Automated Data Capture Systems

Allan Jones, Head of Business Development, International Terminal Solutions Ltd reviews the use of automated data capture systems to provide accurate, real-time information to enable the TOS to better manage the terminal operations, by making more timely and effective decisions.

There are 3 key areas to which the TOS has direct influence: planning the terminal operation, operation execution and then analysis of terminal performance. To plan, the TOS needs to have accurate information on the terminal status, scheduled work and the resources available. The operation execution requires accurate and timely updates with confirmation of each activity as it takes place, and the results need to be accurately recorded in preparation of the next operation plan and to provide the basis for terminal performance analysis. Most terminals use networked mobile computers on the Container Handling Equipment (CHE) to collect data, but the data feeds to the TOS still tend to be manual and with this there is an inherent human delayed response and a higher possibility of erroneous information being updated to the TOS. In this environment how does the TOS know, for example, the correct container has been picked-up or grounded to the intended location? It has been estimated by an EU funded project that the extra costs due to these issues (for a 300,000 TEU capacity terminal) is in the region of EUR 280,000 per year. These costs are the sum of the loss in productivity for the cranes, unnecessary re-handling in the yard and cost of personnel monitoring the yard status (doing overnight inventory checks etc). These issues become even more profound when the TOS is used to optimise the operation execution, as there is then a near real-time need to both know the precise location of each item of CHE and to allocate and reallocate work to this equipment on the fly, in order to optimise equipment usage. And this has to be managed to provide a smooth workflow to the CHE operatives. To achieve this there is clearly the need to provide real time feeds and to automate various manual functions to ensure accuracy as the plan is executed. In this article we will concentrate of the execution of the operational plan and explore how introducing levels of automation to complement the TOS will help it do the job of running an efficient terminal operation.

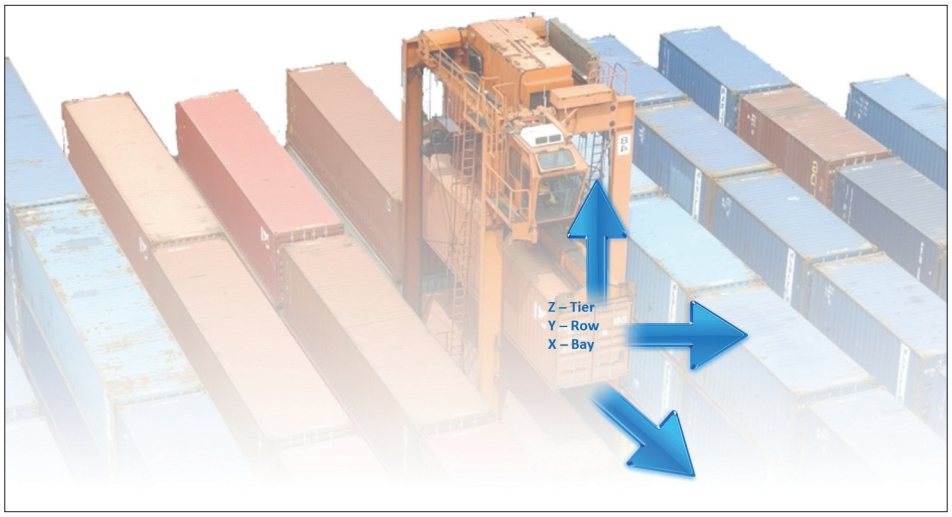

Figure 1: The PDS determines container locations

Operation execution

Key to an efficient execution of the plan is knowing when containers are in transit and precisely where all the containers are located when grounded. This may sound obvious but performance in this area varies from terminal to terminal and unless you can free up your equipment for the next task and have yard accuracy, time will be wasted in poor equipment utilisation and searching for containers. Many terminals rely on the CHE operator advising (and sometimes choosing) where they ground the container, which is obviously open to human error and time delays. Housekeeping activities such as stack inventory checks will put the records in order, but only for a short period before the daily activities re-introduce further errors. In some situations compounding these inaccuracies will lead to degrading performance as the day progresses.

Accurately recording container storage locations

This is normally achieved through a Position Determination System (PDS) such as the ITS G-POS system, which uses DGPS technology to determine each location. The PDS will determine in real time the container pick-up or set-down location, and will keep the TOS up to date. It provides the row and bay, and will also resolve the height of the container to a tier by using other measurements. Some TOS systems will take only the horizontal component from the PDS and then derive the height. This is probably fine for most situations, but inaccuracies will always degrade yard performance. To accommodate this ITS provide an alternative specification G-POS solution for users of this type of TOS, with the ability to upgrade later when additional TOS functionality becomes available.

Enforcing container location accuracy

As described above the PDS will help the TOS run an efficient terminal by accurately recording the container location. However, unless the planned move is enforced there is still the possibility for errors to be introduced if the CHE picks up or sets down in a different location. The new location will still be advised, but the plan is now out of step and depending on how the TOS deals with this, containers may not be where the TOS needs them for optimised storage. The PDS can enforce each move the TOS requires by managing the Twistlocks. The PDS will allow the Twistlocks to lock only if the spreader is on the correct container (for pick-up) and, similarly, it will allow the twistlocks to unlock only if the container has been placed in the correct location. There will of course be exceptions that need to be handled, and to do this G-POS has a number of exceptions that can be set by the operational management and ultimately remotely overridden by the management if the need occurs.

Managing job hand-offs

Within a busy terminal the job hand-off points, where one CHE hands off the job to another CHE, are always areas where vulnerabilities can exist. A prime example of this is where the truck or prime-mover hands-off the job of moving the container to the RTG/RMG. The TOS will have booked the truck in through gate and the driver given instructions to go to the relevant load / discharge point. However, arrival of the truck at the gantry crane is unlikely to align with its position in the work list prepared by the TOS, because it will be interspersed with other trucks and prime movers operating within the yard area. It is then up to the crane driver to try and figure out which truck is at the pick-up point. This is an issue faced by many of our customers and one where the PDS can automatically identify the truck to the crane. OCR and RFID technologies are typically used for this, but with the advent of very low cost, long-range passive RFID tags, this technology now provides a much lower cost solution. The truck is temporarily tagged at the gate (or permanently if it is a frequent caller) and prime movers are permanently tagged. When they arrive at the crane the PDS will associate the truck with the container to identify the move on the TOS work list, and then ensure the container is picked up from or grounded in the correct location in the stack.

Figure 2: Twistlock controls ensure correct container

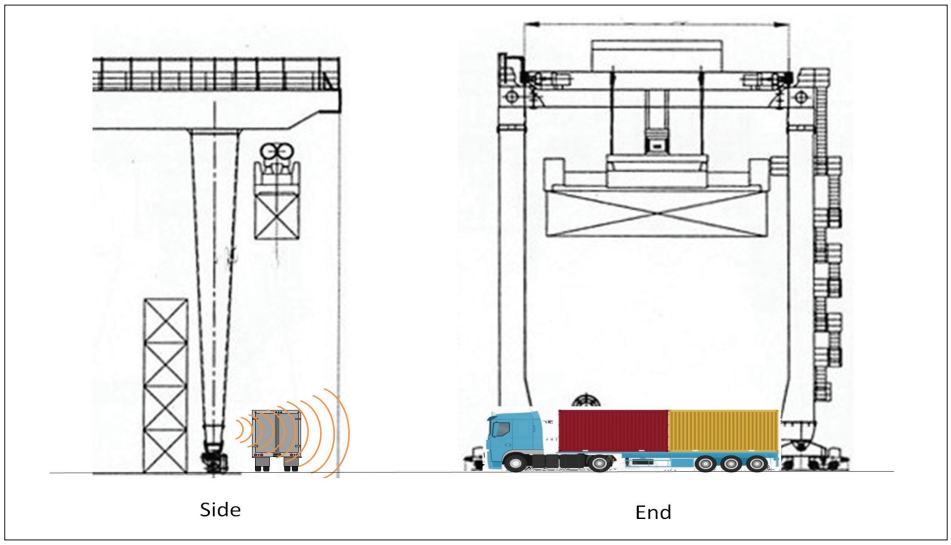

Figure 3: Use of passive RFID to detect truck

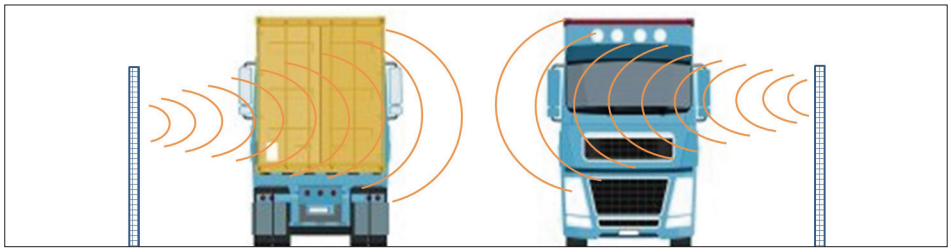

Figure 4: Portals at each ASC lane to detect truck ID and direction

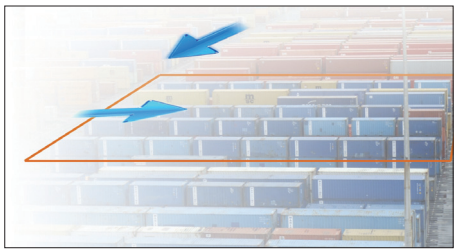

Figure 5: Geo-fences sub divide the yard

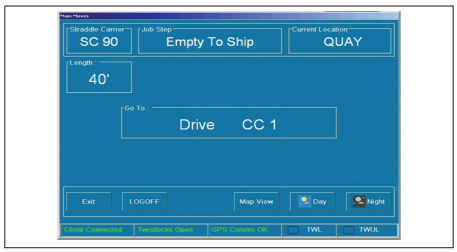

Figure 6: Sample job step screen for a straddle carrier

Considerations for automatic stacking cranes

Automatic Stacking Cranes (ASCs) are somewhat like RTG/RMG operations, except the operator is remote and typically handles only the final placement of the container – the rest is automatic. To allow the crane to operate in this automatic way the TOS work list will need to be adjusted to align with the sequence at which trucks arrive at the crane. Therefore, in addition to the RTG/RMG functionality described above, an expanded PDS called a Real Time Location System (RTLS) will use portals at the end of each road lane to determine the truck arrival sequence and the communication between the TOS and PDS will need to be dynamic to keep the work list synchronised. There will tend to be a number of passing lanes adjacent to the ASC, and the area will be busy at certain times. Consequently the RTLS has to be able to determine which trucks are merely passing, and which are in the lane. The use of passive RFID tags makes this easier, although the portal readers still need to determine movement direction.

Optimising terminal execution

As well as optimising container stack storage space utilisation, the modern TOS will also provide facilities to optimise the movement of CHE. An example of this is Job Stepping (used by Navis N4 PrimeRoute and other TOS systems) which is a critical process to better manage both the yard strategy and equipment deployment. The progress of the CHE is reported by the PDS as it makes its way through the yard and this allows the TOS to optimise movements, based on the current position of each item of CHE and its current allocated job step. The TOS needs to be advised as each CHE passes through 'Geo Fences', which sub-divide the terminal into a number of smaller sections and define the job steps. At that point, based on which CHE is closest to the target container, the system can re-allocate the target move or maintain the current one. Clearly, the only way this aspect of the TOS can operate is to be advised in real-time that the CHE is approaching the end of its present job step. There are PDS systems that require the CHE operator to press a button to advise the TOS that the job step has been reached. However, this manual

intervention will struggle to keep pace with a busy and fluid environment, limit the opportunity for CHE movement optimisation and the constant button pressing requirement can become frustrating for the driver and therefore delayed or overlooked. For job stepping to work at its best, a well designed and implemented PDS should automatically update the TOS and request the next job step.

Keyless system

This level of automated data capture has been a goal at ITS, and many of our PDS users have implemented 'keyless' systems for their CHE operators, in which the mobile computer no longer has a keyboard. The operator registers with the CHE at the start of shift by using their site access/ID card. Using the information from the card, the PDS logs them on to the TOS and then starts to display their first move. As the CHE passes through Geo Fences (if Job Stepping is used) the TOS is automatically updated by the PDS, displaying any reallocated jobs and then confirming completion of the move by unlocking the twistlock and advising the TOS, which then repeats the cycle by allocating another job. The only time a CHE operator needs to touch his keyboard is for exceptions, and this takes place through a soft keyboard, which will be customised to the exception.

Architectural considerations

A comprehensive messaging system using modern technology such as XML is required to provide seamless integration between the PDS and the TOS. Most modern TOS will support this as it is required to communicate with other systems used in the terminal, such as accounting and HR. The diagram opposite is a schematic of our own G-POS system, and shows the various layers involved. G-POS puts intelligence on the CHE (an industrial computer), which is used to track the CHE and the container positions, and for keyless operations it will also manage the user interface with the CHE operative. This system will also communicate with the CHE equipment interface layer (the PLC) to manage twistlocks and take any other information required for monitoring purposes (safety alarms, fuel, engine temp etc.) The key is to network this with a central messaging capability (MRS Middleware in the diagram) to manage the exchange of information with the TOS and any other system (e.g. HR for when the driver logs on, Engineering systems for equipment usage data). Most modern systems use XML for messaging, but there are other standards in use, so the messaging layer will also manage different protocols that may be in use between different systems.

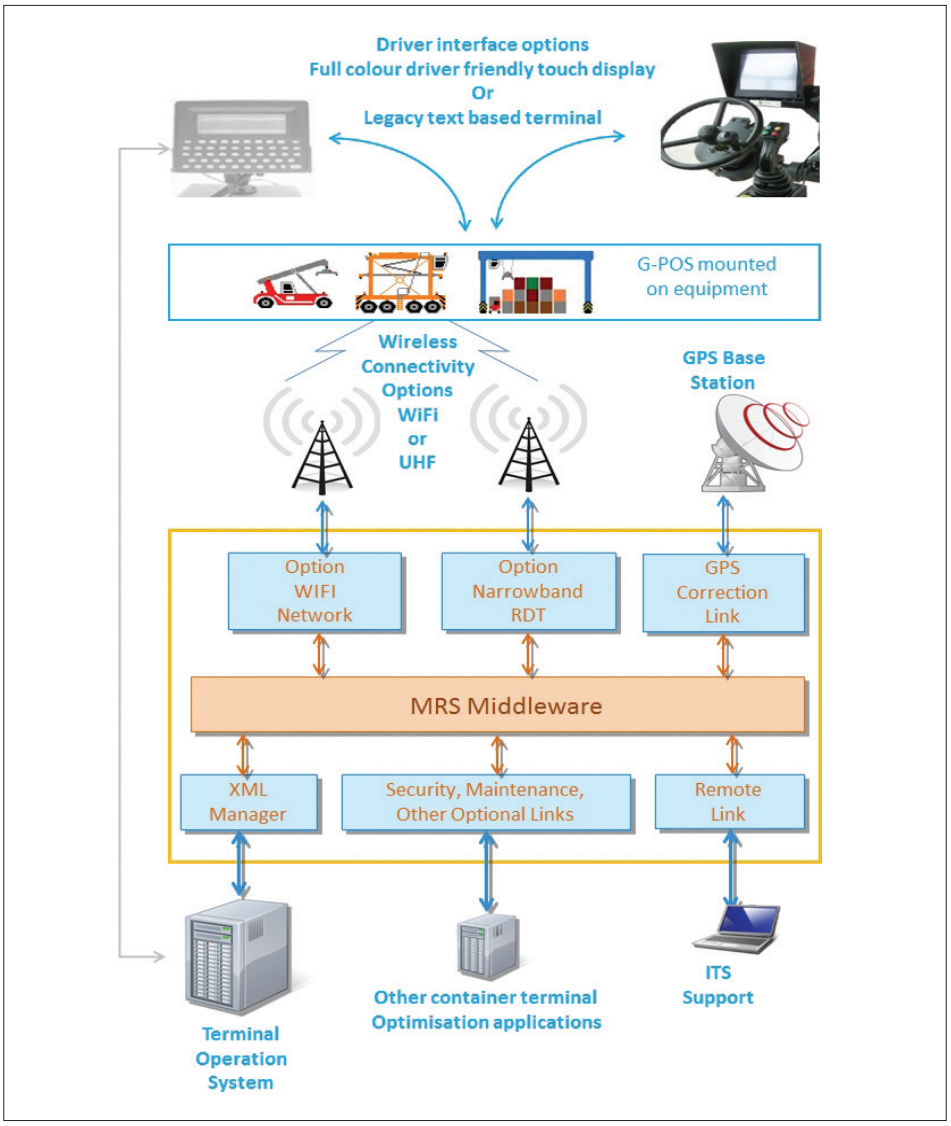

Figure 7: PDS messaging architecture

Terminal performance analysis

The TOS records all container movement activity and then this will serve as a rich source of data for performance analysis. The analysis requirements will vary for each terminal and in addition to what would be seen as regular statistical analysis (moves per hour et al), in many instances the data analysis requirements fall outside data available from the TOS, such as incident locations, equipment status, alarms and operator actions. The PDS can have the capability to record information directly from CHE and provide usage statistics. An example of this is the recording of tip alarms on Straddle Carriers to identify high incidents of alarm by operator, CHE and location on the yard. The key is having intelligence on the CHE to collect and then to store the information in open form on central databases.

Summary

The TOS is the central nervous system for the terminal and all the major TOS systems are highly effective at managing the daily operation. However, the nervous system also requires sensitivity at its nerve endings, and the value of the PDS is to be the "eyes and fingers" for the TOS. We discussed how the PDS will manage the storage locations for the containers and enforce the work orders of the TOS. It will provide real time tracking to allow the TOS to optimise the operation and with its intelligence mounted on the CHE, it will simplify the job for the operative and help him do his work accurately and efficiently. Most of all, it will reduce costs by playing a key role in enforcing terminal plans and running an optimised operation. WPD