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Wireless Management of Industrial Vehicles

By Greg Smith
I.D. Systems, Inc.

Before beginning an overview of wireless fleet management technology, it is fundamental to understand why end-users of such equipment should care about managing it at all.

First: SAFETY AND SECURITY. Bad things happen when untrained or unauthorized people use industrial vehicles. According to statistics compiled by the US Occupational Safety and Health Administration (OSHA), close to 100 deaths and approximately 100,000 injuries occur every year in this country as a direct result of powered industrial truck accidents. Consequently, OSHA has expanded its regulations on operating such equipment (see 29 CFR Part 1910). In particular, OSHA now requires that all employers must ensure that only trained operators use powered industrial trucks, and that such equipment is in safe operating condition prior to use (via a pre-shift inspection checklist, for example).

Figure 1: Example of vehicle hardware from a wireless fleet management system *

Beyond adhering to government regulations, employers should be concerned about vehicle safety because it impacts the workplace environment and productivity. As former Alcoa CEO Paul O'Neill made clear, if management genuinely focuses on workplace safety, workers get the message that management genuinely cares about them, which boosts morale and, as a result, increases productivity. Improving safety practices also increases productivity by decreasing sick days due to injuries. A safer workplace also means lower workman's compensation costs and less risk of exposure to liability costs. Ultimately, improving safety, including industrial vehicle safety, improves a company's operating results and profitability.

Hand in hand with safety is security - a concern of increasing importance to corporations and government agencies alike. The US Transportation Security Administration (TSA), for example, is focusing on the security of vehicles with access to commercial aircraft. And the US military is increasingly concerned about not only its own equipment, but also the vehicles that third-party contract warehouse operators use to handle Department of Defense material.

Second: UTILIZATION. The greatest expenses associated with industrial equipment are the capital costs to acquire it and the labor costs to operate it. A run-of-the-mill forklift typically costs between $20,000 and $30,000, with some specialized units, like turret/reach trucks, costing in excess of $70,000. And the prices of larger, more complex machinery increase exponentially - a high-capacity portal crane, for example, can cost 100 times more than a forklift.

But acquiring industrial equipment is only the tip of the cost iceberg. A two-shift operation will spend between $50,000 and $200,000 annually on the personnel needed to operate each piece of equipment. A detailed understanding of how industrial equipment is utilized and how its productivity can be measured should therefore be of vital importance to the management of any organization that operates such equipment. As the saying goes, "you can't manage what you can't measure." And because of the ways in which much industrial equipment is allocated and utilized, there are often ample opportunities for an organization to reduce the size of its fleet and, as a result, significantly decrease both its capital and operating costs.

Third: MAINTENANCE. As any fleet owner knows, labor is not the only significant ongoing cost associated with industrial vehicles. The annual cost to maintain a piece of equipment can reach 10 to 20 percent of its acquisition cost, even with a "fixed" third-party maintenance contract (which typically only covers simple low-cost preventative maintenance, but not high-cost "abuse" damage charges). Furthermore, a lack of timely information on the health of equipment, an inefficient process for maintenance planning, and poor control of equipment that needs maintenance - all common management issues - contribute to increased equipment down time, which simultaneously increases maintenance costs and reduces productivity.

Why Wireless?

If an organization is convinced that managing its industrial equipment is important, the next question becomes: does fleet management necessarily require an investment in new technology (After all, industrial equipment has been in productive use for decades without any fancy technology attached to it)? If so, what technologies are most effective for fleet management?

A brief look at some of the fundamental requirements for fleet management - and the existing "low-tech" ways most companies currently manage those requirements - suggests that wireless technology can add significant value.

· Access control is the most fundamental element of fleet management. Without it, there is virtually no accountability for use of equipment, no way to guarantee OSHA regulations are being met, no means of keeping equipment where it is needed, and in many cases no way to measure operator productivity. Without technology, the only option for vehicle access control is a manual "key control" or "driver sign-out" system. But these methods are anything but foolproof, even at the point where operators take possession of their vehicles. And once the vehicles "go mobile," these manual systems lose all control over vehicle usage. Clearly, a technology that can automate access control, no matter where vehicles may be, and provide visibility of who has used (or misused) equipment would be a valuable foundation for improved fleet management. It is also obvious, since vehicles are inherently mobile, that for any automated access control system to work effectively, it would have to involve wireless technology.

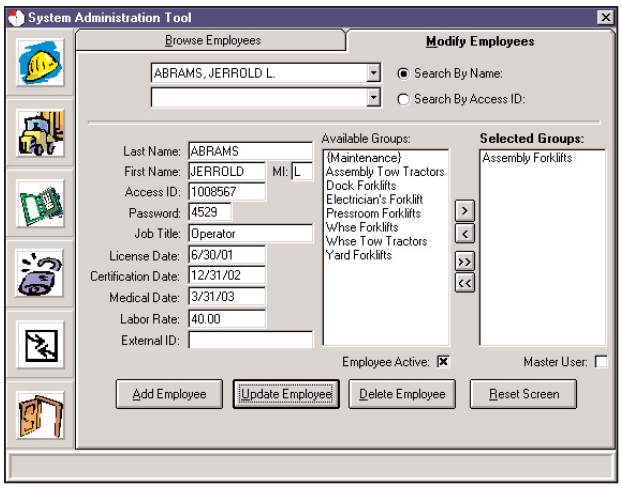

Figure 2: Typical access control software in a wireless fleet management system *

· Safety inspection checklists are a core component of most corporate health and safety policies for operating powered industrial equipment. Unfortunately, without technology the only way to administer a checklist is through a manual paper process. Such paper-based checklists are prone to human errors and omissions, processing delays and labor-intensive handling. Paper checklists - if they get filled out and turned in at all - are often simply filed away. Even when paper checklists are reviewed, they can take weeks to get from the vehicle operator to a safety manager or mechanic, and the delay can turn minor maintenance and safety issues into major problems. Wireless technology can therefore play a key role in making checklists more effective and manageable - by automatically uploading accurate checklist data, making that data available in real time to safety and maintenance management, and correlating completed (and non-completed) checklists with operators to ensure compliance with health and safety policies.

· Utilization analysis of equipment without wireless technology is basically limited to a reading of hour meters and the experience (or intuition) of operations management. But hour meter readings cannot provide the data necessary to make valid judgments on whether a fleet is "right-sized" or not. First, what do the meters actually measure? In most internal combustion vehicles and older electric vehicles, the primary hour meter measures key time, not motion time, and thus does not reflect the vehicles' true productivity. Second, even when hour meters do indicate vehicle motion, they cannot shed light on peak vehicle needs (how many vehicles are used simultaneously at any given time), particularly the varying peak needs of different operational groups. Consequently, to determine proper fleet size, operations managers typically rely on their experience, which boils down to either an educated guess or a subjective assumption on the proper ratio of work volume to vehicle quantity. In either case, the decision is made without meaningful quantitative data, which almost always results in a fleet with too many vehicles.

· Vehicle location tracking is simply not an option without wireless technology. Location tracking is vital to fleet management because, combined with access control, it eliminates "missing" vehicles (and the lost productivity they cause) and ensures that management can see at any moment what vehicles are available to get the required work done. Without real-time visibility of equipment (and access control), there is no way to ensure that all vehicles allocated to a specific operation will be available when they are required for peak workload. This lack of visibility contributes directly to the "oversizing" of fleets - operational managers must request more vehicles than they truly need to meet peak workload, because they cannot count on all of their vehicles being available (within physical proximity) at any given moment.

· Vehicle dispatching can be made much more efficient with wireless technology. Instead of manually handing off

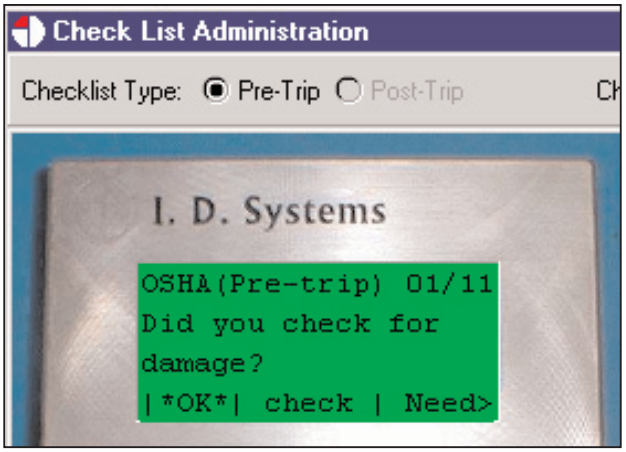

Figure 3: Electronic safety inspection checklists are a key part of wireless fleet management *

paper-based work orders, which is typically a time-consuming, unproductive process, management can use wireless communications to provide workers on mobile equipment with work instructions, requests for overtime, quality assurance reminders, and other text messages.

· Fleet maintenance - like checklist administration and fleet utilization analysis - becomes significantly more effective with wireless technology. Even the most advanced non-wireless maintenance systems rely on manual processes (data collection from vehicles and data entry into a database) that are prone to error. This data processing is not only subject to the "garbage in, garbage out" syndrome, it is also labor-intensive. And the data collected (vehicle hour meter readings) does not always reflect true usage of equipment, as discussed previously under utilization analysis. Furthermore, non-wireless systems cannot provide mechanics with an easy way to locate and gain control over equipment that is overdue for maintenance or needs to be locked out for safety reasons. Wireless technology can also provide additional maintenance functionality, such as automated battery rotation management, that is unavailable through manual systems.

Wireless Technology Options

Wireless technology comes in many different flavors for a wide range of applications, but for vehicle and fleet management, there are basically four wireless communication options: satellite, cellular, high-bandwidth radio frequency (RF) and narrow-band RF.

Satellite communications are preferred for applications where vehicles roam over wide areas throughout the world, and where cellular communications are not viable. Military and railcar applications, in particular, often link mobile assets to central management via satellite. But for campus-based applications (factories, warehouses, ports, airports, etc.), satellite communication has two major drawbacks: it cannot be used under roof or any other overhead obstruction (the transceiver requires direct line-of-sight to a satellite), and it carries an extremely high ongoing cost for the communication service.

Cellular communication with mobile equipment is a good solution for over-the-road vehicles traveling in areas where cellular coverage is good. Many trucking companies use cellular-based systems to track and manage their tractor-trailer fleets. But like satellite-based systems, cellular systems suffer key limitations for campus-based applications. Because cellular systems rely on GPS satellite receivers for positioning data, they too are ineffective for location tracking when vehicles are under roof. And like satellite communication systems, cellular systems require ongoing monthly service costs, which can make them very expensive over time.

RF systems are shorter-range than satellite or cellular systems, they work well both indoors and out, and they do not require any ongoing monthly communication costs, so they are much better suited for campus-based fleet management applications.

The most common indoor RF systems for industrial applications are wireless local area networks (WLANs), most of which operate over a license-free 2.4 GHz communication standard known as 802.11b (more popularly referred to as Wi-Fi). WLANs are used for a wide range of applications, some of which (like warehouse management systems) relate to some extent to vehicle operation. But WLANs cannot offer many functions that are essential for vehicle and fleet management - they do not provide operator access control, vehicle location tracking, motor usage/maintenance data collection, or battery rotation management, for example. In addition, vehicles that communicate through a WLAN require constant connectivity; if a vehicle goes out of range of the WLAN, or if the WLAN goes down for any reason, the vehicle's wireless terminal will cease to function. Vehicle-mounted wireless terminals also drain energy from a vehicle's battery at a high rate, which makes it virtually impossible to use such terminals on internal combustion vehicles (which have relatively small batteries). Finally, at some secure installations, such as military bases, WLANs may not be deployed due to security risks.

Narrow-band RF systems are much better suited for campus-based vehicle and fleet management than any other RF systems. First and foremost, they can support every key vehicle management function, from access control to location tracking (both indoors and out) to battery rotation management. Second, they can perform autonomously, even if

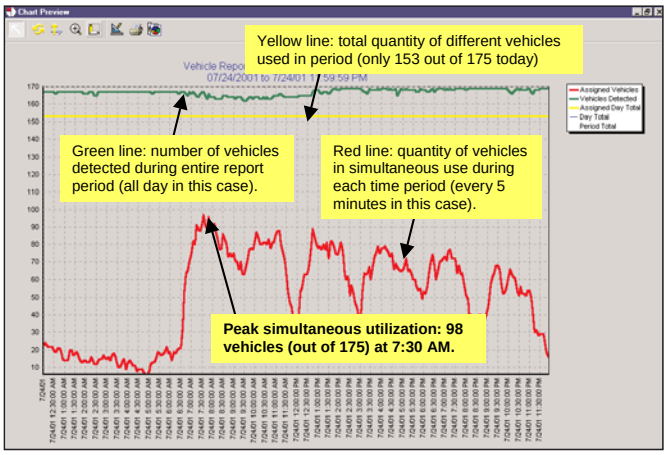

Figure 4: Simultaneous utilization charts are among many unique productivity tools provided by the most advanced wireless fleet management systems *

the local area network is down or the vehicles are not in RF range of a networked device. Third, they have low power consumption and low RF energy output, so they can be installed on any type of equipment without affecting any other RF systems. Finally, narrow-band RF systems can be configured for a level of security sufficient for deployment at even the most sensitive military installations.

Who Has Narrow-Band RF Fleet Management Technology?

Organizations deploying narrow-band wireless fleet management systems run the gamut from heavy industrial manufacturers to consumer goods producers and retailers to government agencies. Those organizations include 3M, Alcoa, Archer Daniels Midland, Avis, Daimler Chrysler, Deere & Co., Ford, General Dynamics, Hallmark Cards, Northrop Grumman, Target, Walgreen, the US Navy, the US Postal Service and the US Transportation Security Administration.

Clearly, any organization with a significant investment in material handling equipment or other industrial vehicles can potentially benefit from wireless fleet management technology. But it is interesting to note that various organizations focus on different aspects of fleet management. Ford Motor Company, for example, has made access control and pre-shift OSHA checklists the cornerstone of its industrial truck safety program. Avis is intent on automating the car return process to improve customer service and eliminate the labor cost of vehicle data collection. The US Postal Service has realized major cost savings by conducting detailed utilization analyses of powered equipment. And the Transportation Security Administration is seeking to introduce enhanced vehicle security functionality to protect and secure equipment that operates in close proximity to commercial aircraft.

What Wireless Fleet Management Systems Do

Wireless fleet management systems start with "intelligent" vehicle hardware mounted inside a vehicle's cab (See Figure 1). This hardware incorporates an interactive keypad, a visual display, a link to the vehicle's ignition system and other sensors and memory to store a database of operator identification numbers. To start a vehicle, an employee must enter his or her identification number on the keypad (or present an electronic form of identification such as a proximity card). Only trained or authorized drivers, as indicated by the stored onboard database, will be able to start the vehicle. Unauthorized personnel will not be able to start the vehicle.

Because the vehicle hardware stores authorized driver IDs in its own memory, it controls vehicle access autonomously. It does not rely on constant RF communication or network access to provide access control.

By automating vehicle access control, fleet managers establish operator accountability, create a new way to measure driver productivity, identify driver training opportunities, associate maintenance issues with specific drivers and optimize the quality of the work force.

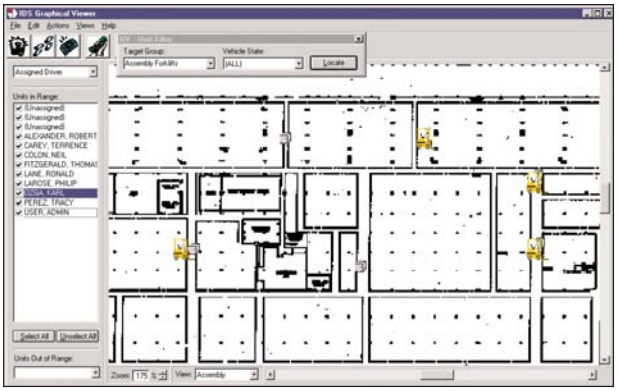

Figure 5: Advanced wireless fleet management systems can provide real-time vehicle location and status (plus historical travel paths), both indoors and out *

Wireless connectivity makes access control easily manageable by remote software (see Figure 2). Management can quickly update drivers' license and certification status, add newly hired drivers, deactivate drivers who are no longer employed and change the authorized groups to which drivers belong. A driver will be able to start only those vehicles that are placed in the same specific group(s) in which he or she is placed.

In some systems, special access control features are available, such as automatic deactivation of operators whose license, training certification or medical clearance expires. Security enhancements are also available, like supplemental personal identification numbers (PINs) to defeat the use of lost, stolen or counterfeited identification cards. And as an additional safety enforcement tool, many systems offer an optional impact sensor to help monitor vehicle abuse.

When an authorized driver logs onto a vehicle, he or she is automatically prompted to complete an electronic checklist via the vehicle hardware display (see Figure 3). Some wireless fleet management systems can define different checklists for different types of vehicles (e.g. diesel tow tractors, LP forklifts, electric cranes, etc.), determine how frequently checklists are required (typically once at the start of every shift) and update checklists automatically by remote software. Management defines the questions, possible responses, and, in some cases, the "severity" of each response. Reports provide a comprehensive audit trail for all fleet checklists, detail the specific maintenance/safety issues identified by drivers, and identify drivers who are not completing their checklists. Some advanced systems can also be programmed to respond automatically to different checklist responses by, for example, automatically generating e-mail alerts.

A wireless system's ability to continually collect up-to-date vehicle utilization information is indispensable for identifying and tracking under-utilized vehicles. Sensors integrated with the vehicle hardware detect and record a vehicle's motion/idle state and other operational data. The system stores and automatically uploads this information to a database on the local area network. The system can report the data - for both drivers and vehicles - by time, group, shift, and other management-defined parameters. The most advanced wireless fleet management systems feature expanded utilization analysis tools, such as graphical charts of driver productivity and simultaneous vehicle use (see Figure 4).

Advanced systems will also feature real-time graphical views of equipment location and status (See Figure 5). Because this location tracking is RF-based, there are no ongoing costs associated with it, in contrast to systems that use cellular or satellite communications to report vehicle location, which have a high recurring communication cost. Depending on system options selected, additional iconography (e.g. vehicles that are low on fuel, excessively idle, due for maintenance or in an unauthorized area) can also be displayed. The accuracy of the location algorithm is dependent on the number of factors, but is generally between 50 to 200 feet, which is sufficient for practical operational purposes. If more accurate location is desired, many systems offer a GPS receiver option for vehicles that operate outdoors.

Real-time location tracking software will also typically have a historical replay feature that can play back vehicle (or operator) location and movement from any cross-section of time, which can augment productivity analysis. In some cases, this software can also generate an automatic alert when a vehicle enters an "unauthorized" geographical area, and enable security personnel to shut down any unauthorized vehicles remotely.

Text paging is yet another productivity tool incorporated into some wireless fleet management systems. This tool can allow management to send work orders, maintenance notices, overtime requests, quality control reminders, and other messages to drivers - individually, by group or in a fleet-wide broadcast. Messages targeted to an individual will "follow" that driver to whatever piece of equipment he or she logs into, and messages targeted at specific vehicles will be displayed no matter what driver logs in. This tool can save supervisors, drivers and mechanics alike a significant amount of labor time.

The simple goal of planned maintenance is to reduce overall fleet repair costs. A wireless fleet management system enables reductions in both preventative and unplanned maintenance costs in a number of different ways.

Preventative maintenance events (PMs) are usually performed according to a vehicle's hour meter or by calendar.

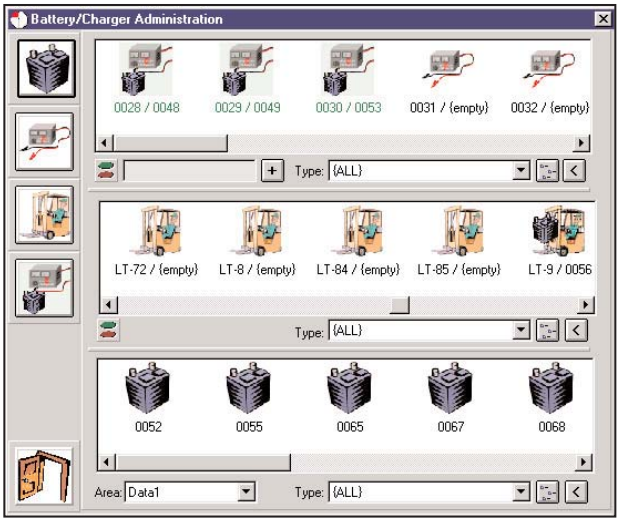

Figure 6: Automated battery rotation management for electric vehicles is a feature of a few wireless fleet management systems *

Both methods are inexact. Many hour meters, especially on internal combustion vehicles and older electric equipment, do not reflect actual motion time and, as a result, overstate a vehicle's utilization. In many applications, actual vehicle drive time averages less than 50 percent of "key time" hour meter readings. A wireless system's detection of actual drive and idle time is therefore extremely important in determining the true activity of each vehicle and its proper maintenance intervals. Without that accurate data, too many PMs will be performed on some vehicles, while other equipment many not receive enough PMs.

By providing safety checklist data to maintenance in real time, a wireless system can identify small issues when they arise, so they can be corrected before becoming large, costly problems. Expedited checklist data can also eliminate delays in ordering parts and, as a result, reduce unnecessary vehicle down time.

Another important tool provided by some wireless systems is the ability to deactivate vehicles overdue for scheduled maintenance. A manager can deactivate a vehicle remotely via system software so that, temporarily, nobody can use the vehicle except for a "master user," such as a mechanic. Advanced wireless systems will also incorporate automated maintenance scheduling software, and an option to export vehicle usage data to existing maintenance databases.

For electric vehicles, some wireless fleet management systems offer battery management options. In the most basic versions, a voltage sensor detects when a battery is running low and the system flags deep-discharged batteries. In more sophisticated systems, battery rotation management software (see Figure 6) will respond to a request for a battery swap by specifying which charger the operator should go to and which battery he or she should retrieve. If more than one charging area exists at the facility, the message will also indicate the closest charging area to the vehicle's current location. After the operator has performed the battery swap and before the vehicle can be started, the vehicle hardware will require the operator to present a ID tag that is tethered to the battery. This assures automatic confirmation of which battery was in fact placed on the vehicle.

Summary

Advanced wireless technology delivers multi-faceted solutions for industrial fleet management and can deliver a compelling return on investment in many applications, as demonstrated by the wide range of leading corporations and government agencies that have deployed the technology.

Greg Smith is director of communications for I.D. Systems, Inc., a provider of wireless fleet management solutions. He is also a member of the Material Handling Association of America and chairman of the Safety & Security Committee of the International Aviation Ground Support Association.

Contact I.D. Systems at www.id-systems.com

**** Editor's note: Image courtesy of I.D. Systems, Inc.***

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