OPTICOM™

Interoperable mobility systems: Designing solutions for the long term

For traffic and transportation engineers, designing for the future can be tricky. It's all well and good to put in place the most reliable and fit-for-purpose technology for the tasks required today, but will that technology still work effectively in five years? Will the system interface reliably with others? Those systems might not be in place yet; further, given the pace of technology advancement, we can't even know what sorts of system will exist in future.

The potential for connected traffic and transit systems to sit at the very heart of the smart city is real. But the planning required to make that a reality needs to start now.

The development of tomorrow's technology, particularly for traffic and transport systems, will be inextricably tied to the push for Smart Cities. Making cities smart is essential. The world is becoming increasingly urbanized, and there's a need to cater for those high-density populations in the most efficient way possible. They need intelligent solutions to their living and mobility needs which capitalize on the way that the smart sensors of the Internet of Things can bring disparate technologies and systems together. But to make Smart Cities a reality, those systems need to be able to work together to share data in order to interact smartly and effectively.. Tying those systems together requires interoperability. And interoperability tends to work best when standards are in place.

For Smart Cities and in general, the advantages of interoperability standards are obvious: they allow systems, products and technologies from different manufacturers and suppliers to communicate and interact. Interoperability standards mean that agencies and departments are not tied into proprietary solutions. Interoperability standards allow those agencies and departments to tailor and expand their systems when those changes are required and affordable. And agencies and departments need specialists to ensure technologies, and the interoperability standards that allow technologies to operate to their full potential, are utilized intelligently.

STANDARDS AND DIVERGENCE

Some technologies naturally converge towards a single standard, as is the case with TCP/IP, while others seem to diverge as soon as the standard is published. This is often the case with specialist technologies, where manufacturers will conform to the published standard but also introduce proprietary protocols. This can differentiate a brand from the rest of the field, but it can also allow that brand to provide 'full interoperability' only when using its own equipment, and a more limited form of interoperability with that of other manufacturers.

This is less often the case with communications technologies, which are more broadly adopted across multiple industries – and as a result experience less divergence from the published

INTEROPERABLE MOBILITY SOLUTIONS

Because technological advancements are occurring faster than the typical municipal budget cycle, the need for solutions with staying power is greater than ever.

Mobility systems, including priority control and traffic preemption, that show promise on paper or in pilot projects might not always pan out in the long term. Funding can disappear or champions at an agency can move on, leaving systems without the support they need to function.

Standards and best practices can help mitigate some of these issues by getting different stakeholders to agree on certain requirements. It's critical for stakeholders to collaborate as new standards like 5G, DSRC and NTCIP are developed.

Ultimately, the standards and solutions that are developed today will set the stage for innovations further along the horizon. Making sure that solutions solve problems for today and tomorrow is crucial to enabling safer and smarter mobility.

standard. Interoperability is deemed to be in the best interests of all, and there is acceptance that users will 'mix and match' their devices and systems in order to tailor them to their specific needs.

Standards for ITS systems tend to fall into both categories, and it remains to be seen if they trend towards genuine convergence as fully realized Smart Cities become closer to reality.

INTEROPERABILITY CHALLENGES

There are challenges to true interoperability which go beyond the technical, and these are often about relationships. Because funding is an issue for US transportation infrastructure, states and cities need to develop short-term funding strategies to maintain that infrastructure. The Catch-22 is that short-term funding makes it difficult to build the sorts of long-term relationships that develop trust between agencies and departments.

For Ben Smith, Speed and Reliability Engineer at IndyGo, the Indianapolis Public Transportation Corporation, it's a difficult trap to avoid without knowledgeable intervention:

"For a technology to be successful, a long-term champion of that technology must remain at an agency to build and maintain relationships," Smith said. "But these champions may leave for new jobs when the funding for good wages and newer technology dries up. As a result, we repeatedly see promising technologies sit unused after they are deployed, which erodes trust in the usefulness of technology in general."

"Having the manufacturer sell a managed services contract is helpful to agencies by reducing the burden of maintaining a larger specialized workforce, for sure," Smith said. \ "But a managed services contract in itself does not replace the relationship-building and relationship-maintaining ability of a champion within the agency. Ideally, agencies would be able to make the most of the advantages of both: utilizing managed services to reduce that burden where appropriate, but also employing a technology champion to ensure those systems are working across departments and agencies where possible."

INTEROPERABILITY STANDARDS: THE TRAFFIC TRENDS

Standards for interoperability are not a new idea. Getting systems to work together has long been a goal for technologists, and that's no different in the world of ITS. Some standards in use now have existed for many years, such as NEMA TS1 and TS2 – which have helped provide traffic engineers with interoperability in the traffic cabinet – and J1708 and CANbus, which have provided interoperability on vehicles. And standards like GPS and now GNSS provide unified geolocation functionality.

Some of the prominent standards for interoperability in traffic and transportation technologies – at this point in time and in the near future – are NTCIP, DSRC, and 4G/5G cellular communication. In order to plan for the future integration of traffic and non-traffic systems, it's worth considering and specifying equipment that conforms to one or more of these communications standards. Each has its own strengths.

NTCIP and 4G are currently in widespread use. NTCIP is the standard for smart communication with traffic-side infrastructure, and 4G is used to connect vehicles to other vehicles and to infrastructure. 5G is the evolution of 4G, and DSRC is a future radio standard specifically for Connected Vehicles communication.

DSRC, of course, is not the first time radio has been employed for traffic equipment communication and interoperation. Radio is now perhaps the most common form of next-generation (post-optical) traffic communication in use today. GTT's Opticom signal priority and preemption systems use the 2.4GHz radio standard, as does WiFi communication for traffic equipment. Other traffic infrastructure equipment communicates using the 900MHz band standard.

NTCIP

NTCIP is the National Transportation Communications for Intelligent Transportation System Protocol. A joint product of the National Electrical Manufacturers Association (NEMA), Institute of Transportation Engineers (ITE) and the American Association of State Highway and Transportation Officials (AASHTO), the NTCIP standards are designed to "reduce the need for reliance on specific equipment vendors and customized one-of-a-kind software."[1] It's the oldest of the interoperability protocols, in existence for over 20 years.

NTCIP is the foundational standard, in a sense, for interoperability on the traffic side. Most traffic signal equipment will require NTCIP conformance in order to be sold. Both DSRC and 4G/5G leverage NTCIP for their Connected Vehicles intersection communication. It has traditionally provided a limited level of interoperability, and has often been deployed with a level of proprietary functionality which has allowed some brands to effectively tie customers into using their equipment if they want to exploit it to its fullest potential.

But NTCIP is evolving. Where DSRC is an interoperability standard tied specifically to Connected Vehicles, NTCIP is broad, and provides a number of ways to communicate with traffic signals. However there are NTCIP standards which address Connected Vehicles functionality: NTCIP 1211, NTCIP 1202 and 1203.

NTCIP 1211 is particularly important for traffic signal priority projects – the standard "provides the vocabulary - commands, responses and information - necessary for traffic management centers, including traffic management, emergency management, transit management, and other fleet management centers and their respective vehicles to interact with, control, manage, and monitor transportation signal controllers implementing vehicle prioritization schemes."[2] It allows multiple requests of traffic signal priority from transit or emergency vehicles while maintaining signal coordination with adjacent intersections.

NTCIP 1202[3] and 1203[4] relate to the ability to interact with Traffic Signal Controller Units and with Dynamic Message Signs. Both are being revised to support DSRC technology.

So NTCIP is vital, allowing for traffic

infrastructure operation and management communication, while DSRC and 4G/5G provide a communication mechanism between vehicles and traffic infrastructure such as signalized intersections.

DSRC

DSRC stands for Dedicated Short-Range Communications. DSRC uses the 5.9GHz public radio bandwidth to create the ability for vehicles to talk to vehicles and infrastructure without interference. The allocated spectrum is specifically for intelligent transport system (ITS) use, although there is some discussion that this spectrum may change or could be "shared" for other uses. It's also worth noting that US, European and Japanese DSRC are not compatible today.

Although the original thinking was that DSRC would be widely adopted by the highway and transit industries, Smith said there's so far probably been more use of DSRC for vehicle to vehicle (V2V) communications in the automobile industry than V2V and vehicle to infrastructure (V2I) for those highway and transit applications. That's certainly the case for Cadillac, which introduced V2V DSRC in its CTS sedan model in 2017,[5] and the company is aiming to introduce V2X [vehicle to everything] to a high volume crossover model by 2023. In addition, "Toyota announced in April that it plans to deploy DSRC systems on vehicles sold in the U.S. starting in 2021, with the goal of adoption across most of its automotive lineup by the mid-2020s."[6]

The U.S. Department of Transportation is funding three Connected Vehicles pilots which aim to test a number of new applications using DSRC. These include a New York City Pilot "which aims to improve the safety of travellers and pedestrians in the city through the deployment of V2V and V2I connected vehicle technologies." [7] The largest connected vehicle deployment to date, it will "evaluate connected vehicle technology and applications in tightly-spaced intersections typical in a dense urban transportation system." Around 5,800 taxis, 1,250 MTA buses, 400 commercial fleet delivery trucks, and 500 City vehicles that frequent these areas will be fitted with CV technology, and using DSRC, the deployment will include approximately 310 signalized intersections for vehicle-to-infrastructure (V2I) technology.

A pilot in Tampa will use DSRC technology for V2V and V2I applications to relieve congestion, reduce collisions, and prevent wrong way entry to its Selmon Reversible Express Lanes facility. CV technology will be used "to enhance pedestrian safety, speed bus operations and reduce conflicts between street cars, pedestrians and passenger cars at locations with high volumes of mixed traffic;" the pilot will use DSRC "to enable transmissions among approximately 1,600 cars, 10 buses, 10 trolleys, 500 pedestrians with smartphone applications, and approximately 40 roadside units along city streets."[8] A number of intersections in this project support Transit Signal Priority using DSRC communication; these DSRC capabilities exist today in traditional proprietary TSP and Emergency Vehicle Preemption (EVP) systems.

The third pilot in Wyoming addresses the needs of commercial freight trucks in adverse weather conditions, notably facing high winds and blow-overs; it will use V2V and V2I DSRC connectivity "to support a flexible range of services from advisories including roadside alerts, parking notifications and dynamic travel guidance."[9] Cellular technology is being used to share these problem alerts among Roadside Units (RSUs), overcoming the radio range limitations of the DSRC signal.

It's worth noting that many of the applications being discussed for DSRC are already possible today using 4G, and will certainly be functions that can be handled by 5G in future – this includes data sharing for Transit Signal Priority and Emergency Vehicle Preemption systems.

4G/5G

5G is the fifth generation of cellular mobile communications, succeeding the current 4G/LTE standard. Due for phased release across 2019 and 2020, with select regions rolling out in late 2018, 5G will aim for high data rates, reduced latency, energy savings, cost reductions, higher system capacity, and increased device connectivity compared to 4G – as well as powerful new M2M (machine to machine) capabilities.

A potential advantage for 5G in the future is that it's a communication standard which will have reach beyond the specialist traffic and transit standards and protocols, allowing forthcoming systems to connect with other, non-specialist aspects of the smart city. That could mean wider integration potential, but also less dedicated traffic specific functionality.

Indianapolis is one of the first cities in the United States to see 5G service turned on. Smith is optimistic about its potential.

"I believe 5G offers the greatest opportunity for the transportation industry, at least in urban areas," Smith said. "There is a need for communications to traffic signals and other roadside devices, but so far the options have been limited.

"The Indianapolis Department of Public Works (DPW) had networked approximately 250 of its 1,000 traffic signals using fiber optics, but that system has fallen into disrepair. The Indiana Department of Transportation (INDOT) has recently abandoned all of its other communications technologies: fiber optic, twisted pair hardwire, and public-band wireless (900MHz, 2.4GHz, 5GHz). INDOT is now in the process of outfitting all 2,400 state-owned traffic signals with cellular modems. I see the future moving toward 5G communication for urban areas."

One of the reasons that there could be rapid uptake of 5G is that there is the potential for cost savings – data subscriptions could be a fifth of the price of the current equivalent phone plan. That's still not cheap, when it's rolled out to thousands of vehicles and devices, but it is significantly more feasible for agencies in urban areas than it is presently.

So will 5G prove to be a better bet for the cities of the future than DSRC? It might not be that simple, according to Brian Wassom of Warner Norcross + Judd LLP.

"In the end, there may not be a binary answer; many have suggested DSRC and 5GLTE solutions will prove to be complementary rather than competitive, offering multiple sensor inputs for different levels of tasks and ultimately leading to a safer driving experience. For now, the most important thing is to stay informed on the technological requirements for emerging vehicle technologies and remain flexible enough to adapt to changing trends. No one wants to end up building a Betamax car for a VHS network."[10]

And standards groups which support the development of 5G and DSRC are exploring ways in which they may be able to align on standards across platforms. Telecommunications expert Qualcomm has been testing interoperability using C-V2X[11] (Cellular vehicle to everything), a standard which is based on 3GPP and could allow 5G cellular-based systems to interoperate with DSRC signals.

INTEROPERABILITY FUTURES

There's no such thing as a sure bet when it comes to technology communications standards. It seems likely that the standards covered in this whitepaper will co-exist or even complement one another for at least the next several years. And NTCIP will serve as the backbone, the foundation, for other traffic standards, continuing to evolve to work alongside and with them. It makes sense that any significant investment in technology should factor in the potential for NTCIP, DSRC and 5G to have a significant ongoing role to play, while also broadening interoperability options as far as possible.

At GTT, we are working to allow our systems, Opticom Transit Signal Priority and Emergency Vehicle Preemption solutions, to interoperate across and conform to the widest selection of technology standards for public services that we can. Our aim is to ensure that Opticom will function fully within whichever Smart City ecosystem it is deployed, now and in future.

Ensuring those interoperability standards and technologies are in place is only part of the battle, though. Funding for technologies that work in the background, invisible and unheralded, to improve the transportation experience, can be hard to come by. Wherever possible, agencies and departments should look to appoint technology champions to promote strategic consistency and further understanding of the benefits of these background technologies, and to ensure that an interoperability plan is in place to safeguard against future inefficiencies and wastefulness.

The potential for connected traffic and transit systems to sit at the very heart of the smart city is real. But the planning required to make that a reality needs to start now.

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