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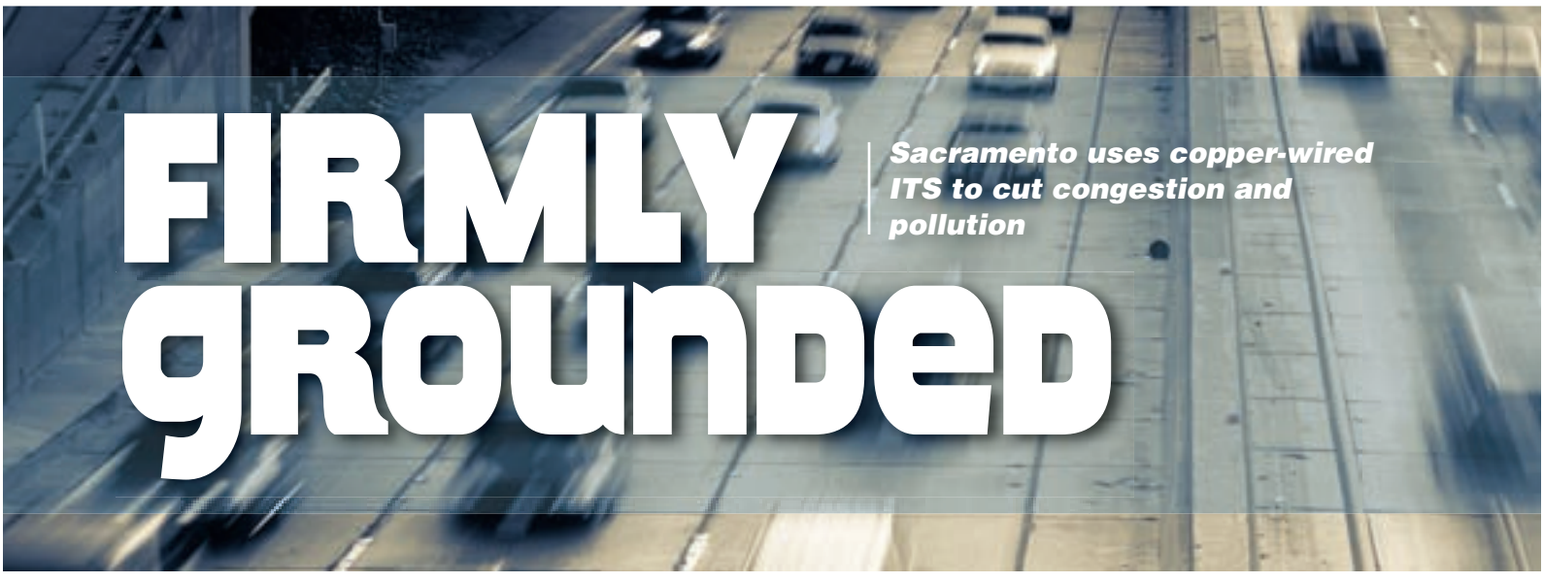


# FIRMLY GROUNDED

***Sacramento uses copper-wired ITS to cut congestion and pollution***

***Many U.S. cities are now tackling road congestion by deploying intelligent traffic systems (ITS) that display information and control stoplights in real time. This enables drivers to avoid accidents, plan commutes and take the best routes to their destinations.***

Such moves are now being motivated by new legislation, including President Barack Obama's $787 billion American Recovery and Reinvestment Act, as well as the "Main Street Mayor's Report," a response to Obama's stimulus package that was released by the U.S. Conference of Mayors in December and outlines a plan where hundreds of cities are ready to start working on more than 11,000 infrastructure projects. The projects represent an infrastructure investment worth $73 billion, according to the "Main Street Mayor's Report," which also claimed nearly 850,000 jobs could be created over the course of the next two years.

"With an ITS-over-copper solution, cities all over the U.S. are realizing they can finally achieve dramatic improvements in traffic flow, along with equally impressive reductions in pollution and carbon emissions," said Eric Vallone, vice president of marketing at Actelis Networks in Silicon Valley, Califlornia. "Additionally, they are eliminating the high cost and disruption of having to dig up roads to lay new fiber-optic lines in order to upgrade their networks."

An emerging theme is evolving, according to Vallone, that the existing copper infrastructure can provide all the data-transport capacity needed to deliver an ITS solution. And while an ITS requires much higher bandwidth than is available over legacy modem-based connections installed over the past two decades for basic stoplight monitoring, the underlying physical infrastructure dominated by copper cabling can ramp up to the required capacity with the help of the latest intelligent Ethernet-over-Copper (EoC) technology. Some cities are already traveling down this road.

In California's Sacramento County, for example, the cities of Roseville and Sacramento, the capital of California, now have a new ITS running over a mixture of fiber and copper, integrating the required components to improve traffic flow and cutting pollution throughout their areas. The two cities also are starting to link up traffic management in all of Sacramento County to extend the benefits of the newly deployed ITS solution.

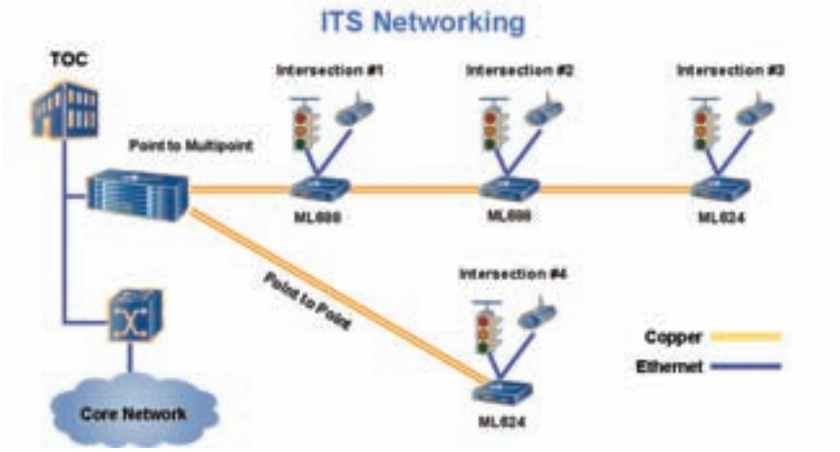
Full-blown ITS requires integration between several key components over the IP/Ethernet infrastructure. First, video cameras, updated IP-based traffic controllers and other sensors are needed to monitor traffic flows and events such as accidents and, perhaps, extreme weather, generating data that must be transported back to a central system for analysis.

Second, there has to be intelligent software to perform the analysis and determine appropriate action.

Last, there has to be the means to exploit the analysis on behalf of drivers, which can be done by controlling stoplight timings and displaying information, warnings or instructions on dynamic message signs (DMS). Information to help drivers plan journeys in advance also can be made available on the web and, potentially, conveyed directly to the vehicles.

## Growing pains

The need for traffic management had become particularly acute in the Sacramento area, which has been a victim of its own rapid growth over the last decade or more. Traffic has increased in tandem with the rise in economic activity, and Sacramento now ranks as one of the 30 most-congested cities in




**With EoC, copper can deliver fiber-like performance. The city of Roseville soon realized that its copper infrastructure was capable of delivering all its ITS data traffic.**

the U.S., according to the latest Urban Mobility Report issued by the Texas Transportation Institute. The foundation for this growth, a spirit of technological innovation, also has encouraged early adoption of technologies that tackle the problems, and so it is not surprising that the region has been quick to deploy ITS.

In fact, the city of Roseville also was one of the first to adopt first-generation traffic management based on 2,400-bps modems in 1988, long before anyone outside universities and large enterprises had heard of IP or Ethernet. At that time the city used these modems to link traffic lights so that timings could be changed remotely, although with no return path it was not possible to perform any traffic monitoring or provide any real-time response. That all came much later, with the IP-based ITS that is only now being seriously deployed.

"For cities such as Sacramento and Roseville, ITS could clearly help solve their traffic-management problems and improve quality of life for all their citizens, including pedestrians, who would benefit from reduced pollution," said Charles Clawson, director of enterprise sales at Actelis. "But the big question was, how best to provide the underlying communications links, since these had to reach all intersections controlled by stoplights, and also wherever other sensors or DMS displays needed to be located."

In his experience, Clawson said, often the network engineers turn first to fiber optics, knowing that it can provide all the capacity they need. But then when they do a financial analysis, they find that fiber just doesn't add up.

## Extended reach

"Copper provides a near-immediate return on their investment," said Clawson. "It's true most cities do have some fiber that will often make an ideal backbone for their ITS network, but the fiber only reaches a small percentage of the intersections and other points on their road network, and the cost of trenching to extend the coverage is prohibitive."

Yet the existing copper infrastructure comprising twisted cable pairs usually does reach most, if not all, of the required stoplights and monitoring points, making it relatively inexpensive to provide all the coverage required by running just a few more circuits at most. And the advent of EoC technology means that copper can deliver fiber-like performance sufficient for all ITS applications. The city of Roseville soon realized that its copper infrastructure was capable of delivering all its ITS data traffic.

"We had all of this twisted copper pairs in the ground and asked, If it can carry DSL to homes, why can't we leverage it in the traffic industry," said Jason Shykowski, senior civil engineer for the city's public works department.

After evaluating possible options for equipment, it became clear the answer was, in fact, yes, providing the chosen telecommunications/ITS vendor could really deliver fiber-like rate, reach and reliability, dubbed "The Three *R*'s of EFM" by Actelis' Vallone. This meant going further than consumer DSL, delivering full symmetrical Ethernet service with carrier-grade resiliency and redundancy. Traffic management, after all, is a critical application where failure of any single set of stoplights has a ripple effect that can quickly cause congestion throughout a whole city, particularly during morning and evening commutes.

In a city where different utilities and construction companies can dig up the road, there is always the risk of a copper cable being cut. The network, therefore, needs to be resilient against failure of any single link, and at the Ethernet level this is supported by the Spanning Tree algorithm, as Shykowski noted: "Our copper gets hit a lot, and the spanning tree allows us to keep our communications lines up by rerouting the various signals when something gets hit by a contractor, which happens often."

Further protection against loss of a copper cable can be provided at the physical level by bonding multiple copper pairs together, as allowed by the IEEE EFM (Ethernet in the First Mile) over copper standard. The ability to aggregate up to 32 pairs together has the primary purpose of creating higher bandwidth circuits, but also protects against failure of any single pair, since transmission can continue at reduced bit rate over the remaining pairs of a link.

Bandwidth was a major consideration in Roseville's selection of EoC equipment, with Shykowski noting that further increases in bit rate have been achieved since the initial deployment, avoiding need for any further cabling.

"Since we started installing Actelis' gear, they have had one software upgrade that actually increased the bandwidth per pair," said Shykowski. "It allows us to leverage the 70-plus miles of copper in the ground and use that to complete our high-speed IP network without having to replace any infrastructure at all."

## Signaling better flow

In the nearby city of Sacramento, the copper infrastructure also provided the required coverage, since it had originally been installed to reach all existing traffic signals back in the

1970s, according to Shad Bennett, the city's head of traffic engineering and operations.

"So the chances are that if we want to put in a completely new signal, we can just add a quarter of a mile interconnect cable down to the next signal and have a copper path from our central location right out to the edge of town."

Sacramento tunes the timing of the traffic signals in response to changing conditions using Actelis Networks' Ethernet over copper ITS solution.

Being able to control stoplights individually in real-time not only allows traffic flows to be optimized during normal conditions, but also minimizes disruption from accidents or construction work.

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"If the city is doing some street widening or there's a construction crew doing some work in the lane, we can remove that zone remotely," explained Bennett. "We don't have to send a whole crew there, and I can manipulate the signal so that disruption will be minimized. Then, I can get the traffic through without significant delays."

In fact, Sacramento's intelligent traffic management story did not begin with stoplight control, but with video surveillance cameras about a decade earlier, starting the march toward IP/Ethernet. In those days copper had nowhere near the capacity to carry video across a city, so the cameras were installed on Sacramento's fiber rings, which meant they could only be deployed quite close to the city center. Nevertheless, they provided valuable information about the impact of morning and afternoon commutes, helping to plan road developments and enabling different stoplight timings to be tried. This expansion of capabilities created a thirst for wider camera deployment to extend the benefits and enable traffic management to be better coordinated across the whole city.

"Really, it was the cameras that spurred the need for higher bandwidth," said Bennett. This led to the creation of an all-IP network that allowed all signaling and monitoring equipment, not just cameras, to be consolidated on a single IP connection, making the whole ITS infrastructure easier to manage.

It also provided the framework for further added-value services and benefits through integration between various components. In particular, having a coherent IP/Ethernet network allows engineers to monitor and troubleshoot the network much more quickly and effectively. Technicians can respond almost immediately to failure of a stoplight, camera or DMS display.

Since both Roseville and Sacramento, along with many other cities, have some fiber as well as their extensive copper infrastructure, EoC equipment for ITS can ideally support both. As Roseville's Shykowski pointed out, the choice of vendor is narrowed to those whose EoC equipment can connect to both fiber and copper.

"Actelis provided an ML600 platform with both fiber and copper ports. This gave us the perfect mix, as we could have a fiber trunk line and still use that same switch throughout our network—for both the copper and the fiber."

Another common theme is the potential for use of the new IP/Ethernet network by other city agencies, such as law enforcement and emergency services. Then as already noted there is scope for adding value to all services by extending them across the whole county, integrating local networks together.

"The county and Elk Grove, Sacramento County's second city, are also using Actelis gear," said Bennett. "We're all kind of growing at the same spot, but each agency is picking and choosing what technology works best."

At the same time, Roseville and Sacramento may follow cosmopolitan cities such as New York and London, which have deployed sophisticated camera networks to enforce lane restrictions, congestion-charging zones and speed limits, through automatic plate recognition. The same system can then be used for law enforcement, for example, in the tracking of stolen or suspect vehicles.

There also is scope for providing access via the web for real-time camera feeds to help people plan their own journeys and avoid accidents, construction work or congestion. With cars increasingly having access to the Internet, web camera feeds mean drivers can adjust their routes during their journeys as traffic conditions change. Indeed the IP/Ethernet network itself could provide Internet access for vehicles on the roads. Roseville already provides map-based public access to its network of traffic cameras via the Internet.

It is the copper infrastructure, installed a generation ago, that has enabled this ITS to happen so quickly within tightly constrained budgets. In the case of ITS, the infrastructure brings not just improved traffic flow, with spin-off benefits for commerce, but also cleaner air and lower carbon emissions, complying with President Obama's new drive to make America a leader on green energy and reduce dependence on imported foreign oil. TME

Information provided by Actelis Networks, Fremont, Calif.

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