Efficiency today, flexibility for the future
Building the foundation for a high-performance intelligent transportation system
Because modern roadways demand a modern communications network

The road operators responsible for managing critical highway, tunnel and bridge infrastructure face intense pressures while working to fulfill their mission to the public. They need to keep traffic:

- **Safe** – by protecting travelers and road workers to reduce accidents and fatalities
- **On time** – by improving traffic flow, reducing travel time and congestion, and making highway operations more efficient
- **Connected** – by providing travelers with real-time information on traffic, roadworks and weather conditions

Road operators rely on intelligent transportation systems (ITS) to achieve those goals. But as those systems become increasingly smart and data-intensive, they’re outstripping the capabilities of the communication networks they run on. The emergence of automated vehicles and vehicle-to-everything (V2X) connectivity will magnify that challenge even further. What’s needed is a network that’s up to the task of supporting a modern, more advanced ITS: one that can improve **efficiency today** while providing **flexibility for the future**.

Nokia is making it possible to achieve both through a full suite of intelligent, purpose-built, multi-service, converged broadband networking solutions.

### Solutions backed by decades of experience in the field

Our solutions are built on more than 25 years’ experience working with road operators around the world, giving us real-world insights into the challenges they face in maintaining traffic flow and road safety.

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<th>Challenges</th>
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<td>+66% vehicles on the road by 2035&lt;sup&gt;1&lt;/sup&gt;</td>
<td>+66%</td>
<td>Est. hours of traffic delays caused by congestion only in the US in 2014&lt;sup&gt;2&lt;/sup&gt;</td>
<td>6.9 billion</td>
<td></td>
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<tr>
<td>62% of new vehicles built in 2020 connect to the internet&lt;sup&gt;3&lt;/sup&gt;</td>
<td>62%</td>
<td>Est. number of connected vehicles on the roads in 2020&lt;sup&gt;4&lt;/sup&gt;</td>
<td>250 million</td>
<td></td>
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1. Navigant Research  
2. Texas A&M Transportation Institute  
3. GSMA  
4. Gartner
Traffic management, electronic toll collection and other ITS applications require a constant flow of information — not just data but real-time video and voice, too — to improve traffic flow, increase safety and enhance the traveler experience. Supporting all of that consistently requires a service-centric and highly reliable communications infrastructure.

As road operators continue to adopt more (and more demanding) ITS applications, the underlying communications infrastructure has become fragmented and inefficient: a patchwork of networks and legacy interfaces operating in parallel and with limited interconnectivity, hampering integration and innovation. Many of those networks were built on older SDH, SONET or TDM technologies that are nearing end of life or, in some cases, end of support — and will soon need to be replaced.

Now is the time for you to modernize your communications infrastructure — to gain efficiency today and flexibility for the future. The starting point is adopting a single, converged, broadband network that can support a mix of mission-critical and less-critical applications with full interoperability for legacy technologies as well as newer, more advanced IP services capabilities.

**Figure 1.** ITS applications of all kinds depend on communications infrastructure
What’s in an optimized communications network for highways, tunnels and bridges

Nokia has the broadest portfolio of network-based communications technologies and solutions for road operators, allowing you to build the foundation for an ITS that can meet your needs both today and tomorrow.

Our converged, multi-service architecture lets you adopt a wide range of technologies in your communications network, from IP/MPLS, passive optical LAN and microwave to LTE, Wi-Fi, V2X and edge computing.

Figure 2. Conceptual network architecture of Nokia solutions for highways and tunnels
### Key elements of the Nokia network architecture for highways and tunnels

#### Wired access
- Hardened, compact passive optical LAN platforms and IP/MPLS access routers switches bring quality of service to roadside equipment while providing legacy interfaces for existing equipment and SCADA systems.
- Point-to-multipoint microwave platforms provide connectivity to roadside equipment where fiber is not available or too expensive to trench.

#### Wireless access
- V2X communications intelligently integrate connected vehicles with roadside technology.
- LTE-4G technology improves mobile network coverage on highways for travelers and V2X communications.
- Wi-Fi provides broadband connectivity that improves the traveler experience and supports roadside operations.

#### Cybersecurity
- Standalone network security that includes endpoint security, identity access management and audit compliance management.
- Product-attached network security that includes encryption, firewalls and centralized key management.
- Security consulting services and managed services for security operations centers.

#### IP backbone
- IP/MPLS routers switches form a single converged backbone that includes Layer 2 Ethernet and Layer 3 IP virtual private network services for different ITS applications and traffic types, each with configurable levels of quality of service (while still maintaining robust security).
- Optical transport provides high-bandwidth WDM packet transport between control centers, data centers and other major locations.
- Short- and long-haul microwave packet radio provides backbone connectivity where fiber is not available or too expensive to trench.

#### Roadside cloud
- Edge computing platform processes data at roadside for the most demanding ITS applications, providing a flexible platform for deploying new roadside services and supporting V2X communications.

#### Network management
- A network services platform offers unified management tools for easy configuration and control of the end-to-end communications infrastructure.
- A range of unified network and services capabilities, including network planning and optimization, service implementation assurance, and transmission infrastructure integration.
With a single converged communications backbone network, you can interconnect your ITS applications more easily, collaborate seamlessly with partners and other stakeholders, and significantly improve your operating efficiency. This agile, integrated approach to networking lets you add new ITS applications faster and more cost-effectively by bringing connectivity wherever it’s needed.

**Lower costs and simpler operations**

Day-to-day operations are easier with unified, end-to-end management across IP/MPLS, optical and microwave domains. By replacing your patchwork of networks with a streamlined communications infrastructure, you can greatly reduce operating, maintenance and training expenses. Remote monitoring and configuration of roadside equipment eliminate the need to send technicians onsite to assess situations and help minimize downtime for network repairs.

**Better network and ITS application resiliency**

A highly available and highly integrated communications infrastructure allows traffic management systems to collect and analyze data from loop sensors, laser scanners and other roadside equipment in real time. That means you can respond faster to congestion, emergency situations and extreme weather conditions.

While extreme weather could cause link failure at multiple spots in the network simultaneously, Nokia offers robust, multi-fault resiliency through high path diversity (ring, multi-ring and mesh topology) to keep the ITS up and running.

**Flexible deployment and migration paths**

Because Nokia’s solutions integrate seamlessly with fiber, copper, microwave and cellular wireless transport interfaces, you can deploy and optimize your network over the medium that works best for you.

Our solutions also allow for safe, smooth migration from TDM-based technologies to MPLS. We support both IP-based and legacy roadside equipment — everything from decades-old weather stations to next-generation surveillance cameras.
Flexibility for tomorrow

New mobile and transportation technologies are changing the way people travel, with the first significant wave of self-driving vehicles expected to hit the road by 2020. These connected vehicles will generate and receive massive amounts of data. Your communications infrastructure must be flexible enough to support emerging technologies that will enable a wide range of connected capabilities in the future — even if the exact requirements for those capabilities are not yet clear.

**Integrating roadside technology and in-vehicle systems**

V2X communications are poised to have a huge impact on road operators and travelers. For example, traffic flow and road safety will be improved through collision warning and overtaking assistant systems that correlate data from multiple sources to detect and analyze dangerous traffic situations, even at high speeds.

Connecting vehicles to each other and to the environment can enable the creation of new value-added services such as automated parking and tolling systems, and traffic advisories delivered through mobile apps or in-vehicle displays. And once vehicles are capable of driving themselves, in-vehicle infotainment services will become essential.

The right technology choices will make it easy to add these capabilities and satisfy the bandwidth demands of tomorrow’s travelers. Thanks to research from Nokia Bell Labs and partnerships with the automotive industry, Nokia’s solutions for highways and tunnels are V2X-ready now.

**Transforming roadside services with edge computing**

The Nokia roadside cloud is an edge computing platform that brings scalable processing power and storage to the roadside. It adds distributed processing and storage along highways and in tunnels while integrating with wired and wirelessly connected roadside equipment. This lets you support highly demanding roadside services such as real-time traffic analytics — and easily onboard innovative new roadside applications at any time.

By adding edge computing to your roadside networks, you will be better prepared for the rise of connected and autonomous vehicles, which will require reliable, low-latency integration with roadside systems.

Nokia was first to demonstrate how edge computing, using a live LTE network, can be used to support safety-critical V2X communications.
Be future ready — and generate new revenue streams in the process

With budgets constantly under constraint, road operators can leverage the capabilities of Nokia’s single converged network for ITS to dramatically improve the economics of their highway infrastructure.

With the right network in place, you can:

• Deploy new, advanced roadside services quickly and securely
• Grow tollway revenue
• Monetize the network by providing carrier connectivity services to third parties, such as rural Internet providers
• Lay the telecoms groundwork for commercial development along highways
• Become an integral part of smart energy infrastructure by providing communications to electric vehicle charging stations and wind/solar farms along highways
• Support future smart city infrastructure and local transit communications by sharing the highway communications network with the city
Why choose Nokia as your partner?

As a trusted advisor to road operators around the world, Nokia has the experience and technologies you need to be efficient today and flexible for the future.

We have expertise in all aspects of wired and wireless communications technologies, offering the broadest portfolio of solutions for highways and tunnels. The cutting-edge research and innovations of Nokia Bell Labs have made us an industry thought leader in edge computing and cellular-V2X. And we have a proven track record of deploying communications networks for ITS across the globe, meeting today’s most stringent ITS requirements as well as those of next-generation V2X applications.

How our approach is different – Unlike other technology vendors serving the traffic and highway industry, Nokia can provide:

• One converged network for all ITS applications
• End-to-end quality of service to support mission-critical ITS
• Secure and smooth migration path from legacy technologies
• Compact and hardened platforms designed for harsh roadside deployments
• Unified, end-to-end network management platform
• Advanced cybersecurity features
• Integration of edge computing into critical communications networks

We also provide services to help you plan, optimize, deploy, operate, maintain and upgrade a converged communications network for ITS.

“We chose Nokia because of their technology, their approach and their commitment to deliver this contract.”

RON DAVISON, MANAGING DIRECTOR OF GENESYS, HIGHWAYS ENGLAND, UNITED KINGDOM
What’s next?

If you’re looking to build or upgrade the communications network that powers your ITS, Nokia is a partner you can count on. **Click here** to discover more about our networking solutions for highways and tunnels.

References

**White paper:** “Converged communications for intelligent highways”

**Application note:** “The road to high-performance intelligent transportation systems”

**Case study:** “Highways England”
About Nokia

We create the technology to connect the world. Powered by the research and innovation of Nokia Bell Labs, we serve communications service providers, governments, large enterprises and consumers, with the industry’s most complete, end-to-end portfolio of products, services and licensing.

From the enabling infrastructure for 5G and the Internet of Things, to emerging applications in digital health, we are shaping the future of technology to transform the human experience. networks.nokia.com

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