traffic
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TOLL AHEAD

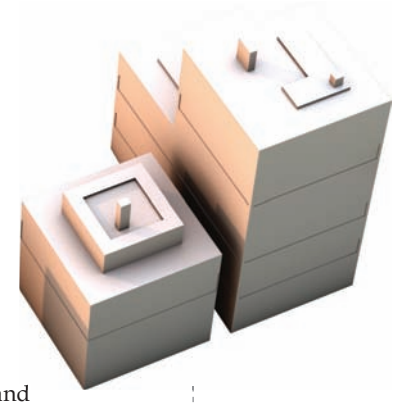
Collected development

The race is on to apply a new technology to an old problem – the instrumentation of arterial roads with traffic detection equipment. **Nick Bradley** speaks with the experts who feel Bluetooth is the optimal route to a new era in real-time traffic information and more

Illustration courtesy of Magictorch

Ever since the late 1960s – for as long as Phil Tarnoff has been involved in the field of traffic engineering – DOTs have been searching for the industry's Holy Grail: a viable way of instrumenting arterial roads. "But even today, 40 years on, only 6% of the USA's arterials have any detection on them at all," confirms *Traffic Technology International*'s longstanding contributor. All of that could be about to change, though, thanks to some smart thinking from what is currently just a handful of experts who have been researching Bluetooth as a potential source of traffic data.

Tarnoff and his colleagues at the University of Maryland can trace their initial forays into Bluetooth back to early 2007, although industry-wide momentum has picked up over the past 12 months in particular, with commercialized products materializing from at least four vendors. "As far as we know, we were the first developers of a Bluetooth tool for monitoring traffic flow," Tarnoff reveals. "We initially began development to support the validation of Inrix's travel-time data in relation to our work for the I-95 Corridor



Coalition." Ultimately, though, the Bluetooth data proved more accurate than Inrix's GPS probe data and was generated at a much lower cost than through floating cars. "We estimated the cost per travel-time data point of the Bluetooth data was just 1/300th of the cost of comparable floating car data," Tarnoff adds. As development continued at the University of Maryland, horizons expanded with potential in applications beyond travel information and incident detection. The decision was therefore taken to establish Traffax Inc to market what subsequently became known as 'BluFax'.

At roughly the same time, academics at the Texas Transportation Institute (TTI) began conducting their own research. "We've been working on probe-based data for 15-20 years; it's just the methods have changed as technology has evolved," says Darryl Puckett, research scientist. Bluetooth, he feels, is the next stage in that evolution. "Texas DOT and Harris County have over 800 directional miles of travel-time monitoring coverage using toll tags and AVI," adds Puckett's colleague, Tony Voigt, a TTI research engineer. "Several of the agencies with which we're closely linked, such as the City of Houston and Harris County, have been looking at bringing travel-time monitoring capability down to arterials but until now installation and maintenance costs have precluded all systems."

"If there is a downside to Bluetooth, it's that it's not a silver bullet," says a refreshingly honest Puckett. "You cannot get the same information that you can with loops or radar. Ultimately, I see it developing as a complementary technology. But in cases where travel time is the main requirement and other factors are not so important, I think Bluetooth's a slam-dunk!"

"It provides additional functionality that up until now may have been the preserve of the DOTs and agencies with more funding behind them," Voigt continues. "For me, this is where Bluetooth changes the game. It brings down the cost and the infrastructure requirements hugely, so smaller counties, cities and municipalities can now enter the game should they choose to."

"We've estimated it brings down the cost in comparison to AVI by a magnitude of two," Puckett states. "An AVI station here in Houston has run between US$100,000-US$150,000, covering two directions of a freeway. Our equivalent solution, AWAM (Anonymous Wireless Address Matching), can cost less than US$10,000. In our field demonstrations at the ITS America Annual Meeting in May, we replicated the data-gathering capability at one location on a freeway with only one of our AWAM devices, whereas the AVI system took a minimum of eight antennae plus two readers to do the same thing. The cost of installing that – not to mention the lane closures, construction, the hard infrastructure needed such as overhead sign bridges for the AVI antennae – all disappears with Bluetooth."

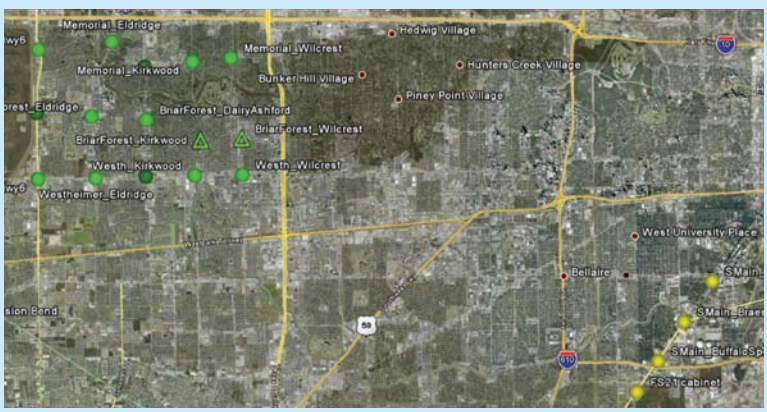
Privacy protection and filtration

Of course, Bluetooth devices within vehicles might not be the only ones to pass a reader – pedestrians, transit riders, etc, could all be in possession of their own Bluetooth-enabled technologies. Will these not influence readings? "Our host software uses various statistically based algorithms to filter matches that appear to be outliers," explains TTI's Tony Voigt. "These algorithms can be configured based on the characteristics of each individual segment being monitored."

The research engineer admits the distinction of transit vehicles versus other vehicles and pedestrians is difficult in practice, but possible using TTI's in-house-developed field software processes. "Much of our intellectual property is based on this. We have seen gains in matches of 50% over other processes with our patent-pending methods, which allow for a more robust analysis capability, including potentially differentiating transit vehicles.

A further critical aspect of the TTI process is privacy protection. "We have the capability to make the MAC address data collected anonymous before transmitting from the field, which we can do without any reduction in the fidelity of the data." But isn't anonymity a major benefit of Bluetooth? If MAC addresses are not linked to a user, why the extra process? "If there is even a very small chance that a hacker could sniff the communications pathway from field to host, there should be procedures and protocols in place to minimize the threat."

Voigt says anonymizing the data may be more of a benefit if the raw data is archived for later analysis. A partial MAC address when anonymized then archived is less subject to scrutiny, although there are methods to use to enable further use of the data for operational and planning purposes, such as higher-level origin/destination studies.



TTI's AWAM can distinguish 'groups' of Bluetooth devices on a particular route

Proved in the field

Arguably the highest-profile deployment to date is on the Eisenhower Expressway in Chicago, Illinois, which features BlueTOAD, as developed by the Wisconsin-based company TrafficCast. Neal Campbell, a product of the Motorola production line, is TrafficCast's CEO. "Last year, I got together with a few guys and we just started penciling some ideas down about producing a real-time, connected Bluetooth device," he says of BlueTOAD's origins. "We built it on standard cell phone platform technologies, processors and modules. We wanted it to be completely live and autonomous, so at first we just focused on individual technologies."

BlueTOAD has enabled Illinois DOT to maintain the communication of vital driver information throughout the I-290 project, when extensive congestion and delays are likely

The team worked up some magic as far as detection ranges were concerned as well as the speed with which Bluetooth devices could be detected. "Academics sometimes get caught up in the bits and bytes, whereas the management team I've assembled know about industry," Campbell says. "There's nothing simple about wireless real-time communications and very rapid Bluetooth detection. That real-time aspect was really our focus. The people I've hired have years of experience; they've built real mobile phone systems before, which I think has had a tremendous impact on our progress."

He is not spinning the story here either. In just over a year, TrafficCast has taken BlueTOAD from sketches on paper to units being deployed – either commercially or at trial stage – in 12 US states. Campbell won't reveal how much has been invested into BlueTOAD, but will admit he has backing from a venture fund. Regardless, he insists the achievements over the past year are down to the people around him and the product offering – not a blank check. "We're getting match rates in the 3-6% range," he says. "Most traffic science will tell you that if you're getting 5% or 6% sample rate, you've got very, very accurate real-time traffic information. And that's what we've found. We do a lot a benchmarking, taking cars with GPS receivers on the road, driving them down the expressways, and with BlueTOAD we're literally within tenths of a mile per hour in respect of our travel times."

Alongside its flagship deployment on the Eisenhower Expressway, TrafficCast has also recently worked with Wisconsin DOT on a trial in which BlueTOAD units were deployed to analyze the proportion of vehicles leaving a particular freeway exit serving a local tourist attraction. "We strategically placed our BlueTOAD units at specific locations to ascertain the percentage of flow based on Bluetooth densities, while at the same time conducting origination and destination studies, obtaining real-time travel data, and even valuable information for metropolitan and planning organizations. What's nice about this technology is that it can show you what's happening before, during and after construction, and in the long term what impact those changes had on the infrastructure."

In this respect, Campbell thinks that performance measurement of other ITS deployments could be a key area for technologies such as BlueTOAD, which can be installed and collecting data within 15 minutes. "What we're seeing with the Reauthorization Bill is that performance metrics have to be supplied," he says. "US taxpayers have spent all of this money on new infrastructure, so they want to know what the real, measurable benefits of all that investment have been. As a result of its relatively low cost, I fully expect Bluetooth to become the de facto performance measurement tool."

The perfect complement?

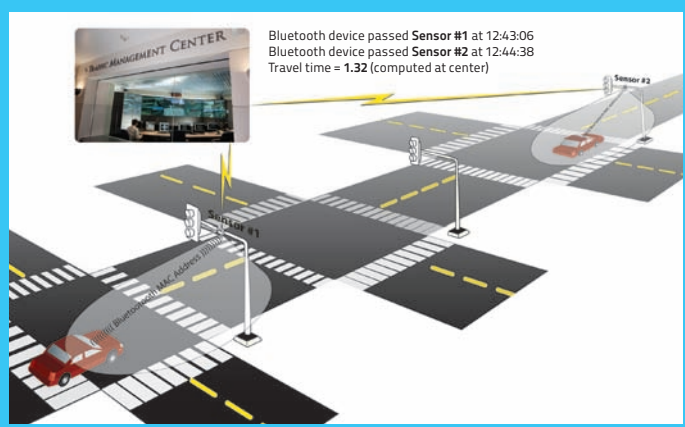
A further deployment of Bluetooth in Minnesota has also been announced by Iteris, as part of Mn/DOT's 2009/2010 ITS Innovative Idea Program. Developed using software and hardware licensed from Savari Networks in Santa Clara, the technology is being analyzed at six intersections. For Iteris to switch on to Bluetooth so quickly is a shrewd move, as it could technically be integrated with

Bluetooth: how does it work?

Every Bluetooth device has a unique Media Access Control identifier, known as a MAC address. If the device passes a Bluetooth reader on the roadside, the sensor picks it up, timestamps it, and when passing another reader further down the road, the exercise is repeated. The data can then be transmitted to a central server, at which simple travel time calculations are performed.

"MAC addresses are unique 48-bit addresses assigned by manufacturers of consumer electronic wireless devices such as cell phones, laptops, hands-free headsets, MP3 players and GPS devices that have either WiFi or Bluetooth capability," explains Abbas Mohaddes, president and CEO of Iteris. An 'inquiry' mode will establish a link between a pair of devices, and these inquiries are made whenever a device is 'paired' with another device, in doing so allowing a Bluetooth receiver to pick up a MAC address when the device passes by within the respective range.

According to Mohaddes, the actual range of a Bluetooth receiver is dependent on the strength of the device itself. "We tend to focus on a power class that operates in a range of approximately 100m, so we set our device at key locations and collect data as vehicles pass each device, then we calculate their travel time from one point to another."



The Iteris system works by timestamping a MAC address at two different points and then calculating a travel time at a central server

The only game in town for arterials

The BluFax unit was used to validate GPS data in the I-95 Corridor Coalition project

"We differentiate between the market for permanent installations for producing real-time data and the market for temporary installations as an alternative to floating car studies," says Phil Tarnoff, CEO of Traffax Inc. He suggests that as consultants and other data-collection companies become aware of the trade-offs between automated (Bluetooth) and manual (floating car) data collection techniques, the demand from the market will increase rapidly, to the extent that he forecasts the floating car will become extinct in the next five years.

"Penetration of the real-time (permanent) market is also rapidly increasing," he adds. "But the competition for real-time travel data is fierce due to the availability of competing technologies such as probe data, cellular geolocation technology, toll tag technology, and the use of conventional detectors such as loops, radar, and so on.

In terms of both cost and accuracy over the use of floating cars for traffic studies, Tarnoff says Bluetooth has a significant edge. "For real-time applications, it measures travel times much more accurately than point detection devices (conventional detectors) as the Bluetooth units are measuring space mean speed, not point mean speed."

Also, when measuring travel times on freeways, it has a significant cost advantage over toll tag devices that operate in a similar fashion, as a single Bluetooth unit can measure flows in all lanes and in some cases both directions from a roadside installation, whereas the toll tag units must be mounted over the lanes.

"When measuring travel times in real time on arterials, Bluetooth technology is currently the only game in town," Tarnoff states. "Vehicle probe technologies such as those offered by Inrix have demonstrated that they provide adequate accuracy for most traveler information systems, and offer the benefit that the data can be purchased from the vendor without requiring the installation of roadside infrastructure. But the cost of installing and maintaining Bluetooth equipment is comparable to that of the purchased data, while providing larger sample sizes that are essential for arterial and ramp data collection."

Many applications exist for Bluetooth technology that can leverage O-D capabilities

several of its existing ITS products, in doing so offering customers added functionality.

Such a strategy is confirmed by Ravi Puvvala, CEO of Savari Networks, which developed the hardware and software. "We offer a future-proof solution by incorporating technologies such as DSRC, Wi-Fi, 3G and Bluetooth into a single device. DOTs can not only use our platform for accurate travel-time measurements but also for other applications such as emergency vehicle priority, congestion pricing, etc. Furthermore, when combined with existing ITS equipment such as video detection or even ALPR, we believe that DOTs will find a huge value proposition in our ability to use and bridge today's infrastructure with tomorrow's needs. When considering the multi-faceted nature of our solution, the cost of installation and maintenance of our device is negligible."

"We have been looking at various technologies for travel-time calculations," confirms Abbas Mohaddes, president and CEO of Iteris. "We've looked at GSM for over 10 years, but there are technical challenges, although it's certainly progressed with the advent of new smart phones." Mohaddes also feels that ALPR currently has a cost disadvantage, suggesting agencies might be less than enthusiastic about deploying a network of license plate readers. He adds, "Loops are just starting to be utilized for travel-time calculations, but in general we don't favor invasive technologies for environmental, installation and maintenance cost reasons. And although cell phone tracking, or Wireless Location Technology, has proved its worth along freeways, it may be of less value in an urban arterial setting due to the reduced distances being traveled, as well as interference from buildings." Arterials, he goes on to explain, also introduce added complexity as more paths are potentially feasible and systems must be able to correctly distinguish between wireless devices that aren't located within a vehicle and those that are. Bluetooth, Mohhades is sure, ticks many boxes so Iteris will continue to investigate its use in other projects and products in the future.

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Big business?

Alongside products from TrafficCast, Traffax, Iteris/Savari, and TTI's soon-to-be-available AWAM, suppliers elsewhere have made advances, notably Trinité Automatisering in the Netherlands with BlueTracking. So how big could the market be? "Outsiders to ITS might assume the market could be deduced by dividing the number of miles of urban roadway by sensor installations at two-mile intervals," suggests Phil Tarnoff. "It's actually more likely 5-10% of that, so the Bluetooth 'pie' might only be large enough for several small suppliers." Historically, he concludes, agencies have been slow to make use of real-time travel-time data on arterials, so for this reason he predicts sales expanding gradually. "But as Bluetooth is one of the few techniques capable of measuring arterial travel times, it could dominate this segment of the market for years to come."