CONTAINER OWNERS ASSOCIATION

Guide to Container Tracking and Telematics Technology

An Overview of Technology Issues and Choices for Container Operators and Leasing Companies

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Contents

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Glossary of Terms

API
Application Programming Interface – the ability of different technology systems to communicate under a common, yet to be agreed standard.

BT / Zigbee
Bluetooth includes BLE (Blue Tooth Low Energy), a development of BT protocols to reduce power and/or increase range and Zigbee: globally standardised for PAN at 2.4 & 5.8 GHz ISM bands.

CAT-M1
Software upgrade to existing LTE base stations, introduction is being prioritised in the USA

IIOT
Industrial Internet of Things (different to the "consumer" Internet of Things - IOT)

ISM
Industrial, Scientific, Medical bandwidths – unlicensed, frequencies vary geographically (some are global).

Licensed radio spectrum
Usage of radio spectrum purchased from governments. Different bands/frequencies used in different countries, meaning that multiple bands are required to have global coverage

LoRa
Unlicensed, 900 MHz ISM, local regulations on transmission power
Regional variations: EU: 868 MHz, N&S America: 915 MHz

LTE
LTE (Long Term Evolution) is a standard for wireless broadband communication for mobile devices based on GSM/EDGE and UMTS/HSPA technologies.

It is commonly marketed as 4G LTE and uses different bands in licensed spectrum depending on the country and so use of LTE requires more expensive hardware. It includes the IIOT standards LTE-M (also known as CAT-M1) and NB-IOT.

NB-IOT
Narrow-band IOT requires new transmission hardware, introduction being prioritised in the EU, static application only, not compatible with CAT-M1.

Proprietary LANs/PANs
Specialised ISM bands with incompatibility issues

RFID
Radio-frequency identification (RFID) is where a 'tag' attached to a container can be interrogated by an RFID reader with radio waves.

There are passive 'tags' which gain their energy from the radio waves transmitted by the reader and semi-passive and active tags which have a power source (battery) to increase the operating range from the reader

Sigfox
A global network operator providing an LPWAN (low power ultra wide area network) using ISM transmission frequencies 868 MHz in Europe 902 MHz in the US. It is "ultra-narrowband" for good transmission through solid objects, supports up to 140 uplink messages a day each with a payload of 12 octets and data rate of up to 100 bytes per second.

3GPP Roadmap
Global cellular operators technology roadmap: migration from 2G-3G-4G-5G, main focus on consumer but also covers IIOT

Unlicensed radio spectrum
Use of spectrum open - user must follow radio interoperability requirements

WAN / LAN / PAN
Wide/Local/Personal Area Networks – different coverage ranges

WiFi
Globally standardised LAN technology at 2.4 & 5.8 GHz ISM bands

Background

Historically, data connectivity of containers mainly focused on reefers using a ‘wired’ connection, initially via a ‘4 pin socket’ – and, more recently, using a ‘modem’ to transmit data via the reefer powerline connection.

Dry container data was limited to “location-only” - from trials with RFID tags but primarily by visual gate reporting of the container serial number.

The smartphone revolution that began in 2007 enabled complex, hi-tech features to be manufactured in volume, supplying a global consumer market of c.1 billion units per year.

As a result, advanced battery technology, multiple transmission frequencies, movement and shock sensors, etc, are economically-priced features enabling their inclusion in niche, industrial applications.

For containers, this new IIOT technology enables data to move by wireless connectivity and brings the possibility of real-time data throughout a voyage.

For reefer containers, high value or sensitive cargo can be monitored, settings changed in transit and maintenance issues identified.

For dry freight containers, precise location data, shock/damage or door opening can be transmitted.

The evolution from ‘wired’ to ‘wireless’ provides great opportunities - but adds significant complexity because of the wide range of communication technologies available, how they are used around the world in different countries and communication issues with containers on vessels.

“Basic” Dry Van Communication Issues

As dry vans are not connected to power, a primary decision is to whether to fit a simple RFID device only reliant on sending back basic data to an RFID reader, or a more sophisticated device which has its own power, normally from a battery.

A simple RFID tag can now be reduced to an adhesive printed circuit little thicker than a standard decal and there are ongoing projects to enable these tags to enable more information than just the container serial number.

A device using a battery - or solar power - can record and communicate more data, such as an impact to the container, if the door has been opened or temperature as well as the identification details of the container.

These will need a small box and attachment to the exterior of the container in a position which minimises potential damage risk.

Simple RFID tags will have only a small cost and can be fitted quickly and economically. Powered devices will be more costly to purchase and install.

In summary, issues to consider are:

- Data flow (Two-way data flow is the norm in RFID, including for battery-less tags. One-way flow is the exception)
- The frequency of communication required
- Battery life – module size, cost, “recharge-ability”
- Device and installation cost
- Low or zero power consumption
- Sensor technology requirements – shock/impact, door opening
- Compatibility with vessel partners
- Landside: Country specific communication issues
  (Most RFIDs can operate in all countries, either by using common frequency bands, or by offering cross-compatibility. The UHF band is from 865 to 868 MHz in EU, versus 902 to 928 MHz in the US. Most UHF tags can operate simultaneously in both. By nature, RFIDs "adapt" their operating frequency to that of their local environment.)

Basic Reefer Communication Issues

- Landside transit: has different requirements to the ocean leg
  - Local infrastructure or satellite can be used during land transit
  - Ports/Terminals can use or modify existing infrastructure
  - 3GPP roadmap implementation differs between countries
- On vessels, owners/operators must invest in on-board communication hardware
  - There are a variety of transmission technologies available
  - Can it communicate with alliance partners’ hardware?
- Global use will require multiple communication technologies
  - Different cellular technologies and frequencies used in different countries
  - Container operators’ choice of hardware - compatibility for vessel sharing
- Telematics technology providers for the container:
  - Balance client’s needs for range of locations, options, power, budget
  - Higher quantity and frequency of data requires more power
  - Simple location data requires limited power (although "simple" location data needs to be acquired through GPS, which requires considerable power, especially if this is done very irregularly)
  - More countries and alliance partners increases transmitter requirements
  - Choice of transmission technology may impact compatibility and cost

Requirements and Considerations

Dry vans and reefers have different requirements. Specifically, with reefers:

- Access to power keeps data module active under power or batteries
- Perishable nature of cargo means larger range of data and frequency
- 2-way communication is likely in many cases to enable setting changes, PTI instruction, etc

- Power consumption of the module can be higher enabling a wider range of transmission technologies

If dry van communication is to be independent from reefers, technology requirements can be different.

On reefers, a number of issues must be considered for different parts of the operation - when identifying criteria for reefer data communication - before finalising telematics hardware and software providers.

Decision-making groups at shipping lines must consider:

- Vessel communication infrastructure
- Reefer container fleet specifications
- Ports/Terminals
- Landside/inland operation

Landside and inland operation

Operators will need to list the countries where the reefers will operate - and then evaluate the range of communication options this will require.

The data size transmitted for reefers is small relative to the graphics rich/video requirements for consumer smart phones. This enables use of all the cellular transmission generations (2G through to 5G) and data connection to take place successfully - even when signals are relatively weak (compared to the high demands of smartphones). But coverage is not uniform across countries and it is possible that important areas of operation of the reefers may be in poor or zero coverage areas.

While there are international protocols on the technology of each generation, the availability of each generation (2G, 3G, 4G, etc) will vary between countries.

For example, countries are taking different approaches over the coming 5 to 10 years, in some cases, they are ‘sunsetting’ 2G or 3G - while others are keeping 2G and 3G operating. Also, in Japan and Korea the 2G standard is not compatible with 2G systems elsewhere; so when they retire 3G transmission, neither 2G nor 3G devices will be able to roam there.

As 2G and 3G networks are phased out in some countries, the choice of 4G/LTE comes down to:

(a) consumer grade ‘Cat 1’, where if the device can transmit over all bands/frequencies gives global coverage but is costly and requires data roaming contracts with all carriers; or

(b) one of the two IOT targeted technologies, “Cat M1” or “NB-IOT” which are cheaper but both have issues with lack of global coverage. These options can be supported with some level of 2G and/or 3G backup to allow coverage globally during the transition and before 2G/3G is phased out.

Terminals

Terminals may use WAN technology linked to cellular networks or have their own unlicensed ISM based coverage using technology - such as LoRa or Wifi. This will have different hardware requirements for telematics devices.

On Vessels

For ocean transit, there is no access to land-based cellular networks. Creating a vessel-based LAN can be achieved by installing a transmission base station which can provide vessel-wide coverage. Notably some available technologies cannot be used in inshore waters if they are using a frequency band which is part of licensed spectrum – they can only be used in the open ocean and must be turned off when in coastal waters.

Suitable technologies include WiFi, LoRa, BT, Zigbee, CAT-M1 or NB-IOT technology. The vessel communication technology needs to be able to communicate with containers underdeck and may require signal boosters. It also needs to be compatible with the API of multiple telematics hardware vendors used by the industry where the vessel is carrying containers from other shipping lines and alliance partners. The data can be aggregated on the vessel for reefer monitoring by the crew where required.

Data received can be transmitted to cloud or data centres by normal vessel communication links and as this is expensive, low-latency, packet-switched, compressed data is preferable.

API

Application Programming Interface – this needs to be integrated and agreed across the industry to ensure data can be transmitted by any hardware provider and provide the same standardised information to data users. This is similar to the way that different Android or Apple smart phones are able to operate around the world, receiving and sending data that all devices and network providers can process.

Establishing a standardised and integrated API amongst all industry participants is underway (but is not completed at the time of preparing this Report). It is a top priority that all stakeholders and hardware providers serving the industry cooperate to achieve this.

Conclusion

Lines considering implementation of wireless reefer data transmission have a range of technology options available today to achieve this.

Collectively, the Telematics system providers are putting in place a standard API / Application Programming Interface (under the auspices of a neutral industry body) to assist hardware and software developers to provide compatible products for the industry to use. This will significantly reduce long-term costs for shipping line reefer operators.

Detailed evaluation work will be required by the vessel and container operator before finalising the specification of a workable wireless data solution for a reefer or dry van fleet.

Cost considerations will include all of the following:

- the purchase and installation of hardware on containers and ships
- coordinating with terminals on their communication infrastructure
- data transmission on land under data roaming contracts

Data transmission technologies already in use - both those that are in different stages of rollout around the world and those that are under development - underline the complexity of issues to be considered and confirm that telematics technology will continue to evolve over time. But there are existing solutions today from a range of Telematics suppliers which can provide real time data monitoring of all equipment and remote control of reefers.

Given the wide variety of communication technologies that will need to be considered, operators of reefers will likely need to carefully consider the capabilities of products being offered by different Telematics suppliers to see which systems best meet their needs today and over the coming years. They should also consider what options conference and partner shipping lines are utilizing and whether alternative systems are also compatible.

Finally, operators will also need to consider API issues between differing systems to ensure greater flexibility and lower costs of operation over the long term.

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