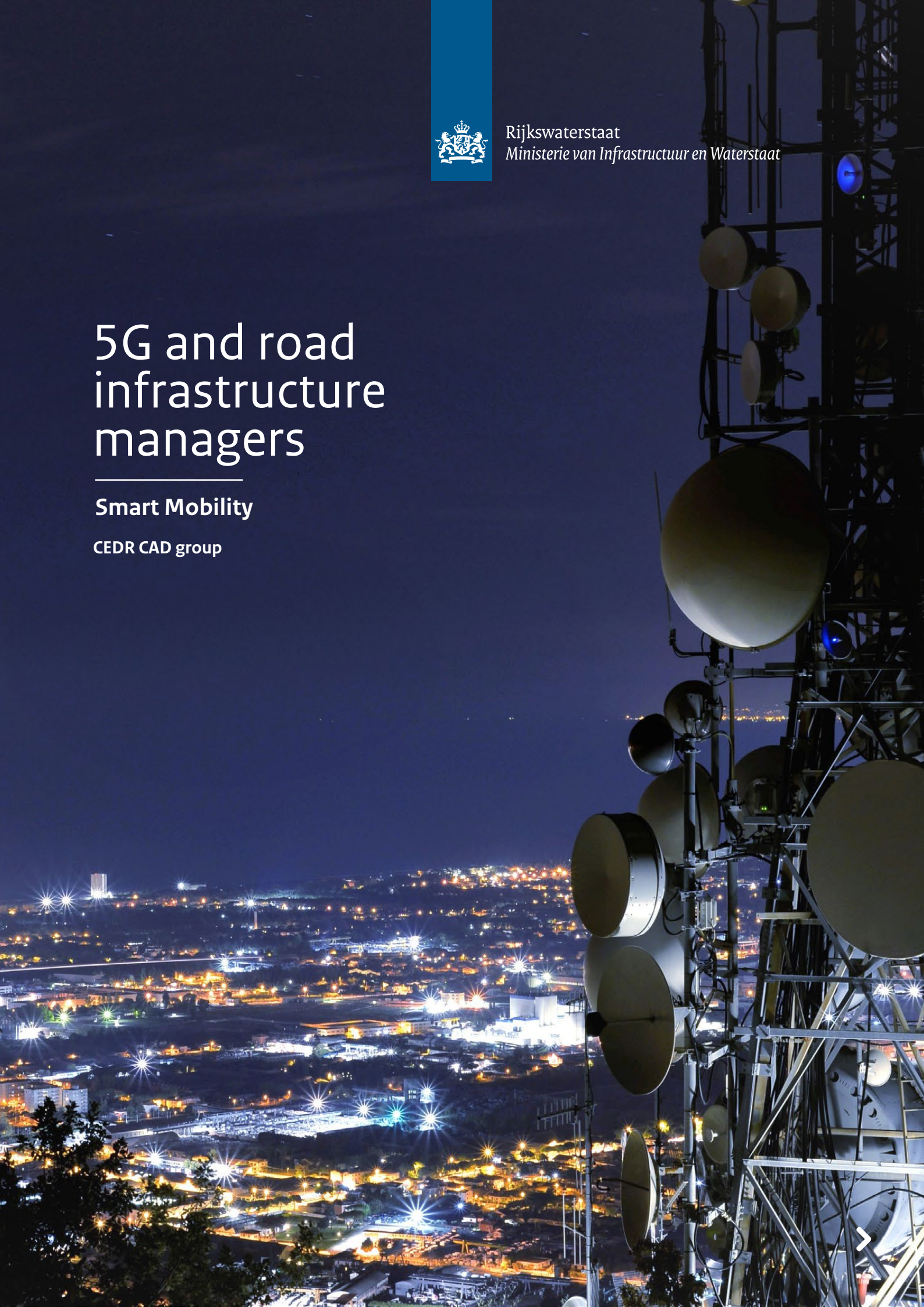


Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

5G and road infrastructure managers

Smart Mobility

CEDR CAD group

Introduction

Europe is on the eve of introduction of a new mobile network: 5G. This is the successor to the existing 4G network, and its predecessors, 3G and 2G. A new generation of mobile network is rolled out around every 10 years. Each new generation offers new possibilities. 2G allowed us to use mobile telephony, 3G added internet capability; with 4G we gained rapid internet services and with 5G it will be possible to link almost any mobile device (not just smartphones) to the internet with high data speeds and short response time. When 5G is introduced, the average user will at first notice little of these new possibilities. They will not become apparent for a few years. And yet, 5G is already strategically important to road infrastructure managers. With this white paper we are putting 5G on the agenda as a subject on which road authorities need to take a wide-ranging view and make decisions. First and foremost we intend to give an insight into what 5G is, and what the impact and opportunities for road authorities are. In addition, we are formulating the strategic questions to which they need to find answers. At this stage, this is just a white paper and in no way a position paper or strategy.

Introduction to 5G: What is it?

5G (fifth generation) expands on the possibilities offered by 4G by means of a number of improvements in software and hardware. So it is better to see 5G as a necessary evolution of the existing network. The roll-out will be implemented in a series of steps over the next few years. The European has on 30 June 2020 adopted regulation to facilitate the initial roll-out of 5G. Full functionality will take at least another 5 years. Much of the existing infrastructure will be used in a gradual migration to 5G. Essentially, 5G will offer higher data-transfer speeds and lower latency. The speed that 5G can achieve (potentially) is 1.25 Gb per second, or hundreds of times quicker than 4G (max. 150 Mb, or 4G+, with 225 Mb). And many more devices can be connected at the same time (internet of things). It is necessary for mobile network operators (MNOs) to implement 5G, not least in order to be able to cope with the large numbers of connections in the future. The roll-out of 5G in Europe is trailing behind countries like China and South-Korea. In general it can be stated that most developed countries will see initial launches of (partial) 5G networks in 2020.

Network coverage

In the first instance, coverage will be based on the existing network. In other words 5G will not, in and of itself, lead to better coverage in tunnels or other black spots (areas with no or unreliable reception). Coverage (as at present) of 98% does not necessarily mean all that much: there could still be lots of small black spots or areas in which network capacity does not support advanced functions. And there will still be differences in coverage between MNOs. The existing 4G antennas have, to a greater or lesser extent been adapted for 5G use. That means that the existing telecoms companies can quickly roll out a 5G network if they are given permission to do so. However, transmission of a 5G signal is not everything. The appearance of a 5G icon on your telephone is just a small (but highly visible) step. Most of the work (and expense) is in the back office and the digital infrastructure.

Density of transmitters

4G network transmitters are often located many kilometers apart. Where land is open, this is not such a problem, but in an urban, forested or mountain environment a much higher transmitter density is necessary.
A feature of 5G is that it can support different frequency bands (see picture below):

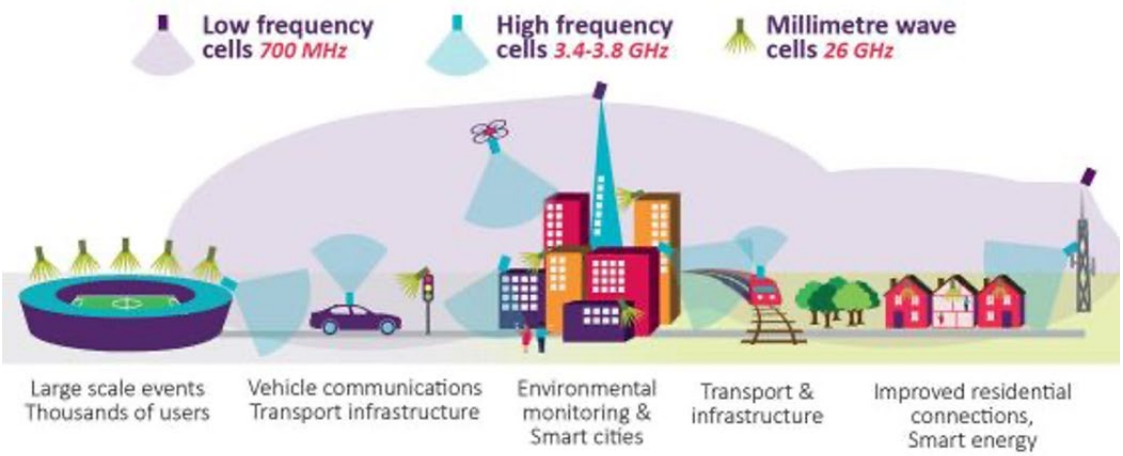
Higher frequencies require a high density of transmitters, as they have a limited reach of several hundred meters. This is because they transmit at higher frequencies that are needed to carry greater volumes of data. Those frequencies have a smaller range and cannot penetrate buildings as easily. It is estimated that the 5G network needs three to five times as many transmitters. In order to guarantee a 5G connection in future for traffic on motorways, MNOs will also need to install extra roadside transmitters on the inter-urban road network, where coverage is not otherwise available. This will make a valuable contribution to the future digital infrastructure. All these transmitters will need to be connected to a fiber-optic network and electricity and need a mounting point. For that reason the MNOs are also looking at road authorities, whom mostly already have a fiber-optic network (along parts of their roads). This raises the question of whether, and how, it is possible to share those fiber networks and other facilities safely and under what conditions. For each country, this will create a set of unique regulatory challenges and policy dilemmas.

Availability of radio frequencies

Although 5G is a transmission technology that can also use the existing frequency bands for 2G, 3G and 4G, the European Union has designated three preferred frequencies for 5G: 700 megahertz, 3.5 gigahertz and 26 gigahertz. In addition, the current 4G frequency bands can also be used for 5G hardware. Some frequencies for 5G are still in use for other applications. The 26 gigahertz band will be used for microwave radio relay links. The agreed three frequency bands all have their own function within 5G. By combining the frequencies with each other, 5G can offer new applications.

Data processing

Much of the work for making the best use of 5G must be done in the back office of the telecoms companies. For instance, more computing centers are needed. That makes quicker data processing possible, and allows



more users. The computing centers needed for that are closer to the infrastructure. This is Multi-access Edge Computing (MEC), close to the users. Which means computing centers in stadiums, to stream video footage, computing centers in residential areas for Netflix, computing centers in ports for industrial applications and logistics, computing centers in agricultural areas for 'smart farming' and computing centers at the roadside for smart mobility.

Splitting up the network

In contrast to the current generation of mobile networks, the network managers can differentiate their 5G range according to speed, capacity and latency, depending on both the user and the application. What is unique to 5G is 'network slicing'. The mobile network can be split up into 'slices', which do not obstruct each other and have a range of properties. These slices can also be spread over a range of providers. So, one slice might be devoted to streaming video footage (high bandwidth), another slice for industry (with high reliability), a slice for medical applications (with low latency), a slice for crisis management (as a back-up for the emergency services telephone number, 112) and a slice for mobility (with low latency and high coverage). It will still be a few years before this functionality becomes available. 5G roll-out is also possible without slicing: more than anything else, it requires MNO's to invest in their back offices and systems, rather than in transmitters.

More stringent SLAs

With Multi-access Edge Computing and Slicing it is possible to provide a differentiated network with various business models, including more stringent SLAs for availability and performance. The SLAs that are currently on offer are based on a 'best efforts' obligation. These services will be very useful to public authorities including NRA's, but will of course come at a cost.

Opportunities and threats for road authorities

Use of 5G for road traffic

5G may offer a solution for connecting all vehicles with each other and with the infrastructure (C-ITS), so that eventually a connected and collaborative traffic system will emerge. The use of 5G for self-driving cars is being promoted by the MNOs as an important application. Connected, cooperative and autonomous driving has the potential to have a wide impact on road safety and may be a better way of optimizing road capacity. 4G is sufficient for many applications; however, it is expected that 5G will be able to deliver greater accuracy, for instance in displaying the position of vehicles, especially when combined with satellite positioning systems like Galileo. The market has already made substantial investments in a subscription-free alternative (wifi-p) specifically for this application. Many of the envisaged 5G services can also be achieved with this technology. In the lobby it is argued that the technologies are competing against each other; from the point of view of road authorities, we still see them as complementary and the best policy is not to make technological choices and to adopt a 'technology-neutral' standpoint.

Monitoring networks and sensoring assets

The combination of reliable, high-speed network coverage and room for many connections represents an opportunity for road authorities to develop its own working method, not least in combination with cost-effective sensors. Real-time asset management and very accurate monitoring of, for instance, wear and tear is possible at a reasonable cost outlay.

Communication in the field

The emergency services also need to have data connections. At this point in time, these connections can only be delivered by the mobile network operators. This means that the data connections have to 'compete' with the other users. 5G also offers road authorities opportunities for more reliable and better quality communication (for instance for incident management, winter service or road works).

Threats

5G remains a wireless technology. A signal jammer costing as little as €100 can reduce its availability to zero. So this requires an integrated approach in the field of availability, integrity and security. At European level, too, questions still need to be answered about the security of 5G networks. Here and there in society, there are concerns about the possible health consequences of the higher radio-frequency radiation caused by 5G. There is not yet complete clarity on this point. With the corona crisis linked to 5G by conspiracy theorists, protest against 5G has culminated into vandalism against transmitter stations.

Questions for road authorities

Although 5G is getting plenty attention in the media, a lot is still unclear. Road authorities will need to explore in greater depth how to use 5G in practice, and what impact this has on relationships with the market. Questions that we can already identify include:

- How does 5G perform in practice?
- What sort of functionality is available, and what conditions are necessary for this?
- How is the architecture configured, and what chains of information does this create?
- When will the network be available, and what preparations will be made at government level?
- What will the business model for 5G be? In Asia (China, South Korea, Japan) the infrastructure is generally paid for by the authorities.
- Who is going to pay for extra coverage (in tunnels, black spots etc.)? Or should we try to work that into the licensing conditions for the auction?
- Who is going to pay for Multi-access Edge Computing for mobility applications? Will that be the mobile network operators, the service providers, the automotive industry or the authorities?
- Who is going to pay for the mobility slice? Will that be the mobile network operators, the service providers, the automotive industry or the authorities?
- Is there a threat to our networks if third parties gain access to fibre-optic networks (security aspect)?

Strategic key issue for road authorities

MNOs will ask road authorities for assistance in respect of rolling out the 5G network. In essence, the MNOs need three things in order to roll out 5G. These are: mounting sites/securing points, access to a fixed network connection (fibre-optic) and an electricity supply. The most important issue that is currently facing road authorities is joint use of the fibre-optic network.
The networks that is owned and operated by road authorities for their own use often have available capacity, which the MNOs are very interested in. After all, the large numbers of transmitters must all be connected to the fibre-optic network. That can be done relatively easily in urban environments, but in rural areas and, in particular, alongside motorways, there is no other fibre-optic network than the road authority network. It would be very costly for MNOs to roll out their own fibre-optic networks. So pressure is already building on road authorities from outside to make their networks available.

That means that road authorities will have to make a strategic decision that demands a wider policy consideration and framework than merely the policy area of transport. Furthermore, rail network operators, who also have their own fibre-optic networks, can expect to receive the same question. In essence, there are now five different scenarios that need further development:

- Not offering access to the fibre-optic network for reasons of cyber security. It is debatable whether this is a sustainable or desirable course, due to the potential societal benefit and lobbying pressure.
- Offering access on the basis of physical 'dark fibres' that are rented out. Initial analysis reveals that would involve a property transaction, taking it into a different legal framework.
- Offering access on the basis of available capacity in the 'software defined network'. Road authorities often do not yet have a software defined network but this is where most are eventually heading, and it works reciprocally: third-party networks can also safely be integrated in the road authorities network.
- Offering access on the basis of capacity on the network in the form of a service. Under those circumstances, road authorities would become a service provider for MNOs. This raises the question of whether that is lawfully possible, and what conditions would be attached. Cyber security threats would also have to be investigated in greater detail.
- Road authorities will roll out the 5G network on behalf of the joint MNOs along the motorways, by integrating transmitting stations in the future road side stations.

It is important, in each scenario, to be aware of the requirements of the MNOs and, at policy level, to get a clear view of the policy and legal frameworks with at least the Ministries of Infrastructure, Foreign Affairs, and Economic Affairs. Making fibre-optic networks available to third parties is about more than technology alone. Think of change management and the impact on road authorities own operations. Capacity management and the financial impact thereof are also important. The road authority organisation must then be able to act as service provider. At a practical level, road authorities will ultimately have to translate that to a framework for action in the form of requirements relating to:

- Access to technical areas
- Cyber security
- Joint use of road authorities structures as mounting sites
- Joint use of electricity
- Service levels and legal framework
- Performance in terms of road authorities use in monitoring networks and operation of traffic management

What next?

The efficiency of 5G demands not only the use of technology, but also a change in the principles of architecture and design. So development will have to move from use to technology, otherwise we will be approaching the problem from the wrong end. In that sense it is also important not to have excessively high expectations of the additional benefits provided by 5G in advance of its roll-out. The benefits are not in the technology, but in its successful use.