Port radio data networks – back to the future

Can middleware designed for terminal operations provide a wider technology choice?

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Container terminals and port facilities are generally busy areas with the movement of cargo on and off the facility, and using heavy plant and equipment to handle the cargo. It is therefore not really a surprise that the use of radio frequency (RF) communications in this environment is quite widespread in order to aid the efficient management and monitoring of the cargo movements and status of the equipment and plant.

In ports and terminals, systems integrators utilize many types of RF communication for the transfer of operational and engineering data. This can vary from very short range systems to site wide networks.

Most short range applications are point to point devices or RFID type systems, such as container truck identification or security card access systems. These types of systems are used for driver authorization to permit use of the equipment. Short range systems are also implemented to reduce costs involved in cabling where this would be difficult to do.

However, when referring to port installations, inevitably one tends to think of the site wide wireless data networks, and most people will immediately think of a WiFi network; however this is not the only option, with several others being available, including Narrowband and GPRS (GSM).

WiFi

Mention a site wide radio data network and you immediately think of an IEEE 802.11 network, or to give it its more common name, a WiFi network. These are very common in ports and terminals these days because they are very flexible and most applications can use them to connect through to mobile equipment. In fact we commonly use WiFi networks to connect management and monitoring software to mobile equipment for functions, such as position determinations systems (GPS enabled equipment and tracking systems), and automated asset management, telemetry, and equipment status condition monitoring.

WiFi networks, however, are not always practical, can be expensive on larger sites, and rarely operate reliably straight out of the box. Most WiFi networks operate in the 2.4 gigahertz frequency band and the maximum eradiated power allowed limits the range to approximately 100 meters to 140 meters. This effectively means on all but the smallest of sites multiple access points will be required to cover the site with a cohesive network. This, in my opinion, is the weakness of this type of technology, as the access points need to be in line with the site of the mobiles and will also need to be connected to the site Local Area Network (LAN). This can lead to gaps in the coverage and, to compensate for this, ITS write our mobile applications allowing for potential patchy WiFi coverage by building in local processing and data buffering.

There are however some instances where the installation of a WiFi network is not possible or practical due to the lack of suitable access point locations or other reasons. An interesting recent example of this is the Messina Lines terminal at Genoa, Italy.

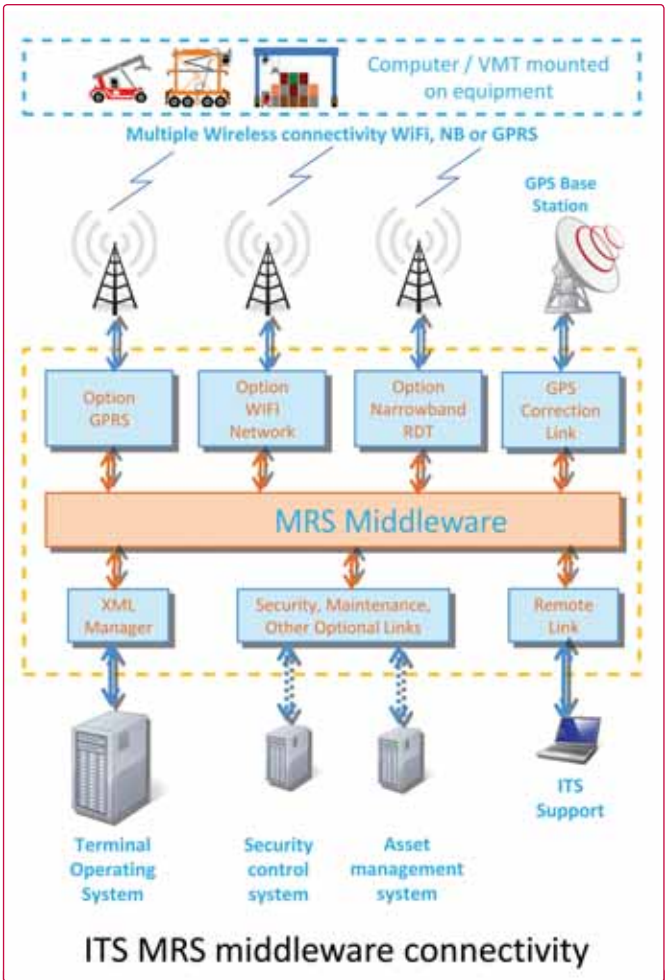

Figure 1. A block schematic.

Narrowband

As part of a site wide upgrade project, Messina Lines had decided to replace its existing internally developed Terminal Operating System (TOS). The system selected offered mobile connectivity using a thin client over a WiFi network. However this became an issue at the Genoa terminal, as, in common with many terminals, the site is leased and construction of suitable additional structures to mount access points was not possible. A number of vendors were approached but a workable, reliable, proven solution could not be found using WiFi.

Traditionally, Narrowband technology was used with a direct connection to the TOS (running a computer screen emulation at a lower data rate bandwidth). However, when WiFi came along, with its much wider bandwidth and higher levels of data exchanges, most TOS systems developed their interfaces solely

Figure 2. A picture of a RDT terminal connected to the MRS middleware.

for this medium in mind. So, at Messina, the new TOS was only able to connect to a WiFi network, which of course the terminal wasn't able to implement.

ITS have a long history using Narrowband technology in ports and terminals and have several Narrowband networks deployed. The feedback we get is that the users are happy with the Narrowband systems as the reliability is very high and has a range of several kilometers. This effectively allows a whole yard to be covered from a single transmitter with excellent coverage, even down between the containers in the stack.

Several years ago it became clear that TOS connectivity could become an issue for existing Narrowband users, so ITS started to develop the MRS middleware application. In its early days this was purely a translation programme to convert the bulky XML messages from the TOS in to a more streamline format that could transmit over the Narrowband network with its lower band width. The translation software was then connected to the existing radio frequency network management software (radio network server) and this then allowed all current TOS systems to connect to the Narrowband network and retain all the functions and features that modern terminals expect, making the Narrowband network completely transparent to the Terminal Operating System and the users alike.

Following on from this the logical step was to expand the connectivity of the software applications to create the MRS middleware. This has been in operation for a few years and the MRS application is designed to accept connections from multiple servers and clients such as TOS systems, access control systems, asset management and ERP systems, and many others. The main function this connectivity provides is the ability for the mobile to access and be accessed by various management systems. Two good examples of this are for security and engineering purposes, where security database applications can authorize remote mobile equipment operators using their access cards or log on PIN numbers and for engineering. Asset management systems can communicate directly with the equipment or operators to report faults and update equipment status.

ITS have many clients who utilize this MRS middleware technology, some using the WiFi connection but many using the Narrowband option. A prime example of this is one of Europe's largest transhipment hubs managing several million TEUs per year. This terminal runs all its GPS enabled PDS, mobile operator terminals, drivers' security card log on and remote asset management across a Narrowband network using the ITS MRS middleware application.

GPRS (GSM)

In the last five years many new technologies have matured and the focus has been on multiple radio frequency connectivity. This first started with dual connectivity to either a Narrowband or WiFi network, to ensure that software and systems could connect seamlessly. As mentioned above, this has been successfully implemented on a number of terminals, some using WiFi and some Narrowband. More recently, however, we have added GPRS or GSM connectivity to the middleware. GPRS or GSM technology is the transmission method used by mobile phones to send and receive data, and industrial rated mobile modules can be integrated into mobile systems for data only applications.

We first started this development when one of our existing UK customers wanted to also add a remote connection to roving equipment that could go off site, the key requirement for GPRS or GSM being to add network coverage to remote or extended sites where it was not commercially viable to add infrastructure. We finished our beta phase testing of this earlier this year and have now fully integrated this alongside the Narrowband and WiFi connectivity. The first implementation connects mobile harbor cranes and tugs to an asset management system. Interestingly one of the mobile harbor cranes is actually on a sister terminal some 30 kilometers from the main port area. Now the asset management system receives reports via WiFi for on site equipment and GPRS for off site equipment, all routed through the MRS middleware software.

Initially we were concerned that with GPRS or GSM there might be a notable lag in the data transmission, rendering it unsuitable for some purposes. However with messages being sent to the asset management system and acknowledgments being received back in only a second or so we are very pleased with the results, and more importantly so is the port with the purchase of additional mobile systems as their roll out progresses.

When asked what is the best radio data network for a container terminal, the answer almost certainly should be it depends on the sites' particular circumstances and requirements. WiFi networks, without doubt, offer good levels of connectivity but can be costly

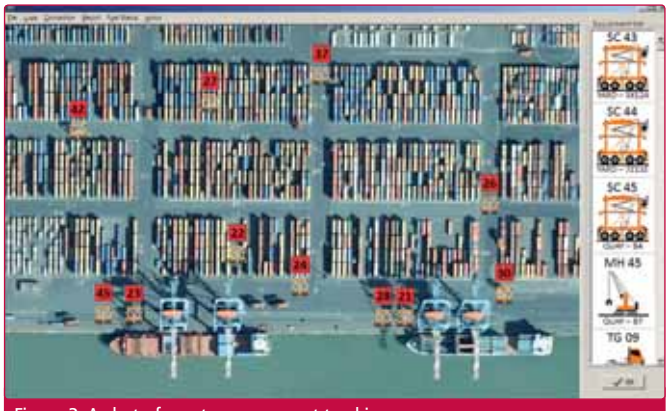

Figure 3. A shot of asset management tracking.

to implement, especially if there is not existing infrastructure to support and connect the multiple access points required to the main site wired network.

Coverage can also be an issue and this needs to be considered when writing any software for the remote mobile units, as connections can drop without warning. Narrowband networks have strong propagation and are relatively low cost to implement but also have some restrictions in their connectivity through lower band width, unless you also implement a well designed middleware application to handle this. GPRS or GSM technology can work well, and in fact is the only practical solution if you want a connection to your mobile equipment when it is outside the range of any site wireless network. But consideration also needs to be given to the running cost associated with the mobile phone operator's network charges, and occasional delays in data transmissions. However, whatever technology is adopted by the terminal it is quite clear that well designed middleware provides that optimal solution for flexibility to connect to any type of RF media both now and in the future, when additional functions and systems are implemented.

ABOUT THE AUTHOR

Richard Lambert studied Production Engineering at Nottingham Trent University, England. He has worked in the petrochemical and steel production industries, with projects aimed at optimizing production with the introduction of real time control and automation. Richard has over 20 years experience in implementing system solutions to port and terminal operations. Initially joining Morris Automation as a project manager, then leading the Ports and Terminal division of Savoye Logistics as the solutions director.

ABOUT THE COMPANY

In 2002 Richard lead a group of Port automation specialist to set up **International Terminal Solutions Limited**. The company specializes in turnkey automation projects for container terminals, concentrating specifically on the development and implementation of systems aimed in streamlining and increasing container terminals operational efficiency.

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