



# Wireless Technologies in Industrial Markets

An Examination of Mesh Technologies  
in Transportation



## Executive Summary:

The transportation market not only encompasses light rail and buses, but also the infrastructure that supports these vehicles and trains must be addressed. Transportation systems and the supporting infrastructure are becoming increasingly important for cities around the globe. It is critical that transportation is easily accessible and meets the economic and social needs of an urban area. Key concerns include the safety and security of passengers, enhancements in operational efficiencies, green initiatives, and the ability for travelers to be more efficient and productive; therefore, the use of wireless technologies in the transportation market is becoming more and more prevalent.

Standards-based 802.11 a/b/g/n WiFi is often the wireless technology of choice for businesses. However, high interference, mobility requirements or critical applications may demand other wireless options such as Motorola's industrial strength MEA (Mobility Enabled Access) technology. Motorola's flexible Wireless Broadband Mesh portfolio offers both 802.11-based solutions as well as purpose-built MEA products.

In this third paper in a series of solution papers addressing mesh wireless technologies in industrial markets, the best solutions for transportation environments will be covered. This paper will describe how MEA as well as 802.11 technologies can be deployed in many situations, from mass transit, to road and rail infrastructures, and how the various mobility requirements, from low to high speed can be met. The unique strengths and capabilities of each wireless mesh technology will be examined and discussed using real world examples.



## WiFi and MEA – Two Access Options

Transportation requirements call for the consideration of two different broadband wireless communications – WiFi and MEA. These are two very distinct access technologies. WiFi is based on the 802.11 standards and off-the-shelf client devices are used to access the network. On the other hand, MEA is a purpose built industrial strength wireless mesh technology that was designed specifically to offer high speed mobility and perform in the most challenging environments around the globe.

### The Origin of WiFi

The WiFi or 802.11 standard was originally developed by the Institute of Electrical and Electronics Engineers (IEEE) with the purpose of wirelessly extending the link between the LAN port in the wall and the desktop computer. It has evolved over the years and now the generic WiFi term not only covers the 2.4 GHz 802.11b standard, but also includes products based on any of the 802.11 standards. WiFi is commonly used in enterprises to provide wireless high speed connectivity to the network for access to the Internet, email and other office applications.

### The History of MEA

The purpose-built Mobility Enabled Access (MEA) technology was originally developed for the US Department of Defense, Defense Advanced Research Projects Agency (DARPA) for battlefield communications. Through its client meshing, MEA enables each client device to act as a router to and from every other device. Therefore, signals do not have to try to penetrate difficult environments such as railway tunnels, but they simply use other client devices to pass the signal along while bypassing interference-causing barriers. MEA is also built to handle strong multi-path signals and high RF interference without significant degradation. MEA meshing works with the environment and not against it, resulting in communications that are fast, reliable, and mobile.

### The Capabilities of WiFi and MEA

WiFi and MEA technologies are increasingly being thought of as complementary, differentiated only by the applications and environments they support best. This is becoming important to customers in transportation sectors that are investigating outdoor and indoor wireless strategies, requiring solutions that cover many different needs and can include:

- Communication based train control systems
- Passenger services
- Off load of onboard CCTV video surveillance content
- Analysis of critical transportation system data and diagnostics

Both WiFi and MEA can be used in wireless mesh networks and the strengths and trade-offs of each technology must be considered.

In the past WiFi traded throughput for range, making it the technology of choice for short-distance environments in unlicensed radio bands. However with improved standards, such as 802.11n, the increase in bandwidth enables more advanced applications using WiFi, such as video surveillance, and increasingly with the advances in Motorola's mesh algorithm technology, low to medium speed mobility can be supported in standards based environments.

However, with the harsh and congested RF environments present in many cities' transportation systems Motorola's 6300 series (Solo) products with the MEA technology are often the solutions of choice for critical data applications and communication at high speeds for control systems.

### Glasgow City Bus System

First Bus in Glasgow, Scotland deployed a hybrid Motorola WiFi and MEA network to help relieve traffic congestion and improve bus transportation throughout the city. The system utilized MEA's enhanced mobile connectivity and reliability to track the movement of 500 vehicles over eight key bus routes, collecting and transmitting data used to enable real-time traffic control. The network supported mobile units located in city buses and access points across the city. Results have been exemplary and included journey times, reduced congestion and increased passenger satisfaction.

MEA's strength lies in its ability to offer consistent throughput with exceptional interference mitigation. Motorola's 6300 series Mesh Wide Area Networks (MWAN) with MEA technology are able to evaluate the entire 2.4 GHz band, choosing the best channel for communications on a packet-by-packet basis. This enables the network to dynamically avoid other radio transmissions or interference. Motorola's MEA radios feature client meshing as well, wirelessly extending and strengthening the network as the radios move throughout a transportation system. MEA's "bullet proof" reliability ensures there is no loss in connectivity so communications are not missed and any issues can be handled proactively to mitigate delays and breakdowns.

When considering the different wireless technologies for operators, the type of physical network and the types of applications that are being used will be the key determining factors. Sometimes instead of deploying a WiFi or MEA specific network, a hybrid network is implemented to leverage the strengths of both technologies. WiFi's ability to support off-the-shelf clients and higher throughputs may be important in certain areas of the network while the range, high speed mobility and reliability of the MEA technology is important in other parts to provide the optimal connectivity, cost-efficiency and performance required by a transportation operator.



### The Adoption of Meshing Technologies by the Transportation Industry

Both types of mesh wireless technologies are in use by the transportation market today. The business case for using mesh wireless networks has become clear. Transportation system operators are reducing investments in cabled systems and coupled together with the need for increased bandwidth over what is currently available with legacy systems, is driving operators and manufacturers to adopt wireless mesh technologies for the purpose of:

- Automation, train control and tracking
- Advanced passenger information and services
- Real time CCTV and video surveillance

Communication-based train and transit control systems are increasing efficiency and reducing congestion in the rail market. The capabilities, functionality and cost-efficiency of wireless mesh technologies are key to gathering and sending information to and from mass transit systems and centralized control points. As the metro rail market prepares for tremendous growth in passenger ridership over the next few years, the Motorola 6300 series with MEA technology is a key product designed to meet requirements regarding capacity and efficiency planning as well as safety remits for positive train control.

Looking at rail and mass transit systems on a macro level, a pattern is emerging. There are two types of connectivity needs: connectivity **within** a bus or train and connectivity **to** the bus or train from a central management site. In most cases, WiFi is the preferred form of connectivity within the vehicle, providing communications capabilities to passengers, dynamic in-vehicle signing and data collection to help maximize safety and service.

### Considerations for Transportation Operators Deploying Mesh

Whether it is a train, bus or other form of mass transit the physical environment will play a key role in the technology selected. The various factors, which must be taken into consideration include:

- When high speed mobility is required over high throughput then MEA should be considered. However, if high throughput with low to medium speed mobility (70 mph or less) is required then WiFi should be the technology of choice.
- MEA should be considered for applications that require not only high speed mobility, but also interference mitigation, secure hand-offs and dynamic infrastructure recovery, for critical applications.
- WiFi should be deployed when greater throughput for customer service applications and large video backhaul requirements come into play.
- In urban deployments there can be an increased radio noise floor; therefore, whether deploying MEA or WiFi design and planning tools are important for assessing transportation networks. The One Point Wireless Suite should be used to design, deploy and manage a mesh network for an operator.

Regarding the ability to communicate to and from trains and buses with broadband connections there are clear requirements in particular for video surveillance. This application can aid in crime prevention with onboard cameras providing content remotely, to PDAs, or video captured on platforms can be fed to and from trains while approaching and departing stations. Accessing video in real time addresses increased capacity and safety requests and the ability to monitor not just stations and static elements, but those that move also.

Options for combining mesh technologies in deployments, the hybrid approach, are very important to consider for this market. Many transportation operators have to service both passenger operations as well as enterprise business needs. The ability to use a combination of WiFi and MEA technologies enables and allows multiple applications to co-exist. A hybrid network permits a user to access both office applications for voice, video and data as well as interact with passenger information services. These hybrid mesh deployments are also used in signaling systems to monitor a train's position and efficiency, co-existing with a mesh network that monitors stations with wireless cameras for crime prevention and uses handheld devices with WiFi for delivery of video also.

### The Roadways and Infrastructure Supporting Mass Transit Systems

The operators of mass transit systems are increasingly using wireless broadband technologies, but those agencies that are responsible for the roadways and other infrastructure that these vehicles travel on also use wireless broadband in a variety of ways, especially in the monitoring and management of roadways and infrastructure to ensure safe and efficient functionality. For sensor networks that monitor roadways, bridges and other infrastructure components, MEA is becoming a preferred technology because of its exceptional ruggedness, longer ranges and reliability under harsh outdoor conditions, and because of the mission-critical nature of the information collected and transmitted.

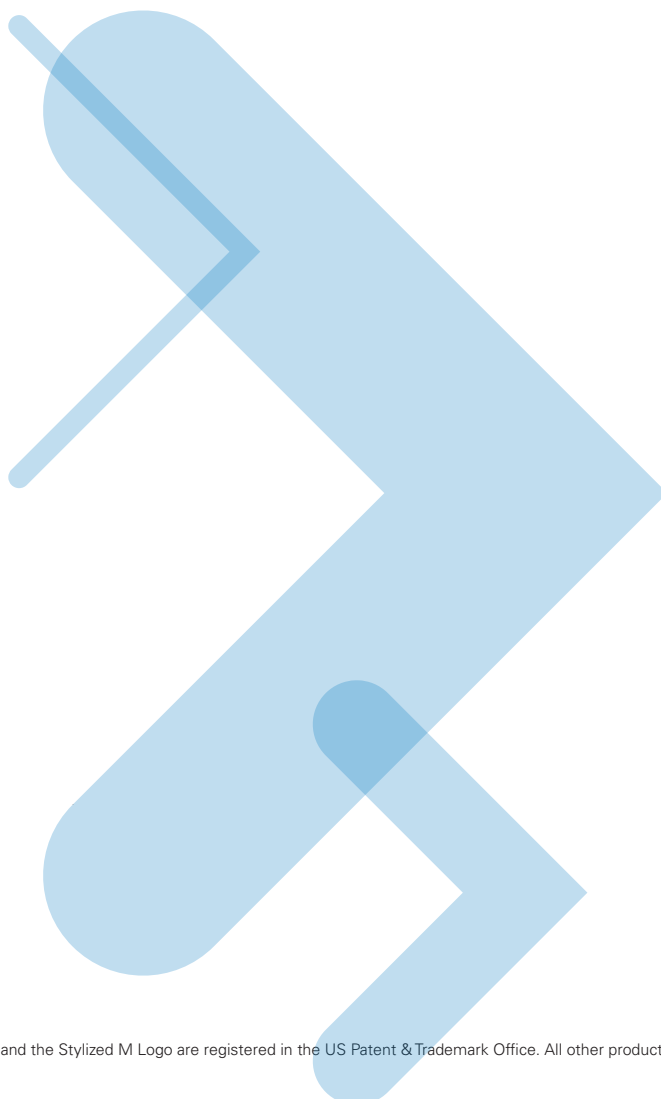
In bridge and highway monitoring applications, for example, MEA networks transmit data from sensors built into roadways and bridges. Information includes crucial safety data from embedded technology such as strain sensors that predict potential failures—like the 2007 Minnesota bridge collapse—before they can occur. MEA networks also transmit weather information, providing early warnings of freezing and icy roadway conditions, for example, enabling Departments of Transportation to ensure the highway salting process is timely and accurate.

### Green Initiatives

As the transportation industry works to reduce its carbon footprint, wireless technologies that offer high-speed mobile communications are being increasingly used in green initiatives. These range from keeping up-to-the-minute tabs on fuel efficiency and emissions data from not only buses, but cars and trucks as well. Here both MEA and WiFi based technology can help streamline emissions-friendly traffic initiatives, providing real-time monitoring of traffic in the new High Occupancy Vehicle (HOV) lanes.

### In Closing

Motorola is the industry leader in providing outdoor wireless mesh communications and the only company offering both WiFi and MEA solutions to meet the connectivity needs of the transportation market. A growing number of transportation operators as well as other agencies supporting the infrastructure needs of this market are turning to Motorola for hybrid or single technology mesh networks. These networks serve many purposes, including among others; improving passenger safety and security, enhancing the productivity of personnel as well as travelers, increasing operating efficiencies and meeting green initiatives.



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