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Transportation Network Modernization

Building Next-Generation Networks to Fuel Intelligent Transportation of the Future

A Department of Transportation (DOT) holds the critical responsibility of managing and maintaining roads and highways within its respective state. At the same time, DOTs face growing pressure to improve the motorist experience and make roads safer, more efficient, and less congested — even as traffic volumes grow and budgets shrink.

To address these challenges, many DOTs have deployed intelligent transportation system (ITS) technologies, including high-resolution pan-tilt-zoom video cameras, digital sensors, Vehicle to Everywhere (V2X) communication, artificial intelligence (AI), drones, and automated toll booths. Such technologies have the potential to help DOTs improve traffic flow, speed accident response, and enhance overall road safety. However, the growing abundance of these technologies creates another challenge: The avalanche of data ITS devices generate can quickly overwhelm legacy communication networks, increasing congestion and the potential for outages.

To overcome these growing challenges and fully capture the benefits of ITS technologies, DOTs need a modern network foundation that provides the capacity, resiliency, performance levels, coverage, and scalability to support — and make the most of — growing amounts of data.

The Adaptive Network™ vision

The technology devices DOTs implement can be spread across thousands of miles, and the data they collect must make its way to an operations center where decisions are made about what to do with it. In some cases, like a traffic accident, data needs to be acted on quickly. But legacy networks can easily become over-subscribed, leading to congestion or outages that negatively impact the ability to receive data in real time. For a DOT, that can mean the difference between helping a motorist in trouble and finding out too late that urgent help was needed.

Legacy networks can also be complex to manage. Whenever ITS devices need to be added or replaced, each one requires a new IP configuration. The supporting network elements then need to be deployed and configured. Whenever the network elements need to be repaired or replaced, it can take days to accomplish, interrupting operations and generating additional expense.

To meet today's demands, DOT networks must be fast and reliable. But given current budget constraints, building new networks from scratch or conducting major 'rip and replace' projects is out of reach for many transportation agencies.

Another approach is to optimize existing infrastructure and make a gradual shift to a more modern network. This strategy, built on Ciena solutions to create the Adaptive Network vision, allows DOTs to steadily move to a more predictive, automated, and agile network.

The Adaptive Network vision is built on three key pillars:

1. Programmable infrastructure refers to physical and virtual network devices that can be accessed and configured via common open interfaces, are highly instrumented (with the ability to export real-time network performance data), and can adjust as needed to meet the demands of the applications running on top of them. For DOTs, getting data in

near-real time can mean the difference between life and death. Programmable infrastructure helps prevent network outages and congestion and results in improved network reliability and resiliency.

2. Analytics and intelligence help predict potential network problems and anticipate trends. This also allows DOT staff to conduct 'what-if' modeling to see instantly the potential downstream implications of changes to the network. In the same vein, combining network traffic data with analytics software can provide traffic managers a clearer view of what is happening throughout a highway system. They can then quickly resolve problems, dispatch emergency crews, alert motorists to pending hazards, and recommend alternative routes to their destinations.

3. Software control and automation simplify the act of managing and automating networks end to end across multi-vendor, multi-domain hybrid networks. This reduces complexity and provides DOTs greater control. A DOT no longer needs a separate staff to manage various vendors' network devices; it is all done through a single 'pane of glass.'

A modern network that can readily adapt to change also allows a DOT to define priorities for various ITS devices, so the most critical data comes across the network fastest, enabling authorities to react to emergency situations quickly. It can also rapidly scale, self-configure, and self-optimize by constantly assessing network pressures and demands so, as the numbers of devices deployed and the data generated by those devices increase, the network automatically adjusts.

One DOT in the United States uses the hardware and software that forms the Adaptive Network to meet growing network capacity needs and improve reliability. The department deployed various ITS technologies over the last few years, including video camera streams that send alerts to its command center when it appears a vehicle has gone off the road; video cameras and road sensors along a mountainous stretch of highway that detect congestion and problems caused by weather, accidents, or high traffic volumes; infrared technology that detects and alerts drivers to the presence of animals; and smart traffic cone technology in construction zones to send alerts to roadside digital signs and in-vehicle displays.

To accommodate the real-time data generated by these technologies, the DOT adopted optical transport and Ethernet switching solutions from Ciena. This also provides adaptable connectivity so the department can add new and diverse devices, services, users, applications, and data in the future. That scalability is key. Ten years ago, department leaders purchased an OSI 48 circuit thinking it would accommodate them far into the future.

Just a few years later, the department had already maxed out its bandwidth. Today, it is using 10GB and looking to move to 100GB within the next three years as it continues to evolve technologically and leverage real-time data, predictive analytics, and machine learning for a broad range of road safety applications that require little or no human intervention.

The Adaptive Network builds a foundation for innovation

Network modernization can enable DOTs to better manage and even monetize their fiber assets. Most DOTs have fiber-optic networks spread along their respective highway systems. Those networks often contain excess capacity DOTs can share with rural towns or villages in need of broadband access. By pooling fiber resources, a DOT can connect several small remote towns, for example, and allow them to provide previously cost-prohibitive ubiquitous broadband to residents and businesses.

A modern network can also help DOTs prepare for autonomous vehicles. As autonomous vehicles evolve, network demands will escalate, making it even more critical for DOTs to utilize modern, flexible, and scalable networks. Autonomous vehicles, as well as the many systems expected to emerge alongside them — from electronic waystation billing to automated speed violation warnings — will require two-way information exchange with vehicles and demand greater network flexibility as compute and analytics processes are pushed out of central operations centers and closer to the edge.

Moving toward a modern network

Moving to a modern network that relies on programmable infrastructure, machine learning-based analytics, automation, and virtualization can help DOTs fuel intelligent transportation initiatives and ensure always-on availability of mission-critical applications. As DOTs increase the use of ITS devices, they can also reduce stress on employees and allow them to work on higher-value initiatives. Perhaps most critically, a modern network ensures a smooth flow of data among roadside devices, operations centers, and data centers to make roads and highways safer, more efficient, and less congested.

Migrating to a modern network can be a gradual, ongoing process that keeps downtime to a minimum and does not require DOTs to rip and replace old networks. The Adaptive Network is even more critical today, as shrinking budgets compel DOTs to accomplish more with less.

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