ATS Technology Description • Automated Systems and Associated Companies

Applications for:
Automated Container Handing in Marine Terminals + Intermodal Facilities
Automated Shuttle Car Systems for:
Near Dock + Long Haul Container Moves
and Passenger Transportation

AS Technologies

Automated Container Handling • Integrated Automated Container Terminal System
Alternative MagLev • Permanent Magnet Linear Motor

Overview

Automated Systems [AS] has developed a fully automated method for handling containers in Marine Terminals and Intermodal Facilities called the Integrated Automated Container Terminal System or IACT. The IACT is comprised of tailored equipment designed to Steel Mill Severe Duty Standards [AISE or CMAA Class F], optimized operating methods and the proprietary supervisory software to manage the facilities.

Four Berth IACT Marine Terminal

IACT Intermodal Facility

The same mechanical and software components of the IACT Marine Terminal are used in the Automated Intermodal Facility [AIF]; they are just arranged differently to meet those particular operating requirements. System design is very flexible and can be adapted to virtually any site and to meet any throughput requirement.

Background

Integrated Automated Container Terminal
Automated Intermodal Facility

PROVEN INDUSTRIAL SYSTEMS APPLIED TO CONTAINER HANDLING

Building on prior work by Morgan Crane, ATS has developed the fully automated IACT for use in Marine Terminals and Intermodal Facilities.

Acceptance Test Automated RMG

Generation 1 Matson Richmond CA

Generation 2 US Steel Automated IPS Birmingham Alabama

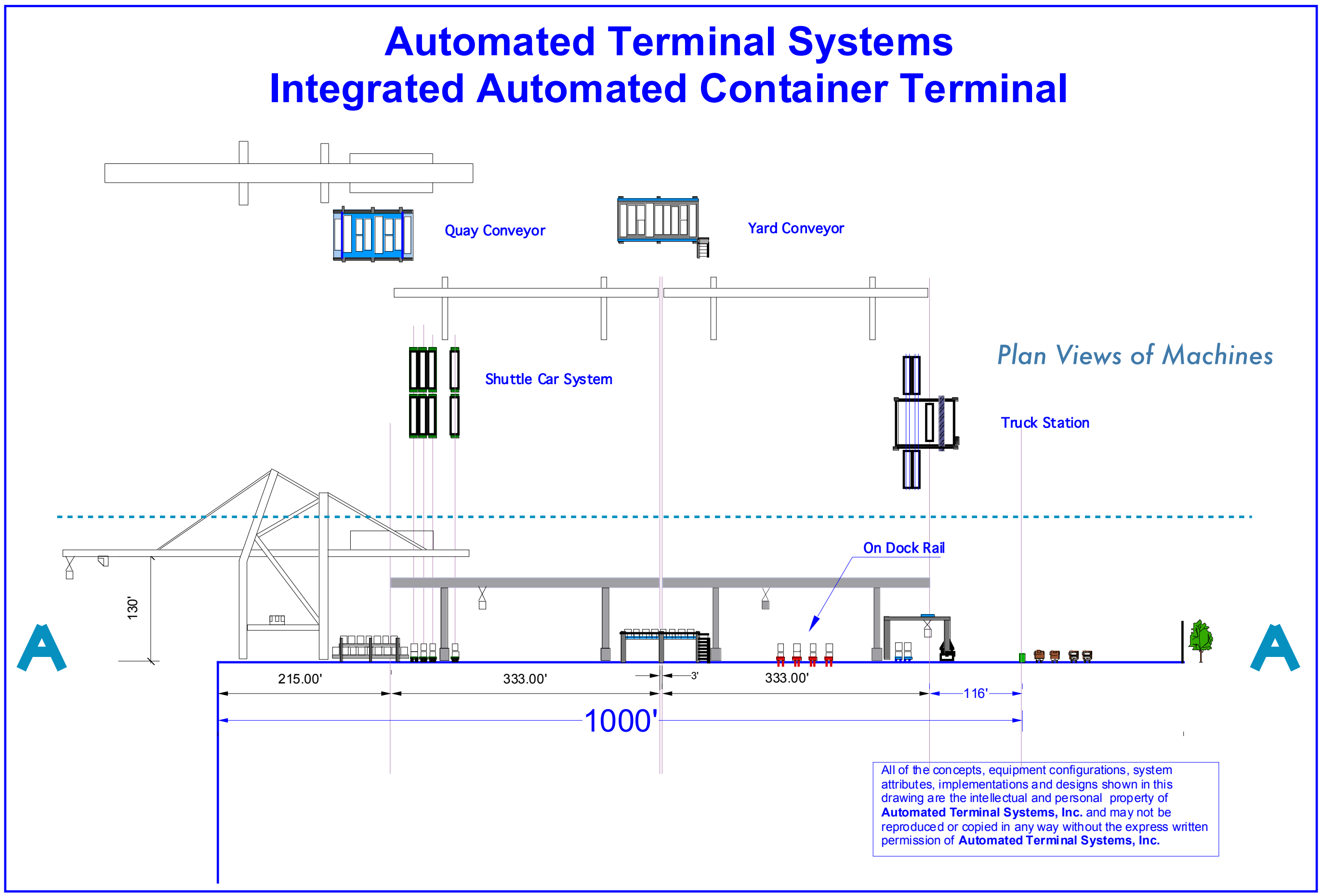
AS Systems adhere to a few simple principles to overcome the most glaring deficiencies in current Marine Terminal and Intermodal operations:

- Replace numerous small light weight container handling machines with a few robust large machines designed for Continuous Duty;
- Simplify rather than elaborate - Apply Occam's Razor, eliminate superfluous operational and mechanical elements of the Container Handling process;
- Use proven Industrial Engineering and Operations Research methods to optimize the facility layout to support automated operations; and
- Integrate the physical and virtual elements of the system with a Real-Time Process Control Optimizer.

The result is an all-electric **KYOTO Compliant©** robust integrated system for handling containers, designed from the ground up to run fully automated 24/7/365. Benefits include reduced equipment counts, high throughput and substantially reduced capital and operating costs.

Technology Description

INTEGRATED AUTOMATED CONTAINER TERMINAL [IACT]



System Description

Container Processing

The preceding drawing contains all of the standard elements of the Integrated Automated Container Terminal. A Container Yard Elevation is provided in cross-section. Plan Views of each of the Machines in the System are provided above the cross section.

A typical import sequence proceeds from let to right of the drawing and is:

- Containers are picked from the ship by the Ship-to-Shore Crane [STS] and deposited on the Quay Conveyor at the most seaward position on the Conveyor. This an indexed position known to the System Supervisory Controller and communicated to the STS. [Note: all pick/deck positions in the IACT Facility are indexed and known to the System Supervisory Controller];
- The Quay Conveyor transports the containers toward the first CY - which is called the 'Waterside Yard';
- The RMG picks the container from the Quay Conveyor land side end and deposits it in the Waterside Yard;
- When directed by the Supervisory Controller, the RMG moves the container to the Yard Conveyor;
- The Yard Conveyor transports the container toward the Land side Yard;
- The RMG in the Land side Yard picks the container from the Conveyor and places it in the Land side CY;
- At the appropriate time, the container is moved to the Truck Load/Unload Station for delivery to the Trucker;
- The Trucker is directed to the appropriate Load/Unload Station by the Supervisory Controller and the container is delivered to the Trucker.

Export Move sequences are the reverse of those described above. The operation of each of the machines is detailed in the next section.

Two other features should be noted; a Shuttle Car System between the Quay Conveyor and the Waterside RMG allows shifting of containers between hatches of the same ship or between berths for transshipment operations. The Shuttle Cars can also be used to quickly reconfigure the CYs in the event that berth assignments change.

This IACT arrangement also includes true On-Dock Rail. That is, rail cars can be loaded and discharged on the Berth with the same container handling equipment without an intervening drayage move by Chassis Hustlers or Trucks. Because On-Dock Rail operations are intermittent, containers can be stored in the CY over the rail tracks when no trains are in the facility.

Technology Description

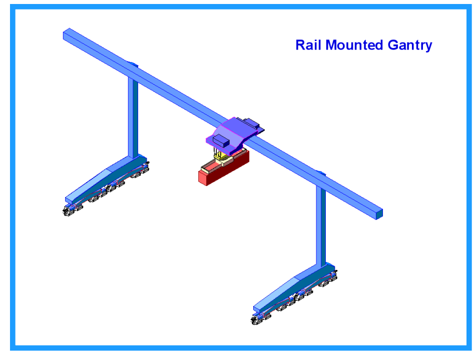
System Elements

Supervisory System Controller [SSC]

ATS has employed the latest thinking in Operations Research combined with intimate knowledge of Container Operations to develop an advanced autonomous Terminal Operating System. The SSC seamlessly integrates machine management with planning, operating, and management functions into a single system which we call the Integrated Automated Container Terminal or IACT. The IACT is a Real-Time Process Control method that continuously optimizes the facility through an iterative process that balances schedules, container inventory, machine functions, maintenance and manning.

Rail Mounted Gantry Cranes [RMGs]

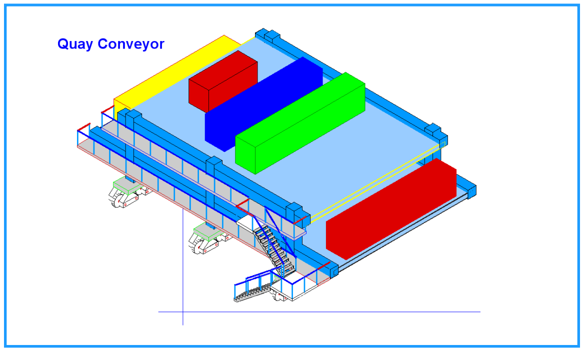
The principal container handling devices in the IACT are large fully automated Rail Mounted Gantry cranes [RMGs]. Based on the successful Morgan Steel Mill MonoBox RMGs, these cranes feature a 60/40 Cantilever. Although crane dimensions are adjusted to meet site constraints the ATS Reference Design specifies a 100 meter Main Beam with a 60 meter rail gauge. A single RMG of this design will replace 4 - 6 RTGs or 3 -5 conventional RMGs at a lower capital cost.



In combination with Quay Conveyors and Yard-to-Yard Conveyors the Cantilevers facilitate transfers between Container Yards [CYs], where required, and service of the Truck Load Unload Stations for receiving and delivering containers landside, both of which are described below.

Quay Conveyors

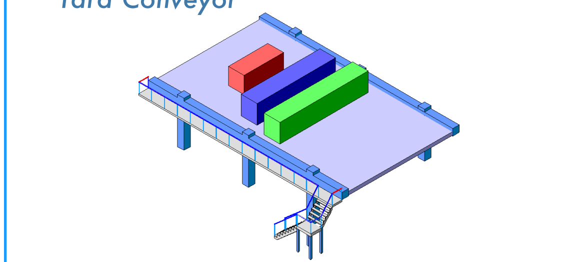
A two-tier, bi-directional Conveyor provides the interface between the Ship-to-Shore Cranes [STS] and the RMGs that service the Container Yards of the IACT. These Quay Conveyors are mated electronically to the STS cranes they support. Each end of the Conveyor is an indexed position known to the Supervisory Control System and communicated to the STS. This allows full automation of the STS over the Quay. The provision of the second tier allows two-way operation of the STS in loading and discharging the ship. The combination of automation, SmartCrane Anti-Sway and duel cycling allows the IACT to achieve more than 55 Moves per hour per STS.



Yard Conveyors

If the facility geometry or throughput considerations require more than 1 Container Yard, transfers of containers between the Waterside and Landside CYs is accomplished using a stationery Yard Conveyor in conjunction with the RMGs.

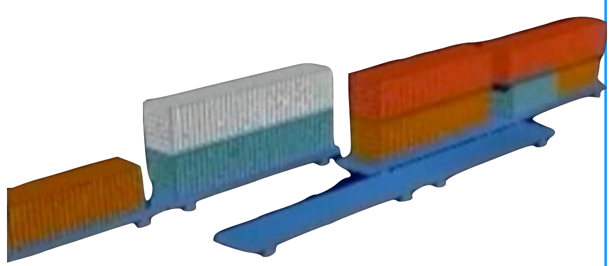
Each end of the Conveyor is an indexed Pick/Deck point that is known to the SSC and communicated to the automated RMGs



Shuttle Cars.

Shuttle Cars are employed in the IACT to relieve the RMGs of long moves relocating containers from Berth to Berth or within the CYs. The Shuttle Cars can be operated individually or in teams depending on throughput demand.

Shuttle Cars are also a component of the Truck Load Unload Stations as described below. Each car is powered by 2 or 4 Direct Drive AC motors, depending upon the application requirements.

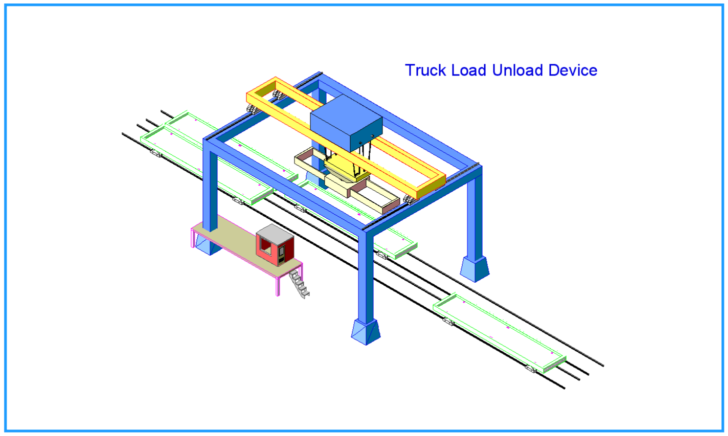


On-Dock Shuttle Cars

Truck Load/Unload Stations

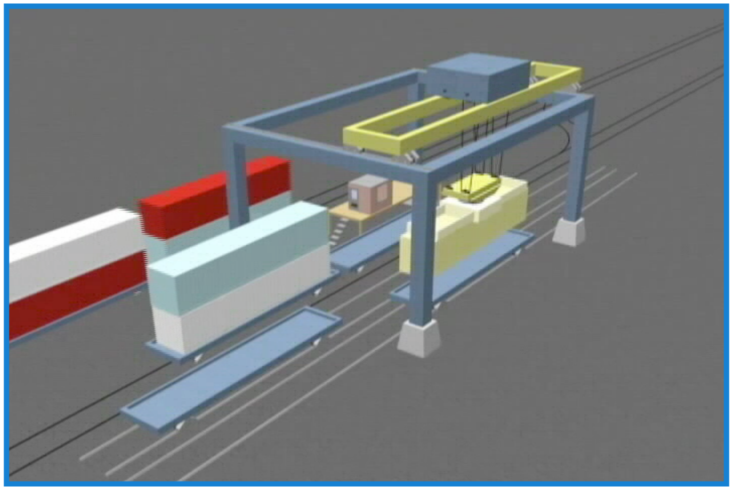
Trucks are serviced at Truck Load/Unload Stations which consist of a stationary Overhead Crane or EOT [Electrified Overhead Trolley], and two banks of dedicated Shuttle Cars that receive containers from either the Trucks or the Container Yard RMGs.

Containers are removed from In-Bound Trucks and placed on the Shuttle Cars which serve as surge pots and make the containers available to the CY RMGs. Containers queued for delivery to trucks are delivered to the Shuttle Cars from the CY by the RMGs and delivered to Trucks by the EOT.



Shuttle Car Load/Unload Stations

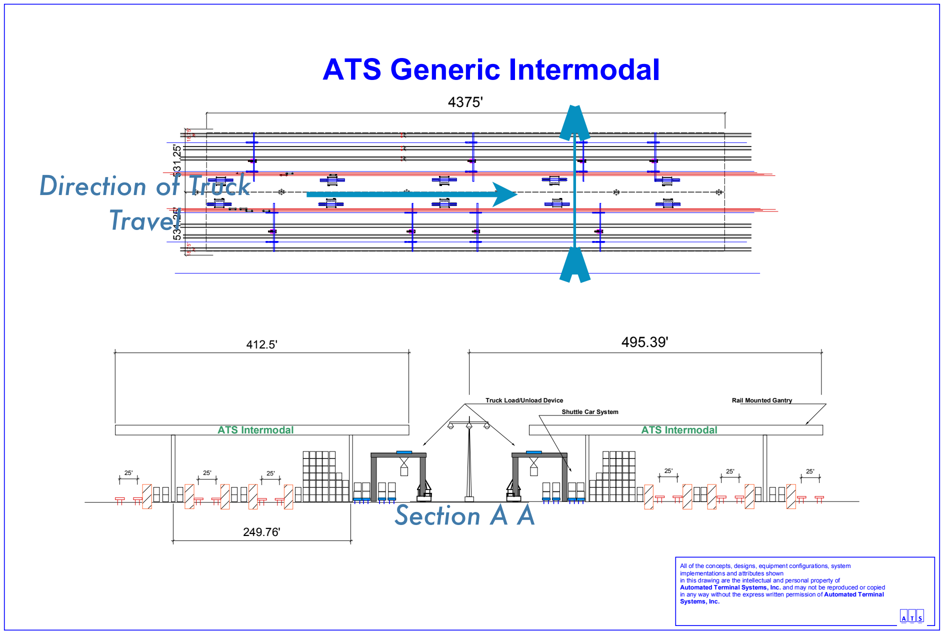
A modification of Truck Load/Unload station is shown to the right. It is used to service medium and long haul shuttle cars rather than trucks in an automated container transfer system described in the following sections. While an Operator on the ground is employed to interact with the Truck Driver, that functionality is not required in the fully automated system.



Automated Intermodal Facility [AIF]

System Description

The configuration shown to the right is one of many possible implementations. By splitting the Rail Yards, this layout avoids the use of Yard Conveyors between the CYs, thereby reducing the equipment count.



In this design, truck traffic is confined to the center roadway with Truck Load/Unload Stations on either side of the through roads. Trucks enter one end of the facility [left side of the Plan View], are directed to an appropriate Truck Load Unload Station by the SSC where, as in the IACT, the containers are received or delivered and then exit the other end [right side of the Plan View]. All truck traffic moves in one direction only. There are no trucks or Chassis Hustlers in the facility.

Outside truck traffic and congestion are eliminated while reducing the required facility footprint by more than 50% when compared to conventional Intermodal Facilities of similar capacity.

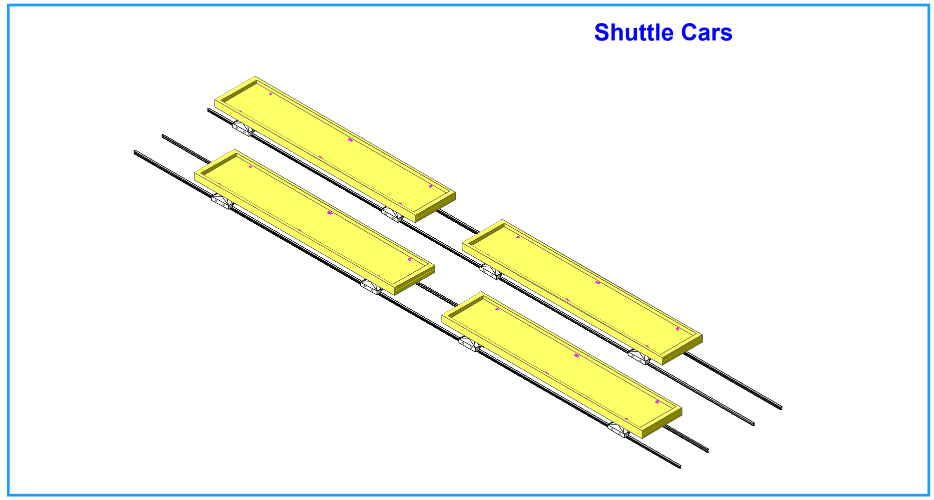
In this arrangement, containers are stored and sorted adjacent to the Load/Unload Stations. When containers are scheduled to to be loaded to trains, the system directs the RMGs to move the container to staging areas along the rail sidings. The containers are arrayed in the reverse order that they will be stowed to the rail cars.

Similarly, containers inbound to the facility on rail cars are picked from the cars by the RMGs and deposited immediately adjacent to the rail tracks. Containers are later moved to the general stow for delivery to trucks at the Load/Unload Stations.

Automated Shuttle Car System [ASCS]

Short and Medium Haul

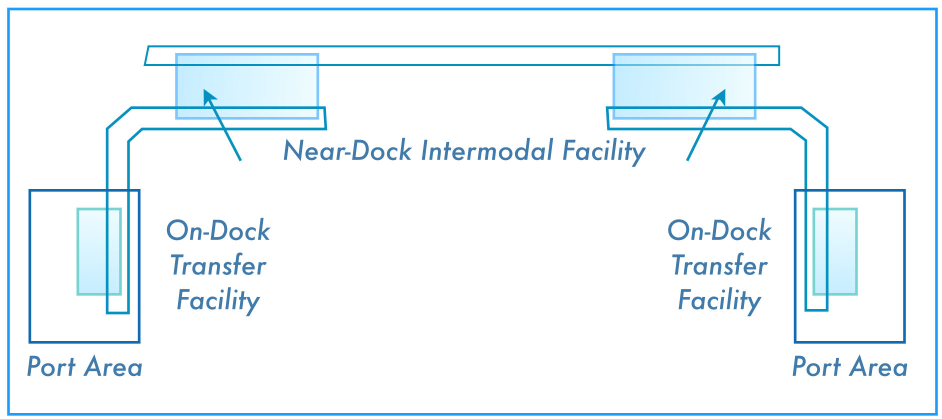
As described above, a component of the IACT is an Automated Shuttle Car System employed on the Berths to move containers from one berth to another. It is also used as an element of the Truck Load/Unload Stations that transfer containers to and from Over the Road trucks. The Cars are powered by two or four AC direct drive motors depending upon application requirements. The On-Dock Shuttle Cars as well as the Shuttle Cars used in the short haul mode run on steel wheels on steel rails.



Shuttle Cars in a slightly different configuration can also be used to move containers over intermediate distances. For example from the Marine Terminals to Near Dock Intermodal Facilities. An ideal system would encompass automated Marine Terminals and complimentary Automated Near-Dock or On-Dock Intermodal Facilities serviced

Suggested System Configurations

Origin and Destination points would be served by Automated Intermodal Facilities connected seaports with a Shuttle Car System running in a Loop as shown in the schematic to the right. Transfers of containers at the seaports would be accomplished by transporting the containers to the Intermodal Facilities either by a medium haul Automated Shuttle Car System from On-Dock Transfer Facilities as shown in the drawing.



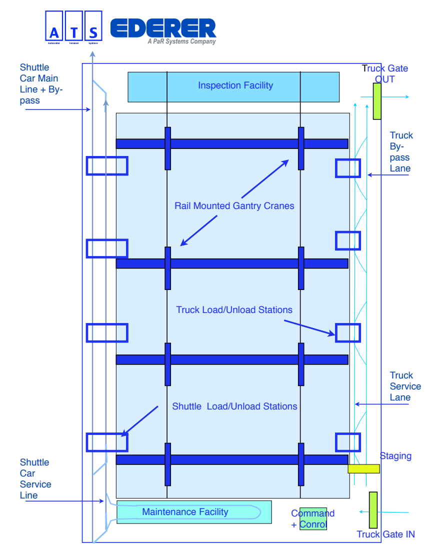
Containers would then be moved to the Intermodal Facilities and transferred the long haul rail system. The Automated Shuttle Car System would be used in conjunction with the

Automated Intermodal Facility technology to receive and deliver containers, manage the Container Yards and dispatch the Shuttle Cars within the System.

An alternative that employs the Fastransit Alternative MagLev technology as described in the next section could be used for the long-haul transportation instead of conventional rail. The Shuttle Cars would use the Fastransit MageLev propulsion system for higher speeds and lower operating cost. The cars would run on Guideways rather than rails. Rather than train consists, the System would dispatch and control individual Shuttle Cars on demand as in the short-haul ATS Automated Shuttle Car System..

On-Dock or Near Dock Transfer Facility

The configuration, shown in schematic to the right, contemplates an On-Dock or Near-Dock Transfer Facility. As in the Generic Intermodal illustration, trucks or Chassis Hustler Combos enter the facility at one end [the bottom right side of the drawing], are serviced at the Truck Load Unload Stations and exit at the top of the drawing.



Schematic Marineside Terminal Alignment • Response to D1 + E1

Automated Shuttle Cars that run between the Marine Terminals and the Intermodal Facilities are serviced at the opposite [left] side of the drawing. They enter the facility at the bottom of the drawing and exit at the top. As before, all traffic, whether Shuttle Cars or Trucks is one-way.

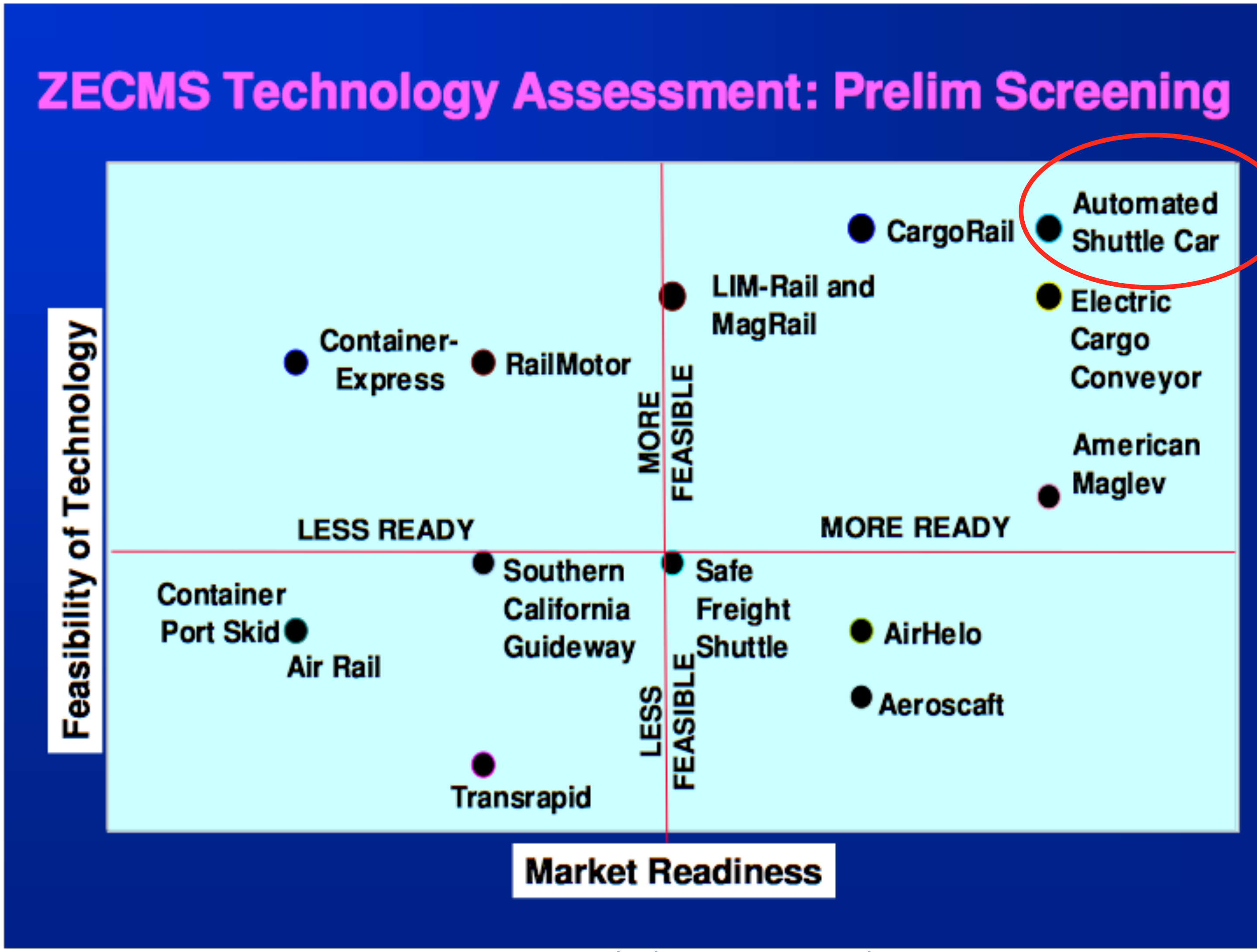
The RMGs pick the In-Bound Containers from the Truck Load Unload Stations and deposit them in the CY for intermediate storage and sorting. The Outbound Containers are then picked from the CY and deposited in the Shuttle Load/Unload Stations on the left side of the drawing. The Shuttle Cars are serviced by the Load/Unload Stations in a manner similar to the Trucks except that the Shuttle Stations are fully automatic.

Container transfers are effected at the Load/Unload Stations in less than 30 seconds for Shuttle Cars and less than 45 seconds for trucks.

ATS and Ederer have proposed a similar system for implementation at the ports of Los Angeles and Long Beach as part of the so-called Zero Emissions Container Mover System or ZECMS. The ATS proposal was rated highest overall among 14 technologies. {See: Chart on the following page.]

If topography, facility geometry and existing infrastructure permit, the intermediate move between the Marine Terminals and the Intermodal Facilities by the short haul system can be eliminated by implementing an On-Dock system that employs the Alternative MagLev Technology.

At inland points, transfers from the long haul system to trucks would be accomplished at appropriately sized Automated Intermodal Facilities.

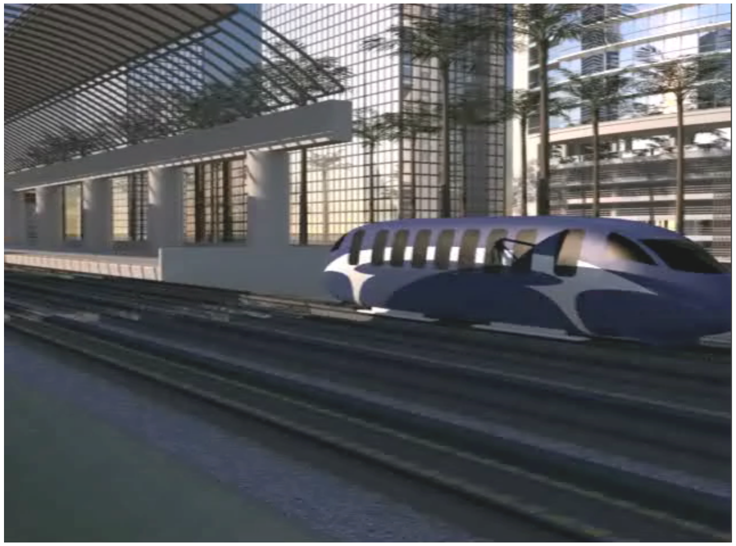


Source: URS Cambridge Systematics Final Report

Fastransit Permanent Magnet • Linear Motor
Alternative MagLev

Alternative MagLev • Permanent Magnet - Linear Motor

Fastransit has licensed this technology from LaunchPoint for development and deployment in transportation systems. The technology can be employed as a conventional long-haul train consist for passenger operations and as an individually dispatched single car system for the transportation of cargo [principally containers] or passengers for short haul, Metro or Long Haul Point-to-Point services

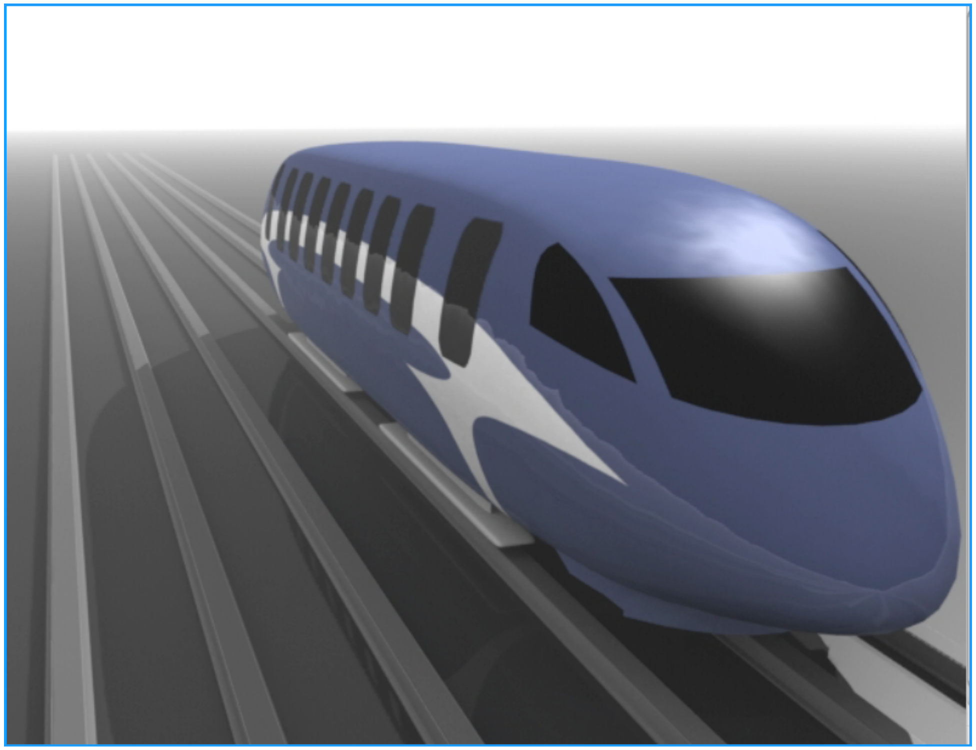


Single Car Individually Dispatched Passenger Configuration

Cargo Transporter Configuration

Alternative MagLev is simpler, lower weight cheaper to build and operate and more flexible than conventional MagLev. Optimal alignment configuration for the Single Car Individually Dispatched method is a loop with all traffic traveling in one direction as shown in the preceding section.

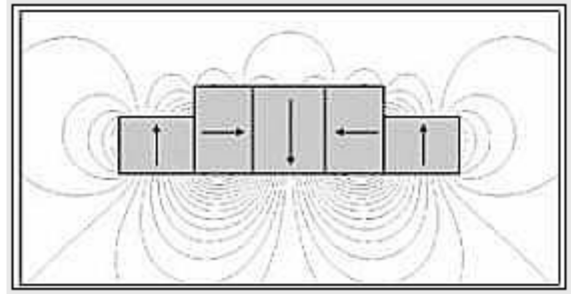
The system will be controlled through a combination of the ATS Supervisory Software similar to that employed in the management of machines in the IACT and traditional Train Control Systems.

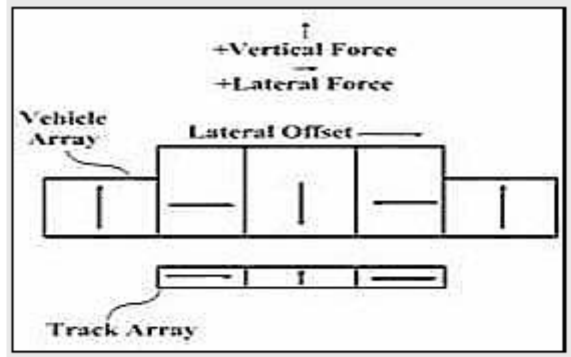


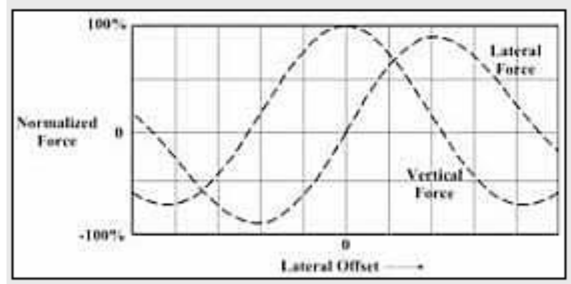
For Long Haul Passenger Service, the Alternative MagLev Technology can be employed with conventional passenger car designs operated in train consists or as Individually Dispatched Cars. Passenger and Cargo systems can operate on the same set of guideways, so long as the passenger trains and the Shuttle Cars travel at similar speeds.

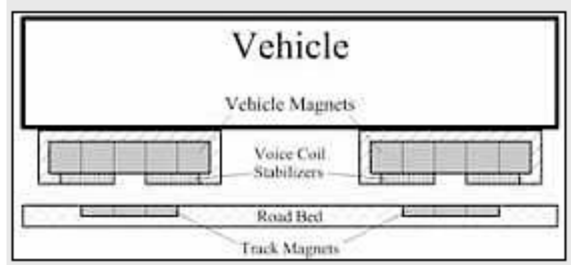
Individual Car Systems can also be operated as if they were horizontal elevators. That is, passenger demand at stations can be monitored and when an appropriate number of passengers have indicated that they wish to travel, a car can be dispatched form a nearby magazine.

Rather than the complicated and expensive Conventional MagLev, Fastransit's Alternative MagLev uses high-strength neodymium-iron-boron permanent magnets, assembled in a configuration known as a Halbach array, to form the core of the SPM suspension design. A typical Halbach array and its magnetic field are shown in the figures on the next page.









Halbach Arrays

The polarities of individual magnets in the array are arranged such that the fields reinforce each other on the “active” face, producing a very strong magnetic field, and largely cancel each other on the “inactive” face, leaving almost no field at all. [Top Right figure.] Halbach arrays were invented over two decades ago and are used in a variety of industrial applications.

To create a maglev suspension, two Halbach arrays are employed as shown in the second figure. The active face of the vehicle array or “ski” points downward, while the active face of the stationary track array points upward. The vehicle array is much larger in cross section than the track array to provide sufficient lift force while minimizing track costs. The skis extend for most of the length of the vehicle. With practical magnet dimensions, the skis provide a levitation gap of three to eight centimeters at all speeds, with no levitation power requirement and essentially no drag.

This suspension design produces in excess of three times the force of an equivalent mass of magnet material configured as simple opposing dipoles, and also confines the field to a much more localized area. The vertical and lateral forces produced are illustrated in the third figure at right. With vehicle and track arrays vertically aligned as shown in the graph (offset = 0), vertical force is maximized and lateral force is zero. As the lateral offset increases, the magnitude of the lateral force grows and tends to increase the offset even more, i.e., the suspension is laterally unstable.

To control lateral instability, electromagnetic voice coil lateral stabilizers are mounted under the vehicle magnets to interact with the track magnets, resulting in the suspension shown on the lower right. A feedback control system monitors ski alignment with respect to the rails and varies electric current in the voice coils to adjust the magnetic fields and keep the vehicle centered. Using “virtual zero power” control, stabilization power is on the order of 100 watts per ton of vehicle weight.

This design also confines magnetic fields almost entirely to the levitation gap, preventing high intensity fields from penetrating the vehicle above and adversely affecting cargo or passengers. The magnetic field inside the carriage is even less than in the Transrapid design, which is equal to 1 gauss, or the typical background magnetic field on the surface of the Earth.

Links to Our Websites and Additional Contact Information:

Additional information from Automated Terminal Systems is available at: https://www.atsysusa.com
and from SmartCrane at: http://www.smartcrane.com
and from Fastransit at: http://www.fastransitinc.com
and from Morgan Alliance at: http://www.morganengineering.com
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