Whitepaper

# Preparing Today's Logistic Operations For Tomorrow's Wireless Opportunities

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Wireless communication is a technology of the present and the future in logistics. Real-time communication and control is a market requirement. Wireless LANs have become indispensable for efficient distribution center management. Cell phones, pagers and e-mail devices have also become mainstream business tools. Businesses will be hard pressed to create a sustainable competitive advantage solely by implementing these technologies. As wireless communication becomes even more pervasive, companies can regain advantage by integrating established and emerging wireless technologies to create end-to-end logistics visibility and control.

Businesses are already profiting from new developments by leveraging their previous investments in wireless LAN technology to add new devices and functions to their networks. Businesses of the near future will fully exploit wireless investments and capabilities by converging multiple devices and wireless technologies – including wireless wide-area networks (WWANs), wireless LANs and Bluetooth-enabled personal area networks (PANs) – to create systems that provide end-to-end visibility and control in real time.

This white paper describes how logistics operations can benefit from advances in wide area, local area and personal area wireless communications and related computing and data collection technologies.

**Wide Area Communications**

The anticipation of highly touted, super fast third-generation (3G) wireless wide area networks (WWANs) has been tempered by unmet expectations and the often disappointing performance of early wireless communication technology. The first WWANs emerged in the 1980s and were characterized by limited coverage, slow transmission speeds (9.6 to 14.4 Kbps), incompatible competitive technology protocols, and usage rates that were cost prohibitive for most businesses. U.S. networks were based on circuit-switch technology developed primarily to carry voice traffic.

Second-generation (2G) systems evolved to packet-switch technology, which was developed for data transmission. These networks were marginally faster (up to 19.2 Kbps) and offered other important functions like two-way communication, and "always on" connectivity that eliminated the need for the user to dial in to establish a connection. Coverage and roaming opportunities were still limited because 2G networks built on a variety of incompatible technologies, including CDPD, DataTac, IDEN and Mobitex.

Most of North America is now covered by 2.5G wide area wireless data networks. For the first time, WWAN offerings can affordably meet the needs of mainstream logistics operators. Rates are based on the amount of data transmitted, and are typically 10 times lower than the initial 2G network plans. Speeds (up to 115Kbps) and coverage have also improved to the point where the technology is a viable business tool for many logistics operators.

**Current WWAN Technology Options**

One of the most important developments in the evolution of the U.S. WWAN industry has been the shakeout of available technologies. All 2.5G networks are based one of two technologies, CDMA 1XRTT and GPRS. The more focused technology landscape enables more roaming, and therefore more coverage, and has helped spur development of mobile devices and software to support wide area communications.

**CDMA 1XRTT** offers speed of 144 Kbps (although actual throughput is typically between 50 and 60 Kbps) and is capable of supporting data and voice communications, so mobile computers and cell phones can be used as multi-purpose devices. Data transmission is generally possible wherever cell phone coverage is available, a vast improvement over earlier wireless data offerings. Leading CDMA providers include Sprint PCS and Verizon.

**GPRS** is offered in the U.S. through AT&T Wireless, Cingular, T-Mobile and others, and is an evolved form of GSM technology that dominates the wireless landscape everywhere outside the U.S. GPRS offers 115 Kbps connectivity (typical throughput is 20 to 50 Kbps).

Speeds, coverage, rates and other network features are continually evolving. There is already considerable buzz about 3G wireless services, touted to provide mobile Internet access that would create a host of new consumer applications. However, for the logistics professional, 2.5G is a sweet spot that offers the right combination of speed, rates and cost to enhance operations and provide a fairly rapid return on investment. Here are some ways logistics operators can take advantage of current wide area wireless offerings.

**WWAN Applications**

Supporting operations with WWAN communication is especially effective if drivers are commonly rerouted throughout the day for additional pickups or deliveries, when pickup or delivery confirmation is required, and when operations would benefit from improved order visibility. If pagers, cell phones or wireless e-mail devices are used in addition to mobile computers WWANs offer the opportunity to converge devices and pay a single wireless service charge.

For example, AAA Cooper Transportation is an LTL carrier headquartered in Alabama that primarily serves the southeastern U.S. previously used voice radios to dispatch its drivers for additional pickups and deliveries. AAA Cooper conducted a mobile computing and WWAN communication trial at its Dallas terminal, which typically processes 700 to 800 pickups and 400 to 500 deliveries a day with 50 drivers. Daily delivery and pickup manifests are loaded onto the mobile computers that are kept in the truck. Drivers use the computers to record their arrival and activity performed at each customer site by entering a few keys. When each pickup or delivery is completed the transaction record is sent to the terminal over a WWAN connection. The information provides a real-time view of driver activity and produces information that enables AAA Cooper to answer customer inquiries quickly.

When wide-area wireless data communications were used to support mobile operations the company increased productivity by approximately one hour per driver per day. By transmitting pickup and delivery information throughout the day, AAA Cooper's planning systems could calculate the most efficient way to dispatch additional pickup requests and manage drivers in the field.

Back-end operations can also benefit from real-time updates of route activity. Ace Beverage, a beer distributor in California,

provides an excellent example. Like most distributors, Ace Beverage used to plan route operations and build the next day's loads after receiving order information from its pre-sales staff at the end of each day. Salespeople were required to have their orders in by 6 p.m., which left warehouse workers and dispatchers 11 hours to plan the routes and load the trucks. Operations frequently ran behind schedule if business was heavy or orders were received late, which led to overtime pay for distribution center workers and late deliveries for drivers.

Ace Beverage issued mobile computers with wide-area wireless data access to its pre-sales staff. Orders are now transmitted to the distribution center throughout the day, instead of being received en masse at deadline. Ace Beverage can now begin building loads by 2 p.m. and has eliminated between 15 and 20 hours of driver and distribution center overtime per week. Improvements to warehouse efficiency also saved an estimated $50,000 in capital equipment costs. New applications and simplified communications enabled by the mobile computers save each pre-sales representative an estimated 60 to 90 minutes daily, which frees more time for selling and interacting with customers.

Most businesses can easily envision how real-time route communications could improve operations and create competitive advantages. The traditional barriers to implementing wireless communication systems have been cost and coverage. Developments in WWAN, wireless LAN and mobile computing technology are rapidly removing these barriers. As the examples have shown, the benefits and business justification for end-to-end communications are not limited to large companies.

**Wireless LAN**

Wireless LANs use is certainly not new in logistics – the technology is a staple for dock, yard and warehouse management – but it does offer several important new capabilities that businesses can take advantage of to enhance their operations. Voice-over-IP phones and other new types of peripheral devices are available for use on wireless LANs, more bandwidth is available and protected by internationally recognized 802.11a and 802.11g standards, and the dramatic increase in the availability of public access wireless Internet "hot spots" is creating opportunities to use hybrid WLAN-WWAN networks for logistics applications.

Here are some wireless LAN developments and ideas on how logistics operators can take advantage of them to create responsive systems of the future.

**Voice over IP Telephony**

Many businesses are starting to use Ethernet network lines to carry telephone traffic. The advantage is no long distance charges are incurred when calls are made using the corporate data network. Because the widely used 802.11b wireless network standard follows Ethernet protocols, VoIP telephony works on these wireless networks. For many businesses, this capability will enable real time, two-way voice communications with mobile yard, dock and warehouse workers for the first time. Businesses that give their workers voice radios, pagers or cell phones for on-premise communication in addition to mobile computers can eliminate the separate communications devices and their support costs by consolidating all wireless communication on the mobile computer and wireless LAN.

Imagine the error prevention and time savings that convenient voice communication could provide. When discrepancies or problems arise, workers could support their decision making by calling a manager to report the situation and discuss options. For example, consider a yard driver that is directed to deliver a trailer to a specific dock location by receiving a wireless message on his in-cab computer. Upon arriving at the prescribed location he finds the dock blocked by an unattended trailer. The situation might typically be handled by driving to the dispatcher's office to report this situation, or by temporarily parking the load, perhaps blocking other movements, and setting off by foot to speak with the dispatcher.

By enabling the in-cab computer with voice-over-IP capability, the driver could report the problem immediately without leaving the vehicle. The dispatcher could instruct the driver to wait briefly unloading is nearly complete for the trailer in the dock door is nearly complete, or could direct the driver to a new dock location for immediate processing. Whatever the outcome, the problem would be resolved without a productivity-wasting, time-consuming trip to the dispatcher's office. Because the driver never leaves the vehicle or temporarily stores the trailer, there is no chance it could be lost in the yard.

VoIP could also be used to help verify loads, resolve picking and putaway questions and improve other distribution center and yard operations where decision making is required. One of the great advantages of VoIP is that is works perfectly well with existing 802.11b networks, which is the most-used wireless protocol for enterprise applications today.

**Higher Throughput WLAN Standards**

802.11b is a wireless networking standard established by the Institute of Electrical and Electronics Engineers (IEEE). The IEEE 802.11b standard specifies the use of the 2.4 GHz frequency band and supports data transmission speeds of up to 11 megabits per second (Mbps). Many logistics applications are also currently served with pre-standard legacy technology, which typically has throughput of 1-2 Mbps and may operate at other frequencies, including 450 MHz and 928 MHz.

Acceptance and usage are growing for other IEEE wireless networking standards – most notably 802.11a and 802.11g – that offer faster data transmission. These standards aren't necessary to support warehouse picking and putaway, dock and yard management and other common logistics applications, but offer additional bandwidth that could be used to carry new types of data traffic to create even more application possibilities.

The **802.11a standard** was ratified the same time as 802.11b but failed to gain the same level of acceptance. 802.11a specifies throughput of up to 54 Mbps and utilizes bandwidth in the 5 GHz spectrum, which, unlike 2.4 GHz, is not available for use in all parts of the world.

The newer **802.11g standard** has the same maximum throughput as 802.11a but operates at 2.4 GHz, which solves some of the usability limitations associated with 802.1a. Most importantly, 802.11g-standard radios must be backward-compatible with 802.11b networks. That means companies can use their existing 802.11b access points to communicate with 802.11g devices. When access points reach their end of life and need to be replaced,

802.11g models can be installed to provide faster throughput without requiring mobile equipment changeover.

The higher-bandwidth standards pave the way for future logistics applications that include wireless voice, data and video communication from a variety of devices for end-to-end real-time visibility. Today, wireless LANs are used primarily to send brief pickup, putaway and dispatch messages. Some organizations route voice traffic over their industrial wireless networks, others support data collection operations with wireless bar code scanners and printers, and still others are using radio frequency identification (RFID) to track pallets and capital assets.

Adoption of all these technologies is growing rapidly – various studies found wireless VoIP use quadrupled from 2001 to 2002, RFID is growing approximately 30 percent annually, and cordless products are one of the fastest-growing segments of the bar code industry. This increased proliferation means that wireless LANs of the near future will carry phone calls, pages, bar code scans and print instructions and thousands of individual RFID tag readings in addition to regular mobile computer data transmissions. Logistics providers could perform all traditional and emerging applications for dock, yard and warehouse management with a dual-radio mobile computer that would also go over the road to satisfy remote dispatch, transaction reporting and voice communications needs.

The U.S. military uses converged wireless logistics systems today. Material shipped to support the conflicts in Afghanistan and Iraq was tracked from dispatch to receipt in the field through a combination of mobile computers, wireless LANs, remote RFID readers and manual bar code scanning. The integrated systems met the DoD's goal of providing total asset visibility. Many businesses share the same goal, and before long will be sharing the same techniques for attaining it.

**Hot Spots**

A growing wireless consumer service may also give a boost to future logistics automation efforts. "Hot spots," which are wireless LANs established to provide Internet access to consumers, could soon have a role in business operations. There are currently approximately 31,000 hot spots in operation, but there will be 135,000 by 2007 according to research by London-based Datamonitor PLC.

Hot spots were first available in airports and a few business hotels, but the number and types of locations is expanding quickly to include coffee shops, fast-food restaurants, campuses and public places. As the volume and variety of hot spot locations grow, so does their value to business.

Truck drivers could periodically update their location and status, upload completed pickups and deliveries and other activities throughout the day with their wireless mobile computers when Web access was available through a hot spot. Data exchanges could be planned at regular intervals if routes consistently pass through areas where wireless Web access is available. This may not be possible today but could become practical fairly quickly. For example, hot spots are operational at dozens of McDonald's and Starbucks locations and each company plans to expand its offerings. Because there are McDonald's locations at thousands of interstate highway exits, and Starbucks are present in many high-density office and residential areas in the U.S., full hot spot implementation by these chains would mean that truck drivers would likely have wireless Web access several times throughout the day. Companies with logistics operations in areas served by hot spots could use the hot spots to supplement their wide-area network coverage. Wireless data network operators are encouraging hybrid network applications and are sponsoring many new installations as a way to augment their service.

To take full advantage of wireless developments logistics operators will need flexible mobile computers capable of handling multiple radio technologies. An 802.11b-standard radio is required to access hot spots, while wide area data transmission requires a separate radio matched to the wireless network. Mobile computers for logistics available today currently provide simultaneous support for up to three radio types (wireless LAN, WWAN and Bluetooth short-range radio). When supported with the right software, these mobile computers can continually probe the airwaves to see what coverage is available and automatically configure themselves to communicate using the lowest-cost network. Multiple radio support enhances connectivity and makes the most efficient use of wireless communication.

**Bluetooth**

Bluetooth is a complementary wireless technology that provides convenience and flexibility for using multiple devices within a single application. Bluetooth has a maximum range of about 30 feet, can be used in place of cables to help mobile computers communicate with peripheral devices like printers, bar code readers or GPS units. Bluetooth is much less effective when used as a true networking technology because of range, security and other limitations.

The immediate benefits to replacing cable connections with Bluetooth are the elimination of cable repair and replacement costs, and improved safety, ergonomics and productivity. Bluetooth can also help future-proof your system and provide a migration path that simplifies the process of adding new technologies. Because mobile computers with Bluetooth can be used with any other Bluetooth-enabled device, the mobile computer itself does not have to have all the functionality needed for current and future applications. For example, if a company is bar coding pallets now and may add RFID in the future, it could use Bluetooth to manage communication between the computer and reading device. That way, RFID reading would not have to be included, and paid for, in the initial mobile computing investment. When the time comes to add RFID to the application, Bluetooth-enabled handheld RFID readers would be purchased and the mobile computers would not need to be replaced.

**Using Converged Wireless in Real-World Logistics**

The combination of multiple wireless technologies, mobile computers and automated data collection can provide total visibility in logistics. All cases, cartons and reusable assets like pallets and totes should be identified with bar code or RFID to provide the foundation for total tracking and visibility. Wireless LAN systems can track items through receiving, cross dock, storage and distribution operations throughout the premises. Tractors and trailers may be permanently identified with RFID tags, with unattended readers used to automatically monitor their movements and locations throughout the facility. A combination of automatic identification, wireless LANs and VoIP telephony would manage loading and dispatch operations.

Real-time control does not need to end when the truck leaves the yard. Wide-area wireless communication enables dynamic management of transportation operations, so drivers can be rerouted for additional pickups throughout the day. By getting new dispatch instructions as they are received, rather than in a batch during a phone call near the end of the day, drivers can choose efficient routes and sequences that reduce wasteful trips, saving time and fuel.

If a driver is delayed at one stop, it may impact his ability to serve the rest of the route on time, which is a large potential problem for companies who must meet tight delivery windows. Real time communications allow the driver to communicate directly with customers to determine the next available delivery location. The driver can then adjust accordingly.

Companies can also use their WWAN connection to improve consistency of service and productivity when temporary or casual workers service routes. Messages about special customer rules and requirements could be pushed to irregular workers to ensure contract compliance and service consistency. If the instructions were unclear, the driver could call for clarification using the same device.

Sometimes when freight is broken up to maximize loading efficiency, confusion arises about what items belong with each delivery. Drivers could resolve these questions by consulting a manifest record stored on the mobile computer, or using the device to call for instructions.

Successful deliveries could be completed by using a digital imager built into the mobile computer to take a picture of the freight to document its delivery conditions. Next, the driver could begin printing delivery documentation through a command sent over a Bluetooth connection between the mobile computer and a printer that could be worn on his belt or mounted in the truck. The driver and customer could review the paperwork and immediately resolve any discrepancies that could potentially hold up payment. A pen-input mobile computer could electronically capture the customer's signature for proof of delivery, then communicate the image and delivery confirmation to the host computer system to update CRM and distribution applications. If these applications are Web based, information from field operations can be accessible to the enterprise and its customers around the world within seconds of the transaction being completed in the field.

The Bluetooth connection could also be used to record truck activity for route and productivity analysis. Carriers can embed a GPS module with a Bluetooth connection on the vehicle and query it periodically with the mobile computer to record and store the data. This wireless monitoring application requires no operator activity and can be done without the knowledge of the driver. Data or alerts could be reported back to the carrier over the WWAN.

**Measuring Results of Wireless Technology Implementations**
While wireless connectivity and performance is critical to smooth operation in the logistics operations applications described here, there is also the need to implement software, applications and business processes to take full advantage of the technology and these are often bundled into total solutions, making identification of individual elements difficult. In addition, customer agreements prevent specific disclosures of system costs and specific savings. However, in support of the technology applications and directions described in the paper, the following points of evidence have been extracted from a several different customer case studies:

1) A large international parcel delivery company responsible for moving over 50 Million parcels per year introduced WLAN technology at all sorting centers and handheld computing technologies for all carriers. The company realized a 33 percent improvement in productivity at the beginning and end of shift activities due to faster, more accurate route information transfers and a substantial increase in customer satisfaction due to Proof of Delivery, instant alerting and on-line status reporting facilitated by real time GPRS reporting of route progress by all delivery personnel.

2) A large LTL carrier, with more than 110 cross-docks and service centers across the United States, implemented WLAN systems along with wireless printers and handheld computers/scanners in every center. All access points are administered as one network, and software and firmware upgrades to equipment are conducted over the air to all connected devices. The combination of electronic manifests, auto downloads of route assignments and end-of-shift auto reporting saved the company more than 50 cents on each customer billing event. This, along with other improvements in efficiency, led to a payback of less than 11 months.

3) A large LTL in the southeast US, with operations in more than 17 states, implemented handheld computers with WLAN and wide-area wireless integrated in each unit. In conjunction with a yard and dock door management application, the company was able to reduce phone traffic to their dispatch centers by 70% - 80%. Much of the savings was used to grow the business with the existing employee base and recover the cost of the systems in less than one year.

4) A large Canadian oil production company, producing more than 230,000 barrels of crude oil each day, implemented wireless handheld computing for its delivery drivers and WLANs within its service centers where 90,000 line item units, ranging from tools to 320-ton earth moving trucks, are managed, repaired and serviced. The improvements in inventory management and more accurate, timely customer deliveries allowed the company to improve its return on capital by 25.7% in the first full year of operation. As they find new ways to use the technology, they continue to improve this KPI by nearly 20% year over year.

**Conclusion**
Businesses have implemented most of the "future" applications described in this paper, but no single company has integrated all the possible features and applications that converged wireless communications makes possible. By building the logistics IT infrastructure upon a foundation of standardized technologies and flexible products that facilitate easy upgrades and allow new functionality to be added over time, businesses can meet current needs and position themselves to quickly take advantage of future opportunities.

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