High Performance Wireless Backhaul for

Intelligent Transportation Systems (ITS)

Deploy ITS to Increase Traffic Efficiency and Reduce Costs

Introduction

Each day, millions of people depend on their public transportation systems and roadways. With ever increasing populations and the rise in mobility that comes with it, nations around the world are facing a serious land transportation challenge. The rapid urbanization and shifts in population density coupled with limited road system capabilities has resulted in constantly increasing commute times, fuel consumption and air pollution thereby reducing the efficiency of the transportation infrastructure. These inefficiencies are also seen to be having grave environmental, social and economic consequences.

In light of the potentially crippling problems due to traffic congestion, every nation wants a transportation system that is economically efficient, safe and environmentally sound while moving people and goods in an energy efficient manner. Building new road infrastructure as a solution to meet transportation demand is prohibitively expensive, and in many cases building additional roads or adding new lanes in highly congested urban areas is now physically impossible.

This scenario offers a real challenge of adding vehicular capacity without adding road infrastructure while reducing transportation times, fuel consumption, vehicle wear and improving safety. Add-ing intelligence to today's transportation systems to better manage these factors that are always at odds with each other is a critical need worldwide.

Why ITS

Applying the latest technological advances – from advanced traffic signal control systems and speed meters to video surveillance and red light running cameras – to the transportation infrastructure has had a dramatic effect on the way traffic is managed. But what really makes the transportation system intelligent, effective and efficient is the fact that all these technologies can be combined into a single integrated system offering higher level benefits than any one of the individual technologies. This revolutionary approach towards managing transportation is called Intelligent Transportation Systems (ITS).

The United States Department of Transportation defined ITS as "well-established technologies in communications, control, electronics and computer hardware and software to improve surface transportation system performance." ITS refers to building intel-

ligence into the transportation infrastructure by adding electronic sensors, communication systems and information technology to improve the effectiveness, efficiency and safety of the transportation network. Harnessing the synergies of this integrated system is the essence of ITS.

ITS represents a wide collection of applications from basic traffic signal control systems to advanced systems incorporating live traffic density sensors, ramp meters, speed sensors, red light running cameras, automatic license plate recognition systems, secure CCTV systems, parking guidance and information systems, weather sensors, variable message signs, electronic transit fare payment systems, container management systems and so on. In addition to the real-time data, predictive techniques based on historical data are also being used for advanced modeling.

For example, electronic sensors can sense the weather conditions and presence, position and speed of vehicles on a road and relay that information to the communications network, which carry the signals to the central control center of any ITS system – often called the Traffic Management Center (TMC). The inputs are collected, processed and analyzed by the computing systems at the TMC to decide on the next course of action. As it can be inferred, it's the communications network that makes the system work.

Depending on the traffic needs of the particular area and cost to benefit evaluation of the technology, specific ITS applications can be deployed. The transportation authorities need the deployed system to be cost effective from the initial installation to everyday operations and maintenance. Some applications prove to be more cost-effective than others, and as technologies evolve, the choices available change.

Why Wireless

Legacy traffic surveillance systems relied on old wire line networks to transport the video data and as the traffic surveillance needs increased, networks expanded to cover more sections of the road infrastructure. More cameras meant more wires; and these wires need to carry the data quite some distance before converging at the TMC. Not only is the deployment of more and more wires to connect all the new components of an integrated ITS cost prohibitive, but in dense urban environments it is often impossible due to the inability to trench and further disrupt roads. The cost of wiring over long distances or in urban environments is not the only evident issue, as maintaining these wired networks has always proven to be herculean task while not forgetting the fact that the coaxial cables that carry the video signal inherently have high attenuation.

While the cost of cables itself is substantial, it is hardly much compared to the planning, legal work and physical installation expenses. The Total Cost of Ownership (TCO) of laying cables, as objectively analyzed in the Farpoint Group's Wireline vs. Wireless white paper, points to the prohibitive cost of deployment and operation along with the long time-to-deployment of wire line networks.

Meanwhile, wireless technologies have radically progressed to offer better performance versus the incumbent wireline service. The real benefits include the go anywhere capability of wireless systems, where wired networks have physical restrictions. Rapid deployment ability along with a quicker ROI over wireline is proving wireless networks to be not only the most viable alternative, but the most fiscally responsible option as well.
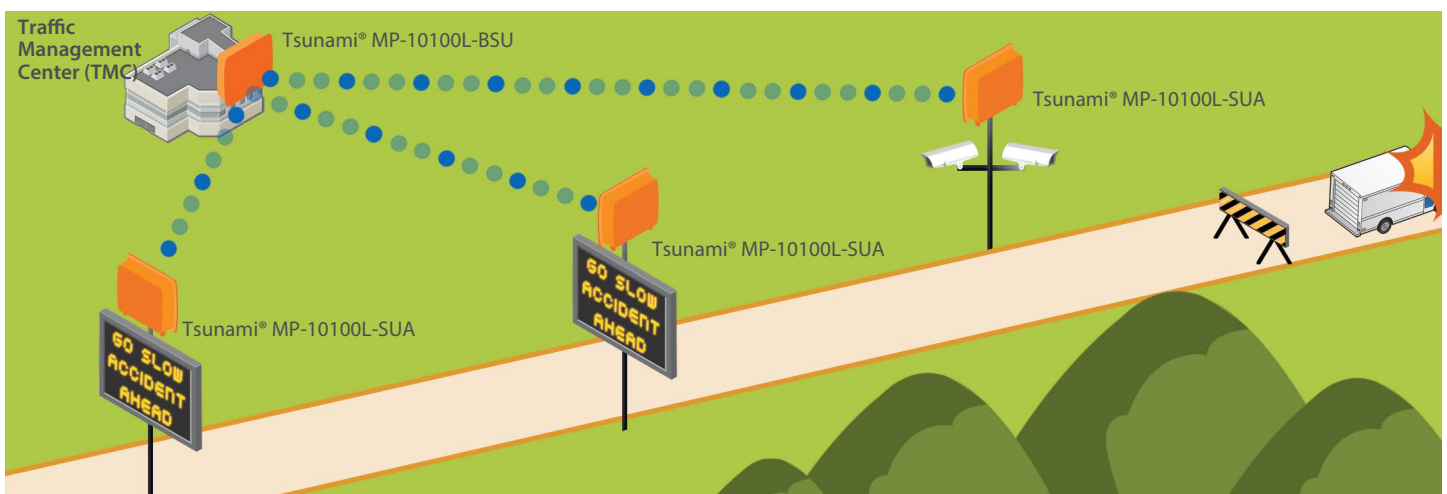

Figure 1: Variable message sign boards powered by Proxim wireless backhaul products

What is the Best Wireless Technology for ITS

Though there are many wired ITS components already in use today, the need to expand and scale those networks cost-effectively and in a timely manner introduces an opportunity for wireless solutions to take over where wire left off. And for new wireless ITS deployments the ease of initial deployment, flexibility, scalability and cost-effectiveness of wireless technology makes it the ideal candidate.

More importantly, beyond cost savings, scalability and ease of use, wireless has proven time and time again in real-world deployments to provide the necessary performance and reliability to ensure the ongoing operation of even the most mission-critical ITS networks. But the fact that wireless has proven itself as a reliable alternative to wired technologies is just the beginning. What wireless technology is best for wireless ITS, and what is the difference between systems?

Today, there are three predominant wireless technologies that are being utilized for the successful deployment of wireless ITS networks – wireless mesh, point-to-point (PTP), and point-to-multipoint (PTMP). Each technology has its own merits, and each has its own place in the ITS ecosystem. What's important is to know the capabilities and limitations of each technology, and then make the determination on which technology is right for your particular network based on how well each technology delivers on the specific requirements of your deployments.

Wireless Mesh

Wireless mesh technology refers to modified Wi-Fi radios that connect to each other in a daisy-chained or "multi-hop" fashion, enabling traffic to be passed from radio to radio en route to its final destination. Wireless mesh networks enable many ITS components to be connected together via a wireless network that blankets an area, and does not require that a component have a direct connection (wireless or wired) to the termination point (command center, network operations center, etc.).

Over the last few years, many wireless mesh companies have poured a lot of marketing dollars into establishing wireless mesh as the ideal wireless technology for data-centric applications like video, which is frequently used in ITS systems. Not all mesh technologies are alike, but in general, the same claims are made by all when talking about the fundamentals of wireless mesh – and this includes the self-configuring, self-healing nature and the built-in redundancy/reliability of the multi-hop environment.

However, this topology can often prove to be problematic when it comes to the specific application of delivering video traffic and other data-centric applications prevalent in ITS systems. Latency, unpredictable/undesirable behavior, dynamic bottlenecks and the subsequent capacity shortages have been all too common when trying to support video on wireless mesh. Now, that is not to say that wireless mesh is incapable of delivering video and other ITS traffic – but several misconceptions and unrealistic expectations regarding the performance and ease of use have caused a great deal of confusion around wireless mesh.

Given the fact that wireless mesh radios (also called nodes) are designed to operate as both transmitters and repeater, these networks can be a convenient means of extending connectivity around obstacles that might otherwise prevent a direct line-of-sight link. This is referred to as providing non-line-of-sight (NLOS) operation. Given the use of omni-directional antennas on wireless mesh networks, however, overall system gain and increased reception of interference can often cause mesh units to have high outage and require more cycles to adapt to the environment. So, while NLOS capabilities can be recognized in ideal situations (environments with no other – or very little – radio noise or interference, which are rare), often times wireless mesh deployments can fall victim to the interference of the environments they are deployed in.

As appealing as the term "self-configuring" may be, any mission critical ITS network should be carefully designed to operate to a specific availability and within parameters that are understood and agreed upon by all parties. With that said, dynamic and adaptive technologies are not specific, and regardless of which topology is used a good rule of thumb is to minimize the variables and have a very comprehensive understanding and documentation for how each device in a network is configured. The technology chosen should also provide enough management over these functions to keep the systems under control.

The "self-healing" trait touted as a strength in wireless mesh systems is also important to review. You must ask yourself – why is the system in need of healing in the first place? A properly designed and installed wireless network with adequate signal should perform to 99.999 percent availability at the desired modulation required to support the ITS applications.

So, while wireless mesh technologies certainly have their uses, in situations where high reliability and performance are necessary – like in ITS networks – wireless mesh can present a few problems.

Point to Point (PTP)

Point-to-Point (PTP) technologies refer to wireless systems that provide a dedicated, high-performance link between two locations. This is fundamentally different from the wireless mesh technology discussed above, as the main goal for PTP wireless links in ITS networks is to provide an extremely reliable backhaul link. This could be a backhaul link connecting a single ITS component back to the wired backbone, or it could be a dedicated link that backhauls traffic from a single aggregation point (like the termination point in a mesh network) carrying all ITS data traffic from a larger network back to the network operations center.

By providing a single, dedicated link, PTP eliminates many of the problems such as interference and noise that affect the wireless mesh technologies. Also, because it is not a multi-hop technology, it does not introduce increased latency that can hinder the performance of a video transmission or other critical ITS applications. PTP links utilize higher-gain/narrower beam-width antennas which greatly increase Fade Margin and SNR while minimizing the reception of undesired interference from other systems.

Though the performance and reliability benefits of PTP over wireless mesh are undeniable, these direct links are more costly than wireless mesh links, which means they are not always feasible depending on the project budget. In addition, PTP links can provide a great deal more bandwidth than wireless mesh networks – with some wireless PTP backhaul solutions providing as much as 1.25 Gbps links. So, depending on the link performance of the given PTP technology used, it could be overkill for the particular connection, leaving some bandwidth/throughput unused.

For these reasons, PTP technologies are often used to backhaul traffic from a single termination point (like the termination point in wireless mesh networks) where it can aggregate all the ITS traffic and then transport it to the command center or network operation center.

Point-to-Multipoint (PTMP)

Point-to-Multipoint (PTMP) systems are often a cost-effective means of obtaining a balance between the advantages of wireless mesh and PTP systems. PTMP technologies involve base station units (BSUs) that connect to multiple subscriber units (SUs). This enables the deployment of separate, lower-cost SUs next to each major ITS component in the network, enabling SUs to deliver the video traffic directly from the camera back to the BSU. The BSU acts as the aggregation point for the traffic from all SUs.

Unlike wireless mesh deployments, which can introduce detrimental latency based on the non-direct multi-hop nature of the technology, PTMP networks provide a series of direct connections from the many SUs back to the BSU. This provides a balance between the dedicated connectivity needed to ensure the quality and performance needed for mission critical ITS networks and the cost-effectiveness of a distributed network (as opposed to many dedicated links).

The best PTMP networks for ITS will utilize a polling algorithm (like WiMAX) to provide an efficient and effective means of distributing bandwidth amongst the end points/SUs fairly and in a controlled manner. This helps to provide quality of service (QoS) in the wireless ITS network, and to ensure that each component receives the

Traffic Management Center (TMC)

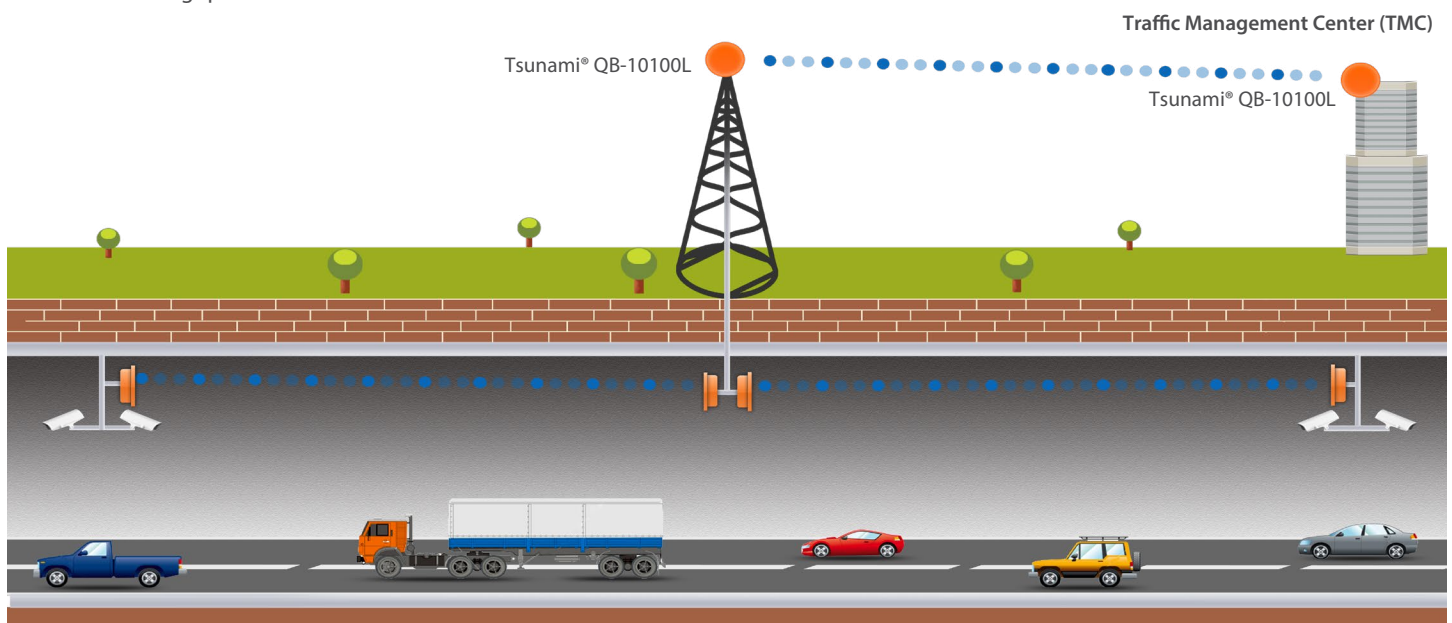Tsunami® QB-10100L

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Figure 2: Point to Point (PTP) wireless backhaul deployment scenario for video surveillance

bandwidth necessary to deliver a constant, reliable stream of information.

Though traditionally a technology that required line of sight connectivity between SUs and the BSU, there are recent advances that have enabled NLOS functionality in some PTMP systems, which provides even great ease of use and configuration. For the best performance, though, line of sight operation among PTMP links still yields the greatest return.

One Size Does Not Fit All

It is important to remember that – though each of these technologies has its strengths and weaknesses in different scenarios – the best technology is largely dependent on the individual needs of the particular ITS deployment in question. In some situations (with low noise or interference environments), wireless mesh can provide an acceptable solution. When the most important consideration is absolute link reliability and performance, PTP technologies can be ideal. And when looking to find a balance between the cost-effectiveness of wireless mesh and the performance/reliability of PTP, PTMP solutions are a solid decision.

It is also critical to understand that you do not need to commit to only one of these technologies. Any provider that only sells mesh will of course try to convince you that mesh is the best solution. Likewise, a provider that only sells PTP will try to convince you that you need dedicated links throughout your video network. As the saying goes – when all you have is a hammer, then everything looks like a nail. But based on the individual needs of each application, you may need a multi-technology solution.

PTP systems can provide the backhaul for wireless mesh and PTMP networks, PTMP and wireless mesh networks can be deployed together to provide a balance of video backhaul and Wi-Fi connectivity, or all three can be utilized for a complete end-to-end wireless network. Depending on your needs, Proxim has a complete portfolio of end-to-end wireless systems so that you can utilize whichever technology is best for your particular deployment.
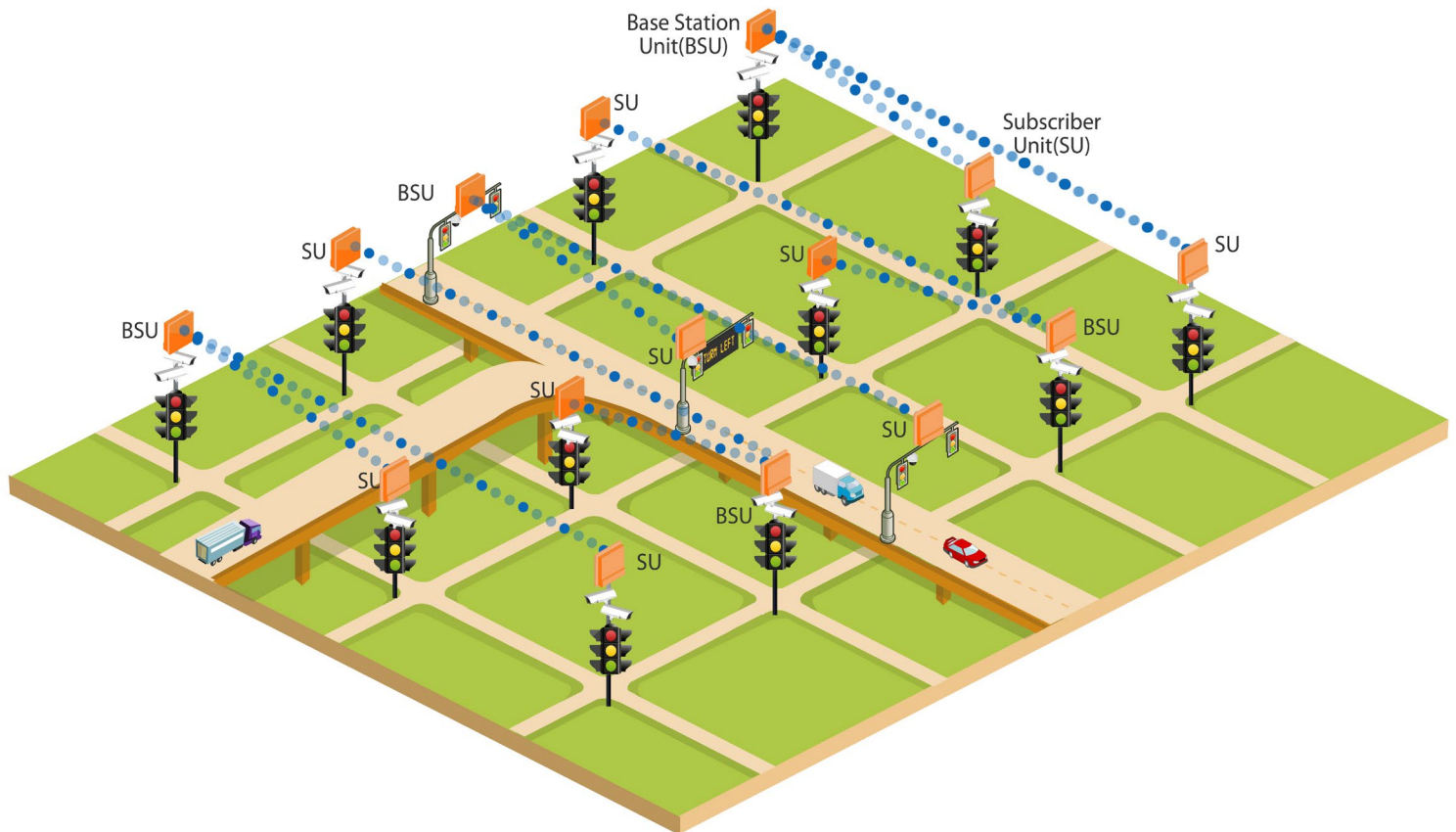

Figure 3: Point to Multipoint (PTMP) deployment scenario

Case Study:

The need to monitor traffic and react in real-time to relieve conges-tion throughout the County of Los Angeles requires a high per-formance, extremely reliable and cost-effective communications network connecting the traffic signals. When the LA County De-partment of Public Works awarded Systems Integrated this project to deploy LA County's Intelligent Transportation System (ITS), Sys-tems Integrated turned to Proxim Wireless for the systems' com-munication networks.

Installation of Proxim's wireless technology reduced both the set up and operating costs for signal communication while also assist-ing the County's goal to reduce traffic problems for the travelling public. The County of LA estimated that utilization of Proxim's wire-less technology to connect the 1,000 traffic intersections saved the County's ITS program $7 million in costs over traditional copper or fiber optic installations. Additionally, the County of LA estimated that the use of Proxim's radios will save the County $708,000 an-nually versus the cost of leased telephone lines. As a result, the County of Los Angeles earned a 2009 National Association of Coun-ties Achievement Award.

This gigantic project requires communications to be provided to traf-fic signals in over 1000 intersections with many of these signalized intersections being equipped with one or more video cameras to enable remote monitoring of traffic flow. These cameras feed live traffic video from the intersection to the County's Traffic Manage-ment Center (TMC) to enable remote adjustment of traffic signal timing for flow optimization to ease congestion.

The County's TMC, located in Alhambra, is a high tech facility which combines multiple technologies and software systems. The primary purpose of Proxim's broadband wireless communication system is to provide communications for the County's traffic management software, Kimley-Horn Integrated Traffic Systems (KITS). Combined, these systems have enabled County and City staff to monitor traffic signals, react in real time to traffic problems and if necessary, adjust traffic signal timing from the TMC to relieve congestion for com-muters throughout LA County.

"The ability to deploy a wireless communications network for moni-toring the operation of 1,000 traffic signals is a huge enabler of productivity for LA County, and will go a long way towards the County's goal to reduce congestion and enable real-time traffic signal monitoring," said John Holbrook, General Manager of SI. "We've found that Proxim's broadband wireless technology not only provides the best performance for delivering bandwidth inten-sive applications like video, but it is also the most cost-effective solu-tion on the market. As a result, we have used Proxim's equipment exclusively throughout this deployment."
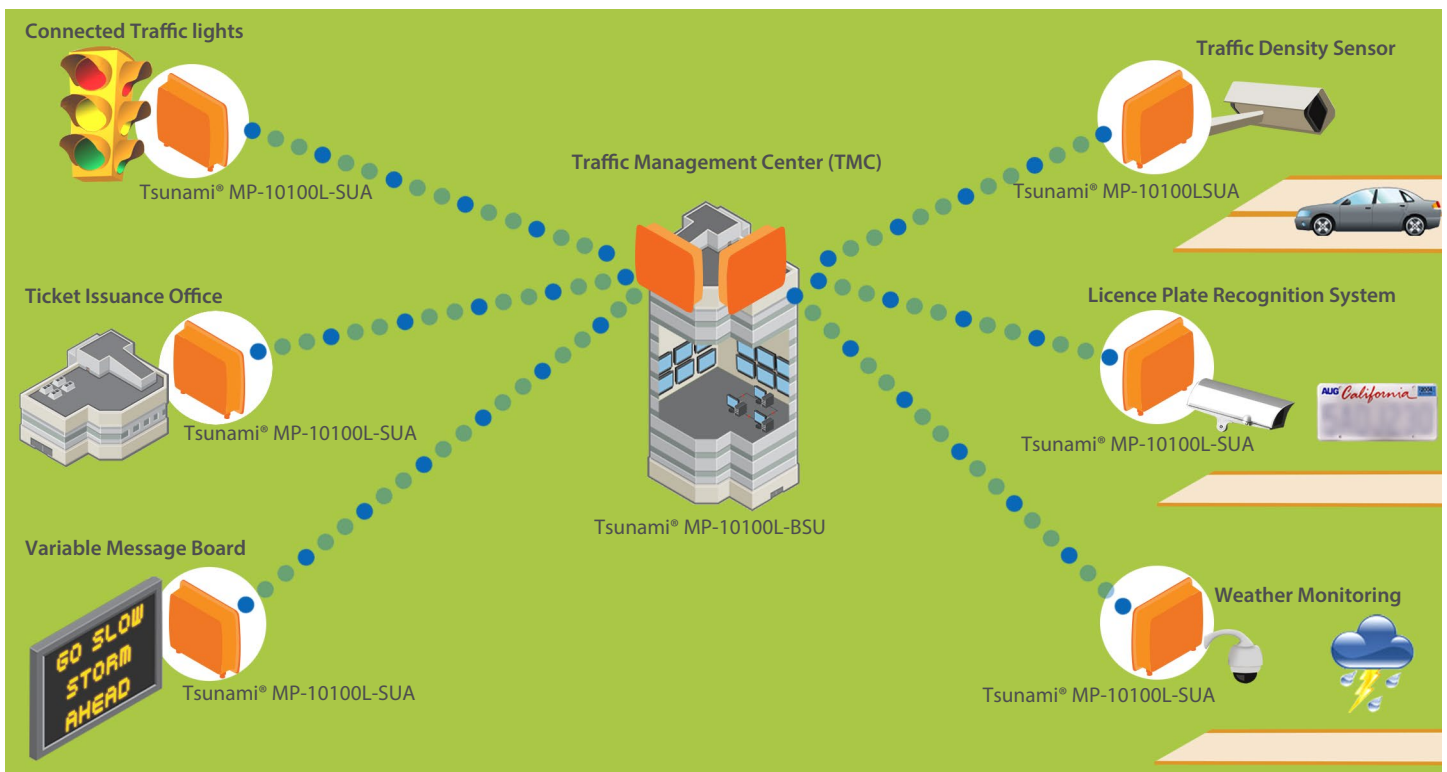

Figure 4: Intelligent Transportation System (ITS) deployment scenario

About Proxim

Proxim Wireless Corporation (OTC Markets: PRXM) provides Wi-Fi®, Point-to-Point and Point-to-Multipoint 4G wireless network technologies for wireless internet, video surveillance and backhaul applications. Our ORiNOCO® and Tsunami® product lines are sold to service providers, governments and enterprises with over 2 million devices shipped to over 250,000 customers in over 90 countries worldwide. Proxim is ISO 9001-2008 certified. For more information, visit www.proxim.com. For investor relations information, e-mail ir@proxim.com or call +1 413-584-1425.

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