Within the priority areas the following shall constitute priority actions for the development and use of specifications and standards, as set out in Annex I:

(a) the provision of EU-wide multimodal travel information services;
(b) the provision of EU-wide real-time traffic information services;
(c) data and procedures for the provision, where possible, of road safety related minimum universal traffic information free of charge to users;
(d) the harmonised provision for an inter-operable EU-wide eCall;
(e) the provision of information services for safe and secure parking places for trucks and commercial vehicles;
(f) the provision of reservation services for safe and secure parking places for trucks and commercial vehicles.

The priority actions are all covered in the Netherlands, although attention has tended to focus on actions (a) and (b). Action (c) is already available in the Netherlands and is brought to the end-user via private parties. Current discussions focus on future systems and possibilities for improving quality and availability. As stated, the Netherlands is also involved in action (d). The freight services (action e and f) are on the public authorities' agenda, as shown by the examples below.

An initial inventory has been drawn up along the A67 corridor in the south of the Netherlands and a pilot project for calculating occupancy rates based on floating car data has just been started.


N198 afrit 8
1200 m
100
52-GJL-8
13-HKG-4
09-GGZ-8

Appendix A

Inventory of Actions for the four priority areas

The highlighted areas received specific attention in the report.

Short description	Explanation	A1	A2	A3	A4
Accident Prevention System for lorries	The Accident Prevention Systems for lorries, a project in the Netherlands, has been carried out for eight months. A total of 2,400 lorries with different systems were monitored and all the data was recorded in the recording system. The systems that were tested are Headway monitoring and Frontal collision warning, Lane Departure Warning Assist, Adaptive Cruise Control, Directional control and Black Box Feed Back.			✓	
ADAS	Advanced Driver Assistance Systems are designed to help the driver with the driving process. When designed with a safe Human-Machine Interface it should increase car safety and more generally road safety.			✓	✓
Airbag for cyclists	Field Operational Test where an airbag is deployed on the bonnet of the car in case of an accident with a cyclist			✓	
Blind Spot Detection and Signalling Systems	Blind Spot Detection and Signalling Systems (DDSS) aim to improve knowledge about the role that active detection and signalling systems could play in reducing blind spot accidents and casualties.			✓	
BISON	A platform on which standards on exchanging data on public transport services are developed, harmonized and guarded.	✓	✓		
Collecting information about black spots	Data on specific black spots on the road network can be identified by focusing on accidents.			✓	
Contrast	As part of the Brabant in-car II projects. Contrast focuses on providing high quality real-time traffic information on all roads in the Brabant region. The applications that are developed will be both available in cars as well as on Personal Navigation Devices.		✓		
Cooperative systems	An EU term for systems that can provide new intelligence for vehicles, roadside systems, operators and individuals, by creating a universally understood communications *language* allowing vehicles and infra-structures to share information and cooperate in an unlimited range of new applications and services.		✓	✓	✓
Databases for heights of bridges, weight limitations and other useful info for special vehicles.	These databases contain information that is relevant to drivers of specific vehicles (incl. heights, weights and environmental zones). The databases themselves are not ITS, but they are a precondition for ITS for specific vehicles.	✓	✓	✓	

Short description	Explanation	A1	A2	A3	A4
Displays at PT-stops	Displaying real-time Public Transport arrival times at the stops.	✓			
DITCM: the faster and cheaper way to innovate in traffic systems	An initiative by various Dutch parties to initiate the Dutch Integrated Test site Cooperative Mobility (DITCM), an open development environment that accelerates and cuts the costs of innovation.		✓		✓
DRIPS (Dynamic Route Information Panels, e.g. P+R information)	DRIPS are road signs that show dynamic information. Road operators can control this information and inform road users.	✓	✓	✓	
Dynamax	System of dynamic maximum speed on highways, communicated through dynamic signing. System is based on collection of traffic or environmental data and, based on a set of rules, the maximum speed is then dynamically adapted. The next step for Dynamax is to bring the information in-car (e.g. pilot of ODYSA).			✓	
eCall	An electronic safety system that can automatically call emergency services if you have an accident.			✓	
Exchange of data between route planner and navigations systems (= GROUN Gegevens-uitwisseling Routeplanners en Navigatiesystemen)	Organisation of exchange of data between mapmakers and road operators about relevant route information, allowing route planners and navigation devices to optimise their route planning.	✓	✓		
Floating car/phone data	Data coming from cars and phones which can be used to further update and improve the quality of real-time traffic information.	✓			
FREILOT	FREILOT aims to increase the energy efficiency of urban freight through deployment of ITS (Intelligent Transport Systems) services. This will be achieved via three challenging objectives: 1. Showing quantifiable benefits to all relevant stakeholders 2. Ensuring that FREILOT implementations continue after the pilot 3. Extending the implementations to more cities and/or truck fleets		✓		✓
Higrids (platform for Multi-modal mobility services)	Stands for *Hybrid Intercity Grids.* Aim is to accelerate the introduction of systems that interact between the technology in a vehicle and the surroundings and the IT-infrastructure. HiGrids has a role as an accelerator, a platform for government and industry to cooperatively create a space for the development for pilots in the field.	✓	✓		
Impuls Dynamic Traffic Management Waterways (= IDVV: Impuls Dynamisch Verkeersmanagement Vaarwegen)	A programme focusing on the more efficient use of the current available capacity of waterways and fleet and on allowing for sustainable growth of container transport.	✓	✓		

Short description	Explanation	A1	A2	A3	A4
Infrastructure data collection systems (Loops (MONICA), bluetooth, cameras)	Different types of data collection systems are available to collect traffic information. Old technology (induction loops) is expanded by adding new technologies such as bluetooth and cameras, awaiting the developments of floating car data.	✓			
Intelligent Speed Alert Tests	A large ISA test has started. One group of drivers only receives feedback about their driving speed behaviour (with the option to intervene when the limit is not respected for a specific time) while the other group are unable to drive above the limit as they have a so-called active SpeedAlert system.			✓	
Mobility management (incl. work smart, travel smart) and ITS	Part of Mobility management is the introduction of *working smart, travelling smart*. Next generation mobility management is initiated with a specific focus on new technologies.	✓	✓		
MOGIN (Mobility and Geo-information The Netherlands)	MOGIN is the Dutch platform where technical operational aspects for sharing mobility information are addressed.	✓	✓		
Multi-modal route planners	Facilitating door-to-door route planning over all modalities.	✓	✓		
National Data Warehouse for Traffic Information (= NDW (Nationale Databank Wegverkeersgegevens))	NDW will provide complete, reliable and up-to-the minute information on the status of the basic Dutch road network. Their website will provide you with relevant information on the National Data Warehouse for Traffic Information, the databank that will collect, process, store and distribute all relevant traffic data	✓	✓		
Navigation devices	Navigation devices are very common in cars; these devices are becoming increasingly integrated and already bring together a large amount of information.	✓	✓	✓	
NDOV (National Data Office Public Transport)	Organisation of the availability and collection of public transport information, combined with the availability of this information for both the end-user and transport operator.	✓	✓		
NDPV (National Data for parking facilities)/Parkline	National data office where information about parking facilities is stored and exchanged. This is a precondition for providing parking services to road users.	✓	✓		

Short descripton	Explanation	A1	A2	A3	A4
ODYSA	ODYSA is a validated system where DRIPS between traffic lighted intersections create an individual speed advice for road users. A pilot where this advice is brought in-car is currently being performed.	✓		✓	✓
P+R route guidance (dynamic)	Signs are installed around cities, providing information about potential P+R facilities that are available. This includes expected travel times for both modes (car and PT) and departure times when known.	✓			
Parking in navigation	The information about parking spaces and areas is a specific application within navigation systems.	✓	✓		
Parking route information system (= PRIS (parkeer routering info systeem))	Dynamic panels next to the road indicate the availability of parking places within specific car parks and inform the driver of location, etc.	✓			
RDSA Radio Dynamic Speed Advice	As part of the Brabant in-car II projects RDSA focuses on bringing both green and blue wave information into the car using RDS-TMC technology. Existing roadside equipment will be fitted with FM-transmitters allowing for a '*cheap*' solution to providing traffic information.	✓			✓
RDS-TMC (Radio Data System Traffic Message Channel)	Traffic Message Channel (TMC) is a technology for delivering traffic and travel information to drivers. It is typically digitally coded using the FM-RDS system on conventional FM radio broadcasts. It can also be transmitted on DAB or satellite radio. It allows silent delivery of dynamic information suitable for reproduction or display in the language chosen by the user and without interrupting normal audio broadcast services. Services, both public and commercial, are now operational in many countries worldwide. When data is integrated directly into a navigation system, this gives the driver the option to take alternative routes to avoid traffic incidents.	✓		✓	
Safe and secure truck parking – project E34 corridor guidance systems	The categorisation (and certification) of safe truck parking areas is a first step towards safe and secure parking for trucks. Within the project, the next step is to create guidance systems for free parking spaces on this corridor.	✓	✓		
Sensor City Assen	A project in which the city of Assen and the province of Drenthe set up a vast measurement network around town. With two hundred measuring points. Assen will become a testing ground for the various practical applications of complex sensor systems.	✓	✓		

Short description	Explanation	A1	A2	A3	A4
SI4MS (Sensor Intelligence for Mobility Systems)	In the SI4MS project, the next step towards an integrated architecture for ITS applications will be made, by developing solutions for cooperative driving, and for dynamic traffic information and distributed traffic management, based on a common ICT and sensor network architecture. These solutions will be compared to current state-of-the-art systemes via evaluations of research implementations and simulations of the key concepts. An outline for the common architecture will be developed during the project, such that it can be extended in future projects to also include also other types of applications.	✓			
Smart-In Car	As part of the Brabant in-car II project. Smart-In Car focuses on the CAN-network in the car. Detailed car information can be collected and combined in real-time with traffic management and traffic information. This combination creates intelligent applications such as personal traffic information, eco-driving, etc. The project focuses (amongst other things) on the collection of floating car data, data fusion and the development of a user application.	✓			✓
SPITS (Strategic Platform for Intelligent Traffic Systems)	SPITS is a Dutch project, tasked with creating Intelligent Traffic Systems (ITS) concepts that can improve mobility and safety. Focus on three areas traffic management, in-vehicle solutions and service download & management solutions.	✓	✓	✓	
Traffic management test Amsterdam	The goal of the FOT is showing the effect of actively performing network-wide traffic management on the ring road as well as the main urban arterials. Operationally this means that the traffic on the ring road stays fluid. If the results are promising this will result in more reliable and robust travel times, an increase in traffic safety to homogenise the traffic flow, no deterioration of the environmental impact and happier road users.	✓			
Travel time prediction in transport management (= RITS (Reistijd-verwachting In Transport-management Systemen) (A15))	RITS ensures planners and truck drivers can access precise travel time information. This allows for better trip planning and the prevention of congestion. Also ETA's can also be predicted more accurately.	✓	✓		
Truck Parking Occupancy Information (TPOI)	As part of the Brabant in-car II project, TPOI focuses on creating safe and available parking places for trucks. The occupancy rates of parking places can be determined using Floating Car Data and map-matching. This information, in turn, is fed back into the navigation systems of trucks to allow adaptations to the planned route. This system has been trialled on the A67 with a limited number of trucks.		✓		✓

Appendix B

Inventory Installed Base

The installed base of ITS connected to the infrastructure consists of the following in the Netherlands for 2010:

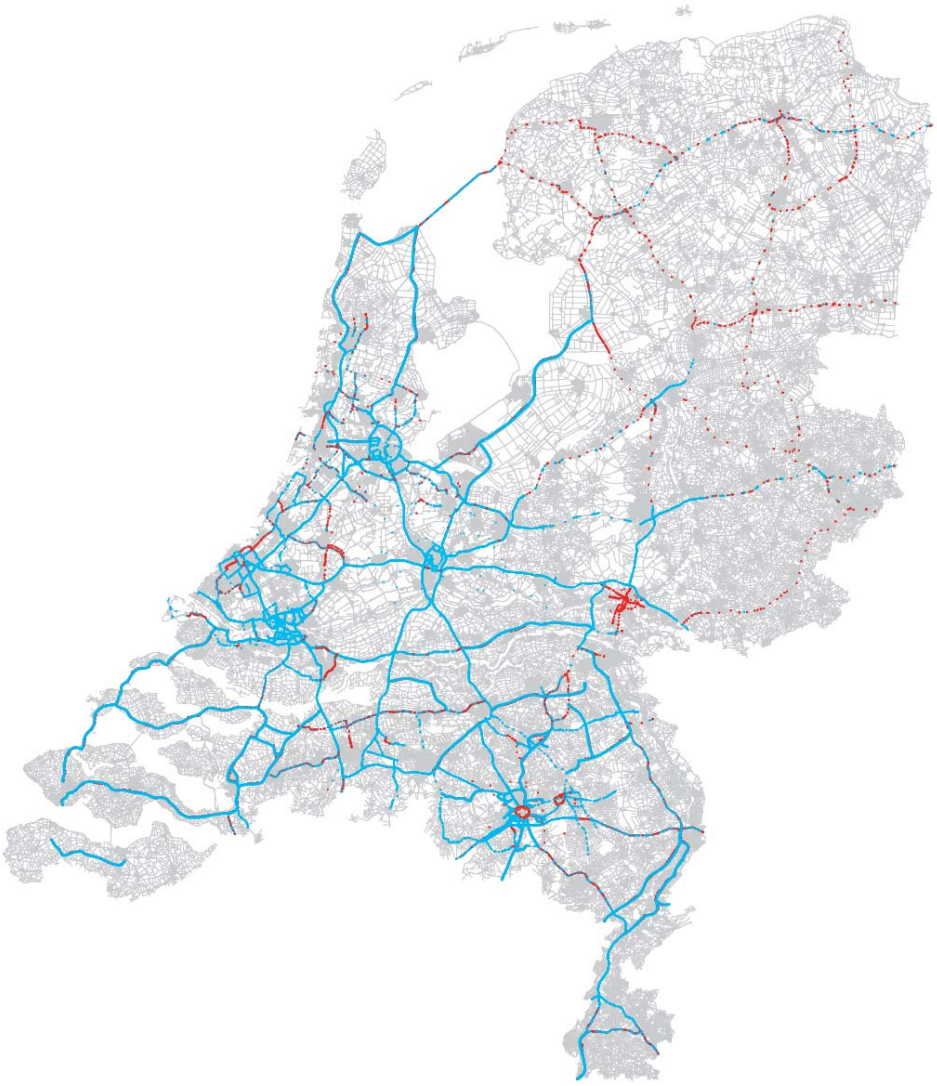
- A total of 2,587.35 kilometres of national roads have been equipped with standard functionality, an additional 1,278.50 kilometres have been equipped with monitoring equipment only. This is approximately 68% of the total road length in the Netherlands. The focus is mainly on the Randstad region.
- Approximately 15,000 VMS's are available on gantries above the road.
- In the Netherlands the total number of traffic lights is estimated to be around 5,400, only a small number is connected to the highway network.
- Rijkswaterstaat has 99 TDI's (Ramp Metering Installation's), mainly on the primary roads in the Randstad.
- Information is provided to the drivers through a total of 118 DRIPs (Dynamic Route Information Panels) placed above the road as well as 135 roadside DRIPs.
- All the information collected and sent is managed in one of Rijkswaterstaat's five traffic management centres. Furthermore, cities and regions are now developing their own traffic management centres to keep traffic in the city area flowing.
- A total of 192 km of the road network is equipped with additional or flexible lanes (sometimes the hard shoulder) which can be opened during rush hours.

Several installed systems have been subsidised within EasyWay or the former TEMPO-programmes.

Table 1: installed base ITS equipement

Objectsubcategory	Unit	Number
Videocamerasystem	#	1987
DRIP	#	118
Roadside DRIP	#	135
GRIP	#	4
Multisign	#	477
Additional information sign	#	148
Monitoring substation	#	287
MTM substation (MTM = Motor Traffic way. Management System)	#	5221
Information trailer	#	227
DRIP on car	#	119
Ramp meter exchange	#	6
Ramp meters	#	104
Traffic Regulation installation	#	265
MTM detection - induction loop	#	16830
MTM detection - radar	#	243
MTM detection station	#	5755
MTM matrix signal	#	14196
MTM exchange	#	5
Monitoring detection	#	1869
Monitoring detection station	#	640
Monitoring exchange	#	11
BI-measuring station	#	461
Emergency parking spot detection system	#	100
Traffic lights (on route)	km	2587,3
Monitoring	km	1278,5
Traffic management center	#	6
Peak and plus lanes	km	192,1
Peak lane	km	78,9
Plus lane	km	113,2
Flexible lane	km	11,1
Buffering lane	km	3,8
Dedicated lanes	km	57,2
Truck and bus lanes	km	13,3
Bus facilities	km	43,9

The figure shows a map with the measured network. The lines in blue indicate the network that has already been measured; the red lines indicate the growth that is foreseen in 2011 (covering approximately 60% of the total traffic flow).



Footnotes

1 *CBS, Statline (consulted juni 2011), table vehicle fleet*

2 *Structuurvisie Infrastructuur & Milieu – NMCA berekeningen*

3 *State of the Art Traffic Quest - Mobiliteitsbalans*

4 *www.treinreiziger.nl/kennisnet/reizigersaantallen/ontwikkeling_reizigerskilometers_per_trein - NS's cijfers uit Mobiliteitsbalans*

5 *CBS 2011*

6 *Vehicle hours lost is the sum of the extra travel time needed for all vehicles, compared to the nominal travel time, in order to get to your destination*

7 *Towards a better use and less congestion, The traffic management programme for primary roads, MinV&W 1994*

8 *The expected travel time is based on the last vehicle that has completed the trajectory*

9 *DVS/AVV (2006) Effecten verkeersmanagement. Cijfers van meer dan 100 (praktijk) evaluaties uit Nederland*

10 *The total amount of money spent over the last 30 years based on numbers from the Dutch Ministry of Finance and Related policy documents*

11 *DVS/AVV (2006) Effecten verkeersmanagement. Cijfers van meer dan 100 (praktijk) evaluaties uit Nederland*

12 *RWS beheerdersvisie*

13 *Slim Benutten, bereikbaarheidsmaatregelen op een rij (2011) KIM Rapport*

14 *Resultaten mobiliteitsprojecten (2011), Ministry of Infrastructure and the Environment*

15 *As part of Connekt*

16 *Letter to parliament, dated 14th June 2011, 'Programme Beter Benutten' from the ministry of infrastructure & the environment*

17 *9292 Travelinformation groep - www.9292ov.nl; 9292 Reiswijzer, 17th volume, issue 1, May 2011, pp. 20-21[5] SWOV factsheet DRIP*

18 *www.ndw.nu*

19 *Static information of parking facilities consists of the number of parking places, location of the parking facility, opening hours, prices etc. Dynamic covers information on actual available parking spots and changes to the static information.*

20 *www.isi-brabant.nl/page/22/welkom-.html*

21 *www.verkeersnet.nl/4705/nieuwe-proef-met-isa/*

22 *Website Connekt - http://www.dodehoekpreventie.nl/en-GB/*

23 *www.vrijbaanvoorvernuft.nl/nieuws/3/nederland_innovatief_onderweg_van_start.html*

24 *www.logistiek.nl/distributie/transport-software/nid11799-ict-gebruik-in-transport-en-logistiek-blijft-stijgen.html*

25 *https://spits-project.com*

26 *www.freilot.eu/en/pilot_cities/helmond/contact.htm*

ITS Netherlands connekt