White Paper

Wireless Technologies for Intermodal Operations

THE FUTURE IS CONVERGING

LXE®

1. Global supply chains

The Internet may give the impression that the world is shrinking, but the world of global supply chains is most definitely expanding. A key issue is that companies in the US, Europe and elsewhere are increasingly outsourcing their manufacturing capabilities overseas. This physically separates the point of manufacture from the point of consumption. This leads to the natural consequence that more and more goods need to be moved around the globe, which for the most part means by ship. The result is that supply chains are becoming increasingly complex networks. Overall, the demand for shipping and global supply chains is actually running ahead of global economies.

With increased globalization and offshore sourcing, global supply chain management is becoming an important issue for many businesses. Like traditional supply chain management, the underlying factors behind the trend are reducing the costs of procurement and decreasing the risks related to purchasing activities. The big difference is that global supply chain management involves a company's worldwide interests and suppliers rather than simply a local or national orientation.

Because global supply chain management usually involves a plethora of countries, it also usually comes with a plethora of new difficulties that need to be dealt with appropriately. One that companies need to consider is the overall costs. While local labor costs may be significantly lower, companies must also focus on the costs of space, tariffs, and other expenses related to doing business overseas. Additionally, companies need to factor in the exchange rate. Obviously, companies must do their research and give serious consideration to all of these different elements as part of their global supply management approach.

Finally, companies who choose to ship their manufacturing overseas may have to face some additional considerations as well. Questions regarding the number of plants that are needed, as well as the locations for those plants can pose difficult logistical problems for companies. However, it often helps to examine these issues in terms of the global supply chain. For example, if a business uses a number of vendors around Bangalore, India than it may make sense to locate the manufacturing plant that would utilize those supplies in or around Bangalore as well. Not only will this provide lower employee costs, but overall shipping and tariff expenses should also be reduced. This would then save the company money.

2. LXE’s intermodal credentials


Terminal Operations System

LXE has been servicing this market since 1980. Currently over 300 ports are using LXE equipment and wireless technology. LXE has the largest port LAN installation in the world. LXE works very closely with its intermodal partner CISCO Systems and is a STI and Premier Certified Partner, and has all the necessary certification for advanced wireless LAN solutions.

LXE deploys a lot of CISCO infrastructure worldwide, servicing ports with equipment that meets the IEEE 802.11 standard. In fact some of LXE's first deployments in the late 1990s were among the first to effectively make 802.11 viable in port installations through value-added products such as the LXE Spire® Antenna, which provided extended range and throughput to make 802.11 viable for covering large geographic areas such as container yards.

LXE also complements the port's infrastructures with NEMA enclosures that make access points and other RF infrastructure products viable for the outdoor environment, and fully supports them with client devices for data collection with IP65 and even IP67 specifications. These specifications enable an effective data capture system worldwide under virtually any condition. Through the years LXE's basic data capture devices have been extended to provide complementary solutions installed by LXE or its partners, along with integration services to enable complementary solutions covering GPS, RTLS, OCR systems for visual gate systems, RFID, voice, monitoring and reading of electronic containers, and diagnostics for frame maintenance. The end result is that LXE is a dominant player in this market.

3. The changing port environment

It is clear when considering today's market that it has changed significantly in the last three decades, since LXE started servicing ports in 1980. The name of the game is no longer merely moving containers off ships and onto another mode of transportation. Today's supply networks are highly complex, and are continuing to increase in complexity. Retailers and consignees of freight are looking at them as complete networks where the intervening lengths may be changed at will to serve their particular cost and delivery needs. Furthermore, as noted earlier, the continual outsourcing by manufacturers to overseas operations, and the separation of point of manufacture from the point of consumption, means that cargo growth is outpacing global economies. In fact the infrastructure of ports is not keeping up with the increase in cargo growth at a global level. Certainly there are some regional differences but the overall need is to find ways

A number of new container terminals are being developed and many of these are implementing new technologies, like automation and methods that are challenging existing operations. Even these are faced with the need to expand and increase capacity. Terminal operators increasingly need to find value-added services beyond the mere movement of cargo. Consignees and port ecosystem partners need access to a wide variety of data that encompasses much more than just the movement of goods. They need to know the health of those containers, change of custody items, scheduling of container yard resources for dockside maintenance and servicing of ships, and scheduling of resources. This implies that there is a huge amount of information and packaged services that terminal operators need to provide to the surrounding partners and communities.

At the same time, security and customs procedures are becoming an increasing factor in port operations and data capture – and all must be implemented without negatively impacting speed of operation. Finally, all around the world, environmental issues and local community issues are placing constraints on operations. Ports are unfortunately viewed in many communities as having negative impacts on the local community and on the environment as a whole.

4. The challenges

The specific challenges faced by any particular operation can vary greatly by instance based on geography, politics, economics, etc., and their relative importance can vary as well. But keep in mind, “the only thing constant is change”. So be prepared that the picture may (and will) change for any particular site in time. Presented below are those which face ports worldwide generally.

4.1 More cargo

Demands on port operations to handle containers are growing at nearly double-digit rates, driven by global trade growth, offshoring and the resulting geographic separation of production from consumption. In spite of recent concerns about short-term economic prospects in regional theaters and markets, long-term global and regional economic growth prospects continue. And given the capital investment levels and lead times port operations face, it is the long-term, larger issues which operators need to address, regardless of short-term economic fluctuations. Expansion plans may be underway in many locales, but generally will be stressed to keep up with demand. Globally, demand for higher utilization of port facilities continues to rise.

4.2 More ships

In addition to the presence of increasing numbers of ships on the world’s oceans, ship sizes are clearly growing, now to over 10,000 TEU in capacity. This creates needs not only for infrastructures to address their shear size, but also to provide turn-around times that do not compromise their utilization.
At the same time, consolidations in the shipping industry can be expected to increase berthings, generally. As a result of both dynamics, ports need the agility to configure quayside operations accordingly.

4.3 More agility

Compounding the aforementioned demands by increased cargo and ship volumes, shifting trade dynamics, both global and regional, create imbalance in the nature, modes and volume of traffic. In turn, these put pressure on operations to adjust to the ebbs and flows on all inbound, outbound and internal traffic and operations. Trans-shipments are on the increase, while the location and volumes of intermodal transfers are also changing. Port operations critically need the agility to adapt.

4.4 More security

Port operations today come under increased scrutiny for comprehensive security in all aspects and all levels of operations. This covers not just cargo with potential weapons material, but also cargo in pirated, contraband, gray market and even human content. Consignees also demand security in cargo handling for purposes of track and trace, changes of custody and pedigree. Beyond the cargo itself, security must also address the integrity of operations at perimeters, points of access and in internal operations. And a certain level of these provisions must be visible and well received by the communities surrounding ports to allay any concerns which might place constraints on current and future operations.

4.5 More visibility

Retailers and consignees in their supply chains are driven by consumer expectations that the products they want will be available when and where they want them. It's very much a case of "no excuses or no SALE!" The visibility and predictability that this requires in supply chains is clearly driven back through port operations all the way to manufacturers. Data and processes must exist not just for consignee visibility, but also for internal operations and planning. What's coming? Where is it now? What/when is the next move? Is the required resource available? Will staging for the next move be ready?

Consider the in-dash visibility now afforded to car drivers not only to track via GPS, but also to see real-time road congestion to adjust time and route accordingly. Queuing of ships, trucks and rail should have no less visibility for port community partners on the exterior, and more for internal processes.

4.6 Less space

Traditional notions about the relationship of container yard density to access are being tested in the attempt to achieve economies of space without compromise of access with minimal moves. Why? Because in some cases existing container yards are being pushed beyond their design throughput capacity in advance of expansion plans or where acquisition of land for expansion is difficult for economic,

political or environmental reasons. Landed/stacked operations must be optimized to provide spatial efficiency without compromise of access and throughput efficiencies.

4.7 Less time

The time a commercial aircraft spends at a gate is pure cost / no revenue for the airline. Many of the more nimble, creative airline operators outperformed their competition through creative processes to reduce gate turn-around time and get aircraft back in the air generating revenue. Likewise, cargo sitting in a container idle in a yard isn't moving towards its destination, and eats time and revenue. While dwell time is a common metric for port efficiency, you must look deeper and further to uncover improvement potential. How many moves does a container take from entrance to exit? What is the move execution time for each? What are the transfer times? Where is the overhead in each?

4.8 Less energy, less environmental impact

Ports are perceived (and many times, real) producers of pollution to their surrounding communities and beyond. There are already many changes in products and technology to start addressing this highly visible issue. Alternate power and more efficient drives in container handling equipment are already being deployed. Ships can cutover to the local electrical grid while berthed. Trucks queued at yard entrance gates contribute significantly to carbon emissions in the local environment as do hostlers waiting for containers in internal transfers. Any and all delays in transfers between container handling equipment in the yard result in excess power consumption, pollution production and throughput reduction. Any unnecessary movement of equipment clearly also has similar impact.

4.9 Less complexity

Today's systems are often implemented with multiple siloed applications, interfaces and infrastructures which may serve discrete functions well, but the ability to see "big picture" issues and execute adjustments is hampered by the complexity of working with discrete systems with little or no interaction or alignment. Discrete issues in one application can have huge, cascading impacts in others. This can spell problems throughout operations and all interfaces to them. Equipment operators are faced with a dizzying array of data, voice and operational equipment, controls and interfaces. This alone can create significant bottlenecks and safety issues. For the IT and support functions, this means managing a myriad of infrastructures, protocols, interfaces and separate systems. For partners in the shipping ecosystem, this can complicate, if not totally preclude, access to critical information needed for supply chain success.

5. New information requirements

All these factors are leading to an increasing need for information beyond the identification and movement of containers. A whole array of information about the movement of containers, the scheduling of resources, and the current real-time state of port operations is vital to operational success, which means increasing amounts of data need to be captured. That includes not only the port operations and its staff but a wide range of third-party employees and other people around the dockside, covering information about services and other operations going on within the yard, above and beyond the direct movement of containers. All of this communication needs to be in real-time to provide proper visibility and a correct view of the health and state of port operations. It needs to be secure for all the right reasons; it needs to be adaptable and flexible to changing demand in bandwidth; and it needs to take into consideration the nature of information – whether it's data, voice or video. In addition, it needs to be based on information technologies and network technologies that are widely supportable and based on standard IP protocols that allow all these systems to converge.

6. Key trends

Over its 30-year history, LXE has stressed the need for – and the value to be gained from – moving data and information collection to the point of activity. Batch is no longer viable. If information is 30 minutes out of date it's critical. Port operators need to know about the movement of material and the nature of that material in real-time; data which can only be captured if performed at the point of transaction. Increasingly, because of the information demands noted earlier, this information might not be simple text data capture but might involve video and voice support. Consequently, this needs to be automated, because increasingly one of the problems seen in all domains is that data and information added by operators can be riddled with errors. There are two problems with data that has been captured by operators. One is that human operators are not very good at repetitive data entry tasks; they create errors. The second aspect is that the time that operators are spending interfacing with the IT system (for example, by entering data) means that they are not involved in the more critical tasks for which they are most valued and paid, which is moving material. An operator's primary role is to move material, not to spend time interfacing with the IT system.

This is the reason why considerable emphasis is placed on automating data collection, so that operators can spend more time on tasks for which they are paid and valued. At the same time, if they are doing less data entry, this means fewer errors!

To enable automatic data collection in warehousing and distribution operations, it’s vital that the technology serves the process and the operators, and not vice versa. Of course, it’s not surprising that confusion arises considering the array of technologies and devices that port operators have to deal with. Ease of use is therefore of primary importance. More IT and new technology deployment tasks fail because it’s not intuitive. On the contrary, it’s frequently interruptive and/or disruptive to operators’ operations.

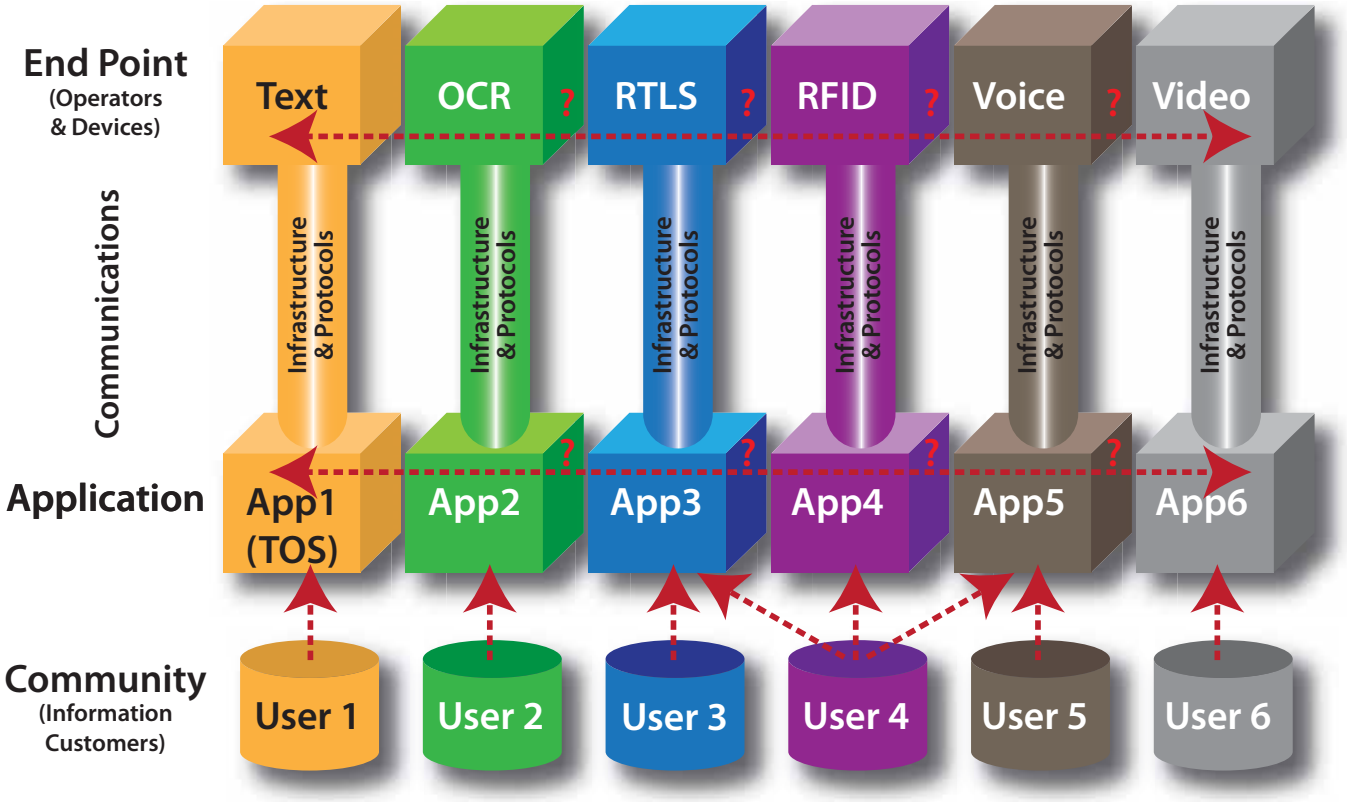
So these devices should be as automated as much as possible, and should work in the background in a naturally intuitive way that serves the operators’ native capabilities and does not make new demands on the operator. Above all else, this information needs to be in real-time, 100% available in a robust environment and 100% accurate.

7. System silos limit solutions

Part of the problem that port operators face in addressing all these demands is that their current systems have been developed as independent solutions from top to bottom. The typical initial operation provides a terminal operating system; a series of end devices that operators use to provide input about the movement of containers around the yard; and the instructions that go out to those operators by traditional terminal operating system. On the back end are the yard management people who are tasked with keeping a finger on the pulse of the movement of these containers.

What has happened over time is that additional systems have been deployed for a variety of different reasons, to provide OCR, RTLS, RFID, voice and video. However, each of these applications has typically been deployed with their own infrastructure and protocols, and their own devices out in the container handling equipment or in the yard. Each application is typically not linked together, with separate interfaces and users. The end result is a disparate rather than an integrated set of solutions.

As noted earlier, seldom if ever do these applications link, so how can the broader community of partners, consignees and the port ecosystem be serviced, when information has to be accessed from each of these systems? Knowing where a container is located in the yard is not sufficient. What is its health? Its temperature? These can be provided by RFID. This could be complemented by OCR or RTLS to provide useful information to the consignee or shipper. If these systems are not inter-linked, then that information might have to be obtained manually through different interfaces, which is an exceedingly inefficient system.

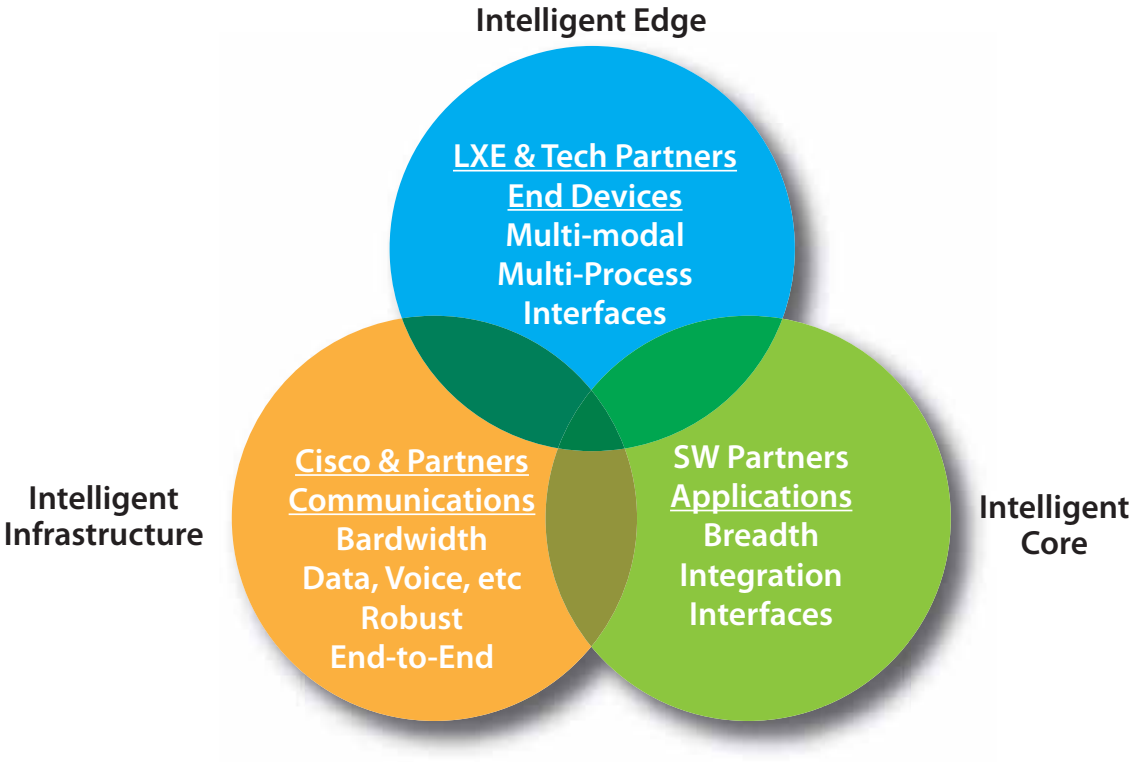


8. Solution: Convergence and intelligence

On the operations side, for the operators out on the container handling equipment, this means a wide array of devices, each with their own function, their own interface, and their own wiring. For each device the operator needs to know how to use it, what to use it for, and when to use it. If there are opportunities for combining OCR and text or voice, video and RFID, it certainly can't be done in the operations mode. For a particular user to get access to information from RTLS, RFID and voice to communicate about the status of a container in the yard, a more efficient system is vital.

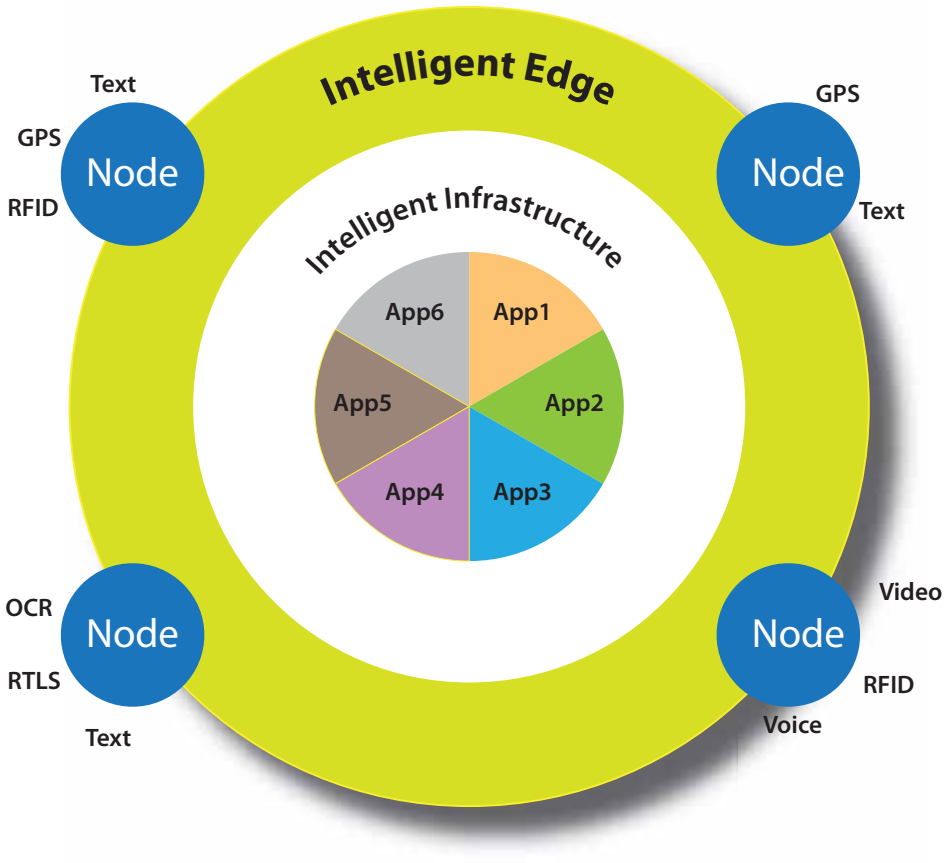
From a high level, the overall solution involves convergence and intelligence. This involves the ability to provide an appropriate link and integrate silos more efficiently. From an application perspective this means that the applications are integrated or at the very least well connected so that they can talk to one another. This involves a way of sharing data between applications across a common interface to a user community on the back end that is useful and informative, and which provides access to the right information through the right interface at the right time.

All of this information capture needs to take place over a common agile infrastructure that is able to deal with data, voice and video. Such a shared infrastructure should be able to provide access to all the information that the applications need at the right time. At the level of the container handling equipment such as RTGs and cranes, intelligent devices are needed that provide multiple modes of input that can capture all this data, feed it back over that intelligent infrastructure, and service all the different application and community needs for input. These data capture devices and computing platforms need to be either installed in the cabs or held by the operators, and should be capable of collecting and processing data, whether it's GPS, RFID, RTLS, text, OCR, video or voice information.



9. Intelligence at the Edge

It is at the “Edge” of the system where most data acquisition occurs and where most benefit can come from its intelligent use. This can include keyboard entry, OCR, RFID, RTLS, GPS, video, voice, biometrics and other technologies. In many installations, totally discrete systems are deployed for different data collection and communications functions. These “siloed” systems hinder collaborative use of different sources, applications and communications that will yield the most improvement of efficiency and accuracy. If there is any combined use of the data, it is either back within applications remote from the execution point in narrowly constructed interfaces, or it is the equipment operator who is left to make sense and use of it. Neither is optimal; neither makes best use of the appropriate resources available at the point of transaction. A better approach collects all appropriate data locally and processes the combined input locally according to operations logic and policies implemented in local “intelligence”.



Let’s take an example. A crane picks a container for placement on a waiting chassis. This operation typically involves communication of instructions to the crane operator from the terminal operating system (TOS) via a screen on a computer in the cab. Often an optical character recognition (OSR) system is used to “read” the container identification number and send it back through its “system”. Back within the data processing center, the OCR application hands the container ID to the TOS, which updates its process and instructions to the operator. The container is picked up and moved to the chassis. Any latency in either system impedes progress; any failure in either system may preclude progress. If the OCR

system failed to accurately “decode” the container ID due to inclement to weather or the poor condition of the ID characters, an inaccurate record and transaction may result. Rather, if the OCR device fed an intelligent process in the cab’s computer which updated the TOS through its local process, latency and communication bandwidth are saved at a minimum. If all works properly, the operator faces minimum distraction as this exchange takes place in the background. If a potential flaw in ID recognition occurs as above, the operator might have local access to the OCR image or direct view of the container to validate and correct.

This example also illustrates an important point. Much automated data (and sensor) capture is done to mitigate potential human error in input. In manufacturing, there can be a large measure of control of environment, timing, etc. But totally automated systems in container yards are challenged to anticipate and detect all potential errors and exceptions in the transaction environment. Here is where the human operator can serve as a very agile “sensor” to assess and correct exceptions, particularly if he has access to data and processes locally.

10. Intelligent infrastructure

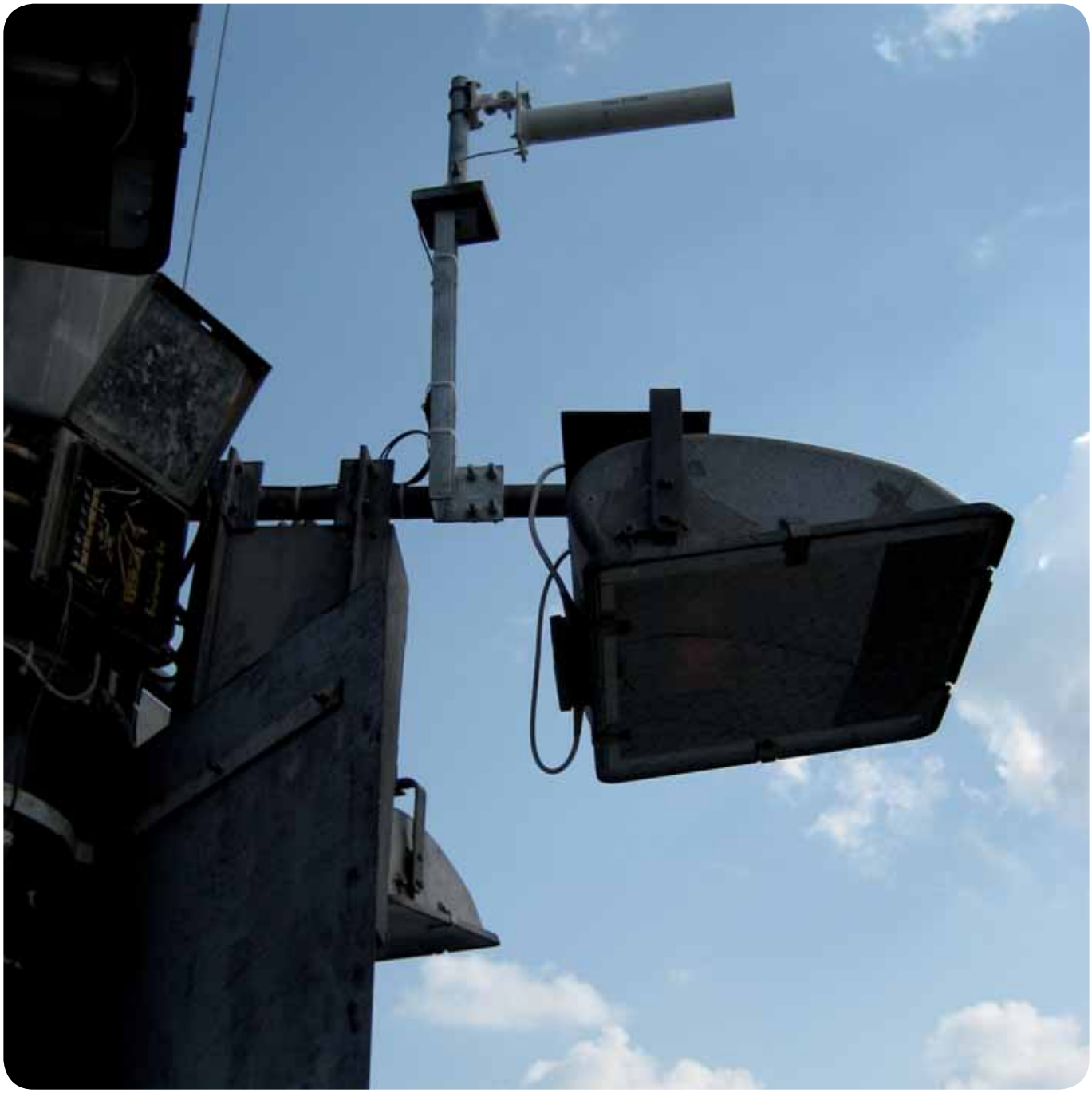
To support this use of converged, intelligent devices an intelligent information network is needed that is capable of handling all that information, whether it's data, voice or video. It should enable converged network services that can provide the necessary information whether it's a single type of data or multiple types of data servicing the applications on the back-end. This is not just a wireless infrastructure but a combination of fixed and wireless equipment for both local and remote access. It needs to serve multiple applications, and above all else it needs to provide all this in an adaptable and robust fashion that provides the right bandwidth for the right needs at the right time. It needs to serve multiple communities, whether that's the port operators themselves or customs, piloting services, shippers or the end consignees. This means it needs to provide access to multiple communities, with the right access and the right security based on the right policies. From an operations perspective this has to be done with common consistent protocols and common management schemes, and not with the independent silo infrastructures with different management tools, different protocols and different capabilities.

11. Intelligence at the core

All the information discussed so far needs to funnel back over the intelligent infrastructure to a set of applications that are highly integrated, that provide the right set of services for all partners, consignees and others in the port ecosystem. There is a great need for high visibility and low latency, enabling immediate visibility into current operations and answers to questions such as Where is the container? What is its health? What is its temperature? Are there any exceptional conditions to deal with? How do I schedule resources most efficiently? All these answers rely on low latency and high visibility, and lead to a process that optimizes resources and which is more efficient, less polluting and less costly, with the full array of information available through all these data capture systems, devices and applications.

12. Partners: Serving the ecosystem

All this comes together through the right set of partners. LXE, its technology and its partners provide the right devices with the necessary computing capabilities and interfaces to provide multi-modal input. LXE teams with companies such as CISCO Systems and its partners, who can provide the right intelligent infrastructure and a robust reliable infrastructure that provides sufficient bandwidth to support data, voice and video in a robust fashion and with solid and reliable communications. The right application partners are also essential, along with the related applications, to provide the breadth of services, the integration of information and the interfaces to service the port ecosystem community, providing an intelligent core to complement the intelligent infrastructure and intelligent edge.



13. Convergence put into practice: Use Case illustrations

To give some substance to these concepts, we have assembled a set of use cases which depict a set of problems or challenges common to port and container yard operations, the solution approach as based on these concepts and the resulting benefits. It is worth noting that these examples are generally not dependent on new technologies, rather just convergence (or "smart integration") of existing technologies.

13.1 Use Case: Quay crane operator interface

Problem/Issue

The quay crane operator needs to focus on the move of the container which may be 30 meters below him. The operator must also read or monitor instructions from the local display of the TOS or other application. The need to attend to both attentively and visually interrupts concentration, focus and time, creating unnecessary strain, delays and safety risks.

Solution approach

In similar fashion to today's GPS systems for automobile drivers, the solution approach employs voice-based instructions, while allowing operator voice response for acknowledgement or input. A headset with microphone and earphone is coupled to the wireless mobile computer displaying the TOS interface. This approach requires some updates to the application software for voice support, but this is fairly common in applications such as warehouse management and distribution applications. So the operator's instructions are "spoken" to him and his responses are fed back by speech recognition. In this fashion, the operator can interact with the application while maintaining focus on the critical container movement.

Benefits

- Operator maintains focus on the container movement
- Efficiency and throughput are improved through elimination of operator interruptions to view and respond to application instructions
- Visual and attention strain to the operator are reduced
- Overall safety during the container move are improved due to improved operator focus
- Using straightforward verbal instructions and responses reduces training complexity and time.

13.2 Use Case: Gantry and crane safety

Problem/Issue

The presence of often a considerable number of RTG's, RMG's and other machinery moving around the port environment can present problems and lead to safety issues. Drivers as well as ground crew can be affected by such hazards.

Solution approach

The automation of proximity control of moving equipment is a first solution to address these issues, followed by equipping the ground crew with RTLS/RFID devices. RTG's, RMG's and other machinery can be equipped with sensors, while critical threshold equipment stops are additional safety features. The end result is that operators and ground crew can receive alerts based on their proximity to equipment.

Benefits

- Improved safety
- Reduced operator and crew strain
- Improved morale

13.3 Use Case: ICT to port transportation

Problem/Issue

Lack of visibility between separate ICT's and ports can lead to queuing and congestion at gates, docks and on roads, and in general can lead to the inefficient utilization and planning of port resources. Furthermore, excess pollution can lead to negative community impact in and around the port environment.

Solution approach

The key is to provide continuous, uninterrupted, real-time visibility. This can be achieved by equipping trucks with Wi-Fi and GPRS links and GPS systems. Wireless link rollover can be automated, while application software for real-time tracking and planning can prove beneficial.

Benefits

- Improved throughput and delivery performance
- Reduced congestion at gates, docks and on roads
- Improved resource utilization and planning
- Reduced pollution, improved community relations

13.4 Use Case: Cab device convergence

Problem/Issue

As technology continues to flow into the port, the multitude of control and communications devices in prime mover cabs can cause problems. For example, the multitude of operator interfaces leads to the need

for training courses. And of course, the more devices implemented, the higher the cost, not just in capital and installation costs but in maintenance and support costs.

Solution approach

Key here is to converge functions onto a single processing platform which provides interfaces for operators and sensors as well as a unified wireless backhaul.

Benefits

- Overall reduced capital and installation cost
- Reduced maintenance and support cost
- Reduced operator interface complexity and training
- Established platform for future expansion

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