# Open interfaces in a terminal automation platform.


**AUTHORS**

TIMO LEHTO

JARI HÄMÄLÄINEN

HEIMO POUTANEN



September 2017


KALMAR

# Open interfaces in a terminal automation platform.

**EXECUTIVE SUMMARY.**

Across the globe, container terminal automation is advancing rapidly. Automation, including the insights learned from the data it produces, is almost universally recognised as the future of improved container handling productivity, safety and business performance. However, when compared with other fields (such as the automotive manufacturing or process industries), automation in the container handling business is still in its relative infancy. This has meant that until recently, most terminal automation systems have been based on extensive integration of various subsystems and solutions, rather than conceived as complete end-to-end automation systems such as those in other industries.

This white paper argues for a systemic approach in designing a terminal automation platform. A key feature of this platform is the availability of new, open application interfaces that enable terminal operators to customise their automation deployments, allowing third-party developers to provide their own offerings that are interoperable with the automation platform. These additional software interfaces, which supplement the application-independent core software components of the terminal automation system, significantly extend the capabilities of the existing Kalmar TLS (Terminal Logistics System). Previously, TLS has only provided application-specific interfaces for a limited number of functionalities.

When combined with support services and a developer infrastructure, these open interfaces pave the way for robust and diverse business ecosystems around terminal automation that provide new opportunities for terminal operators, independent developers and automation system providers. Ultimately, terminal operators will have a broader range of capabilities to develop their systems with agility, based on their individual business processes and needs.

As an equipment-agnostic approach, the terminal automation platform also enables a vast range of new systems and equipment to be connected to the automation solution. Finally, the open interfaces of a terminal automation system enable a holistic view of data from multiple sources, enabling terminal operators to optimise their operations continuously and with greater ease.

This paper provides an overview of the new application interfaces that Kalmar is making available and examines some possibilities by which terminals and developers can utilise and benefit from these interfaces.

## Development of standardisation.

**HISTORICAL PERSPECTIVE.**

In order for terminal automation to develop to the next level in speed of deployment and operational efficiency – and for operators as well as other industry players to be able to reap the benefits of this development – a significantly higher level of standardisation is required.

Currently, a major challenge for most terminal automation projects is that many design and implementation questions need to be solved anew each time. These questions range from basic connectivity and equipment functionality to user interfaces for applications and safety guidelines. With terminal operators unsure of the exact specifications needed for a terminal automation deployment, system providers often need to ”reinvent the wheel” for each customer case.

A markedly different situation can be seen in general process automation. Initially, each manufacturer developed closed systems with unique interfaces for their equipment, but over the decades, the industry converged on a set of interfaces that enable seamless connectivity with standardised technology. This development shifted the competitive focus of automation technology providers away from low-level interfaces and towards higher-value automation systems. Once the connectivity is standardised, diverse industry players can come together to create robust ecosystems that further develop the capabilities of their equipment and software applications.

”With terminal operators unsure of the exact specifications needed for terminal automation deployment, system providers often need to ”reinvent the wheel” for each customer case.

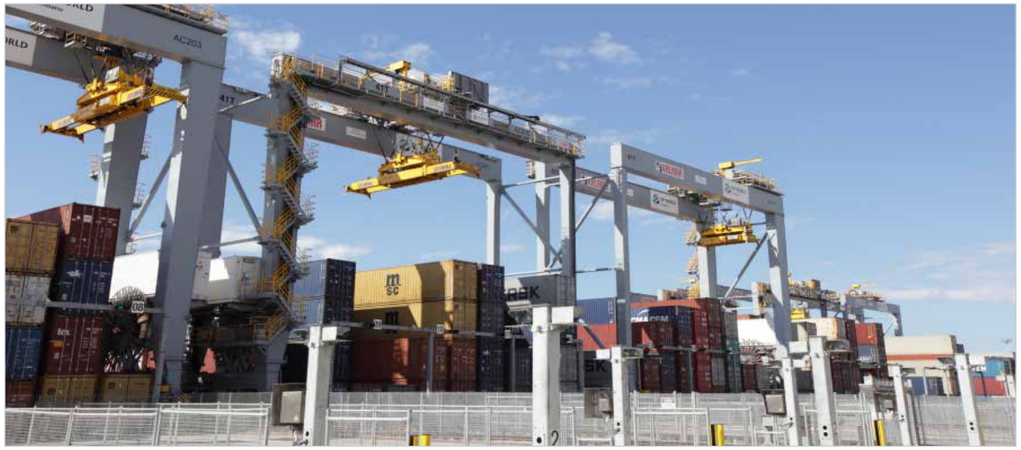
**INDUSTRY OUTLOOK FOR STANDARDISATION IN TERMINAL AUTOMATION.**

In many ways, the development and gradual adoption of container terminal automation mirrors the steps taken by process automation in recent decades; however, some significant differences also exist.

Firstly, when compared to existing highly automated major industries, the container terminal business is significantly smaller. Resultantly, automation will be adopted at a slower rate, and the development of the entire field does not have the same ”critical mass” as, for example, automotive manufacturing.

Secondly, at least at the time of writing (2H2017), the container shipping industry lacks a consistent force of industry consortia and/or international regulatory bodies that would have the expertise, motivation and influence to define a ”top-down” set of industry standards for terminal automation at the needed level of detail. Simultaneously, in a highly competitive, volatile industry, port operators and shipping lines are unlikely to find – at least in the foreseeable future – common ground for defining these standards together from the customers’ point of view.

As a result of these factors, it is reasonable to expect that container terminal automation will progress through a de-facto standardisation effort of established automation system providers defining the required interfaces and selectively opening them for wider utilisation. The opening up of a set of field-proven, robust interfaces with their associated support tools creates common ground on which solutions can be built, customised and expanded, and connected with manual or automated equipment from any manufacturer. The Kalmar terminal automation platform interfaces described in this paper are intended as the first step in this direction.



## Terminal automation platform: What and why?

Despite the continuous advances in terminal automation over the last few years, container handling is still a relatively new industry to embrace automation. Industries such as car manufacturing began automating their operations several decades ago, and have thus been able to develop a significantly wider perspective on how to deploy large-scale automation systems.

By contrast, until recently, container terminal automation has primarily been conceived as an ”add-on” to an equipment investment, instead of a comprehensive end-to-end solution. Automation solutions have been assembled as one-off projects that have required extensive integration of diverse systems and solutions, often from several vendors.

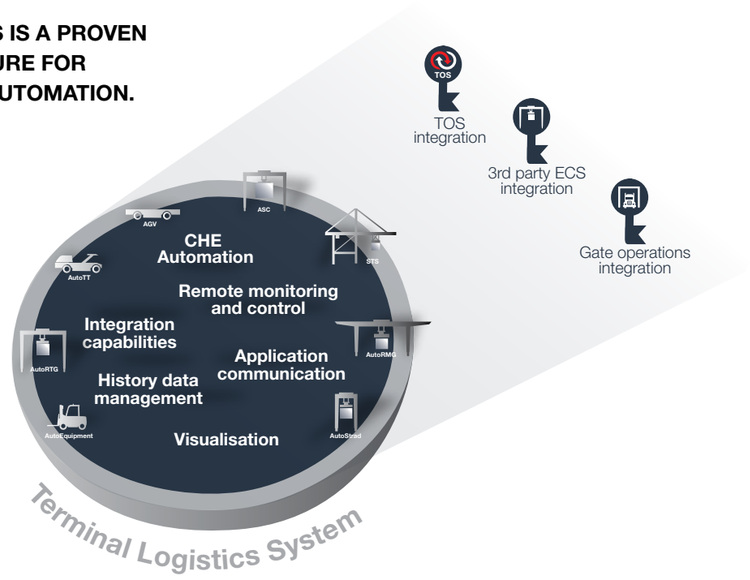
At the same time, as terminal automation advances, the focus in industry deployments is shifting from a limited number of new greenfield sites to automating hundreds of existing container terminals. These brownfield projects require that the automation system can interface with diverse existing fleets and processes at widely differing levels of automation. To reap the full benefit of terminal automation and to fully utilise their existing equipment and software, terminal operators need the ability to flexibly customise their solutions, possibly with the help of third-party developers.

As seen in other, more highly automated industries, successful large-scale container terminal automation will require a balanced combination of two things: firstly, an approach that treats terminal automation as a complete integrated system, and, secondly, open application interfaces that enable collaboration as well as the creation of ecosystems to further develop the capabilities of the automation platform.

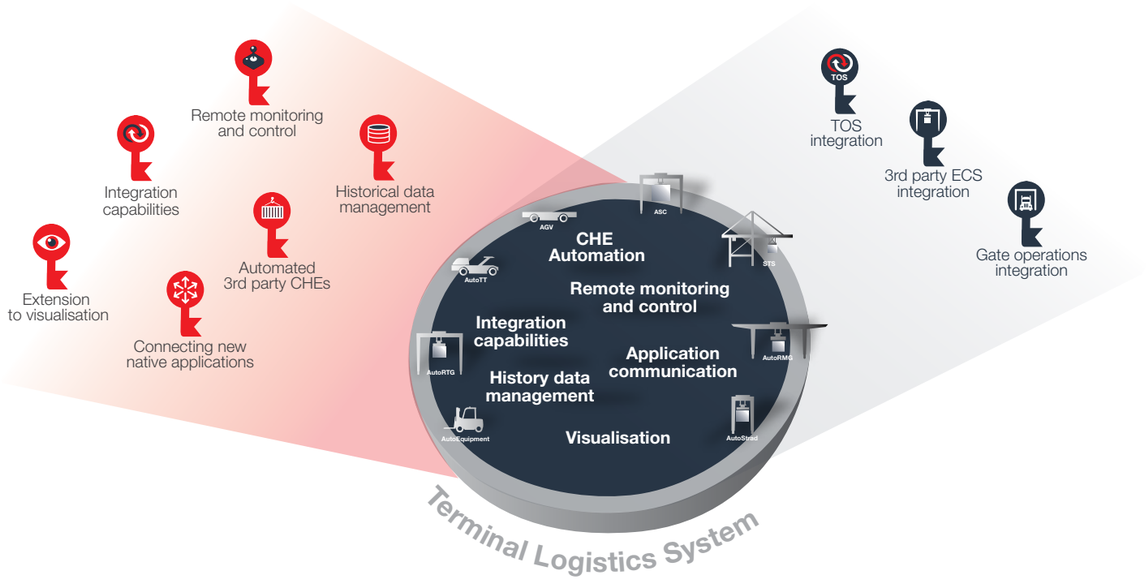
> ”Until recently, container terminal automation has primarily been conceived as an ”add-on” to an equipment investment.

# Definition of an open terminal automation platform.

**KALMAR TLS IS A PROVEN ARCHITECTURE FOR TERMINAL AUTOMATION.**




**KALMAR TLS GETS STRONGER WITH AN OPEN AUTOMATION PLATFORM OFFERING.**




In the context of this white paper, an open terminal automation platform refers to additional software interfaces that extend the application-independent core software components of a terminal automation system. This significantly broadens the capabilities of the existing Kalmar TLS (Terminal Logistics System), which has formerly only provided application-specific interfaces for a limited number of functionalities, most notably for integration with the Terminal Operating System (TOS) and equipment control systems. Previously, these existing interfaces have only been available to selected customers and have been dependent on in-house development by Kalmar.

For terminal operators, the added capabilities that open interfaces bring to Kalmar TLS can streamline decision-making by integrating all data sources as well as control and monitoring functions into a single, vendor-independent solution.

With the addition of new interfaces that enable direct access to the application-independent automation platform core (and thus basic system functionality), the concept of the Kalmar TLS is extended with additional capabilities for partners and developers to customise and augment customers' terminal automation solutions. This aids and speeds the development of new applications, opening up a wider range of potential suppliers and partners that can work with terminal automation.

> "The added capabilites that open interfaces bring to Kalmar TLS can streamline decision-making.

# Key functionalities and features.

The concept of an integrated terminal automation platform with open interfaces benefits all parties throughout the industry. Existing and new users (terminal operators) will be able to customise and augment their solutions with the required functionality. At the same time, open interfaces enable smooth and consistent integration of third-party equipment into the original automation system. Technology development partners may integrate their products with the automation platform in order to extend the capabilities of the system as well as creating new markets for their own software and hardware products.

The terminal automation platform also provides a holistic view of data from multiple sources, allowing terminal operators to optimise their operations with greater ease.

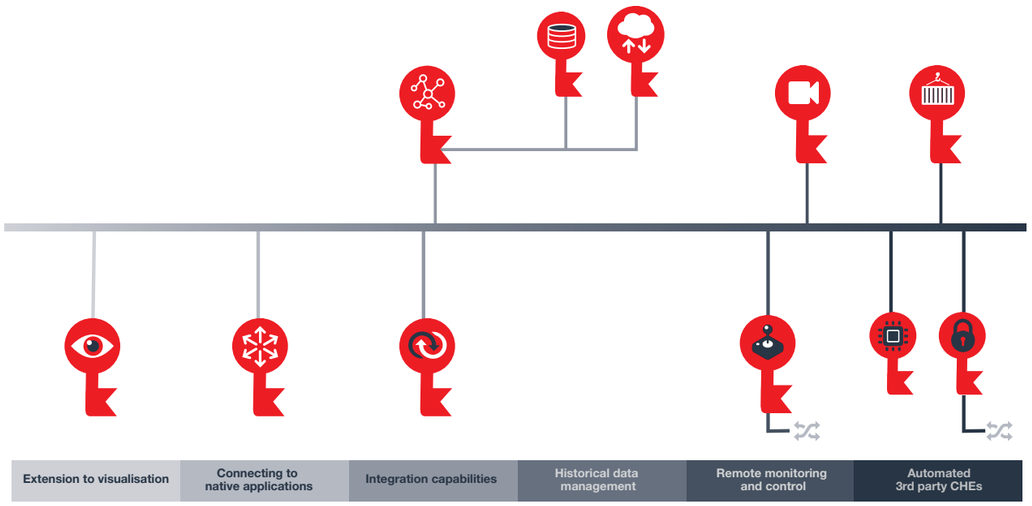



*Figure: System architecture of the Automation Platform.*

A terminal automation platform encompasses several types of system elements. These include ‘core components’ that provide access to automation platform data as well as tools for presenting data; ‘digital services’ that enable creating new value from available data; and ‘controllers’ that handle the integration with equipment and automation hardware. Open interfaces enable direct access to these elements, facilitating the creation of new and customised solutions in multiple application areas.

In the context of this document, a key refers to an open interface or framework with its attendant documentation and developer toolkit. The keys are accompanied by a partner ecosystem as well as licensing and support models for both developers and customers.

## EXTENSIONS TO VISUALISATION.

**GUI Framework key**
**GUI Creator key**

These keys define the access to the information of the fleet management solutions (for example Kalmar Fleetview). Users and developers can build their own user interfaces utilising ready-made FleetView drag and drop widgets from Kalmar’s widget library, or they can use open APIs to create custom widgets when needed. The framework also supports localisation and stylesheets.

## CONNECTING NEW NATIVE APPLICATIONS.

**Application Communication key**

The Application Communication key is a library that enables the easy creation of custom applications. This API enables easy publishing and subscription of data between other components and applications in the system.

## INTEGRATION CAPABILITIES.

**DAQ 3rd Party key**
**DAQ IPC key**

These keys enable connecting devices (such as PLCs, sensors etc.) to the Kalmar automation platform through common interfaces based on standard protocols (Multi-CAN, Iso-on-TCP, Hostlink, Linux SHM, etc.). Alternately, the DAQ IPC key enables the creation of custom interface protocols that can be added to the framework when needed.

**EIS Platform key**
**EIS Communication key**

Similar to an enterprise service bus, these keys extend the functionalities of the system by enabling custom bundles for additional services or custom interfaces. Kalmar, for example, uses this to connect different TOS providers to Kalmar digital solutions.

## HISTORICAL DATA MANAGEMENT.

**History Data Service key**
**Kalmar Cloud Interface key**

The History Data Service key enables the storing and access of data from any connected digital solution in a clustered database. Stored data can include e.g. time-series, events, alarms or user activities. The GUI Framework and GUI Creator keys offer ready-made widgets that can be used to visualise the data or build custom reporting solutions.

The Kalmar Cloud is used to store, process and visualise data, which can then be accessed by cloud applications through the Kalmar Cloud Interface key. The access includes the customer’s proprietary data stored in the Cloud as well as processed data provided by Kalmar.

## AUTOMATED 3RD PARTY CONTAINER HANDLING EQUIPMENT.

**CSP Interface key**
**On-Board Safety key**
**Motion Controller key**

These keys are used to optimise and control equipment fleets. Options are available for different operation types, ranging from automated stacking cranes to automated RTGs, automated straddle or shuttle carriers and beyond. The Kalmar Control System Platform (CSP) includes driver modules for Kalmar vehicle controllers but these can be replaced with custom modules to match any equipment interface.

Vehicle controllers extend the capabilities of manual equipment and prepare it for automation. An open interface for motion controllers enables different brands of

ca
s
s".

equipment as well as custom vehicle controllers to be connected to the automation system. Vehicle controllers integrate container handling equipment with the terminal infrastructure, providing a set of gantry control, horizontal drive and positioning technologies that are fully supported right out of the box.

**REMOTE MONITORING AND CONTROL.**

**RCC Interface key**
**Video Camera Interface key**
**RC Remote I/O key**

Remote monitoring keys make it possible to combine multiple video streams to create views that are uniquely suited to the individual requirements of each usage scenario. An open interface provides easy control of camera connections and disconnections, and enables container handling equipment or terminal infrastructure to be fitted for example with standard analogue cameras  or AXIS IP cameras without any proprietary hardware.

The RC Remote I/O key provides a failsafe connection between the container handling equipment and TLS remote control consoles. Connections and disconnections are controlled with an open interface, and any container handling equipment can be remotely operated either through a Profinet or physical I/O interface.

# Use case examples for open interfaces.

Open interfaces enable a wide range of new possibilities for terminal operators to customise their automation deployments, gain enhanced access to their operational data and develop the system according to their business processes. A key benefit of open interfaces is that they facilitate a joint ecosystem that benefits all parties in the value chain. Technology developers can create and market their own products that are interoperable with the terminal automation system; terminal operators can add new equipment or features to their systems with minimal business risk; and the automation system provider can offer new, advanced capabilities that utilise third-party solutions.

Some examples of potential user cases include the following:

**Requirement:** **Terminal operator wants to customise the look and feel of their applications.**

Brownfield terminals have existing, tightly defined business and administrative processes that any new automation deployment must accommodate. If the requirements of the process change, open interfaces allow terminal operators to carry out the necessary adjustments to their control room operational products either as in-house work or with the aid of partners.

**Solution:** **Extension to visualisation keys.**

The customer can build new dashboards and reports utilising the data provided by the Kalmar automation system.

**Requirement:** **Terminal wants to automate step-by-step a fleet of Kalmar and 3rd party cranes.**

As the first, most basic step towards terminal automation, remote control and monitoring provide immediate productivity gains by enabling a single operator to control multiple machines without having to physically move from one machine to another. Occupational safety and ergonomics are improved significantly by bringing machine operators from the container yard into the comfort of a remote control centre.

**Solutions:** **Automated 3rd party container handling equipment keys, Extension to visualisation keys, Remote monitoring and control keys.**

The customer can start with a solution based on the Kalmar automation system and Kalmar equipment, but can later complement the solution with third-party equipment, while retaining full flexibility for equipment vendor choice. Remote control functionality can also be implemented for third-party equipment as part of the Kalmar automation system. Additionally, the terminal can enhance the Kalmar automation system with new user interfaces and customised visualisation tools that cover the third-party equipment.

For example, a terminal can start with a Kalmar AutoRTG and expand the automation deployment later to include a third-party remote-controlled STS crane. Or a straddle carrier terminal can start with a fleet of Kalmar AutoStrads and expand later to automating existing straddle carriers from other manufacturers.

**Requirement:** **Terminal needs completely new technical application as part of their automation solution.**

Open interfaces also enable the creation of completely new applications for terminal automation. Essentially any manual or automated process or data source can be visualised and connected into the terminal automation system. Even if the goal

is not to fully automate the terminal equipment, standardised controller interfaces enable any machine to be remotely controlled through a single control desk and connected to Kalmar TLS software.

A natural way to utilise the open interfaces of the Kalmar terminal automation system is for technology partners to deliver enhanced sensor capabilities for the system. For example, machine vision enables a host of possibilities for improving the safety and performance of automated and semi-automated container handling equipment, but requires highly specialised technology.

**Solutions:** **New application development keys, Remote monitoring and control keys, Integration capabilities keys.**

With the new open interfaces, technology and software providers can develop and sell their Kalmar integrated products to container terminal operators. These could include, for example, solutions for laser scanners, anti-truck lifting, truck alignment, access control systems, target or load position measurement, busbar electric power distribution solutions or new connectivity solutions. Open interfaces enable technology from other manufacturers to be easily integrated into the Kalmar architecture.


## Key enablers.

In order to be usable, the open interfaces of a terminal automation system require a full Software Development Kit (SDK) as well as some degree of support from the provider of the system. In addition to the actual open API definitions, the SDK will need to include, at a minimum, developer documentation, tools and support. The application interfaces, together with their support and documentation, constitute the keys that enable access to the Kalmar automation platform. To summarise, the keys are licensable modules consisting of an open interface with its attendant SDK, documentation and support.

The basic structure of the licensing model for the Kalmar automation platform SDK is that it is free to try for partners, with various licensing options for development and production use. The license structure can be based on either usage volumes or fleet sizes.

Additionally, a support structure will be in place, ranging from forum access to an issue/ticket service. Optional services can include training modules, technical consultancy, help desk access or a Kalmar verification service that enables independent developers to have their applications certified by Kalmar for function and interoperability.

> ”The basic structure of the licensing model for the Kalmar automation platform SDK is that it is free to try for partners.

# Risks and opportunities.

Any opening up of previously proprietary interfaces always involves some degree of risk for the party sharing the technology. Competition could increase; new players may enter the market to challenge industry leaders; or clients may choose to accomplish in-house what previously would have been delegated to a system provider.

However, it is Kalmar's firm belief that in terminal automation, shared and standardised interfaces are an absolute necessity for the development of the entire industry, and that the benefits of progressively opening these interfaces greatly outweigh the potential risks. Not even the largest industry leaders have all the possible expertise in-house, and open interfaces enable a vastly expanded collaborative landscape for the benefit of terminal operators, independent developers and automation system providers alike.


## AUTHORS

**TIMO LEHTO**
Director, Software and Automation, Kalmar, has been working on terminal automation for over 10 years. He has been designing and implementing software products for most of the Kalmar fully automated solutions. In his current role he is leading the Kalmar software development teams in Tampere, Sydney and San Jose.

**JARI HÄMÄLÄINEN**
(Dr Tech.), Director, Terminal Automation, Kalmar, has a background in telecommunications and the software industry, with over 300 patents in 40 global patent families helping smartphone users in their daily business and pleasure. He has been working 5 years at Kalmar, leading offering and service concept development. He is currently leading product management of Kalmar software and automation development, as well as the simulations lab and test yard automation operations. He is also project director for the Kalmar AutoRTG product development.

**HEIMO POUTANEN**
Product Manager, TLS platform, Kalmar, has over 30 years experience in developing and delivering automation solutions for different industry sectors. He has experience with process industry automation in pulp and paper mills, graphics industry and nuclear power plants and mobile equipment automation in the mining and construction sector. For the last two years he has been responsible for the product management of Kalmar's TLS (Terminal Logistic Systems) platform.


**ABOUT THE COMPANY**
Kalmar, part of Cargotec, offers the widest range of cargo handling solutions and services to ports, terminals, distribution centres and to heavy industry. Kalmar is the industry forerunner in terminal automation and in energy efficient container handling, with one in four container movements around the globe being handled by a Kalmar solution. Through its extensive product portfolio, global service network and ability to enable a seamless integration of different terminal processes, Kalmar improves the efficiency of every move.


**CONTACT**
**www.kalmarglobal.com**
**kalmar@kalmarglobal.com**


**KEEP IN TOUCH WITH US**

KALMAR


Making your every move count

**www.kalmarglobal.com**