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Foreword.

You are reading the second edition of our annual report, Traffic in the Netherlands 2015. This in itself is a good thing, since it means that we came through on our promise to provide an annual overview of the developments within our area of expertise. We really had no choice, since the reactions to our publication Traffic in the Netherlands 2014 were very positive. We would like to thank you for that!

However, there are of course more compelling reasons to provide a progress report. In chapter one, we will list a number of statistics related to traffic, and they clearly reflect that the relative calm on the roads is over for the time being. The economy is picking up, and so are the traffic jams on the roads! We will have to pull out all the traffic management stops to keep our accessibility at an acceptable level in the coming years.

Since cities are once again increasing in popularity and continue to grow, traffic in urban areas also deserves our attention. A variety of developments are underway, which affect the traffic flows in the urban environment: from big data to being connected and sharing of vehicles. But how and what can we expect from these developments? We will discuss this in more detail in chapter two.

And what about the slightly more distant future? The fact is that we are on the eve of interesting innovations that we can safely call game changers. We are talking mainly about cooperative driving and automated driving – and ultimately perhaps cooperative automated driving. It will be a while before these developments become common and exercise their influence on the traffic system, but research and development activities in this area have already been going on in the scientific community for years. The first operational tests are already underway! And since ‘foresight is the essence of management’ also applies to this case, policy-makers and other stakeholders have ample reason to already think about the possibilities and consequences of these developments. We will discuss this in more detail in chapters three, four and five.

Plenty of reasons therefore to again present all figures and developments in a new annual report. This time, we have even provided more in-depth explanations by having a few experts in
the field give their opinion. Starting at page 104, Marion Braams of Rijkswaterstaat and Laurens Schrijnen of the Innovation Lab (De Innovatiecentrale in Dutch) will discuss the future of traffic management centres. What will be their role, in light of the developments such as the transition to in-car systems? Be also sure not to miss the interview with Frans op de Beek, principal advisor on Traffic Management at Rijkswaterstaat, on page 60. His message on the Netherlands as a traffic management country is clear: “We are still a leader in traffic management and ITS, but this may soon change.”

At TrafficQuest, we hope to ensure that the Netherlands maintains its leading position in the field of traffic management. We contribute to this by collecting, analysing and disseminating knowledge. We do the latter in our reports, articles and recommendations, see www.traffic-quest.nl for an overview, but of course also with this annual report Traffic in the Netherlands 2015. After all, understanding can be gained only when you have the overview!

The TrafficQuest team, July 2015
Traffic statistics in the Netherlands.

2013 was the year of fewer traffic jams and less delays, which was partly due to the ‘weaker economy’. However, for 2014 a slight change was foreseen: more traffic and more congestion were expected on the Dutch roads. To what extent did this prediction come true? And what progress is being made on road safety and sustainability? In this first chapter, we will list the key figures.
After a period of economic stagnation and decline, 2014 was finally a year with some positive economic news. In the first three quarters, gross domestic product grew by 1.6% to 2.6% compared to the same quarters in 2013.

An economic upturn usually translates into an increase in traffic, and 2014 was no exception. The port of Rotterdam, for example, handled 5.8% more containers in 2014 than in 2013 according to the Port of Rotterdam, and this naturally led to more lorries on the road. On the N15 – the road to the Maasvlakte – the number of heavy vehicles increased by approximately 4% in the past year, which represents some 400 extra lorries per day on that road.

Elsewhere in the Netherlands, the amount of traffic also increased. Below, we discuss the figures on traffic flows in the Netherlands with special attention to two specific road sections in paragraphs 1.2 and 1.3. Incidentally, all data presented are from the same sources as the data of our previous annual report ‘Traffic in the Netherlands 2014’. For more information about the data sources, please refer to that publication.

1.1. Traffic related statistics

After a period of economic stagnation and decline, 2014 was finally a year with some positive economic news. In the first three quarters, gross domestic product grew by 1.6% to 2.6% compared to the same quarters in 2013.

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Developments on the motorway network

Three times a year, Rijkswaterstaat publishes a public report containing the most important developments regarding the traffic on the motorway network. Figure 1 shows the indicators of kilometres travelled, congestion severity and delay. It is remarkable that the number of vehicle kilometres on the motorway network continues to rise. In 2014, the number of vehicle kilometres travelled on the motorway network increased by 2% compared to 2013; the increase compared to 2000 is even 19%. It is also remarkable that the congestion severity – length times duration of the congestion – has remained pretty much the same, but that the delay increased by 6%. Half of this additional delay is due to the traffic jams. The other half can be explained by the lower average speed outside traffic jams, partly as a result of prevailing speed limits (whether or not these are dynamic).
If we look at the causes of traffic congestion, we see that a shift occurred in 2014. Figures 2 and 3 show that the share of incidents as a cause of traffic congestion increased from 20% in 2013 to 24% in 2014. This once more underlines the importance of incident management, aimed at minimising the consequences of incidents and accidents. On the contrary, the contribution of bottlenecks to traffic congestion has decreased.

The impact of all of this on the additional travel time the road user spends on average is shown in Figure 4: the travel time index of TrafficQuest increased in 2014 by 0.2 points to 6.8. This means that in 2014, an average journey took 6.8% longer than in free flow conditions. So a ride on the motorway network that would take 60 minutes in free flow, took 64.1 minutes in 2014.
Developments on the urban road network

So the amount of congestion and the travel times on the motorway network in 2014 increased slightly compared to 2013. But what about traffic in the cities? The TomTom Traffic Index and the INRIX Traffic Scorecard answer this question. We have provided their (slightly different) figures in Figure 5.

The figure shows that INRIX detects a decrease in congestion in the cities, except for The Hague. According to TomTom, urban congestion remains the same or even increases slightly. To explain these differences we should perhaps look into the different data sources they used. INRIX obtains its information primarily from equipped vehicles belonging to a fleet as well as from roadside systems. TomTom mainly uses data from its navigation systems.

Incidentally, TomTom also distinguishes the motorway network and the urban road network per urban area. Figure 6 shows the congestion indices for Amsterdam, Rotterdam and The Hague. It turns out that congestion on the motorway networks around Amsterdam and Rotterdam has decreased while congestion in the cities increased. In The Hague, the situation is slightly different: congestion increased both on the motorway network and on the urban road network.

Conclusion

All in all we can conclude that there is no longer a decrease in traffic jams and that, at least on the motorway network, congestion increases in some places.

We are obviously talking about averages, which in no way do justice to the different situations on the road network. To better understand what exactly is going on on the road network, we will focus on two specific locations in the following paragraphs: the A12 Zevenhuizen-Harmelen and the connection of the N14 to the A4 near Leidschendam. How did the traffic flows change at these locations in the past year?
**Figure 5:** Congestion indices for urban networks (source: INRIX and TomTom).

**Figure 6:** Congestion indices for motorways and urban networks (source: TomTom).
1.2. Case A12 Zevenhuizen-Harmelen

The A12 between Zevenhuizen and Harmelen is one of the routes where the traffic delay in the past year increased more than average.

As shown in Figure 7, the number of lost vehicle hours increased by 18.1% in 2014 in comparison to 2013 (nationwide this was 5.8%), while traffic performance rose by 1.5%. The increase in vehicle hours delay, incidentally, was preceded by a steep decrease in traffic delay in 2012 – a direct result of the construction of an additional lane on this route. Its effect on the daily lost vehicle hours on this route is shown in Figure 8. This figure clearly shows that the delay starts increasing again after September 2014.

Although the flow of the traffic has improved in recent years, the route concerned is still rather busy. This can also be seen in Figure 9, which shows the variation in the flow on an average full day in 2014 on the road section just past the junction of the N11 and the A12 at Bodegraven. Since the construction of the additional lane, traffic demand continues to increase at this location. Between 2011 and 2014, the average daily volume in this section has increased by 3-4% per year. This increase could be the result of the latent traffic demand for this route. After all, there are no good alternative routes available for cars between Gouda and Utrecht, which may result in a strong ‘back-to-the-rush hour’ effect.

Please note that the value of the 95th percentile of the volume of the rush hour periods in 2011 and 2012 was already nearing the theoretical capacity, but that even higher volumes were measured in the past two years. The fact that the 2013 and 2014-lines of Figure 9 sometimes far exceed the theoretical capacity should not be a surprise to us: the high volumes are peaks of about half an hour, while the capacity values are based on hourly averages. If we look at the peak in the median value of the volume, it turns out to be around 7000 vehicles per hour, which results in an volume/capacity ratio of 0.85. So in rush hour, this route approaches its capacity.

The design of the concerned A12 route is not a complex one. The stretch between Bodegraven and Woerden, for instance, is a long straight road with no discontinuities such as connections or changes in lane layout. Since there are frequent shock waves on this route which propagate upstream over large distances, a dynamic traffic management measure is in place that restricts the inflow into the traffic jam with the intention to break the shock wave. This is mainly done by dynamically reducing the maximum speeds far upstream of the shock wave.

*5% of the highest values of the measured intensities are not included in the chart. This provides a more realistic picture of the daily traffic volume.*
Figure 7: Traffic performance A12 Zevenhuizen-Harmelen (source: Rijkswaterstaat and TNO).

Figure 8: Vehicle hours delay A12 Zevenhuizen-Harmelen (source: Rijkswaterstaat and TNO).
An example is shown in Figure 10. The speed over distance and time is shown above, the signalling of the matrix signs with the maximum speeds is shown below. The figures show that some of the shock waves indeed are dissolved (those around 9:15 hours), while at other times it does not work (those around 7:50 hours).

Figure 9: Traffic flows A12 Bodegraven (source: Rijkswaterstaat and TNO).
Figure 10: Speeds and signs during shock waves on the A12.
1.3. Case A4-N14 near Leidschendam

Mid-August 2014, adjustments were made to the on-ramp of the N14 to the A4 parallel carriage way in the direction of Prins Clausplein. Prior to the modification, the ramp began with two traffic lanes, after which the left lane merged into the right one, and the one-lane ramp joined the parallel carriage way of the A4. The carriage way had two traffic lanes, so it continued with three lanes. After the modification, the section of the carriage way upstream the on-ramp has been narrowed to one lane, while the on-ramp now has two lanes. Here too, the carriage way continues with three lanes. On balance, the narrowing to a single lane has been relocated from the on-ramp to the carriage way. This was done to improve the traffic flow and thus prevent blocking back to the Vliettunnel on the N14. According to a modelling and simulation study, the selected solution was the best. However, what were the practical consequences for the traffic performance?

At the N14, we will take a look at the section from the entrance of the Vliettunnel to the junction with the A4, since this section should be affected most. Unfortunately, no data are available of the Zoetermeerse Rijweg, which feeds the on-ramp from the other side. The vehicle hours delay for the section of the N14 are shown in Figure 11. The figure shows few differences between both situations. Calculations show a 1% drop in vehicle hours delay per working day thanks to the modification, while traffic volume has increased by 2%. A good result indeed.

The results for the parallel carriage way of the A4 from the diverge of the A4 to the on-ramp of the N14 are shown in Figure 12. The absolute numbers are lower, but it is clear that the number of vehicle hours delay increased after the modification. If we take the sum of both routes, traffic performance has increased by 3%, but the total delay also increased from 219 to 256 vehicle hours per working day, an increase of 17%. This means that the modification has a positive effect on the N14, but not on the carriage way nor on the total situation.

Rijkswaterstaat has now concluded that the selected solution is insufficient. The option to extend the buffer lane from the Prins Clausplein is now being considered. There is a risk, however, that this will result in problems downstream.
Figure 11: Delay on working days for the N14 (Vliettunnel-A4) in 2014.

Figure 12: Delay on working days for the A4 carriage way (to the N14) in 2014.
1.4. Road safety in figures

The decline in the number of injuries which began in 2012, has continued in 2013. There were 4% fewer injuries than the previous year. The total number of traffic-related fatalities also continues to fall, namely by 12%. The reduction in the number of fatalities on the motorway network is spectacular. In 2013, there were 58 traffic-related fatalities compared to 90 in 2012, 67 in 2011 and 81 in 2010. The number of fatalities on the motorway network in 2013 is approximately one-third of the number in the years just after the turn of the century.

Figure 13 shows the relative numbers. This concerns the number of traffic-related fatalities and injuries per billion vehicle kilometres driven.

With an eighth position on the IRTAD ranking, the Netherlands is still doing well on an international level. Last year, the Netherlands occupied the seventh position, but we have been overtaken by Finland.
1.5. Air quality in figures

For the developments regarding the air quality, we refer to Figure 14. The figure shows that the emissions of NO$_x$ and PM$_{10}$ are still decreasing significantly. Compared to 2012, the levels for the entire road network in 2013 were reduced by 6% and 10% respectively. CO$_2$ emissions also fell, but less significantly, by just 1%.

**Figure 14:** Development of road traffic emissions (source: CBS).
1.6. Summary

The year 2014 shows a reversal in the traffic performance. After years of falling trends, the indicators describing the traffic performance are rising again. The number of vehicle hours delay on the motorway network has increased, mainly due to incidents. Fortunately, road safety continues to improve. In addition to the number of fatalities, the number of injuries has also decreased, which is a positive development. The trends in the emissions are also positive. In this area, only the CO$_2$ emissions are lagging behind: they have decreased, but very little.
Trends in (urban) traffic management.

The last few years, the population in many Dutch cities is on the rise again. Especially young people move to the city in large numbers. This development obviously has implications for urban mobility. In a few decades, road traffic in the large cities has increased considerably. How do these cities handle this growth? And what do trends like big data, ‘connected driving’ and sustainability mean for (urban) traffic management?
2.1. Urbanisation in figures

The figures speak for themselves. In the period between 2000 and 2013, the population of Rotterdam grew by 4% and that of Amsterdam by 9%. With 15% and 38%, The Hague and Utrecht show even larger growth rates (CBS). Especially young people move to the city.

This development has consequences for urban mobility. Since 1986, road traffic in the greater Rotterdam has increased by 60% while the increase within the ring was 30%. A similar trend can be seen in other cities. In recent years, a clear shift can also be seen from car and public transport movements to bicycle movements. In the period 2000-2012, the share of bicycle movements in Amsterdam, for instance, increased from 33% to 53% compared to the total number of movements. There is even bicycle congestion in some places! This indicates that not only motorised traffic should be managed. Neither can traffic management be limited to the motorway network: all roads deserve attention. All in all, there are plenty of reasons to look at how cities deal – or could deal – with the growth in mobility.
2.2. Developments and their influence on (urban) traffic management

Population growth in the city puts a strong pressure on the mobility, sustainability and quality of life of this urban environment. It is certainly not easy to find a solution for this. It requires an integrated approach, and this in turn, means a close cooperation between the different scientific domains, market participants, authorities and, of course, the residents themselves. Another complicating factor is the physical and financial space in which solutions must be worked out.

Yet there are enough starting points to enhance mobility, sustainability and quality of life in the urban environment. It is particularly important to recognise and acknowledge the developments and trends and to actually use or influence these developments.

In this section, we will identify a number of relevant developments and their impact on traffic flow and traffic management in the (dense) urban environment. This is partly based on a 2014 trend analysis of Rijkswaterstaat.

The influence of (big) data

An enormous amount of data is generated every day. Not all the data are public, but thanks to efforts by the government, the trend is that more and more information is public and available in real time.

Much of these data are interesting for traffic management, but its potential is still insufficiently used. Many travellers and vehicles indicate their location in time and space, and how fast they are moving. Sensors in, above and along the road, for example, provide information about traffic volumes, and the traffic flow as a whole. By combining these data with other sources, it is possible to obtain an accurate and detailed insight into the behaviour of the traveller and traffic indicators under various conditions, including the impact on quality of life and road safety.

A ‘data challenge’ in cities specifically is the fact that we have to deal with mixed traffic: cars, public transport, cyclists and pedestrians. To determine which flows are dominant, which ones get too much or too little space, or which ones should be guided along a different route or to another destination, it is essential to distinguish these flows well. Significant progress has been made in this area in recent years: cities are now much better capable of gaining insight into bicycle and pedestrian flows, for instance. However, the processing, fusing and analysing of large amounts of data should be given the attention they require to ensure that the ‘picture’ of the traffic situation is sufficiently reliable.

Moreover, real-time traffic control requires algorithms capable of quickly calculating complex traffic situations in advance. With the current computing power of computers, combined with more storage and smarter algorithms, it is, in principle, already possible to make (real-time) calculations based on large amounts of up-to-date data. This leads to a greater variety of driver information systems and improved traffic estimations.

The influence of being ‘connected’
Because just about everything and everyone is nowadays connected to the Internet – that is, almost everywhere and almost always – there is much more potential in terms of information provision. This applies to travellers, but also to road authorities and other parties involved in traffic management and traffic information. There are many ways to quickly get information to travellers, and in many cases, it is even possible (in principle) to offer customised solutions, taking account of personal preferences and skills, but also of destination, departure time, travel mode and route of the individual travellers. The options in this area will increase further in the coming years, as we learn from the experiences gained: experiences with commercially available services, but also from several large-scale operational tests using advanced services (see chapter 5).

In the coming decades, we will increasingly be faced with vehicles that, in addition to being ‘connected’, are also cooperative and/or automated. Traffic engineers expect that especially the cooperative element will have a major impact on traffic flow, safety and quality of life. Several cooperative and automated systems have already been tested for urban traffic, and at some locations they have even been put into operation. Examples include the cooperative traffic lights in Helmond and automated vehicles such as the Park Shuttle, which has already been covering the route from the Kralingsezoom metro stop in Rotterdam to three stops in Rivium business park in Capelle aan den IJssel for a number of years.

The influence of the emerging (multimodal) sharing economy
In the context of this report, sharing economy means the sharing of means of transportation and all related services. In freight transport, this is called synchro-modality. It concerns the most flexible and sustainable use of different transport modes in a network under the direction of a logistics service provider to provide the customer (shipper or forwarder) with an integrated solution for its transportation. With the development of ICT, combined with changing preferences with respect to (car) ownership, the limited space to park vehicles and the emergence of multimodal travel and logistics services, ‘synchro-modality’ also becomes possible for the transport of passengers. However, this means that the information required must be available. Still a lot of work needs to be done to change the routine behaviour of travellers and to build confidence in other modes of transport. And last but not least, there must be sufficient

*For more information on this topic, see the State-of-the-Art background document ‘Cooperative systems and automated driving’ of TrafficQuest (2014, in Dutch).
transfer possibilities to reach every destination. For passenger traffic, for instance, this means more choices at transfer points, such as the (electric) bicycle or car sharing for the last, difficult part of the journey that is not readily accessible by public transport.

For traffic management, this means that it will be even more difficult to predict traffic flows and which measures can be taken in response. For urban traffic management, this also means that the link between traffic management and spatial planning must be further developed. What are good locations for transfer points and centres for vehicle sharing? How can we facilitate the multimodal traffic flows this generates? Spatial (big) data can help gaining insight into this.

The influence of the rapid introduction of new technologies
Passenger cars and public transport vehicles are long-lasting and roadside systems usually also have a long depreciation period. The introduction of new technologies in the ‘fleet’ of vehicles and roadside systems therefore takes place rather gradually. In case of mobile devices and services this is considerably faster, which of course, has everything to do with the fact that people replace their smartphone, and certainly its software, much faster. This allows the fast (mobile) or less fast (vehicle / roadside equipment) introduction of new technologies to travellers.

It should be noted that the rapid introduction of new technologies may lead to surprises. They are applied to solve problems, but they may have all kinds of secondary effects that cause new problems. A higher fuel efficiency (or the use of cheaper energy, such as electric cars), for
instance, may result in passengers travelling longer distances, thus increasing traffic on the roads. This currently applies to electric bicycles and in the future maybe to automated vehicles.

For (urban) traffic management, this means that careful thought should be put into the impact of new technologies on the mobility patterns and into the question how the resulting traffic flows (regardless of the transport mode!) should be managed. Obviously, the quicker the introduction of the new technology, the quicker the road authority will need to switch. Cities should also consider ways they themselves can deploy new services to manage traffic flows and parking facilities.

The influence of sustainability
Much more than for long distance connections, road authorities in these urban environments will need to establish a balance between different policy objectives, for the sake of convenience, summarised in accessibility, safety and quality of life. For many cities, the quality of life and the environment are of paramount importance, and therefore they clearly make different choices than other cities where they are given less priority. The Swiss city of Zurich, for example, meters road traffic on the outskirts of the city. This allows them to improve accessibility as well as the quality of life. Rotterdam endeavours to effectively manage the ever-growing stream of cyclists.

How can traffic management be used to support the sustainability of (the mobility of) society? This will become an important task since a focus on sustainability leads to a viable and dynamic city where people like to live and work. Sustainable traffic management is a key component of sustainable mobility. To improve sustainability of traffic management it is important to change the primary focus from the flow of the traffic to the realisation of a combined objective focused on safety, environment and quality of life, in addition to the flow of traffic. This also requires a shift in focus from managing only motorised traffic to managing mixed traffic with a prominent role for public transport, cyclists (including the e-bike) and pedestrians.

The influence of climate change mitigation and climate change adaptation
Climate change mitigation and climate change adaptation relate to reducing climate change and adapting to the effects of climate change. This includes reducing CO₂ emissions (mitigation) or increasing the dikes (adaptation).

As far as the transport system is concerned, traffic management can (modestly) contribute to climate change mitigation, for example, by reducing emissions or by providing additional incentives for the use of bicycles and public transport. Please refer to the previous paragraph. But the transport system will also have to deal with climate change adaptation. For instance, it is expected that we will be confronted with extreme weather more frequently, which will result in a more uncertain availability of the network, perhaps a change in transport modes and the more frequent occurrence of (major) incidents. Climate change and the associated extreme weather events may also
lead to failure of, for example, the electricity system or the Internet – which can make traffic management temporarily impossible.

These developments require a greater focus on asset management. The climate crisis puts high demands on the robustness and resilience of the transport system and the systems used. Traffic management will also need to work under difficult circumstances.

**The influence of the government**
The dominant, agenda-setting, directing and executive role of government in the planning, implementation and management of traffic management systems and in the application of traffic management strategies will change. Certain responsibilities are expected to be passed on to the market, especially if a sound business case can be formulated for an application. In this case, the government will play a more advisory role. Citizens and civil society organisations will actively participate in the entire process, from problem identification to evaluation.

Possible roles for the government in the future are: safeguarding the common interest (formulating, prioritising and assessing objectives in the field of safety, quality of life and accessibility), monitoring compliance with European and national regulations in terms of safety, quality of life and accessibility, setting limits (on the basis of constraints arising from the ownership of infrastructure), stimulating new innovative developments and facilitating these initiatives (making resources for research and pilot projects available).

This ‘new style collaboration’ requires a high degree of transparency of all organisations involved. The government will need to be more open to initiatives by citizens and civil society organisations, and all parties involved will need to work together from the outset.

To traffic management, this alliance between the parties means that new technical, organisational, legal and financial frameworks are needed. Fortunately, a good foundation has already been laid for this in the Netherlands with ‘Gebiedsgericht Benutten’ (Regional-based planning) and ‘Gebiedsgericht Benutten Plus’. The Netherlands is also involved in several public-private partnerships – see Chapter 5.

**The influence of the composition of the population**
In addition to generation Z, the generation that is permanently online, we also increasingly need to deal with a greying society. The large group of over-65s remains mobile and, due to the group’s limitations (sight, viewing habits, reaction time and information processing), requires additional attention, to ensure that this group can safely participate in traffic.

‘Greying’ of traffic management implies that the elderly are given more time to perform the driving task, including the processing of the age-appropriate information, guidance and control provided by the traffic management system. Especially in an urban environment this will play an important role. Older people need more time to get adjusted to new gadgets and are less responsive to information provided, which may conflict with the rapid adaptation and imple-
The influence of changes in mobility
The ‘new way of working’ (flexibility is the norm) has major implications for the mobility patterns. The traditional pattern with pronounced morning and evening peak hours will turn into a more uniform pattern throughout the day. As a result of the increased flexibility, the composition of the traffic flow will also change, with a wide range of movements, all the time. This creates opportunities for more efficient use of available capacity – and dynamic traffic management plays a crucial role therein. The use of control strategies will need to be continually adjusted to the characteristics of the current traffic flows. Since travellers and road authorities constantly exchange information with service providers and vice versa, there are ample possibilities to coordinate demand and supply. However, this does require quickly accessible and reliable information systems.

The travel pattern also changes. In the urban environment, the focus of trips will increasingly shift from the city centre to the different districts (district to district trips). At the same time, the city centre will largely be the focal point of the increasing number of socio-recreational trips.
Moreover, cyclists and pedestrians play an increasingly prominent role in the handling of travel flows in urban areas. Therefore, traffic management will need to focus more on the efficient handling and support of cyclist and pedestrian flows, and the handling of ‘mixed’ traffic (all available transport modes combined). This will present a number of challenges, especially on busy intersections.

**The influence of mobility services**

A final development that will have its impact on traffic and traffic management is the emergence of mobility services by service providers. These mobility providers provide the transport of their customers (individual deals). A mobility service may consist of a vehicle which is made available, or a seat that is reserved at a certain time and route. The rise of mobility providers leads to a modified, and we expect multi-stage, organisation of traffic management.

One possibility is that initially, network system administrators and mobility providers mutually come to a general alignment of the capacity to be used (control strategies to be applied). The traffic management system will then be adjusted based on the information exchange between the traveller and the system administrator. Especially in unusual circumstances (incidents, bad weather conditions, events) this may have a very positive impact.
2.3. Urban initiatives

To conclude this ‘urban’ chapter, we will discuss a number of projects and initiatives that (also) focus on urban traffic problems.

Many developments now taking place in the city, are grouped under the umbrella term of ‘Smart Cities’. In the Netherlands, governments and other parties are also working under the title Smart Cities to tackle societal challenges in urban areas and to increase economic competitiveness. The concept emerges from the development of the ICT and its use in addressing urban issues. Smart Cities is a means to make urban areas more efficient, more sustainable, more liveable, more competitive and safer. Today’s society and the speed with which it changes due to technological advances, provide opportunities to shape the development of cities in new coalitions of citizens, businesses and government. Smart Cities will consist of the interaction between smart technology, smart people and smart government. This means that within Smart Cities, people have more influence on their living environment while the aim is to make a more efficient use of urban systems. One way of achieving this is by linking systems from different domains.

Several cities in the Netherlands are actively engaged in Smart Cities projects. Almere, for instance, is setting up a system that can help analyse problems in certain districts by linking information about topics such as population, income, rent arrears and dropout rates. In Amsterdam, a test is being undertaken with the local generation of solar energy. Tilburg has started a pilot project which allows citizens to adapt the property tax value of their homes themselves.

But a lot more is going on in Amsterdam, also more specifically in the area of mobility. Amsterdam Metropolitan Solutions (AMS) is an initiative that aims to tackle the problems on a metropolitan scale using innovations. To this end, they launched the Amsterdam Institute for Advanced Metropolitan Solutions. This institute combines knowledge and expertise of a large number of leading parties such as TU Delft, Wageningen University & Research, The Massachusetts Institute of Technology (MIT), TNO, KPN, IBM, Accenture, Alliander, Cisco, ESA, Shell, WaterNet and the city of Amsterdam. A variety of data sources will be used to assess the functioning of the city. Integrated solutions and designs to respond to the identified challenges will then be developed based on these insights.

One of the core themes of AMS is the development of ‘Smart Infrastructures’ and ‘Smart Management Systems’ for the handling of urban streams. In addition to traffic, they also focus on energy, water and food. This approach shows an important similarity with the previous TrafficQuest study entitled ‘Analogies with Traffic Management.’

Other initiatives focused on the urban environment have already been discussed above. As stated previously, the majority of road users use a smartphone. The apps on these phones help many
travellers to find a route, based on map information and shared information about speeds. Apps with real-time information can also help to find a parking place near the destination, or indicate a combination of the trip by public transport (P + R).

See the TrafficQuest report of the same name (report of the workshop in 2012, in Dutch). The report is available as a PDF file on www.traffic-quest.nl/rapporten.
The main themes of 2015.

What topics do the professionals in our field talk, write and hold meetings about most? In this annual report we once again address the main themes of the moment. In our opinion, these are: urban traffic management, the integration of roadside and in-car systems, automated driving, human factors and incident management.
The urban areas increasingly have to handle more traffic – a point we have already made in the previous chapters. But that also means that the importance of urban traffic management is increasing.

Traditionally, traffic signal control is the ultimate urban traffic management tool and innovations and experiments in that area continue. The municipality of Veldhoven, for example, was the first to use a network control strategy that regulates traffic based on the degree of saturation instead of the traffic volume. The municipality of Breda investigated whether the traffic lights could be removed at some intersections: as a pilot, the traffic lights were disabled for a few weeks at some quiet intersections.

But matters other than traffic lights also require attention. In July 2014, TrafficQuest organised a workshop on urban traffic management. The interviews and discussions resulted in a set of themes that were thought to be important:

- **Monitoring and evaluation.** Determining the precise impact of urban traffic management – what are the actual benefits? – is still a difficult question to answer. It would be good if cities coordinate their monitoring programmes. This would allow a better comparison of the measured results, and parties could learn more from each

other. An inventory of evaluation methods is desirable: which method is suitable for what?

- **Value added asset management.** What is the optimal allocation of resources for the management, maintenance and operation of road infrastructure, including systems? Answering this question requires the development of an approach that helps road authorities to identify the ‘ideal allocation’.

- **Communication with authorities.** A recurring problem: how do we make the importance of traffic management clear to authorities and policy makers? And how can we keep their attention?

- **Control strategy for the urban environment.** The urban road network has its own dynamics. This requires a control strategy that is capable of dealing with the urban situation (for example: a lot of mixed traffic) and the associated problems.

It would be ideal if an Urban Traffic Management Platform was created to share knowledge and experience on these topics. The participants of the TrafficQuest workshop all agreed on that. At the initiative of TrafficQuest consultations are being held between the parties involved about the initiation of such a platform.

**Practical Trial Amsterdam**

The most important operational test in the area of urban traffic management is the Practical Trial Amsterdam, or PTA for short. In our previous annual report, we have addressed the principles and design of the test with coordinated network-wide traffic management. In this publication we discuss the elaboration of the principles and the first results of the ‘roadside track’ of the trial.

The purpose of the roadside track of PTA is to delay the onset of congestion on the main road, in order also to postpone the capacity drop. Especially for the PTA, the traffic control systems on and near the on-ramps numbered S101 to S107, on the A10-West, have been adapted. Additionally, a real-time traffic control system has been implemented on the S102 corridor to ensure the traffic throughput on the corridor.

The control principles applied in the PTA can be summarised as follows: The systems on the A10-West detect and predict the onset of congestion. Before this congestion actually occurs, the ramp metering systems are activated. Normally, this results in queues. To avoid a local breakdown of traffic, this queue should never block back to the junction at the beginning of the on-ramp. If there is a risk that the queues are getting too long, the traffic control systems of the supplying intersections will be adapted as well, to ensure that traffic towards the on-ramp will have to wait longer in order to improve the flow of the other traffic.

- The capacity drop is the phenomenon that at the time congestion occurs, the capacity (the number of vehicles the road processes) falls sharply, sometimes to 15% less capacity.
This too, is done stepwise: first, the nearest intersections are used as a buffer, then upstream traffic is taken into consideration. On the S102, this is supported by a real-time traffic control system that improves the flow of the traffic on the corridor.

In 2014, these cooperative detection and control systems were evaluated as a whole. To this end, traffic data was collected on the motorway and the urban roads over the course of a number of days in the period from April to June 2014. This data was processed into indicators, and the situation with coordinated controls was compared to the situation without these controls. The evaluation concluded that the deployment of the PTA improved the flow of the traffic on the A10-West at the location of the Coentunnel. This also improved the traffic flow on the A5. Overall, the delay (number of vehicle hours lost) during evening peak hours decreased. However, the ramp metering and buffering at intersections caused the increase of queue lengths and thus the delay on the urban road network to increase. The main outcome of the evaluation is that on balance, the PTA resulted in a degradation of the traffic flow in the network as a whole. Further analyses show that this is mainly due to the too early activation of the metering systems at on-ramps located upstream of the bottleneck. An adjustment to the control settings should improve the situation, which will be tested in phase 2 of the PTA.
3.2. Integration of roadside and in-car system

Thanks to advances in technology and further standardisation, it becomes increasingly easy to share information at high-speed and high-bandwidth between road users, vehicles, the ITS roadside infrastructure and the traffic management systems of road authorities and fleet managers. The physical location of the ITS application is becoming less relevant: it could, in principle, be located anywhere. An interesting consequence thereof is that ITS services could also easily be offered inside the vehicle.

Road authorities see this as opportunities to cut costs: ITS applications that were previously implemented via roadside systems (such as communication via route information panels) could be transferred to the vehicle itself (communication via an app or an on-board unit), and instead of collecting data via roadside detection systems, so-called floating car data can be used. The idea behind this is that it saves on installation and maintenance costs of roadside systems.

Another possible approach is to integrate roadside and in-car systems in order to create added value. For instance, combining and/or fusing roadside and vehicle probe data provides a much more refined and complete picture of the traffic flows than would be possible based on the individual sources. These richer ‘fused data’ would make it possible to provide road users with a much more targeted advice on an optimum speed profile when approaching a shockwave or a queue at an intersection. And road authorities and fleet managers get a better picture of the quality of the traffic conditions in the network – the motorway network, but also the urban road network – and have a better understanding of the remaining capacity in the network.

The benefits of a more refined picture influence all levels of the traffic system, including the operational, tactical and strategic driving task of the road user, the operation of traffic control systems and on-ramp metering systems, and the tactical and strategic traffic management processes of road authorities and fleet managers.

The integration of roadside and in-car is taking shape at several locations. Close to home we have the ‘in-car track’ of the previously mentioned Practical Trial Amsterdam. This project combines traffic data from several sources, including, of course, mobile data, at the traffic management centre. Furthermore, in-car advice takes account in real-time of control scenarios that are deployed from the traffic management centre (and which still mainly consist of ‘roadside measures’).

Japan is the country in which the integration of roadside and in-car is the most advanced. Many vehicles in Japan are already ‘connect-
ed' and there is also a considerable number of vehicles equipped with short-range communications (DSRC). Some impressive figures: there are 63 million navigation devices in Japan, 43 million VICS units (in-car traffic information systems) and 47 million units for Electronic Toll Collection. And that with a population of approximately 127 million people and 57.6 million cars!

But despite this leading position in in-car systems, Japan has no intention of phasing out the existing roadside systems such as (graphical and text) variable message signs. It is even expanding its arsenal of roadside systems – mainly with roadside systems for short-range communication with vehicles, called ITS spots. 1600 of these ITS spots have already been implemented on expressways, and another 1500 will be installed along the highways. Meanwhile, the number of on-board units that communicate with the ITS spots also grows at a rapid pace, to a total of 360,000 in July 2014.

One argument for investing in the ITS spots is that this short-range communication is
cheaper for many applications than long-distance communication. The ITS spots are not installed haphazardly, but only in places where there are problems with road safety and traffic flow. The data collected from the vehicles (probe data) is used to select these locations, for instance, by looking at locations where cars often brake harshly.

A number of day-1 applications run on the ITS spots, including a mobility service, a security service, and Electronic Toll Collection. However, day-2 applications are already being developed. Operational tests are currently being conducted with the lorry applications weigh-in-motion systems and heavy vehicle permission systems. Tests are also being conducted with applications that provide speed and time headway advice on roads in mountainous areas, where traffic jams are common because of vehicles driving uphill too slowly.
3.3. Automated driving

Automated driving is a very hot topic. On 16 June 2014, Minister Schultz van Haegen sent a letter to the parliament in which she indicates that she sees opportunities to “put the Netherlands on the world map as a country where these innovations [of self-driving cars] can take place”. The intention is that the government will facilitate these developments, without imposing restrictive rules beforehand. A first step to achieve this is to adapt the legislation: the Road Transport Directorate (RDW) is authorised to grant an exemption for large-scale test drives on public roads. There are, however, stringent testing requirements, so only serious tests with due regard to safety are considered. If all goes as planned, this legislation will enter into force in 2015. Several interested parties have already announced their interest in performing test drives on the Dutch road network – see next page.

It is no surprise that automated driving is such a hot topic. It has the potential to greatly improve road safety: automated vehicles do not get distracted and have very short reaction times. It reduces energy consumption and thus emissions. Automated driving also increases driving comfort and may eventually even allow ‘drivers’ to do something else. They may even become superfluous, for example, in some of the lorries driving in platoons. Given the expected shortage of lorry drivers, this is a positive development.

Finally, the impact on the traffic flow is also very promising. The capacity of the road, for instance, can be increased substantially: in theory, automated vehicles make very short headways possible, so literally more traffic would fit on the same stretch of road. Tests will need to demonstrate whether the expected benefits actually occur.

In this section, we will discuss the different levels of automated driving, the differences between autonomous, connected and cooperative driving, and we will specify a number of questions (traffic-related) that still need to be answered.

Levels of automation of the driving task

When we speak of automated driving, we don’t necessarily mean that the vehicle is capable of driving completely independently. This is because there are different levels of automation, already starting with relatively simple driver assistance.

A common classification is that of SAE – see Figure 16. Currently, we encounter mostly vehicles with an automation level 0 or 1; only a very small number of cars from higher segments have automation level 2. The highest levels, 4 and 5, ‘High automation’ and ‘Full automation’, are being tested, but there are still quite a lot of barriers to overcome before cars of this level can drive on public roads.

For more information about automated driving, see the TrafficQuest report ‘Cooperative systems and automated driving’ (2014, in Dutch). This document is available in PDF format on www.traffic-quest.nl/rapporten.
Minister Schultz will adjust the legislation in such a way that, in principle, tests with automated vehicles on public roads are possible. Five requests for such tests have already been received. The RDW will only grant an exemption to perform the test if the applicant has successfully completed the (strict) evaluation process. The five applicants are:

**TLN, Scania:** In February 2015, *Transport en Logistiek Nederland* (TLN) and Scania organised a platooning demonstration with self-driving lorries.

**TNO, DAF, Port of Rotterdam, TLN:** Together with DAF, the Port of Rotterdam and TLN, TNO is preparing a platooning test with two lorries. The technical tests have already been carried out. The EcoTwin lorries were demonstrated at the Automotive Week in Helmond in March 2015 – see photo.

**Gelderland, Wageningen UR:** The province of Gelderland and Wageningen UR are exploring the possibilities of using automated vehicles in the Foodvalley area. TU Delft and TNO are also involved in this initiative.

**TU Delft:** The Rail cluster of the Transport Institute of TU Delft is planning to conduct a technical test with automated vehicles on a bicycle path in the Mekelpark. The test is part of a special project in which automated vehicles are used for the ‘after’ transport of rail passengers.

**DAVI (TU Delft, TNO, RWD and Connekt):** The Dutch Automated Vehicle Initiative, DAVI for short, already organised a demonstration in late 2013 on the A10, in which the Minister also participated. The partnership is planning a new demonstration for 2016.
How will we be driving: autonomously, connected or cooperatively?

To place automated driving in the correct context we should also consider other, parallel innovations in road traffic. One of them is connected driving. Since an increasing number of people have Internet access (3G/4G) on the road, the number of in-car information services that inform and alert road users in a smart and personalised way is also growing.

A second parallel development is cooperative driving. In this case, vehicles are not only ‘connected’ remotely to a service provider (or road authority), but also to vehicles and roadside systems in the immediate vicinity. The cooperative technology is also referred to as talking traffic, due to the constant ‘talking’ (exchanging information) with other traffic.*

While automated and connected driving are developing steadily, cooperative driving seems to lag behind a little. This has to do with the fact that starting this innovation requires many parties: automotive manufacturers, suppliers, the traffic industry and road authorities. Another problem is that cooperative driving requires long-term investments, including in roadside stations for short-range communications.

Yet, all stakeholders, including car manufacturers, agree that to realise the full potential of automated driving, this requires cooperation. Cooperative driving will provide traffic with an additional ‘layer’ of intelligence: it evolves from ‘smart, moving units’ into intelligent, collaborative groups. If we speak of real game changers in the world of traffic, we usually do not just mean the development from manual to automated driving, but also the development from autonomous to cooperative driving – see Figure 17. (The game changer 2 in the figure relates to the development from automation level 2 to 3.)

Because traffic will never be able to make all these transitions at once, it is likely that we are at the beginning of a long transition period that includes a lot of mixed traffic: automated vehicles of various levels, whether or not cooperative, and also vehicles that have no more than a cruise control feature. During this transition period, few substantial benefits will initially be achieved. Safety may improve slightly, but in terms of traffic performance, the start-up period may go in all directions: from a slightly positive effect or no effect at all, or even a negative (side) effect.

* Cooperative systems have two ways of communicating: over short distances via IEEE 802.11p (sometimes called Wi-Fi p) for time-critical applications such as safety systems and shock wave damping, and long distance via 3G/4G for less time-critical applications such as navigation and route advice.
<table>
<thead>
<tr>
<th>SAE Level</th>
<th>Name</th>
<th>Narrative Definition</th>
<th>Execution of Steering and Acceleration/Deceleration</th>
<th>Monitoring of Driving Environment</th>
<th>Fallback Performance of Dynamic Driving Task</th>
<th>System Capability (Driving Modes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Automation</td>
<td>the full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Human driver</td>
<td>n/a</td>
</tr>
<tr>
<td>1</td>
<td>Driver Assistance</td>
<td>the driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task</td>
<td>Human driver and system</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>2</td>
<td>Partial Automation</td>
<td>the driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task</td>
<td>System</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>3</td>
<td>Conditional Automation</td>
<td>the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene</td>
<td>System</td>
<td>System</td>
<td>Human driver</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>4</td>
<td>High Automation</td>
<td>the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene</td>
<td>System</td>
<td>System</td>
<td>System</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>5</td>
<td>Full Automation</td>
<td>the full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver</td>
<td>System</td>
<td>System</td>
<td>System</td>
<td>All driving modes</td>
</tr>
</tbody>
</table>

**Figure 16:** Levels of automation of the driving task of road vehicles (source: SAE International, 2014).
Automated driving from different perspectives

However, to actually be able to start the transition to automated driving, whether or not cooperatively, a lot of questions still need to be answered. In a workshop, TrafficQuest has identified a number of bumps on the road to automated driving which it will further investigate in the coming period. Below, we will specify a number of these anticipated points of attention from the perspective of the driver, the road authority, industry and science.

From the perspective of the driver the first question is to what extent he is able to adjust himself to his new role. For example, as long as it is necessary that the driver can take over the driving task (automated driving, but with the responsibility lying with the driver), he must constantly observe whether the process of automated driving is going well. But is he capable of this? Are the situations the vehicle is incapable of handling not the same situations that cause problems to the driver, especially if he suddenly needs to respond actively after a long period of passive monitoring? And even if the driver is more or less prepared to take over the driving task again, for example because he receives a signal that he is approaching a road where automated driving is not possible, can you be sure his attention level is sufficiently high if he hasn’t had anything to do for a long time? And in the longer term: don’t you forget how to drive manually if you are used to automated driving most of the time?

Another question is how road users respond to a mixed traffic flow made up of vehicles with different levels of automation and coop-
eration. Is it desirable that drivers can see that a vehicle in their vicinity is driving in an ‘autonomous automated’ mode, so they can prepare themselves for the fact that this vehicle will (for example) not provide the space required to merge into the traffic flow? And what should cyclists and pedestrians know to safely interact with automated motorised vehicles?

A completely different point is that if eventually monitoring (of the driving task) is not or not constantly necessary, the value of time can be reduced. Travelling is no longer an obstacle if the ‘driver’ is free to perform other tasks. Will this result in more and longer trips (spending more time travelling)?

There are also points of attention from the perspective of the road authority. The first point is that it should be clear whether automated vehicles have specific needs and/or requirements with regard to the infrastructure. Does it, for instance, require a constant high quality of road markings? Only once the requirements are clear, can road authorities determine whether or not they can comply with them, and if so, on which sections of the network.

In addition to the road itself, the roadside systems also deserve attention, especially in terms of the interaction between roadside and in-car systems. Will the roadside systems conflict with in-car recommendations during the transition to automated driving? And which tasks must be fulfilled in case of incidents, road works or bad weather? Can the road authorities assume that vehicles will inform each other thereof, or is roadside information via variable message signs or other systems still required? It should also be explored whether the increase in the number of autonomous self-driving vehicles also results in a shift from a system optimum to a user optimum – in other words, whether the capacity is not adversely affected.

The automotive industry and the traffic industry (suppliers / programmers of roadside and back office systems) are also faced with questions. A very important one is: Do the systems of the different manufacturers speak the same language? Do they interpret each other’s messages unambiguously? And what happens if they don’t?

A question of an entirely different order is how the transition from automation level ‘partial’ (level 2) to ‘conditional’ (level 3) should be communicated to users. This is a crucial transition with many changes for the road user. The provision of information will be essential: drivers are often not fully aware of the capabilities and incapabilities of their vehicle. They tend to overestimate the level of automation of their vehicle, with all possible consequences (for example: taking over the driving task too late).

Furthermore, systems for automated driving should be fail safe, or at least a lot safer than the average human driver. This means that various buffers and backup systems must be built in, with the possible result that they ultimately perform less efficiently than human drivers. So does it make sense, in that case, to automate, considering the costs and benefits?
Researchers face many traffic-related questions. How will automated vehicles of different automation levels affect the capacity? Especially situations in which the traffic currently breaks down frequently, for example at junctions and weaving sections on motorways and at signalised and unsignalised intersections. In these situations it is also important whether vehicles communicate with each other (and/or with the roadside systems) or not. Without communication with the immediate surroundings, getting traffic to merge efficiently is a complicated task.

If there are disturbances in traffic, the consequences may be different than expected. If headways are short, and there is little time to resolve disturbances, instability could increase considerably. Simulations have already demonstrated that shockwaves behave differently with automated vehicles in the mix than in the current traffic situation. It can be expected that (parts of) the traffic flow theory will need to be revised in this case.
Conclusion
All in all, much still remains to be done on several fronts. Research is needed to determine what the traffic flow will be like under different traffic compositions and under different conditions. This particularly involves heavy traffic with frequent interaction between different road users – motorised vehicles, but also pedestrians and cyclists! Especially with autonomous automated vehicles there are concerns in terms of traffic performance, while the deployment of cooperative systems seems essential in order to fully exploit the benefits of automated vehicles.

Initiatives to accelerate the introduction of cooperative driving

In the Netherlands, the DITCM partnership and the Connecting Mobility programme of the Ministry of Infrastructure & Environment are working on accelerating the deployment of cooperative systems – see chapter 5. The Better Traffic Management II (Beter Benutten in Dutch) programme also contributes: the participants in the BTM project Phantom traffic jams on the A58, for instance, are elaborating an architecture for cooperative systems and developing a first cooperative application, aimed at reducing shockwaves (“phantom traffic jams”) as a use case. At the European level, there is the recently established C-ITS platform, in which experts from different Member States work together.

The interest of the Netherlands is primarily motivated by accessibility problems; in other countries, the key objectives are to improve road safety and energy efficiency.
3.4. Human Factors

In the past, TrafficQuest published a number of reports on human factors in traffic management. This subject is now well embedded in traffic management, and also receives sufficient attention in the various committees and programmes: one of the programme lines of DITCM is dedicated to human factors and within Connecting Mobility, there is the theme ‘Human Factors and user behaviour’. The organisations behind DITCM and Connecting Mobility have even launched a joint project, DITCM Connecting Mobility Behaviour. In this project, public and private organisations share their knowledge in the area of behaviour, and a helpdesk has been established as an information source on human factors and user behaviour.

Meanwhile, a number of interesting documents about human factors have been published on the website of Connecting Mobility, www.connectingmobility.nl. The report ‘State of Practice: Behaviour in smart mobility projects’ (2015, in Dutch) organises existing knowledge as applied in sixteen recent ‘smart mobility’ projects. The authors identify which human-machine interfaces have been used in the projects, which part of user and traffic behaviour was studied, and which research methods were used.

There is also the ‘Human factor guidelines for the design of safe in-car traffic information services’ (2014, in Dutch). This document provides practical support to developers of in-car traffic information services and their clients. The purpose is not to ‘give directives, but to stimulate that service providers in any case take account of the capabilities of road users in the design of their services. The document is mainly a manual, meant as a starting point for parties that want to offer good and safe services.

In order to streamline the behavioural research, Connecting Mobility and DITCM have also prepared a short and medium-term research agenda. In 2014, they started with the formulation of the knowledge questions based on relevant literature, working documents, interviews and expert sessions. A short list was then derived from this long list, a list of questions that deserve priority. A selection from the questions:

- To what extent can roadside systems be phased out? At what penetration rate of in-car systems can this be achieved securely and smoothly for all road users? What information will need to remain freely available to all road users to ensure they can properly perform their driving task?
- How do road users adapt their driving behaviour after the implementation of a system? What are the short and long-term effects?
- What effects occur in the automation of the driving task if the driver plays the role of monitor or backup of technical systems?

*This concerns the reports ‘Human factors in traffic management’ (2012), ‘The design road user’ (2013) and ‘Cooperative systems and automated driving’ (2014). These documents are available in PDF format on www.traffic-quest.nl/rapporten, but only in Dutch.*
The complete list is available from the Connecting Mobility website. All the stakeholders involved can contribute to answering the knowledge questions. The intention is that the knowledge agenda is made more interactive in 2015, allowing anyone to add information.

**Abroad**

Of course, human factors research is not only carried out within our borders. At the EU level, the HFAuto project is ongoing, which studies the human factors questions regarding automated driving. And in the US, there is the Human Factors Research Program of the Intelligent Transportation Systems Joint Program Office. The US study also pays great attention to driver distraction, with the aim to better understand the risk associated with distracted drivers and how systems can be designed to support drivers without distracting them from the driving task. Or, when it comes to automated driving, how drivers can take over the driving task from the vehicle if they have been legitimately distracted for a while because the vehicle was capable of performing this task itself. In light of the evolving technological development in the coming years, this topic will remain high on the agenda – also outside the US.
3.5. Incident management

Already twenty years have passed since Rijkswaterstaat, the Dutch National Road Authority, took the initiative to apply professional incident management on the Dutch motorway network. As a result of this approach, the various ‘incident management stakeholders’ – police, fire brigade, ambulance, road authorities and market participants involved such as towing companies – started to work together intensively as well as coordinating their activities properly. Over the years, several measures have been introduced, such as the passenger car and lorry arrangement (dealing with the responsibility of towing stranded vehicles), and the use of incident management has been extended to major secondary roads.

It is expected that these measures have resulted in largely achieving the 2008 ambition to reduce the number of vehicle hours delay due to incidents by 25% by 2015. Only one element will fail to achieve its goal: roadside assistance for broken down lorries. Therefore, a special Action Plan was formulated under the Better Traffic Management programme: ‘Reducing nuisance caused by lorry incidents through the ITS information platform’. We can in any case speak of a successful and also important initiative. Due to heavy traffic on the road network, incidents have a significant impact on the quality of the traffic flow and the reliability of travel time – and achieving the 2008 ambition is therefore a tremendous result.

However, despite the good results so far, recent developments compel to lower expectations for the near future. The contribution of incidents to the total size of the congestion on Dutch roads in recent years has at least increased in terms of percentage points – see Chapter 1 of this Annual Report. At the same time, the expertise in this specific area is crumbling rapidly. The (current) reorganisation of the police, for instance, has led to the dissolution of the KLPD, the organisation responsible for monitoring of the safety on motorways. The result is that the involvement of the police in the handling of incidents has fallen sharply.’ And then there are the cutbacks and reorganisations at the national and provincial road authorities. Rijkswaterstaat, for example, has reduced the number of road inspectors that can be deployed by 100. This is partly the reason the clearance of incidents takes longer.

This impoverishment could easily undo the good results of recent years. It also puts more pressure on the safety of emergency assistance in incident situations. In 2014 alone, as many as 21 vehicles of road inspectors were hit by other vehicles. This cannot directly, and certainly not exclusively, be attributed to the above developments, however, reducing the involvement of the police and the decrease in knowledge and expertise certainly do not help.

To compensate for the disappearance of the KLPD, an experiment has been launched to provide (a limited number of) road inspectors the authority of Special Investigating Officers.
A new ambition is needed to keep the application of incident management on the Dutch roads at an adequately high level. To conclude this section, we will specify some points that definitely should not be left out of such an ambition:

- The roles of the professionals involved in incident management must be reconsidered. In this context, a new setup is required for the distribution of the costs of incident management.
- The efficiency of the roadside assistance and the passing on of the associated costs to the motorist and the transport operator needs attention. Many foreign transport operators, for instance, turn out not to be insured for roadside assistance and this makes it difficult if not impossible to charge the costs correctly.
- The safety of road inspectors and personnel of towing companies deserves more attention.
- It is important to formally and legally establish the traffic management role of the road authorities, with clearly formulated responsibilities and powers, both in regular and irregular situations.
- And finally, more information about incidents will need to be collected. This information is not only important for the emergency services, but also for the road users.
Interview

“We are still a leader in traffic management and ITS, but this may soon change”

TrafficQuest acquires a lot of knowledge by talking with people who work in the field of traffic management and traffic information. For this edition of ‘Traffic in the Netherlands’, we visited Frans op de Beek, principal advisor on Traffic Management for roads and waterways of Rijkswaterstaat. A report of the conversation.
How would you explain the importance of traffic management?

“Everybody understands that there are limits to the number of roads we can build. That’s why we should be looking for ways to make more efficient use of the existing roads, and exactly that is the role of traffic management. By acting intelligently, you can even enhance the accessibility and quality of life as well as safety.

The importance of traffic management also lies in monitoring the collective objectives and conditions. A shift is taking place in this area: tasks are transferred to the market, more responsibility is placed on road users. The idea behind this is that self-organisation works well, especially if there is sufficient information available. In collaboration with the market, the road authorities provide this information. However, once this self-organisation ceases to work well and conditions deteriorate, measures must be taken. In that case, traffic management is not just a nice touch, but a necessity.

This is also the reason that road authorities work together closely. Sometimes, for instance, we allow a traffic jam to occur on the motorway, in order to help tackle an issue with the quality of life or another serious problem on the underlying road network. We pay attention to our ‘system responsibility’.

A lot of changes are going on within the mobility domain. What events of the past year have made an impression on you?

“We are in a transition phase, from roadside to in-car, from collective to individual communication, from ‘Rijkswaterstaat is doing everything’ to a situation where we’re going to do it together with the market. This is a very interesting process! The transition is fuelled by technological developments, such as navigation and the rise of the smartphone. They force us to revise the role of traffic management and rethink our role.

In the past, as a road authority, you were ‘the boss’. You were in charge of traffic management, but nowadays we are more a team player. Traffic management is about services, and Rijkswaterstaat becomes a player in the service chain. This is a completely different position.”

For you as a principal advisor on Traffic Management, what are the themes that currently require the most attention?

“At this moment, that is mainly the aforementioned transition. How will traffic management develop from a traffic engineering point of view? What is the proper setup of the public-private partnership? What is the best way to fill in the new role and position of Rijkswaterstaat?”
There is also a financial side to this transition. The starting point of our new investment strategy is that we no longer invest in conventional informing and advising technology – even though they are maintained – but only in new technologies. Because conventional systems cannot yet be phased out completely, it does not yield immediate savings, but the nature of the investments changes.

In the transition from collective traffic management to a more individualistic approach, behaviour also plays a major role. How can you ensure that the in-car information really reaches the driver? Wouldn’t it be wise to prioritise incoming messages to prevent important information from getting lost or different messages from contradicting each other? And how can you ensure that the driver is not distracted from his primary task, driving the vehicle?

Many of these issues are tackled by the market and the manufacturers of the systems. Rijkswaterstaat can influence the market for aftermarket systems a little, but this is more complicated with manufacturers of the systems.

A current theme of a very different order, but not less important, is the EU Presidency by the Netherlands in the first half of 2016. We are currently very busy preparing ourselves for this task. My own role is to focus on the topic ‘Harmonisation of connected/cooperative and automated driving’.

Will that be the theme of the coming years?

“Without a doubt! The main themes of traffic flow, safety and quality of life will obviously remain the same, because five years is too short a time to achieve a real change. Issues such as emissions, noise and safety will remain important for the time being, especially in cities. However, the main theme for the coming years will be the transition from connected to cooperative and to automated driving. Each of these phases and transitions will have their own challenges. The cooperative phase, for instance, requires Wi-Fi beacons along the road, to communicate the data to the vehicles. But how should their deployment be organised? What is required where? And which services will be allowed in the cooperative system? What are the business models the market can apply? These are important questions, because, as a road authority, you want to anticipate technological developments, to provide guidance in collaboration with the market. The next step, therefore, is to change the organisation. Rijkswaterstaat is still investing in the roadside, not so much in informing and advising variable message signs, but particularly in the information traditionally provided by prohibition and mandatory signs, in which the aforementioned Wi-Fi beacons play an important role.

In the past, we sometimes tended to lose focus a bit, with legislation always being a step behind technology. We have learnt our lessons from that: lawyers have already been involved for the move towards automated driving. Very recently, the law was amended to allow test drives on public roads.
Incidentally, this area also requires international coordination. Some of the laws in Europe differ too much. In France, for example, the change of a traffic light to the green light may not be communicated. If we want traffic lights to communicate with vehicles in order to improve the flow, this would require an amendment of the law in France.”

**You briefly mentioned behaviour. Do you see possibilities to influence the behaviour of the driver in such a way that this benefits the traffic performance?**

“We hope that we can positively influence the driving behaviour with the shift from collective to individual communication. This personalised communication will mainly be provided by the service providers, which requires close cooperation with them. But even then, influencing the behaviour of the road user is still a hefty task. Take, for example, phantom traffic jams: you say ‘slow down, because that way you will prevent phantom traffic jams.’ People follow this advice, but then the phantom traffic jams are no longer visible, since they have been prevented from happening. Will the road user follow the advice again next time?

It is therefore important to inform people properly about what they contribute to. You may be able to explain it through the in-car system, but it may also require commercials in the media. Anyway, everything stands or falls with the acceptance and the proper use of new mobility and traffic management services.”

**How would you rate traffic management in the Netherlands compared to other countries? In what area could we learn something from other countries?**

“As far as the application of traffic management is concerned, the Netherlands is a front runner. We have lane management and automatic incident detection systems, traffic control systems and ramp metering systems. With the current transition, you can see that we are still in a leading position, but that other countries are also starting this transition, and at a much more rapid pace. They are able to do this because they have less ‘installed base’: they can immediately and substantially invest in in-car technology. What we are doing is looking at how we should handle lane management and automatic incident detection in the future, which, incidentally, works perfectly, and what in-car systems can add to that given the current performance. Currently, this contribution of in-car technology is still insufficient, but this discussion will change if you consider the fact that our installed technology will definitely be taken out of use.

In this respect, you can compare the current situation with the introduction of rail transport in the 19th century. Because we had an
excellent working system of canal barges in the Netherlands, we did not start investing in the construction of railways until late in the game.”

Where do you still see major opportunities for the application of traffic management?

“I think there are still many opportunities to improve the quality of life, especially on the urban road network. The importance of incident management also remains undiminished. This also depends on robustness: if we do not have a robust road network, incidents have an enormous impact on the network, and incident management remains essential.

The importance of traffic management during events will also increase. And finally: I am convinced that the introduction of automated driving will lead to all sorts of innovative forms of traffic management. So there will also be plenty of opportunities for traffic management in the future!”

You are expected to pass on the baton of principal advisor on Traffic Management to someone else in 2016. What would you like to say to your successor?

“It is important that he or she continues in the direction in which we are heading and that he or she further develops and monitors the process. The integration between connected, cooperative and automated driving and the consequences this has for traffic management are an important part of that.

The government should create an attractive and stable investment policy for the market and the industry, so that they are willing to invest in mobility management, traffic information and traffic management. In that context it is also important to continue along the chosen route. And Rijkswaterstaat should further position itself as an important player in the service chain.

Does the market only wish to work on those services that are most profitable? That’s possible. However, it is also possible to create a market potential, preferably international, which necessitates standardisation. To prevent cherry-picking, I am thinking of service packages, consisting of commercial services as well as a number of non-commercial services. It requires a lot of international consultations with the market to achieve this, for example, within the C-ITS platform.

But the one thing I would like to make especially clear to my successor is that this is an awfully nice job with many challenges.”
Finally, do you think there are certain topics TrafficQuest should address?

“TrafficQuest is an interesting partnership of organisations that have a wealth of knowledge. We should take advantage of this joining of forces while going through the different phases. Topics you could address include: How can we organise the cooperation with the market to create a robust network? How do we determine appropriate parameters for optimising and balancing the collective traffic management objectives of traffic flow, quality of life and safety? Furthermore, the monitoring role of the road authorities should be established. This task requires an elaboration in terms of traffic engineering (traffic modelling), organisation and behaviour.”
New developments in research.

Long before new methods, technologies and systems are used in the streets, they have been thoroughly tested and evaluated by researchers. Innovations are often even a direct result of (fundamental) scientific research. To get an idea of the future of our profession, a tour along the research tables can be very helpful. We took that tour, and in this chapter we will answer the question: what are the main research themes of the moment?
Travel and driving behaviour

Research goal: Gathering knowledge about the behaviour of road users, including driving behaviour (longitudinal and lateral behaviour) and choice behaviour (destination, route, transportation mode, departure time, etc.).

Explanation: Traffic management aims to influence the behaviour of road users to improve the traffic flow and safety of the entire traffic and transport system. Studying the behaviour of the traveller is therefore a continuous and always important research theme.

Besides research into the traditional modes of transport (car, lorry, train, tram), more and more research is being done into slow traffic (pedestrian, cyclist) and interactions in mixed traffic. The emergence of new technologies in traffic and transportation, such as cooperative systems, automated vehicles and in-car systems, will affect the traditional way of travelling. The extent to which traffic can keep up with developments depends on a good understanding and a good prediction of the behaviour of travellers.

Read more *


* For links and/or downloads, please go to www.traffic-quest.nl/en/traffic-2015.
Traffic situation estimation and prediction of the traffic flow

Research goal: Developing models and tools to understand the current state of traffic systems and to predict the trends in the traffic flow.

Explanation: Estimates of the state of the traffic flow in the network now and in the (near) future are the basis for effective traffic management. Unreliability and lack of knowledge about the current and past traffic situations, after all, lead to inaccurate predictions, causing traffic management measures to be used ineffectively or too late.

Estimates of the traffic situation of the different modes of transport in the network are challenging in several respects. In addition to motorised traffic, the state of pedestrian and bicycle traffic should also be identified, which requires new models and new traffic management measures. Research in this area continues to focus on the combination of data from different sources (infrastructure-based sensors, floating car data, Bluetooth and Wi-Fi data) and from social media (route and destination information).

Managing traffic on motorways

Research goal: Improving the performance of traffic on motorways by applying ramp metering, variable speed limits, dynamic route information panels, etc.

Explanation: Traffic management on motorways is still a major focus area of researchers and road authorities. Route guidance and measures such as ramp metering and variable speed limits are used to reduce congestion and improve road safety. This improves the traffic flow, especially because it prevents, or at least delays, capacity drop.

However, the effectiveness of individual measures is limited. The capabilities of ramp metering, for example, are limited by the available buffer space on on-ramps. However, if we use different control systems in a coordinated manner, we can improve the performance of traffic management. To achieve this, researchers also specifically look at the possibilities of using in-car sys-

Read more *


* For links and/or downloads, please go to www.traffic-quest.nl/en/traffic-2015.
tems to guide traffic and make it safer – see the following section.

**Read more**


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**Integration of roadside and in-car systems**

**Research goal:** Integration of roadside and in-car systems, making use of connected and cooperative driving, in order to optimise the monitoring and management of traffic.

**Explanation:** A great deal of attention is paid to connected and cooperative driving on a road network equipped with communication systems. However, the sole option of communication between vehicles and between vehicles and the roadside, traffic control centre or back office does not suffice. The underlying ideas about how the traffic flow can be positively affected should also be adapted to the new options that arise if vehicles share all kinds of data and (possibly personalised) advice can be offered in the vehicle.

Until now, road authorities mainly communicated with road users through roadside systems, for example, by placing a message on dynamic route information panels. However, most vehicles now have a navigation system or smartphone available – devices which, in principle, could also run traffic management applications. The roadside systems could use these applications to offer their information in-car. In turn, systems in the vehicle can communicate with the roadside systems or traffic control centre, and their information can be forwarded to other vehicles. This may include data on position and speed, or the information that the windscreen wipers of several vehicles are switched to ‘heavy rain’, which can be translated into messages about traffic jams or bad weather later on.

It has taken some time before the research into the integration of roadside and in-car systems really took off, but now there is...
plenty of interest. This is also due to the strong rise of the smartphone and the fact that car manufacturers install an increasing amount of connectivity in their vehicles, which greatly increases the potential penetration rate. The topic has also caught the attention of ICT researchers, thus further increasing the communication capabilities of systems. However, currently there is no large-scale application of specific traffic management applications yet.

In order to reduce the (construction, maintenance and operation) costs of expensive roadside systems, integration is considered highly desirable for the coming period. Integration of roadside and in-car systems also plays an important role in the Field Operational Trial Amsterdam to improve the traffic flow by providing optimal route and travel advice.

**Read more**

- **Developing vehicular data cloud services in the IoT environment.** He, W., Yan, G., & Da Xu, L. (2014). IEEE Transactions on Industrial Informatics, 10(2), 1587-1595.

Automated driving

Research goal: Understanding the impact of the phased implementation of automated driving in the context of traffic management: for road users, for the use of roadside systems and for the design of the road network.

Explanation: Nowadays, automated driving means that the driver leaves the driving task partly to autonomous (sub)systems in the vehicle. The driver remains in control of the vehicle or monitors the driving task, so he or she can quickly retake control. Automated systems can operate continuously (such as steer-by-wire) or only when interventions are needed (for example, for emergency braking or parking assistance). There are different levels of automation – also see chapter 3 and the Automated Driving Roadmap of ER-TRAC.

It is important to gain an understanding of the effects of the introduction of automatically driving vehicles on traffic flows (how does this affect the speed, intensity and density?), traffic management (which measures are necessary or useful?), and the possibilities of this new technology to achieve more efficient and safer traffic. Human factors play a major role therein. For example, how do human drivers deal with the automation of the driving task (both stated and revealed preference)? Before automated driving can be safely introduced to the public road, we will need to have appropriate solutions for human errors and system errors.

A number of relevant projects related to automated driving are:

- Dutch Automated Vehicle Initiative (DAVI). At DAVI, research is being conducted into automated driving, and demonstrations are given with automated vehicles on public roads. See www.davi.connekt.nl.
- Human Factors of Automated Driving (HFAuto). In this project, knowledge is gathered about human factors that play a role in (the safety aspects of) automated driving. See www.hf-auto.eu.
- AutoNet2003. This project develops and tests technologies for cooperative-automated driving, based on a decentralised decision-making strategy in which information is shared with nearby vehicles. See www.autonet2030.eu.
- AdaptIVE. The AdaptIVE project develops features for automated driving by adapting the level of automation to the situation and the condition of the driver. The project assesses legal issues that may affect the introduction of automated vehicles in the market. See www.adaptive-ip.eu.
- Truck Merging Support – a Step towards Autonomous Driving. This is an STW project which studies the merging behaviour of lorry drivers using empirical data. Lane changing behaviour algorithms are developed and the effects of ‘truck merging support’ on the characteristics of traffic flows is assessed.

Read more *

- Cooperative systems and automated driving, TrafficQuest State-of-the-Art
Traffic management of mixed traffic flows

Research goal: Determining how traffic management and road design should be adapted to adequately facilitate mixed traffic (cars, cyclists and pedestrians).

Explanation: The bicycle as a transport mode is becoming increasingly popular: in many cities it is one of the most important modes of transport. That is a positive development, since the bicycle is a healthy and sustainable transport mode. Its popularity, however, also creates new problems in cities, such as parking problems, and sometimes even bicycle traffic jams. Moreover, the more


* For links and/or downloads, please go to www.traffic-quest.nl/en/traffic-2015.
intensive interaction with other transport modes involves traffic safety risks. Therefore, traffic management of bicycle flows is becoming increasingly important. Intersections where many traffic flows come together, are a clear point of attention: who is given priority and why? Due to the increased numbers of cyclists in congested urban areas, bicycle parking and bicycle areas are also given more attention. Nakamura & Abe (2014) provide an excellent overview of the challenges and possible solutions. Furthermore, data collection for non-motorised traffic flows (cyclists and pedestrians) is getting increasing attention. The National Cooperative Highway Research Program (NCHRP) published a report on data collection for bicycle and pedestrian flows, and addresses various data collection techniques (NCHRP, 2014). Most progress is currently being made in the use of floating device data (FDD). An increasing number of people have smartphones, which allows them to monitor their movements and that also serves to collect other data. The data collected provide insight into cycling flows and are also important for the prediction of traffic flows. However, in most cases, this type of research is still in the early stages.

Read more *


## Toolkit for traffic flow analyses

**Research goal:** Improving traffic flow analyses for different types of traffic flows, including the collection of raw data, the development of traffic models, and scenarios for traffic simulations of traffic management and decision support.

**Explanation:** The idea is to develop a toolkit or a ‘data and information platform’ that unites data from multiple networks, of different formats and/or with different spatial scales or time scales. Such a platform makes it possible to relate traffic data to data from other sectors, such as demography, economy, energy and electricity networks, in order to gain a better understanding of issues such as the use of electric vehicles, polluting emissions, quality of life and safety. The linking of different types of data also provides a better understanding of the different traffic flows through a city, which can be a first step towards an advanced ‘multi-scale model’ for short and
long-term predictions, and their use in a decision support system. All this is made possible through various forms of data fusion.

The combination of different data sources creates unique opportunities for data analysis and modelling. For instance, the observed activities and travel choices on any given day can easily be linked to observed traffic situations, events that took place, information that was provided, and so forth. This makes analyses of behavioural choices possible in the short term, but it can also provide insight into the ‘long-term behaviour’: strategic choices of households and businesses and developments in the field of traffic flow (average travel times and delays, variations in travel times, etc.) as output of various models can be combined to generate new qualitative and quantitative insights into the key drivers of long-term changes in behaviour. This information is important to develop personalised travel information, based on ‘push’ technologies. Other possible applications are the optimisation of networks and operating schedules, and the analysis of the influence of minor and major interventions in the system (source: Urban Mobility Lab, 2014).

Relevant projects are:

- Urban Mobility Lab, a project of the Amsterdam Institute for Advanced Metropolitan Solutions (AMS). See [www.ams-institute.org/solution/urban-mobility-lab](http://www.ams-institute.org/solution/urban-mobility-lab).
- DiTTlab, Delft Integrated Traffic & Travel Laboratory. See [www.dittlab.org](http://www.dittlab.org).

### Visualisation

**Research goal:** The development of visualisation tools for the next generation of traffic models and communication tools to explain model results to policy makers.

**Explanation:** It is essential that the results of quantitative analyses, such as performed with traffic models, are communicated accurately. Model calculations and data analyses can contribute significantly to our knowledge, but they do need to be interpreted correctly. A new generation of models and the availability of new types of data result in a wide range of additional information, including information on the reliability and stochastics of traffic or multimodal mobility. To add value, the communication of such information requires new ways of visualisation and presentation.

For print (reports) a combination of visual cues and data templates may be a good way to share additional information. However, for policy processes and operational situations, more and more interactive and

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dynamic platforms are used to make decisions. In such an interactive environment, the possibilities for visualisation and communication are, of course, much broader. However, it must be ensured that the users are not overloaded. What information is necessary and useful in what level of detail, differs from person to person and from role to role. Therefore, a clear distinction should be made between the different groups of users of the information. Decision makers benefit from an overall picture of the results, while policymakers often want more detail and background information. Traffic operators and technicians require even more detailed information as well as unfiltered data. This means that the requirements for the visualisation and communication style differ per stakeholder.

Read more *
- Visualisation of uncertainty in probabilistic traffic models for policy and operations. Calvert, S.C., Jouke Rypkema, Bas Holleman, Daniel Azulay & Arnoud de Jong (soon to be published).

* For links and/or downloads, please go to www.traffic-quest.nl/en/traffic-2015.
4.2. Relevant PhD research

In our previous annual report, we already reported on the PhD studies of Gerdien Klunder and Simeon Calvert, co-financed by TrafficQuest. Below, we will describe the latest developments in their studies. We will also briefly address other PhD studies.

Relationship between data quality and traffic management

Traffic data are becoming more easily available. However, since the quality of these data sometimes greatly varies per source – in many aspects, such as timeliness, accuracy and reliability – the data cannot simply be used for traffic management applications. The PhD research of Gerdien Klunder aims to investigate the relationship between the quality of the different types of traffic data and the effectiveness of traffic management.

To quantify the effect of uncertainty of certain data on the ultimate performance of the system it should first be determined what the purpose of the measure is and how this can be measured and quantified. To this end, a measure of effectiveness (MOE) has been developed. Ultimately, a quantitative relationship should be found between the accuracy of the input data and the MOE. The framework previously established by Klunder was tested on the basis of several cases.

A previous case study examined a network with a ramp metering system. This study showed that the accuracy of the input data has a large impact on the traffic performance of the network.

Using simulations, the effect of the accuracy of the collected data for a ramp metering system on the performance of the network was determined, based on a common configuration of detection loops. It was assumed that the same measurements could also be performed with cameras, which yield less accurate measurements but are cheaper to purchase and maintain. This way, a ‘design/time’ optimisation was performed, which allows for taking an investment decision based on a cost-benefit analysis.

The selected approach has been further elaborated for the queue length estimation at a ramp metering system, using a combination of loop data and floating car data (FCD). A good queue length estimation on the urban road network is relevant, since by activating the metering system in a timely manner, it can be prevented that queues on the urban road network become too long, which results in blocking back. Klunder concludes that it is very difficult to estimate the queue length based on inaccurate loop data since faulty counts have a cumulative effect causing the estimated length to differ increasingly from the actual length. Correcting the error with FCD allows improvement of the estimate. To determine the desirable penetration of FCD, Klunder performed a micro-simulation study and implemented and
compared various algorithms. The results show how FCD penetration and measurement errors affect the accuracy of the queue length estimation and the implications for the effectiveness of ramp metering and network performance. Figure 18 shows the difference in the accuracy of the estimated queue at different algorithms over time, and Figure 19, the effect of the amount of FCD vehicles on the mean error of the estimated queue. Ultimately, this should also be used dynamically, whereby the actual data demand is determined in real-time.

The current study of Klunder focuses on setting up two other case studies in which the combination of loop data and FCD is the central aspect. One of these case studies deals with the individually ‘smart’ routing of traffic based on network-wide speed and volume estimates (smart routing) and the other with the real-time estimate of an origin-destination matrix based on surveys supplemented by floating car data. In the case study of smart routing, she investigates the effect of the quantity and quality of FCD information for determining route alternatives that can be recommended to (a part of) the road users to improve the individual and overall (network) travel time. These ap-
approaches may later be used for various traffic management applications, such as optimised traffic control at intersections or travel time predictions. Again, the question arises what data quality of both the loop data and the FCD is desirable for these applications. An additional question is which measurement errors occur in practice at different types of sensors.

Read more *


* For links and/or downloads, please go to www.traffic-quest.nl/en/traffic-2015.

Modelling of traffic variations

Traffic models are important tools to predict future traffic conditions, including the effects of traffic management. Most traffic models are based on average traffic situations and thus reduce or even neglect the effects of uncertainty and stochastics in traffic. Stochastic variations and uncertainty, however, are generally present in traffic, and it is also clear that they are relevant for the modelling of traffic and the application of traffic management measures. The aim of the PhD research of Simeon Calvert is therefore to provide insight into these stochastic fluctuations and uncertainties, and to develop models that take these into account. This should lead to a more realistic modelling of traffic. In his research, Calvert elaborates on the quantification of disturbances in traffic. Understanding the scope of these disturbances is necessary to generate reliable input for traffic models.

In the past period, much progress has been made in the research, with interesting findings and insights as a result. The research includes the use of Monte-Carlo simulations, a technique to analyse sensitivity and uncertainty through a large series of simulations using random variables. Normally, a large number of simulations means a long calculation time, but Calvert has shown that the use of advanced sampling and sequencing techniques can lead to a substantial reduction in calculation times with minimal extra effort. Based on an analysis of fluctuations in the capacity under different circumstances, he was also able to demonstrate that stochastic capacitance values for Dutch motorways can be quantified in a general way. A distinction is made between the days of the week, the days of the weekend and holidays. These insights are important because they say something about the scope of the uncertainties in models and the effectiveness of measures that affect the capacity.
Another aspect that has been studied is the visualisation of uncertainties. Communication of model results is essential. If done correctly, model studies will be used more effectively. Together with a cognitive psychologist the visual forms of presentation were studied, as well as tested – see Figure 20 for a number of varieties. These visualisation forms can be used in reports or interactive environments.

In the coming period, Calvert will focus on the stochastic aspects of the interactions of vehicles at the microscopic level and on how these can be modelled at the macroscopic level. On an individual scale, interactions have a significant influence on the overall uncertainty. This aspect also includes further research into the capacity drop.

**Read more**


Other relevant PhD research

Ruihua Lu  
The Effects of Information and Communication Technologies on Accessibility  
ICT is expected to have a major influence on the behaviour of travellers and thus on accessibility. However, the understanding of the effects of ICT on accessibility is limited. This thesis aims to increase this understanding by using a generic formalised integrated behavioural model to describe and evaluate the effects.

Qing Ou  
Fusing Heterogeneous Traffic Data: Parsimonious Approaches using Data-Data Consistency  
A reliable and accurate estimate of the traffic situation is very important for all sorts of practical and scientific applications. The problem is that data from different sources are usually different in nature and have different characteristics. That makes it difficult to combine them into consistent and reliable traffic information. This thesis investigates an efficient and ‘economical’ approach to fuse heterogeneous data traffic. The results show that this approach significantly improves the accuracy and reliability of the estimation.

Tamara Djukic  
Dynamic OD Demand Estimation and Prediction for Dynamic Traffic Management  
Dynamic origin-destination matrices (OD matrices) are important input for traffic models that predict the traffic situation in a network. The difficulty of compiling OD matrices of appropriate quality makes the predictions of traffic models unreliable, no matter how well the models are calibrated. The thesis presents methods to produce efficient and reliable dynamic OD information for traffic management applications.
Meng Wang  
**Generic Model Predictive Control Framework for Advanced Driver Assistance Systems**
This study describes a framework for model-based predictive control (model predictive control, MPC) for advanced systems to assist the driver with the driving task. The framework was used to design various autonomous and cooperative control systems. It was also used to investigate the properties of these control systems at the microscopic level, and the resulting macroscopic properties of the traffic flow. The results provide new insights into the effects of these types of systems on the traffic flow.

Lin Xin  
**Assessing the impact of imposing environmental hard constraints in traffic network**
This study focuses on the development and adoption of an evaluation framework to assess the effect of strict quality of life demands on traffic networks. Quality of life demands are often contrary to other objectives of traffic management. Therefore, it is essential to determine the costs associated with these demands. Combined with the traditional approach of evaluating the quality of life, this framework provides decision makers and road authorities with the possibility of finding the best solution that takes account of the traffic flow in the network as well as the quality of life.
4.3. Interesting literature

An important ‘product’ of many scientific conferences and meetings are the submitted papers. In this section, we describe a number of recent publications that are relevant to traffic management and the development of the field.

**IEEE-ITSC 2014**

The IEEE Conference on Intelligent Transportation Systems (ITSC) is an annual event of the IEEE Intelligent Transportation Systems Society. In 2014, the ITSC was held in Qingdao, China. The organisation awarded prizes for the best paper and the best thesis per field of study. For road traffic, the following publications were awarded:

**Best thesis**

**Best papers**
- *Index Modulated OFDM with Interleaved Grouping for V2X Communications.* Cheng, Xiang; Wen, Miaowen; Yang, Liuqing; Li, Yuke.


**TRB 2015**

The 94th edition of the annual meeting of the Transportation Research Board was held from 11 to 15 January 2015 in Washington DC. This largest and most reputable transport congress again had an extensive programme, with more than 5,000 presentations in nearly 750 sessions covering all areas of traffic and transport.

The Greenshields Award is important in the area of traffic handling. This year it was awarded to the paper ‘Empirical observations of congestion propagation and dynamic partitioning with probe data for large scale systems’ by Yuxuan Ji, Jun Luo and Nikolas Geroliminis.

See [amonline.trb.org](http://amonline.trb.org).
CVS 2014

The 40th Colloquium Vervoersplanologisch Speurwerk (Transport Planning Research Colloquium) was held in Eindhoven on 20 and 21 November 2014. The theme was ‘Something with ethics – dilemmas in transport planning’. However, there was also ample attention for the common challenges associated with traffic. TrafficQuest presented a paper on the current issues and the direction urban traffic management should take. The best paper of the conference was also about urban traffic: ‘The choreography of an intersection: Towards a use-oriented design logic for intersections’ by Marco te Brömmelstroet. This paper took a different look at the way cyclists ride and which traffic rules they apply. The question is whether the design of intersections should facilitate or discourage this behaviour. The paper provides some food for thought in this regard, and is simply an educational and great read.

See www.cvs-congres.nl.

NVC 2014

The National Traffic Engineering Congress (NVC) is an annual conference where professionals from research and practice meet and share the latest developments with each other. On 12 November 2014, the fifth edition was organised in Utrecht and drew 400 visitors. Two subjects were given ample attention, namely data in traffic and urban traffic management. The award for the best paper went to a contribution of Willem Schepper and Erik Klok on the use of Wi-Fi in the travel survey (origin-destination) of cyclists and pedestrians.

See www.nationaalverkeerskundecongres.nl.
Traffic management pilots.

After new methodologies and technologies have been studied and analysed extensively, it is time for the controlled tests on the street. These pilots provide interesting insights for traffic management. In this chapter, we will discuss some of these tests in the Netherlands and abroad, grouped by the traffic management sub-topic.
5.1. Coordinated network-wide traffic management

Phantom traffic jams on the A58 (The Netherlands)

The A58 is a heavily travelled motorway where shockwaves, also known as ‘phantom traffic jams’, occur regularly. In the pilot Phantom traffic jams on the A58, it is attempted to reduce phantom traffic jams on the route Tilburg-Eindhoven using in-car information via smartphone apps (Zoof, SmartCAR or Filejeppen).

The project consists of two phases, the ‘connected’ phase and the cooperative phase. Phase 1 started in February 2015 with a user test of limited size, with 60 users. In March, this was gradually scaled up to approximately 2000 users. In phase 1, the apps only use long-range communications (3G/4G), whereby floating device data is sent from the app to a back office, and users receive advice – at least a speed advice. It is being evaluated whether these apps provide logical advice during this ‘connected’ phase, how satisfied users are with the apps and if there are any effects on the traffic flow.

In the summer of 2015, antennas for short-range communications will be installed along the route for the second, cooperative phase. The apps and the back office can then make use of much faster communication and more accurate data from the vehicles, and therefore provide faster and more personalised advice. Phase 2 will also start with a limited group of ‘friendly users’. After a couple of weeks of testing other interested persons can also join.

See www.spookfiles.nl.
**Brabant In-car III**

Brabant In-car III successfully completed early this year. The project continued the line of the projects Brabant In-car I and II, which focused on technical tests. In part III of the project, it was assessed, based on a pilot whether the use of in-car technology results in a functional improvement compared to existing roadside solutions. The case concerns the traffic flow problems on the A67. This motorway has 2 x 2 traffic lanes, short acceleration lanes and a large proportion of freight traffic. Traffic flow is poor and some four hundred accidents happen every year, forty percent of which include lorries. The focus of the pilot lies on providing lane advice combined with speed advice, whereby the advice is tailored to the target group (lorries and passenger cars). Three apps were used during the test: Smoover, ZOOF and Dynamic Lane Guidance. The vehicles provide floating vehicle data and use long-range communication. The results (including the effect on the road) have been evaluated by an external party.


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**Practical Trial Amsterdam**

The Practical Trial Amsterdam, or PTA for short, is a large-scale test of innovative roadside and in-car technologies. In 2014, the roadside systems were tested – see also section 3.1. In early 2015, the in-car tests also started. Two consortia, Amsterdam Onderweg and Amsterdam Mobiel, have each developed two smartphone apps: one for ‘regular traffic’ (daily driving) and one for ‘event traffic’. The participants receive information and advice on an optimal route and parking options via the app. The apps can be found under the names Superroute and Superticket (consortium Amsterdam Onderweg), and ADAM & EVA (consortium Amsterdam Mobiel). The consortia collect traffic data themselves and also use data from the road authorities in the region.

Large amounts of data on the use of the app and the traffic performance in the Amsterdam region are collected during the test. The test will be evaluated extensively, taking into account the user experiences.

See [www.amsterdamonderweg.nl](http://www.amsterdamonderweg.nl) and [www.amsterdammobiel.nl](http://www.amsterdammobiel.nl).

Cooperative ITS Corridor

In the Cooperative ITS Corridor project, cooperative services are realised on an international level. The goal is for parties from the field to gain experience with its implementation. The project starts with collecting probe data from vehicles and providing warnings in case of road works. The idea is to make road users more alert in order to reduce the number of accidents during road works.

The project organisation for the Cooperative ITS Corridor is in place, budgets have been allocated, and a list of requirements is currently being specified. Progress is rather slow: it once again shows that the trajectory from a Memorandum of Understanding to the establishment of a service on the road is not easy and a lot of work. It concerns an international cooperation, but every country has its own approach.

For more links and/or downloads, please go to www.traffic-quest.nl/en/traffic-2015.
The Netherlands wants to be a testing ground for automated vehicles. The RDW (responsible for, among others, the licensing of vehicles in the Netherlands) will grant an exemption to perform tests if the applicants have successfully completed the evaluation process. Five requests for testing with automated (self-driving) cars in the Netherlands have already been received – see page 49.

Tests abroad
Several other countries are also planning or carrying out tests. In Sweden, Volvo is preparing a test with 100 self-driving Volvos on the public road. First, tests are performed with cars that are equipped with the Auto Pilot-technology: they are capable of staying within a lane, adjusting their speed and merge into traffic by themselves. In time, the vehicles must be capable of driving an entire route by themselves.

In the United Kingdom, three consortia are organising tests in Greenwich, Bristol, Milton Keynes and Coventry. The Gateway project tests self-driving shuttles on closed roads. The Venturer project studies the legal and insurance aspects of automated driving and examines how the public reacts to automated vehicles. The UK Autodrive project focuses on vehicle-to-vehicle and vehicle-to-roadside communication and the infrastructure they require.

In Germany, the government prepares a part of the A9 motorway in Bavaria as Digitales Testfeld Autobahn to test advanced automotive technologies. A communication infrastructure will be installed in the roadside to enable vehicle-to-roadside and vehicle-to-vehicle communication, and with which data from vehicles can be collected.

The EU project AdaptIVe develops functions for automated driving in daily traffic, including the corresponding, sometimes complex environments. Various levels of automation are included, up to ‘highly automated’. Demonstrations are carried out with several passenger cars and a lorry.

The EU project AutoNet2030 develops and tests technologies for automated driving, based on a decentralised decision-making
strategy that uses the information shared by vehicles driving close together. This project takes a longer term approach, focusing on technology that could be introduced in the period 2020-2030.

Various projects focusing on automated vehicles are also being carried out in the US. Such as the project ‘Human Factors’ Evaluation of Level 2 and Level 3 Automated Driving Concepts’, which studies the human factors that play a role in automation levels 2 and 3 – see section 3.3. Several concepts and scenarios have been formulated that show what the first generation of vehicles of automation levels 2 and 3 will probably look like. It also formulates the questions that will need answering at a later stage of the project. The project ‘Partial Automation for Truck Platooning’ focuses on the development and testing of cooperative adaptive cruise control (C-ACC) for lorries, to be used in time on the I-710 corridor near Los Angeles, where a separate lane is planned for lorries that is also ideally suited for vehicles equipped with C-ACC. The project will conclude with demonstrations of this system in Los Angeles and Washington DC.

In Michigan, a special test environment is built, called M City, which includes a road network with all kinds of configurations, from 5-lane roads to roundabouts, pedestrian crossings and bus stops. This will be used to test ‘connected and automated vehicle systems’ and other systems.

And finally, in Japan, the SIP Adus project tests systems for automated driving. The project is part of the Strategic Innovation Promotion (SIP) programme of the Japanese government. Improving road safety is the main goal, and demonstrating automated vehicles during the Olympic Games in Tokyo in 2020 is an important milestone. They also strive to produce a dynamic map that can be used by automated vehicles.

5.3. Safety

Connected Vehicle Safety Pilot Program (US)

In 2014, we already reported on the Safety Pilot in the US, which tests the effectiveness and usefulness of the wireless vehicle communication in multimodal driving conditions on the roads of Ann Arbor. The following services are tested in the Safety Pilot: Forward Collision Warning, Emergency Electronic Brake Light, Intersection Movement Assist, Blind Spot Warning, Lane Change Warning, Left Turn Assist, Do Not Pass Warning. The Safety Pilot Model Deployment will be extended and expanded to include services based on vehicle infrastructure communication. Pedestrians and cyclists will be included, as well as (safety) services on smartphones. The pilot is currently in a transition phase from research to commercial use.

SCOOP@F

Within the SCOOP@F project, under the supervision of the French Ministry of Sustainable Development, tests with cooperative ITS are being prepared on five test sites – Île de France, Brittany, Paris-Strasbourg, Bordeaux and the Isère department. 3000 vehicles and 2000 km of road are equipped with additional communication options (Wi-Fi and GSM). Vehicles will share their position, speed, obstacles, etc. with the infrastructure and other equipped vehicles. The roads will share information about the traffic flow, road works, the current speed limit, accidents, wrong-way drivers, obstacles and P + R information. Drivers receive this information on a tablet in the vehicle. The SCOOP@F project will study which services road users appreciate the most. Another objective is to study how road authorities can reduce costs.

For more links and/or downloads, please go to www.traffic-quest.nl/en/traffic-2015.
Tests with ITS for vulnerable road users

Intelligent transport systems are also used to improve the safety of vulnerable road users. In the EU project VRUITS tests are performed in the Netherlands and Spain with systems for cyclists and pedestrians. The Helmond part of the project focuses on warning motorists of potentially dangerous situations with crossing cyclists, who are not yet visible to the motorist. The Intelligent Intersection in Helmond, for instance, is equipped with equipment to test all kinds of safety applications. The intersection detects cyclists and alerts nearby vehicles, after which the vehicles determine whether they have to brake or not (Cooperative Autonomous Emergency Braking).

In Alcalá de Henares in Spain, an intelligent pedestrian traffic light is implemented, the Intelligent Pedestrian Traffic Signal System. There are two use cases. The first one allows pedestrians to request a green light with an app on their smartphones. It is also possible for people with limited mobility to prolong the green time. The second case is aimed at preventing accidents caused by vehicles turning right who have a limited view on pedestrians walking straight ahead. A camera detects the presence of pedestrians and alerts the vehicle. The city of Valladolid, also in Spain, applies Intelligent Pedestrian Detection Traffic Signal and Light Demand. The system has three functions: (1) to detect the number of pedestrians waiting for the green light, (2) to extend the time of the green light if people are still crossing, and (3) to warn vehicles of the presence of pedestrians.

See www.vruits.eu.
Marketplace for data

In our Annual Report 2014, we reported on the platform Digital Road Authority, but in the meantime, the initiative has been given the name Marketplace for data. Work is proceeding on making data available and linking it, so service providers can easily find the data. Agreements and protocols for the use of the data are also being formulated.

See www.marktplaatsvoordata.nl.

NDW Data fusion pilot

In 2014, the National Data Warehouse for Traffic Information (NDW) and DITCM organised a pre-competitive pilot project to study whether the use of floating car data (FCD) and data fusion is a good approach to reduce the number of fixed measurement locations. Three teams participated in the pilot and they studied the quality of traffic data that can be obtained with the use of FCD, data from fixed measurement locations and data fusion for different scenarios for the test location – parts of the road network and the motorway network around Delft. The pilot showed that FCD and data fusion are well suited for the generation of data on speeds. The determination of traffic volumes, however, still requires fixed measurement locations, but fusion with FCD may (greatly) reduce the number of fixed sensors needed. Data fusion also makes it possible to accurately visualise patterns such as in case of shockwaves and incidents. This represents a clear added value, also in gaining insight into the quality and plausibility of the data. The parties involved have gained a lot of insights in a short time and are confident that FCD and data fusion can be deployed in
the short-term. NDW will include the ‘lessons learned’ from the Data Fusion pilot in determining the strategy for future data collection. The organisation expects that data fusion will play an important role in the future of data collection in order to improve the quality and applicability of data and to reduce the data collection costs. The first actual deployment of data fusion by NDW is expected in 2015.

The final report of the Data fusion pilot is available at [www.ndw.nu/documenten](http://www.ndw.nu/documenten). An English summary is available.

### PTA-West phase 2

The first phase of the Practical Trial Amsterdam concerned two separate tracks: the development and implementation of new algorithms for coordinating roadside systems and the use of mobile data to provide road users with better traffic information services. The aim of the second phase is to integrate both tracks, in order to come to an integrated solution with which experience can be gained. The integration will primarily consist of exchanging data collected by both systems. How the systems can benefit from this and how road users will adjust their behaviour is still being studied.

### Data Top 5

Government and the regions have undertaken to improve the data quality within five themes, the so-called Data Top 5. The themes involved are road works, location reference, speed limits, remaining time indication for incidents and traffic measures in traffic management scenarios. Meanwhile, more and more data from this Data Top 5 are indeed being made available and used by service providers. This is a good development, and shows that the transition ‘from ownership of data to maximum transparency and availability of data’ (Roadmap Better Informed on the Road, see Figure 21) is in full swing.

The transition to open and available data can be further enhanced by geographically expanding the availability and improving the data quality and reliability. A market consultation indicated that expansions are expected with traffic light data and parking data.

See [www.beterbenutten.nl/data-top-5](http://www.beterbenutten.nl/data-top-5).
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**Figure 21:** Transitions Roadmap Better Informed on the Road.
5.5. Programmes and partnerships

DITCM

DITCM focuses on the opportunities cooperative systems offer to improve the safety and efficiency of the traffic system. DITCM Facilities is a commercial organisation that provides services and facilities to test ‘smart mobility’ applications. Within DITCM Innovations, a public-private partnership, preparatory projects are executed, which serve a common interest and are often taken up jointly.

DITCM Innovations consists of four programme lines, namely: Human Factors, Cooperative Technologies, Effect Studies, and International Policy. Within these programme lines and across them, projects are launched that focus on topics such as security and privacy, the standardisation of logging and data, and the formulation of a common architecture.

As TrafficQuest, we primarily contribute to the programme line Effect Studies. Cooperative systems allow for faster and more refined interventions in disruptions in the traffic flow than the more traditional roadside measures. Cooperative systems often intervene at the micro level, therefore DITCM devotes relatively much attention to the effects at this level. At TrafficQuest, however, we are mainly interested in the effects of such systems on the traffic performance as a whole and the coherence with existing traffic management measures. Our input is mainly related to these aspects.

See www.ditcm.eu.

Connecting Mobility

Connecting Mobility of Rijkswaterstaat, the Dutch National Road Authority, is the implementation programme for the Roadmap Better Informed on the Road. In addition to the Better Traffic Management Programme, this is an important programme for traffic management and ITS. The Connecting Mobility team facilitates and oversees the necessary cooperation of governments and market participants, including through pre-competitive collaborations of the industry, knowledge institutes and government. Connecting Mobility also monitors developments in the field of ITS, provides overview and encourages innovation. Connecting Mobility and TrafficQuest work together on several levels, for instance, in the field of monitoring the effects of ITS on safety, accessibility and the quality of life.

A lot of information about ongoing and completed ITS projects, services and facilities in the Netherlands can be found on the website of Connecting Mobility: the ITS Overview Netherlands. It also indicates how these projects, services and facilities contribute to the six transitions mentioned – see Figure 21. Furthermore, the Connecting Mobility website provides information about a number of specific themes.

See www.connectingmobility.nl.
SWIPE
SWIPE is a programme within Rijkswaterstaat designed to accelerate the implementation of innovations in traffic management. This includes translating the developments in the field of ITS and cooperative, connected and automated vehicles into the operational practices of Rijkswaterstaat. This concerns, for instance, process-related issues, such as the preparation of measures and programmes. How does the vision translate into concrete developments and how can these be applied? If necessary, the vision will be reassessed if cases demonstrate that it does not work as expected.

CHARM
CHARM is a partnership between Rijkswaterstaat and Highways England, who work together on specifications for the renovation of traffic control centres. The Agency for Mobility and Public Works of Flanders has also joined the partnership. All functions and processes have been described, and the market is invited to make them into advanced traffic management systems (ATMS). ‘Off the shelf’ products are used to achieve this. In the Netherlands, the intention is to equip the five traffic control centres of Rijkswaterstaat with these systems. For the Netherlands Traffic Control Centre (VCNL) and Innovatiecentrale Helmond (The Innovation Lab), other functions will also be provided.

The CHARM project also works on innovative tools, which are being developed in Pre-Commercial Procurement projects. Projects are developed in three areas, referred to as ‘challenges’:

- **Challenge 1**: Advanced Distributed Network Management. A self-learning module for network-wide traffic management. It is intended for the module to find the right balance between different policy objectives.
- **Challenge 2**: Detection and Prediction of Incidents. A module that quickly detects incidents (accidents, breakdowns and traffic jams). The term ‘virtual patrolling’ is also used in this context.
- **Challenge 3**: Support of Cooperative ITS Functions. This concerns a module that supports the implementation of cooperative systems and services that involve the roadside.

Better Traffic Management Programme
The Better Traffic Management programme aims to improve the accessibility by road, water and rail in the busiest regions of the Netherlands. Government, regions and businesses work together to implement a package of over 300 measures and evaluate whether this leads to the desired reduction in traffic congestion. The second effect overview was completed late in 2014. The final evaluation is expected by the end of 2015. The initial results were positive, and it has been decided to continue the programme (‘Better Traffic Management Continuation’). The ministry and the regions will invest an additional 600 million euros in the period 2014 to 2017. The goal is to improve the door-to-door travel time in the rush hour in the busiest regions of
the Netherlands by 10%. A part of the Better Traffic Management projects will be continued within the follow-up programme. Intelligent transport systems (ITS) will play a major role in this follow-up, with C-ITS (Cooperative ITS) as a newcomer. This will represent an elaboration of projects such as Compass4D, Phantom traffic jams on the A58 and Brabant in-car III. In addition, several projects on influencing demand (incentives to avoid using specific roads during rush hour) and cycling projects will be initiated and set in motion.

The follow-up programme covers the following themes:

- Sustainability
- Infrastructural modifications
- ITS
- Bicycle
- Logistics
- Cooperation with the market
- Education
- Public transport (decentralised)
- Travelling outside rush hours
- Employer’s approach

See www.beterbenutten.nl.

Connekt

Connekt is an independent network of companies and authorities that links up parties to improve mobility in the Netherlands in a sustainable manner. Sharing knowledge, know-how and initiatives and connecting members is the main goal. The objective of Connekt is to develop markets for companies in a pre-competitive co-operation and to implement policy for authorities in an effective manner. Connekt continually focuses on current themes relating to mobility such as ITS, logistics and public transport. As a network organisation, Connekt organises numerous activities that facilitate the exchange of knowledge and co-operation between its members. Connekt initiated and participates in DAVI and it supports its members in applying the Lean and Green vision to sustainability, a successful European programme, diversified into Logistics, Personal Mobility and Solutions.

Connekt, at the request of the Ministry of Infrastructure and the Environment, also acted as author in of the National ITS-report, the ITS Plan the Netherlands 2013 – 2017. The platform is the place where new ideas are created, discussed with the members and implemented together. Connekt has more than 400 public and private members in mobility and logistics. The members are committed to smart, sustainable and social mobility. Connekt also has access to a large international network and international knowledge and has MoU’s with ITS countries worldwide. Connekt employs this access in various ways:

- To share international knowledge and developments in The Netherlands
- To influence international developments
- To promote the Dutch mobility sector abroad

Connekt provides continuous disclosure of (inter)national knowledge in the field of mobility and logistics, in order to anticipate both quickly and efficiently on current developments.

See www.connekt.nl.
CEDR
CEDR is the Conference of European Directors of Roads. This partnership was first supported by the EU, in two ERA-NET ROAD projects. Since 2010, the international partnership is supported by the CEDR Group on Research. Meanwhile, they are working on the seventh ‘transnationally funded research programme’, in which the national road authorities from Austria, Belgium (Flanders), Finland, Germany, Ireland, the Netherlands, Norway, Sweden and the UK participate (and have allocated budgets and expertise). The subjects this time are Asset Management and Maintenance and Mobility and ITS. The latter covers the sub-topics of Mobility as a Service, The journey to High and Full automation and The business case for connected and cooperative vehicles.

In early 2015, a number of new project proposals will be evaluated and after the summer, a series of new two-year projects will be initiated. The aim is to launch a CEDR call annually from now on. Interesting projects that emerged from the call of 2013 and that are ongoing (with Dutch partners in the consortium) are:

- PRIMA, Proactive incident management: aimed at the improvement of incident management;
- METHOD, Management of European Traffic using Human-Oriented Designs: aimed at identifying and including human factors aspects in traffic management, to ensure that the available knowledge is used and that measures become more effective.
- In the Netherlands TNO has started in 2015 with the projects ANACONDA and DRAGON. More information about these projects will be given next year.

See [www.cedr.fr](http://www.cedr.fr).

C-ITS Platform
Several cooperative systems are, at least from a technical perspective, ready to be widely implemented. However, there are still many issues to resolve with many stakeholders with regard to legislation, standardisation and organisation of the complex implementation processes. Cooperative systems will not simply be widely implemented – since this requires solid and convincing business cases. The European Commission wants to play a constructive role in the introduction of cooperative systems, and therefore they have established the C-ITS Deployment Platform. This platform includes national governments, relevant C-ITS stakeholders (such as industry and knowledge partners) and various Directorates General of the European Commission. The platform should formulate a vision, roadmaps and policy recommendations and devise solutions to commonly encountered barriers to implementation. To this end, the applications that can already be introduced are studied first. These are the so-called day one applications.

In the Netherlands, an expert group was created to discuss and coordinate the Dutch contribution to this platform. This is a broader group than the Dutch delegates to the C-ITS platform.

In this annual report *Traffic in the Netherlands 2015*, we have devoted a great deal of attention to the changes that await us in the coming years, including the transition from road side to in-car. But what is the opinion of traffic professionals in the field? What do they think of the future of traffic management and, in particular, the role of the traffic management centre therein? We spoke with Marion Braams of Rijkswaterstaat and Laurens Schrijnen of the Innovation Lab.
Laurens Schrijnen works for the Ministry of Infrastructure and the Environment as the Director of the Innovation Lab in Helmond. Marion Braams works for Rijkswaterstaat as a programme manager of CHARM, the alliance of Rijkswaterstaat with Highways England, and the Agency for Mobility and Public Works of Flanders. The purpose of CHARM is the modernisation of the traffic management centres. So both are professionally involved in the future of traffic management in general, and the traffic management centre in particular.

**Can you tell us briefly about your work?**

**Marion:** “From Rijkswaterstaat, I am involved in the procurement of IT systems for traffic management. Within the CHARM project, we are looking for a new generation of traffic management systems for our traffic management centres. We strive for a higher degree of automation to support the operators in these centres even better. Currently, many separate systems are used which we would like to integrate as much as possible. We also want to gain more insight into the actual situation on the road, a common operational picture. Furthermore, we want solutions to new (sometimes unknown) problems such as in-car. We are going through this process with multiple market participants and various procurement strategies such as a pre-commercial procurement approach.”

**Laurens:** “My job is to shape and operationalise the Innovation Lab together with my colleagues [of Rijkswaterstaat, the Province of Noord-Brabant, DITCM and Connecting Mobility]. With this innovation centre, we offer industry and governments the unique opportunity to host innovative projects and to test and further develop cooperative and other traffic management solutions. Best of all, they can experiment with ‘live’ traffic on public roads of municipalities, provinces and the national government. To this end, two desks were set up in the traffic management centre of Rijkswaterstaat Zuid-Nederland in Helmond. This enables a direct link with the data the road authorities have available. The innovative solutions Marion is having developed within CHARM fit well with this. In fact, they are desperately needed.”

**What is the relevance nowadays of a traffic management centre in light of all the in-car developments?**

**Marion:** “Technically speaking, there are already many in-car gadgets, so the traffic management centre may no longer need to carry out certain functions. However, a traffic management centre also has tasks that can hardly or not be taken over by smart vehicles. These tasks include incident management, the operation of bridges and tunnels and the opening and closing of rush-hour lanes. Moreover, the penetration of in-car technology will still be low in the near future. I recognise that the Innovation Lab is applying a combination of proven and new technologies.”
Laurens: “It is, of course, possible for a government to reduce the number of tasks. Why continue to pay for traffic management systems along and above the road, such as variable message signs? Many vehicles also receive the information that appears on the signs via navigation systems or smartphones. New in-car technology could also be made mandatory in new cars, as is the case in the US. At the Innovation Lab, we are not aiming for the immediate removal of these systems, but we would like everyone to sit together and discuss the future of these systems.”

Marion: “In the coming years, there will be a mix of vehicles with and without smart technology on board. One option is to make special lanes available only to equipped vehicles.”

Laurens: “Personally, I now see three future scenarios. The first one is a totalitarian system in which only certain vehicles are allowed on the road. Not very realistic in the short term. The second scenario is that the market offers an increasing number of services to road users as ‘luxury items’. Parking apps, keep-your-lane, driving in traffic jams, etc. And the third scenario is lorry platooning with huge savings on fuel and possibly also on staff (driving times and rest periods). The job of the traffic management centre will be to supervise all these platoons of lorries. After all, a lot can go wrong in case of an incident, given the mass of these vehicles.
I also see a crisis management role for the traffic management centres. You never know upfront when an emergency takes place, so permanent staffing of the traffic management centres will remain necessary. Besides these scenarios, a mixture of self-driving and non-self-driving vehicles is a lot more exciting; the road user will become the traffic manager.”

Marion: “In the final situation in which vehicles are fully cooperative and autonomous, traffic management centres will still be needed in one form or another, but for now they will need to remain at the current level. The transition process obviously takes time. Even though it is technically possible, from an organisational point of view, things won’t move as fast. Furthermore, users will not purchase new technology all at the same time. Let’s take a look at cruise control: it has already been around for twenty years, but it is only now that it is being offered as standard. The question is also whether you would still want a private car in fifteen years. Among the young generation, car ownership is decreasing. Car sharing and Uber, on the other hand, are becoming increasingly popular.”

As long as we still have the traffic management centres, should they be privately owned or remain in government hands?

Laurens: “If I look at the current tasks of a traffic management centre, such as operational traffic management, object management and work in progress, I ask myself: why should this be done by Rijkswaterstaat employees? This could just as easily be done by market parties. This can also be observed in other sectors and abroad.”
Marion: “The choice whether the government performs certain tasks itself is a political one. If a task is outsourced, the form of financing and conditions for specials, such as a Nuclear Security Summit, should be considered carefully. If, for example, we would outsource the measures taken during the NSS in March 2014 to the market, it would become much too expensive.”

What is your opinion on the relationship between government and market so far?

Laurens: “I think it is great that Rijkswaterstaat provides market participants with the opportunity to experiment with the traffic management centre. It shows trust to grant these parties access to the systems, and even have them operate the actuators. With the Innovation Lab, we show the market participants that Rijkswaterstaat really wants to join forces with the market – that they want to innovate and lead the way.”

Marion: “The Netherlands is often seen as (an independent) leader in transportation, since we do not have our own automotive industry. We are also often praised because we and England have very safe road networks. This position allows the Netherlands to subtly give direction to the market. What we have seen with CHARM, for example, is that the way of tendering can change the market. With the use of a particular type of specifications, you can give direction to what the market should develop.”

How developments will proceed exactly is uncertain. In conclusion, Marion and Laurens assert that there are smart ways to prepare ourselves for the uncertain future. CHARM and the Innovation Lab can play an important role therein, especially together.
About TrafficQuest.

TrafficQuest, the centre for expertise on traffic management, is a cooperation between Rijkswaterstaat, TNO and Delft University of Technology. A lot is going on in the field of traffic management; the three organisations work together in TrafficQuest to ensure that the existing knowledge does not get lost and is made accessible to practitioners. This is done by collection, developing and disseminating knowledge. The partners in TrafficQuest together cover knowledge on traffic management from science, applied science and operations. The activities consist of answering questions, giving advice in projects, conducting research and recording and disseminating knowledge.

www.traffic-quest.nl
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