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Continuing Evaluation of Marine Terminal Design & Cargo Handling

Presented by

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AAPA Marine Terminal Management Training Program

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Moffatt & Nichol

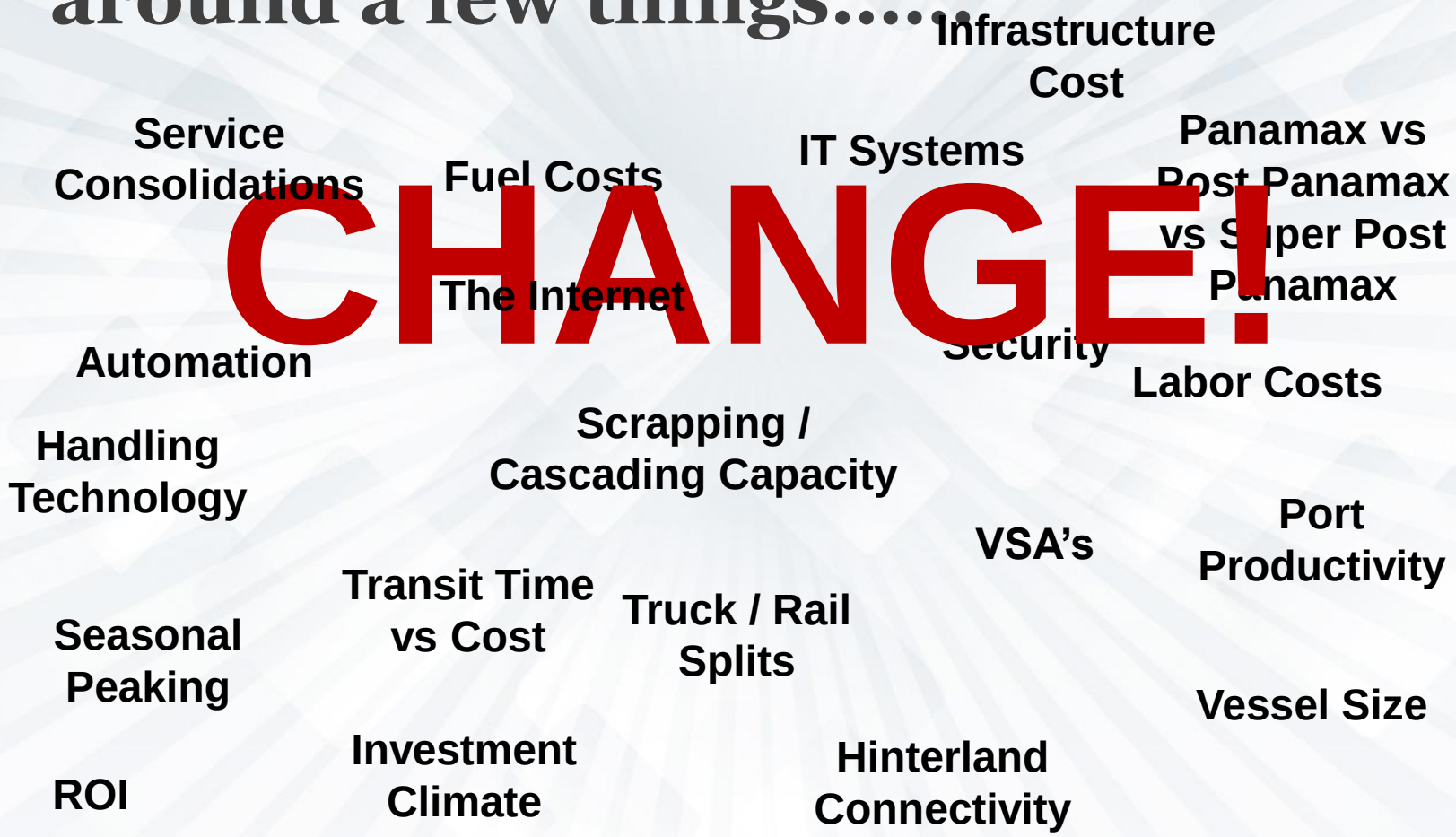
- Founded in 1945 in Southern California to serve the evolving Naval, Port and Maritime Industries
- 550+ employees; 27 offices (North America, Europe, Latin America, Middle East, Pacific Rim)
- A recognized leader in marine terminal planning, analysis, design, and goods movement economics
- Made up of Planners, Engineers, and Economist

Introduction

- Ashebir Jacob, P.E. Senior Port Planner / Engineer
  - Over 25 years experience in container & intermodal terminal planning, design, operations, and simulation
  - Including recent automated container terminals

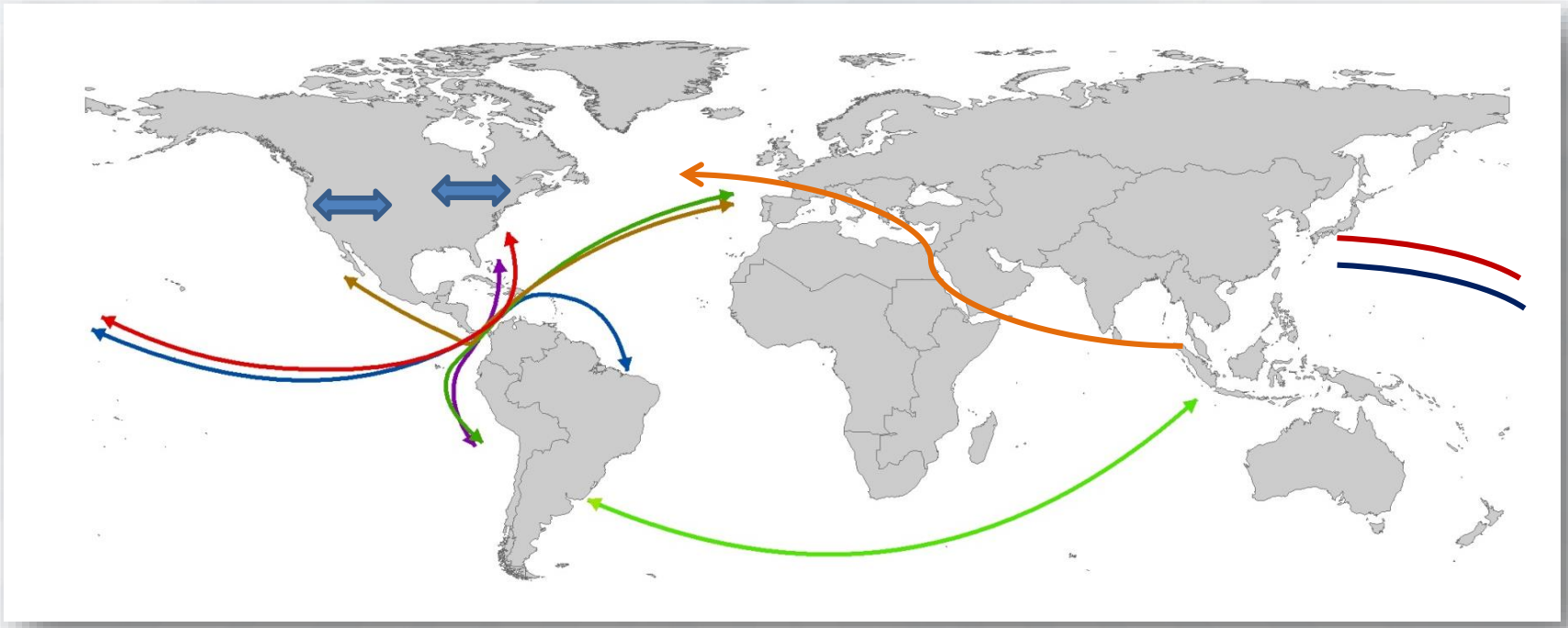
Changes Impacting Terminals

- **We only need to get our arms around a few things…..**

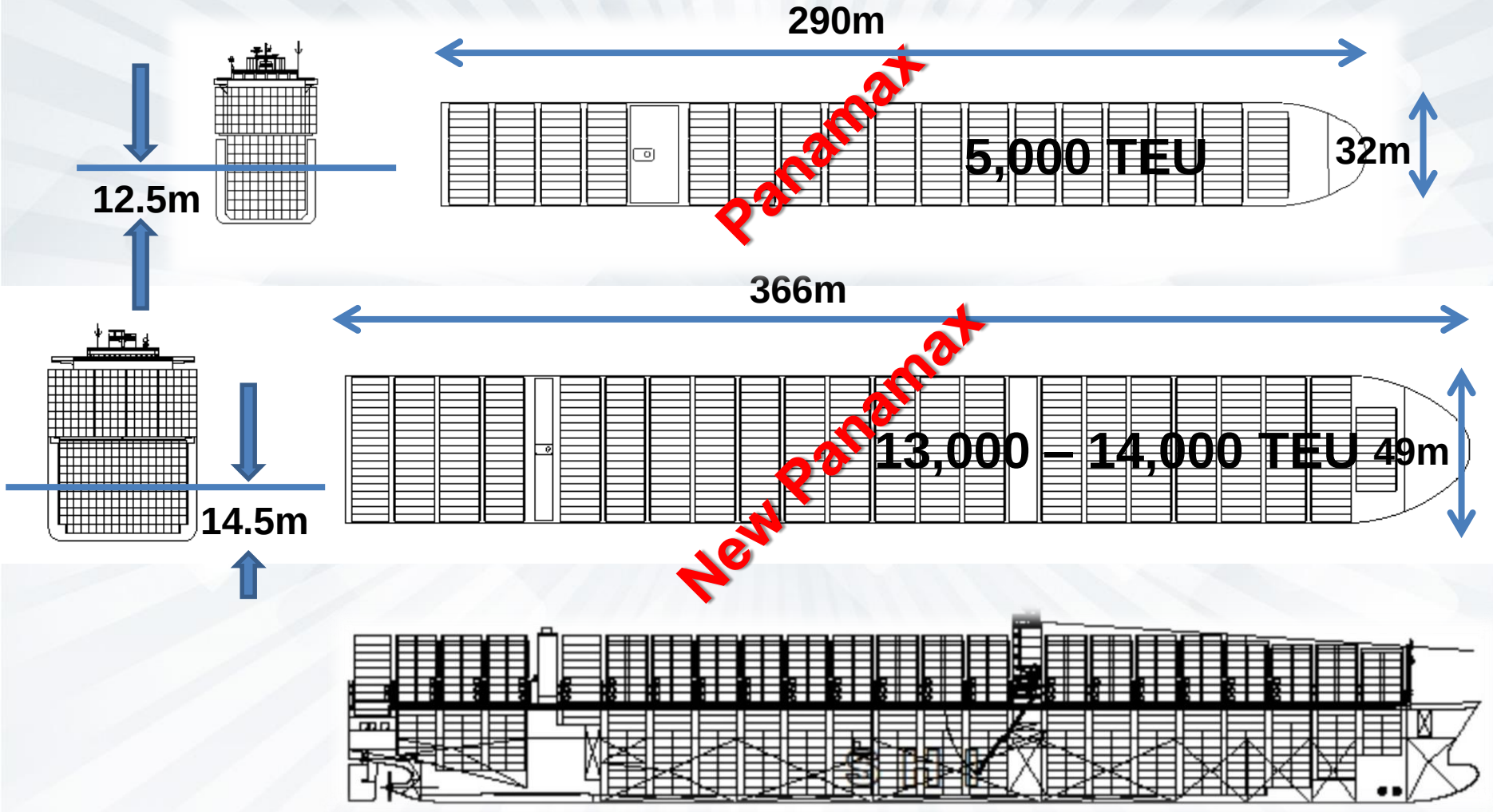


Container Terminal
Post Panama Canal Expansion

- The PC expansion will result in larger vessels transiting the canal
- New Panamax vessel capacity = 250% of Panamax vessel capacity
- Initially, there will be fewer vessels
- North American West Coast / East Coast splits may be effected
  - *However, West Coast NA ports can accommodate >18,000 TEU vessels*



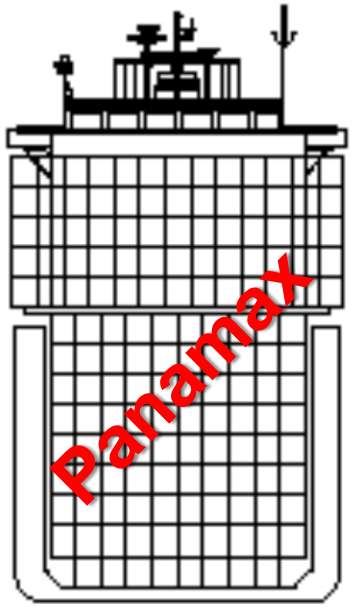
Panamax vs New Panamax



Panamax vs New Panamax

13 Containers 32m

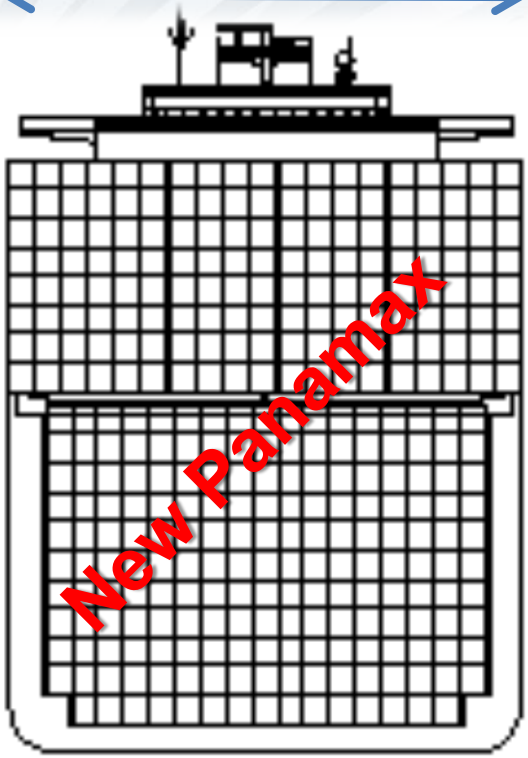
9 + 5 = 14 HC Containers 39m



135 containers per bay / Quay Crane
9 hours Disch + Load

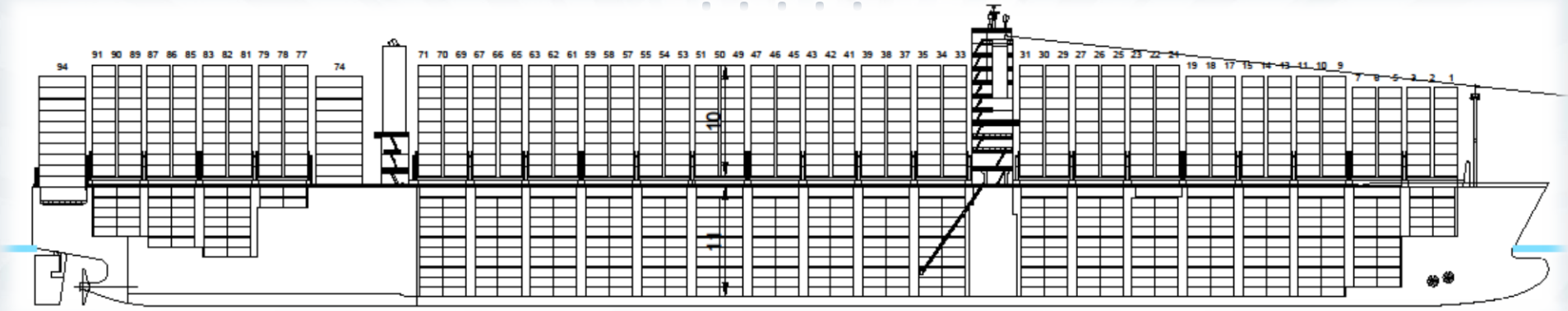
19 Containers 49m

11 + 8 = 19 HC Containers 57m



320 containers per bay / Quay Crane
20 hours Disch + Load

18,000 TEU

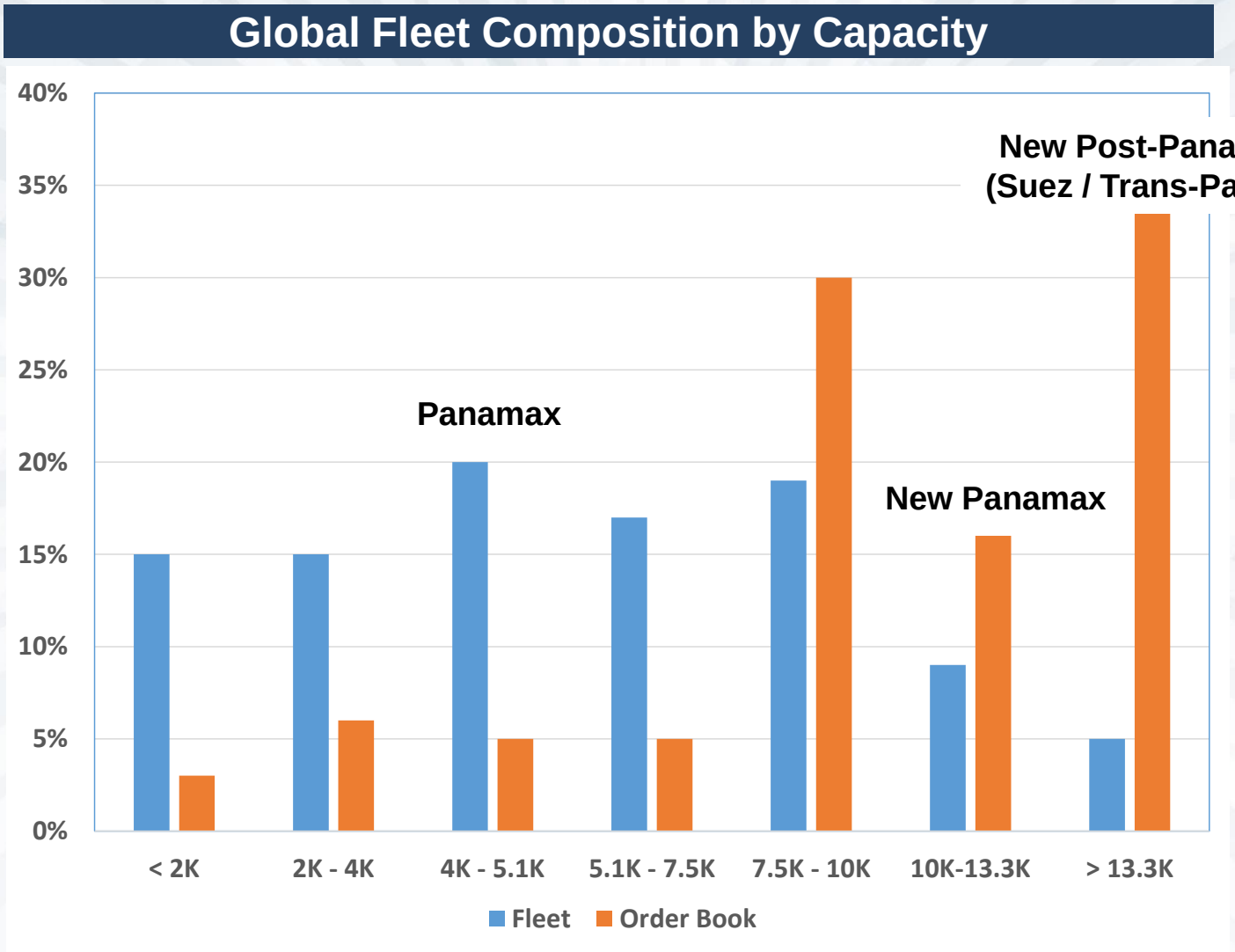


Since the announcement of the Panama Canal expansion, Maersk has built and deployed “New Post Panamax” vessels of 15,000 TEU (Emma Class) and 18,000 TEU (EEE Class)

The 18,000 TEU vessel breaks convention in several areas

- Slower optimum sailing speed of 19 knots
- Twin screw/rudder instead of single screw/rudder
- Optimized hull shape
- Very efficient power plant, significantly reducing fuel consumption and emissions

Larger Vessels = Economies of Scale



Reason for Upgrade

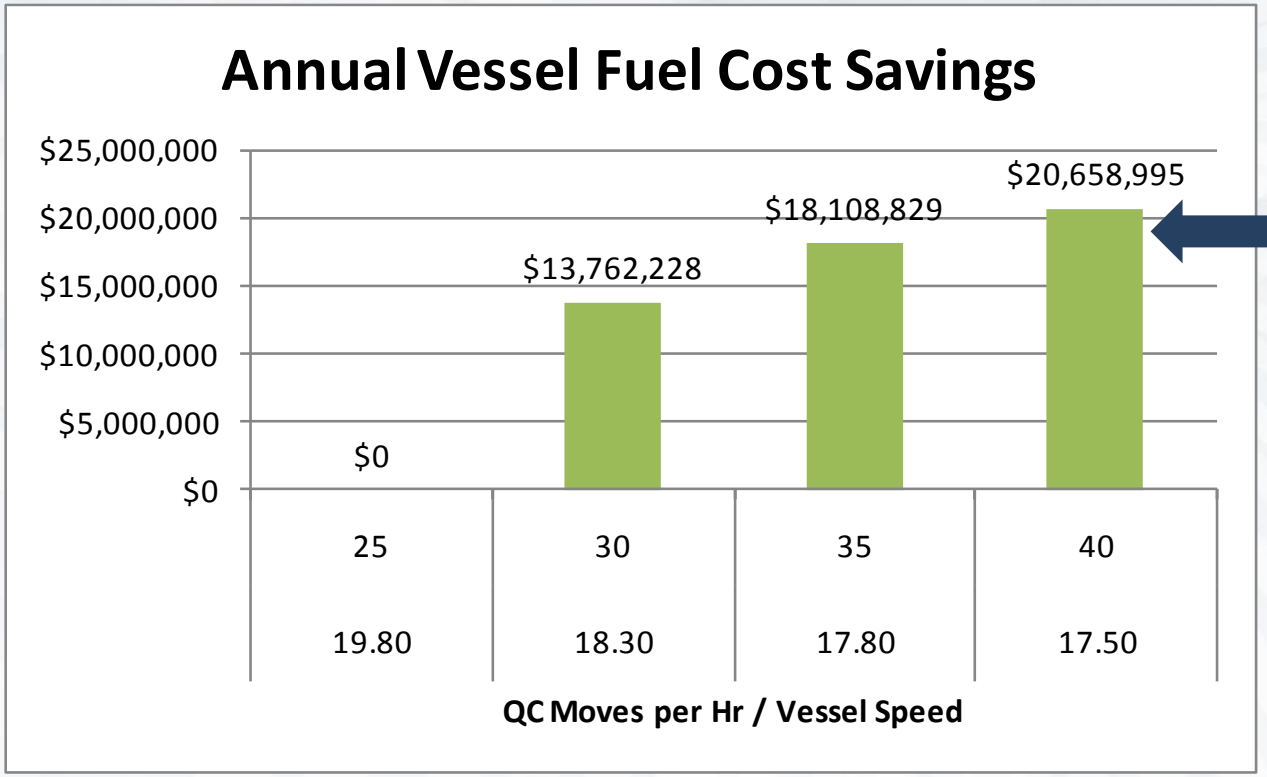
Port Productivity

Ocean Steaming Speed

Cost per Container

Reason for Upgrade

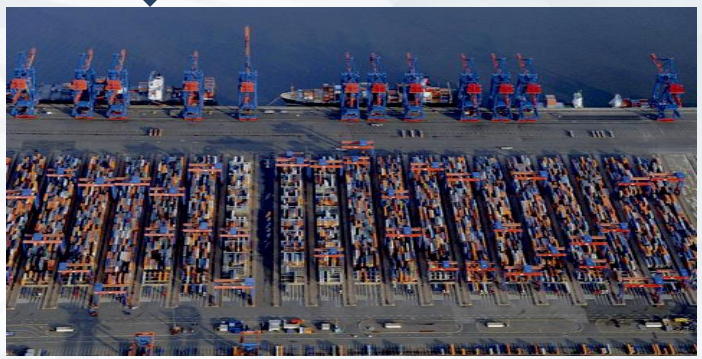
- N. Asia – US West Coast
  - Relationship between quay crane prod and vessel fuel cost



$20.00 / TEU or about
$36.00 / container

Business Case for Container Terminal

Vessel
- Up to 14,000 ctr per call
- Regular schedule with some variation
- Demand for short port stay time



Container terminal
- to handle
- to store
- to sort and consolidate

Train
- "Call size" 600 or less
- tight and regular schedule

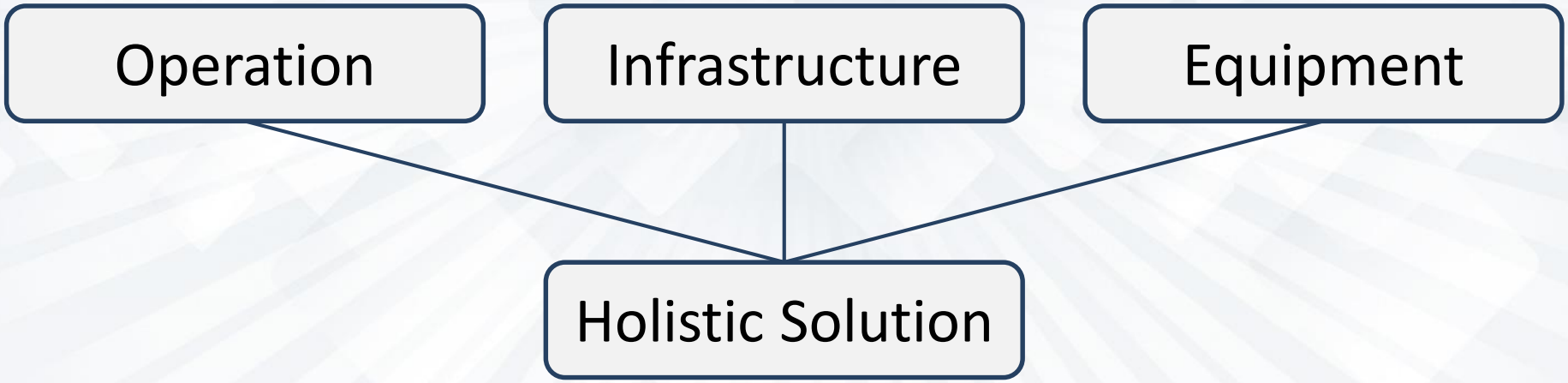
Truck
"Call size" normally 1 to 2 ctr
- Almost random appearance
- Demand for short turn time

Business Case for Terminals

- Development of brownfield or greenfield terminal, it is somewhat basic business as usual
  - Adequate **capacity**
  - Required **productivity**
  - Predictable **cost / opex**
  - Weekly **reliability**
- Strive for optimization
- There is no “standard plan” that will work for every terminal

Holistic Approach to Upgrades

- Prior to development of upgrade plans understand the reason for some of the requirements:



DON'T LOOK AT A PROBLEM IN ISOLATION

Holistic Approach to Upgrades

- System Understanding
  - What will be the optimum vessel service and size for the terminal?
  - Weekly versus other
  - 5 production days versus 6
  - Hoots versus no hoots
  - Something in-between?

Holistic Approach to Upgrades

- Big ships for your terminal?
  - Less than 8,000
  - 14,000
  - 18,000
  - 22,000?

Holistic Approach to Upgrades

- Your terminal's plan for working large vessels?
  - STS Productivity requirements
  - No of cranes
  - Crane improvements
  - Wharf structural problems
- Mooring lines
  - Who determines how vessels are secured?

Holistic Approach to Upgrades

- The solution will range from:
  - Building new port facility
    - Similar to Singapore "Terminal of the Future"
  - Phased upgrade of the terminal
    - Typical solution for many ports in the world
  - Upgrade isolated elements
    - Strengthening care rail beams
    - Deepening channels
    - Increasing STS crane height ….

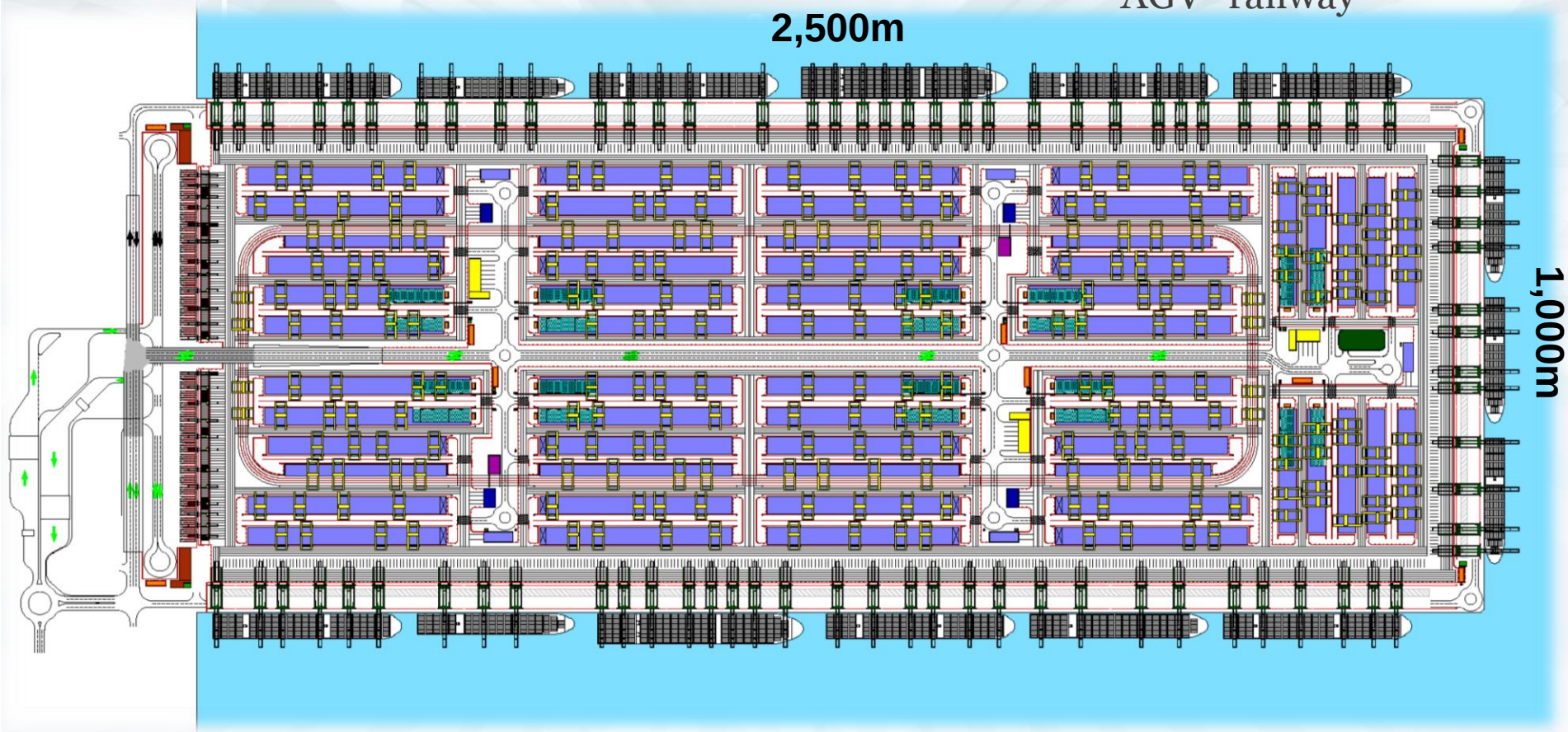
“Terminal of the Future”

Singapore – MN Next Generation Container Port Competition

- 20M TEU per year
- 80% Transshipment

- 200,000 slots
- 78 STS cranes
- 200 Yard cranes

- 27 Landside transfer cranes
- Recessed terminal “AGV” railway



If automation is an option

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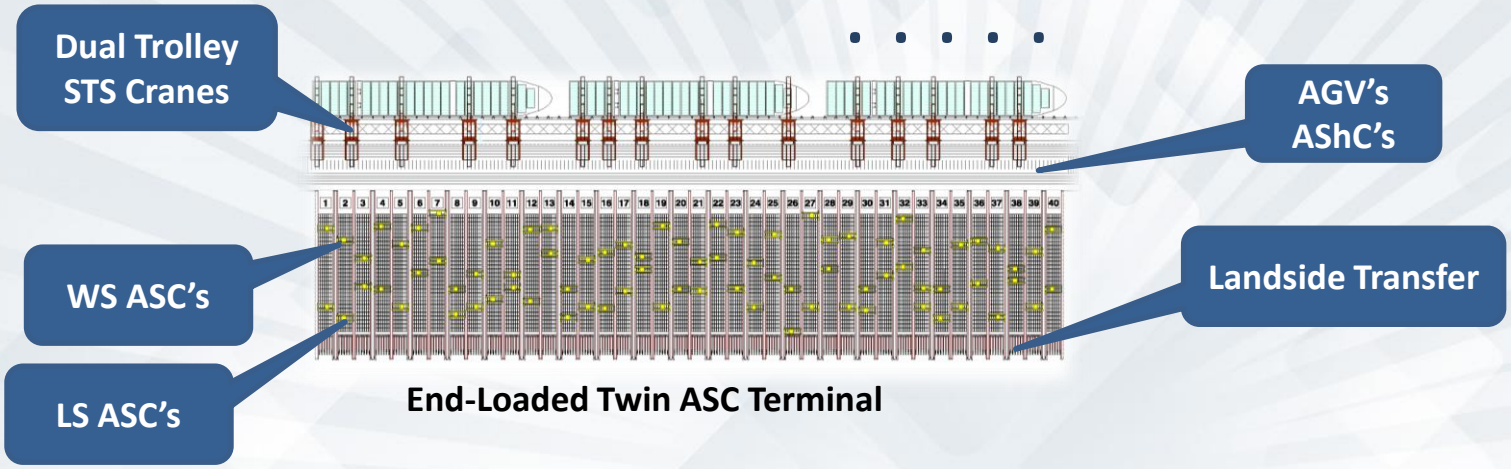


End-Loaded Twin ASC Terminal

Side-Loaded Twin ASC Terminal

- *None automated well optimized terminal may be a solution for many terminals*

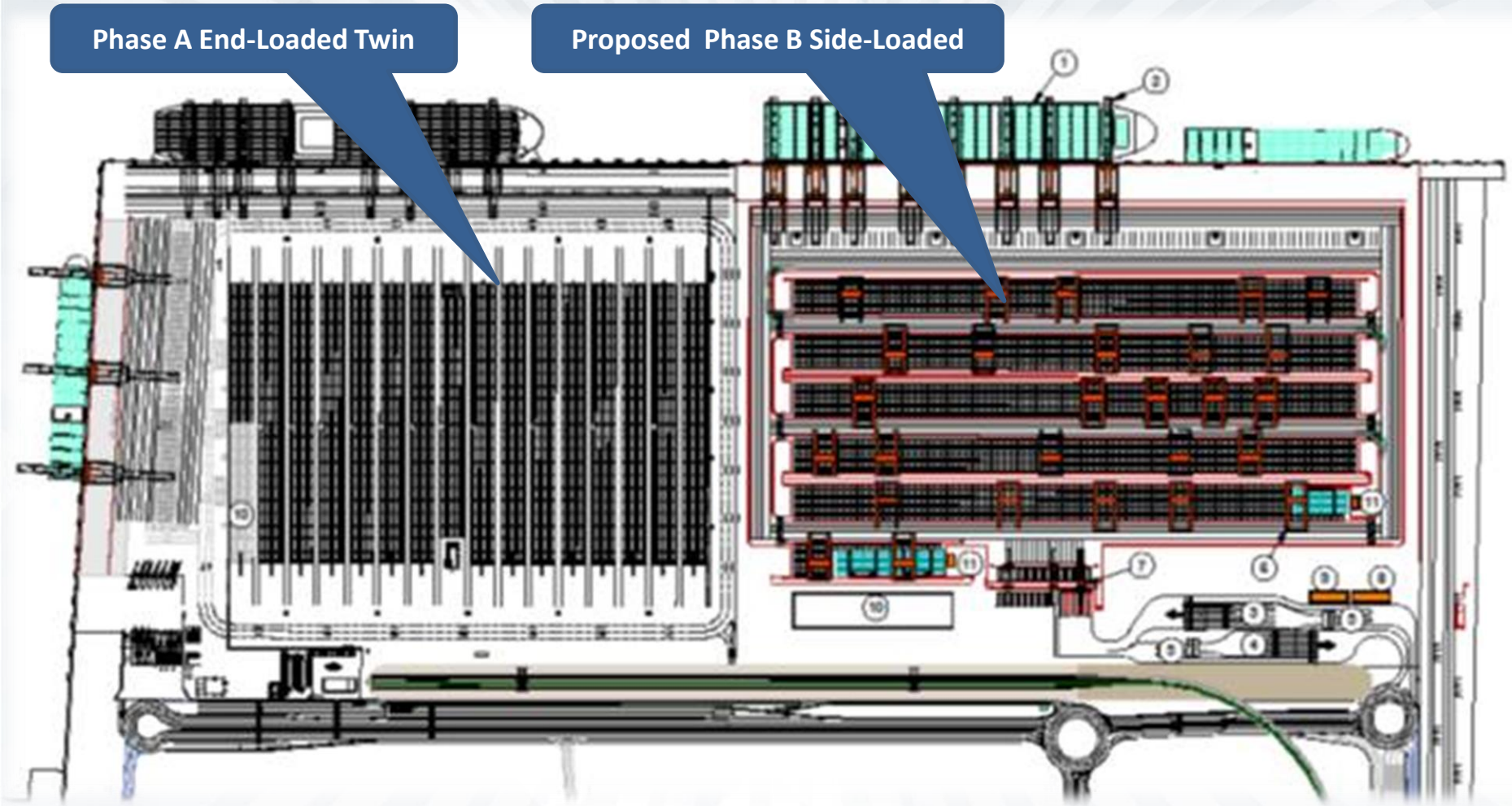
Stacking
End-Loaded or Side Loaded?

- End-Loaded Twin
  - Most cost effective for high import-export, low transshipment
  - ASC's are separated for waterside and landside, difficult to balance
  - Waterside and landside handling capacity is fixed
    - WS ASC~18
    - LS ASC ~13
  - **Won't fit on all sites**

- Side-Loaded
  - More costly than EL for high import-export
  - Higher ASC productivity
    - WS moves ~23
    - LS moves ~ 19
  - ASC fleet is combined, all waterside, all landside
  - Handling capacity is variable
  - Requires fewer ASC's, additional LTC's and more AGV's or ShC's
  - **Won't fit on all sites**

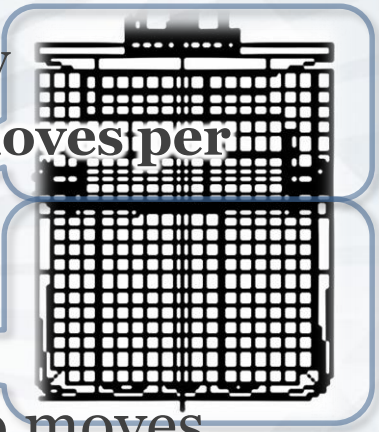
Example Where End-loaded Does Not Work Well

Algeciras - 95% Transshipment



Panama Canal Expansion Effect to Container Terminal Operations

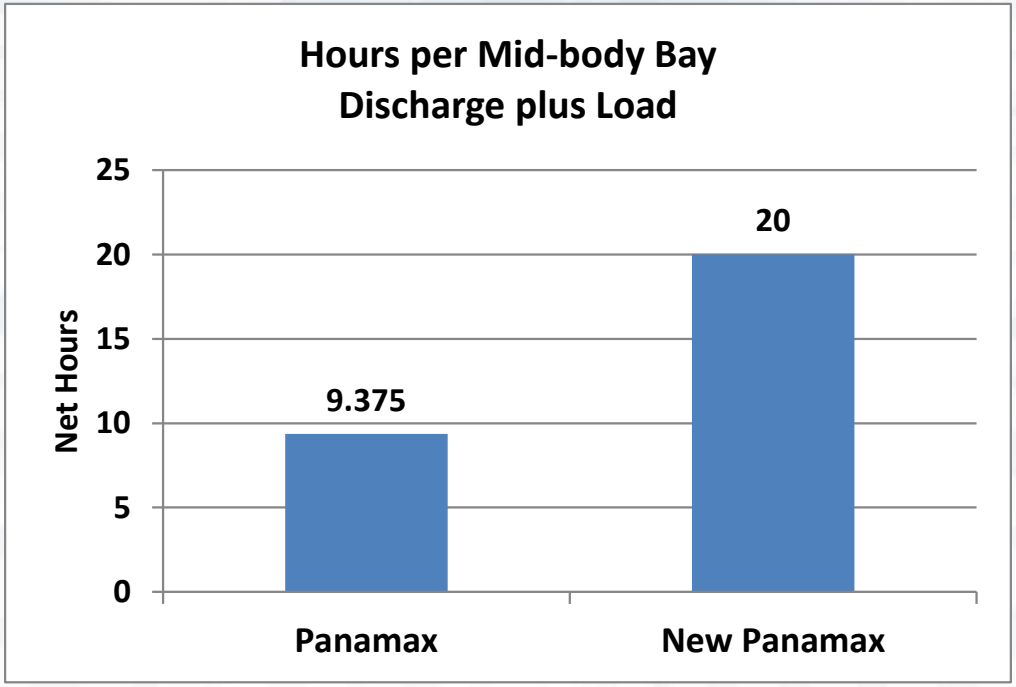
- Increased moves per vessel bay/quay crane
  - Panamax 150 containers = 300 moves per bay
  - **New Panamax 320 containers = 640 moves per bay**
    - 19w x 8h above deck = 152 containers
    - 17w x 11h below deck = 187 containers



- Moves per bay is >doubled over Panamax, so moves per quay crane is >doubled
  - Twin 20' and even tandem 40' lifts become more attractive

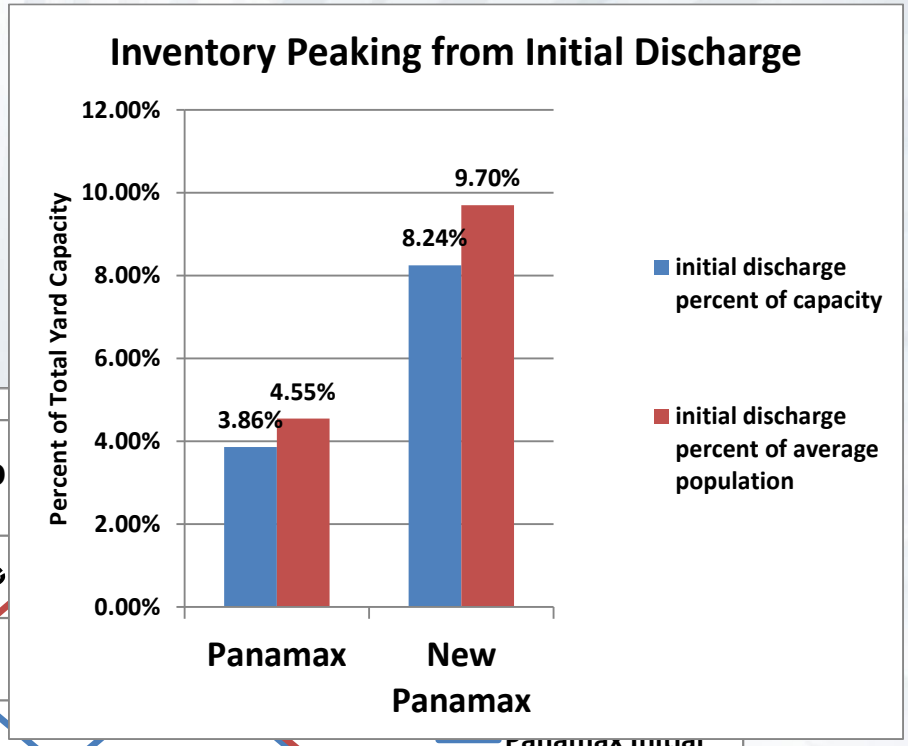
Panamax vs. New Panamax

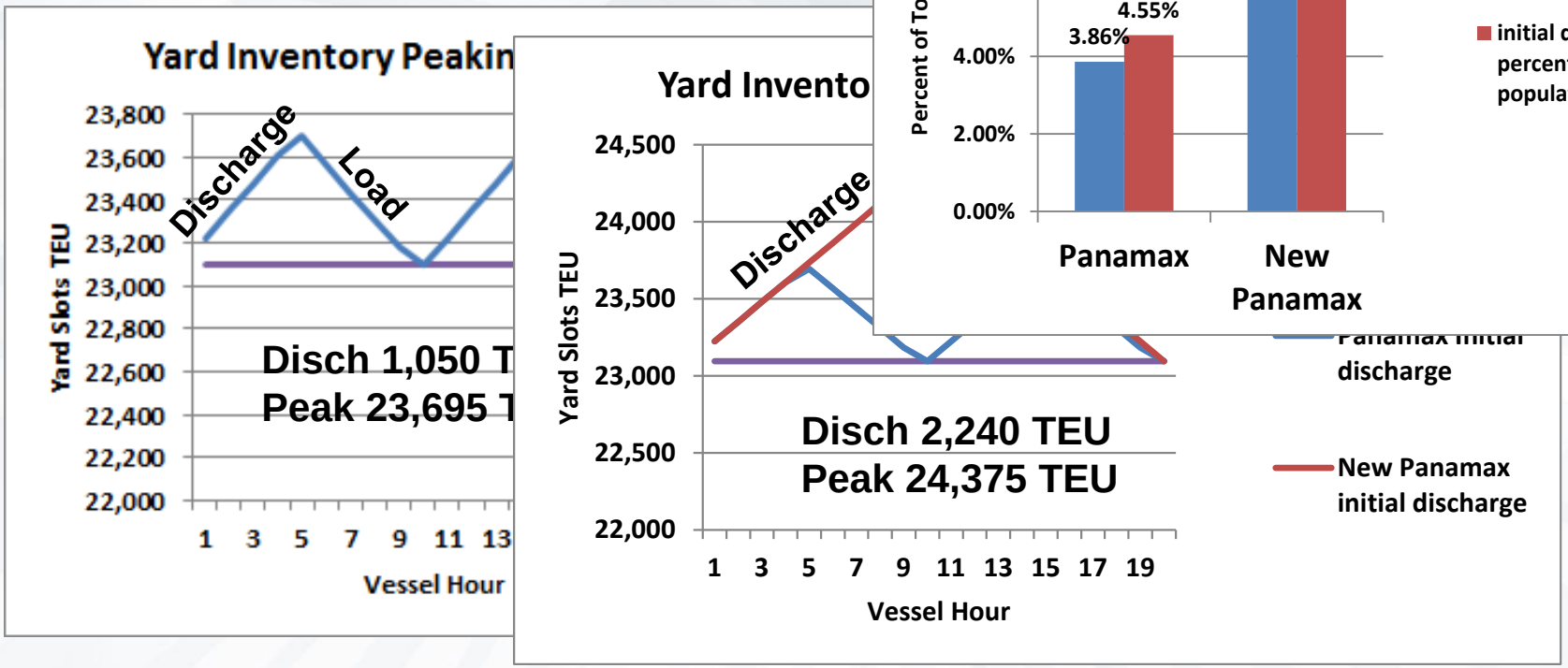
- Effects on port operations
  - Hours per mid-body bay at 32 net moves per hour



Panamax vs. New Panamax

- **Inventory surge due to initial discharge**
  - **Terminal with 25 Ha container storage yard**
    - **27,000 TEU slots, 23,000 TEU average inventory**





Look into system optimization?

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- "System Optimization"
  - The ability to optimize through changes in software and procedures is one principle advantage of these new terminal systems
  - Optimization typically takes years and will change over time
  - Vessels, services, service speeds, terminals, landside transportation all "Right-Size" and "Right Speed" for optimum service/cost
- Consistency, reliability, sustainability and predictability with lowest cost

What can be done?

- Tools to allow operator make the right decision
  - Simulation FXT
  - Emulation FXT
  - Optimization FXT
    - Ability to evaluate every process from beginning to end
    - Develop a process to improve efficiency
    - Implement improvements to TOS with confidence

What can be done?

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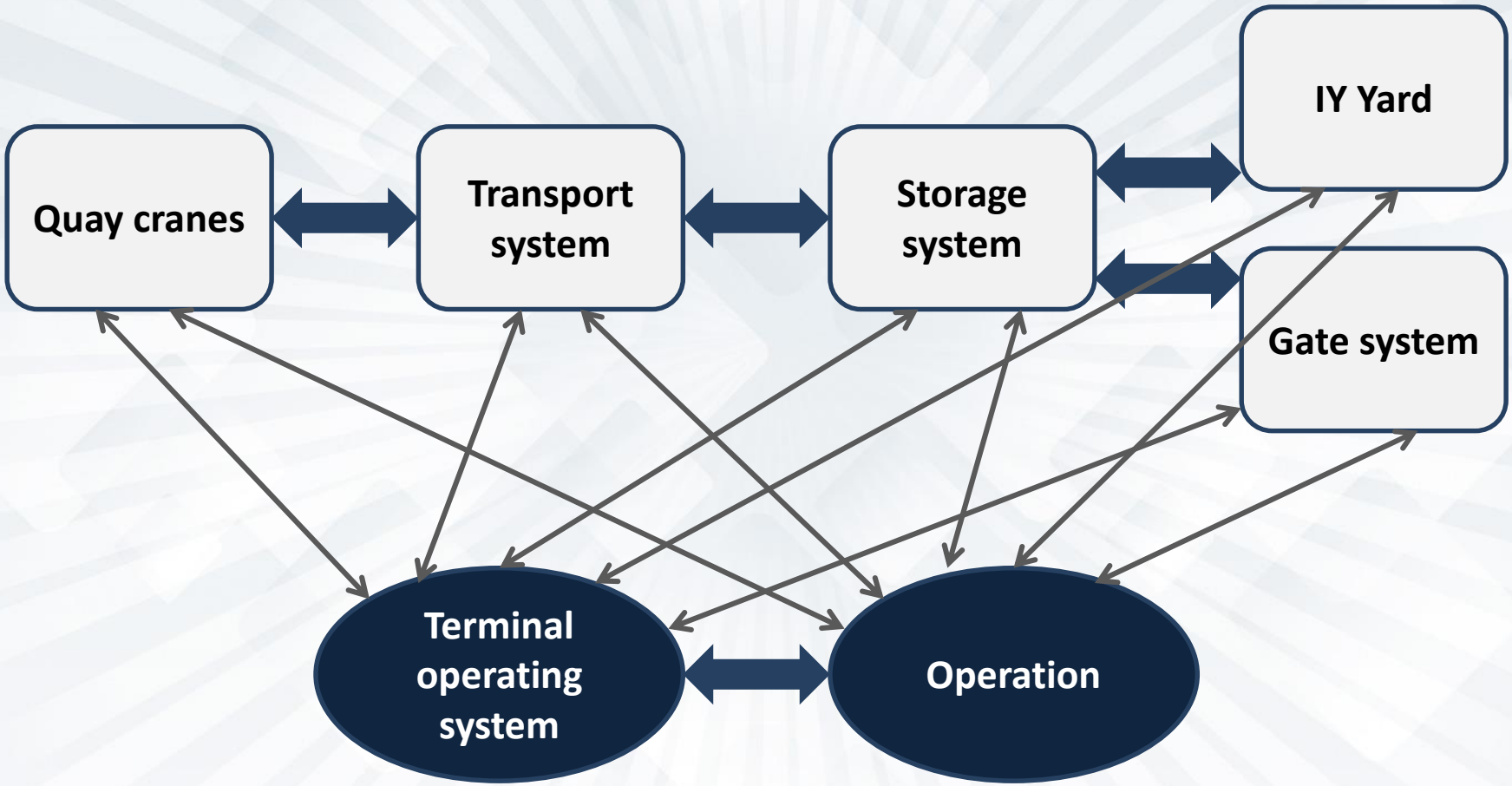
RTG Terminal.mp4

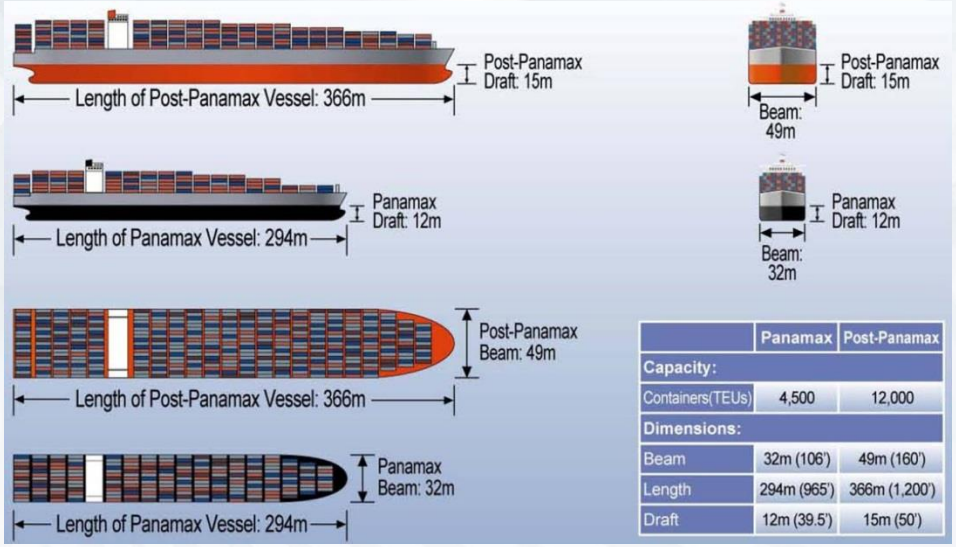
TotalTerminalView.mp4

Improve TOS to Optimize Operational Efficiency



Navigational Issues

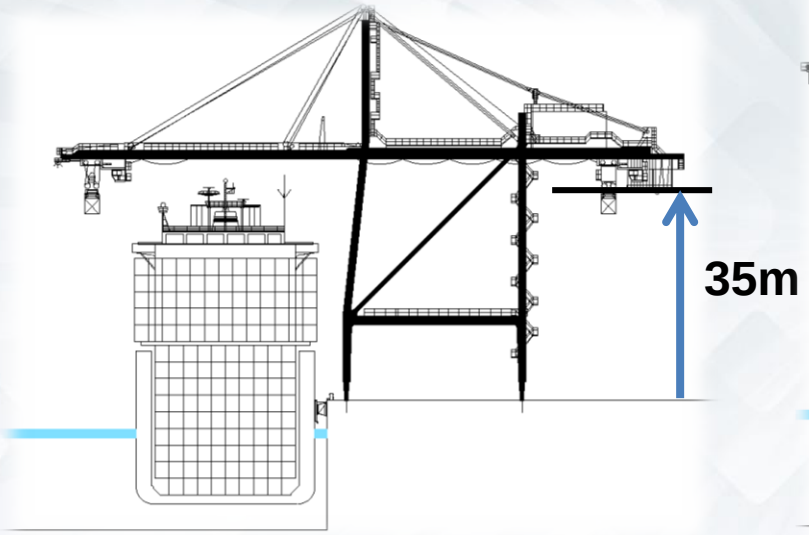
- Channel depth
- Mooring and berthing strength



	Panamax	Post-Panamax
Capacity:		
Containers(TEUs)	4,500	12,000
Dimensions:		
Beam	32m (106')	49m (160')
Length	294m (965')	366m (1,200')
Draft	12m (39.5')	15m (50')

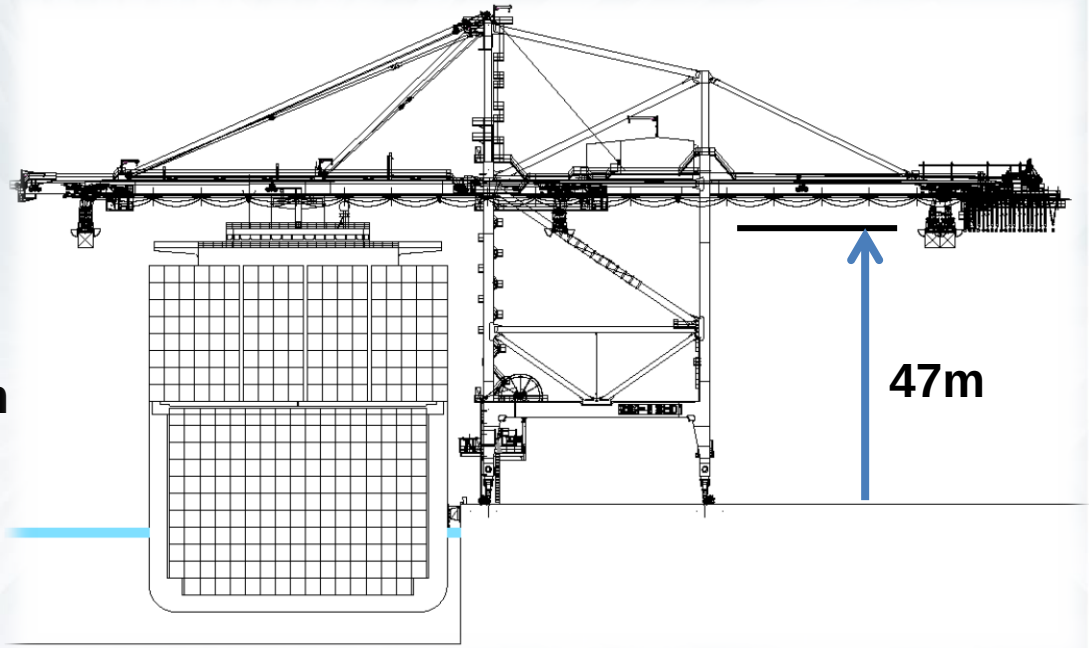
Source: *ACP*

Panamax vs New Panamax STS Cranes



Panamax

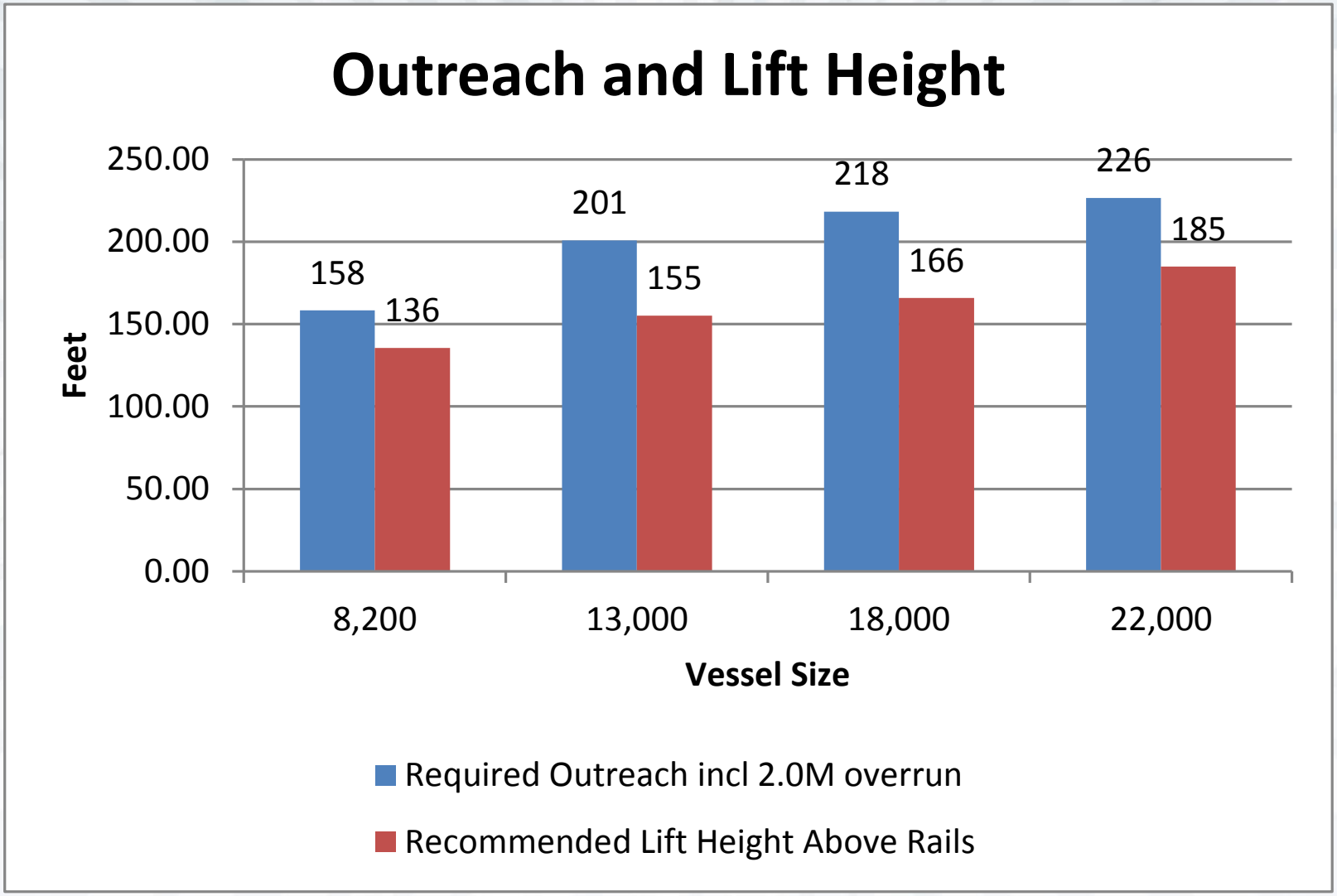
Single Trolley
Twin 20’ Spreader



New Panamax

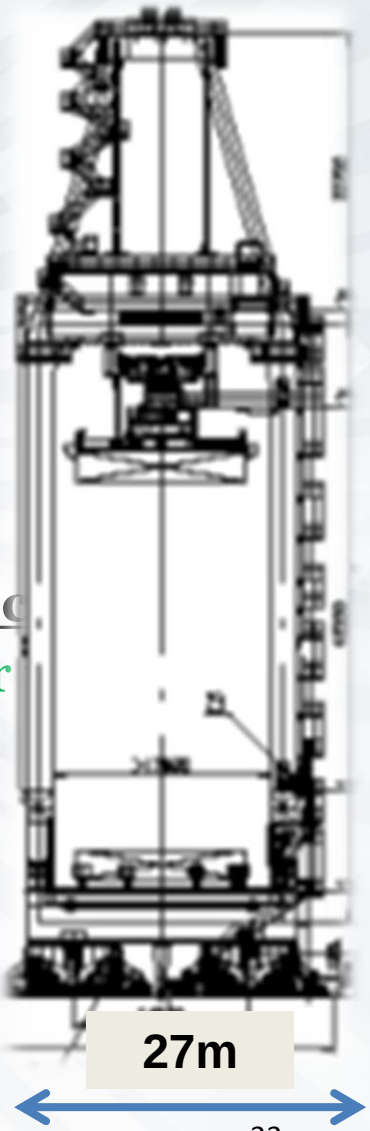
Single Trolley
Twin 20’ / Tandem 40’ Spreader?

STS Crane Dimensions



Panama Canal Expansion Effect to South American Ports Operations

- Increased quay crane dimensions and wheel loads
  - Outreach
    - Panamax 32.5m
    - New Panamax 48m
    - **(~16m increase in QC outreach)**
  - Lift Height
    - Panamax 8 + 5 = 13 HC
    - New Panamax 11 + 8 = 19 HC
    - **(~11.6m increase in QC lift height above doc**
  - Wheel load (cranes can still only be 27m long bumper bumper)
    - Panamax 80 MT per wheel
    - New Panamax 130 MT per wheel
    - **~50 MT increase per QC gantry wheel**



New Generation of STS Cranes

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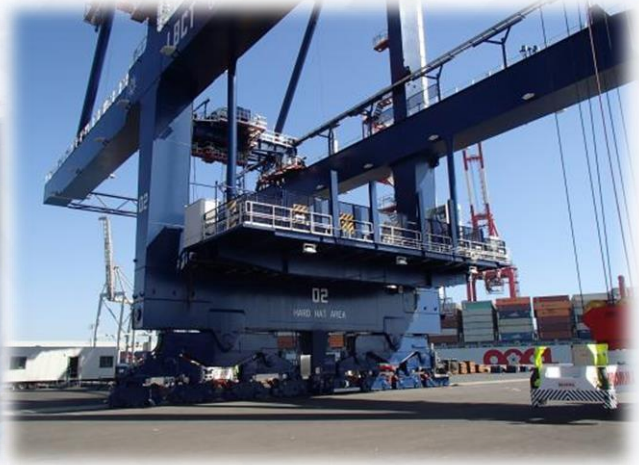

New Generation of STS Cranes

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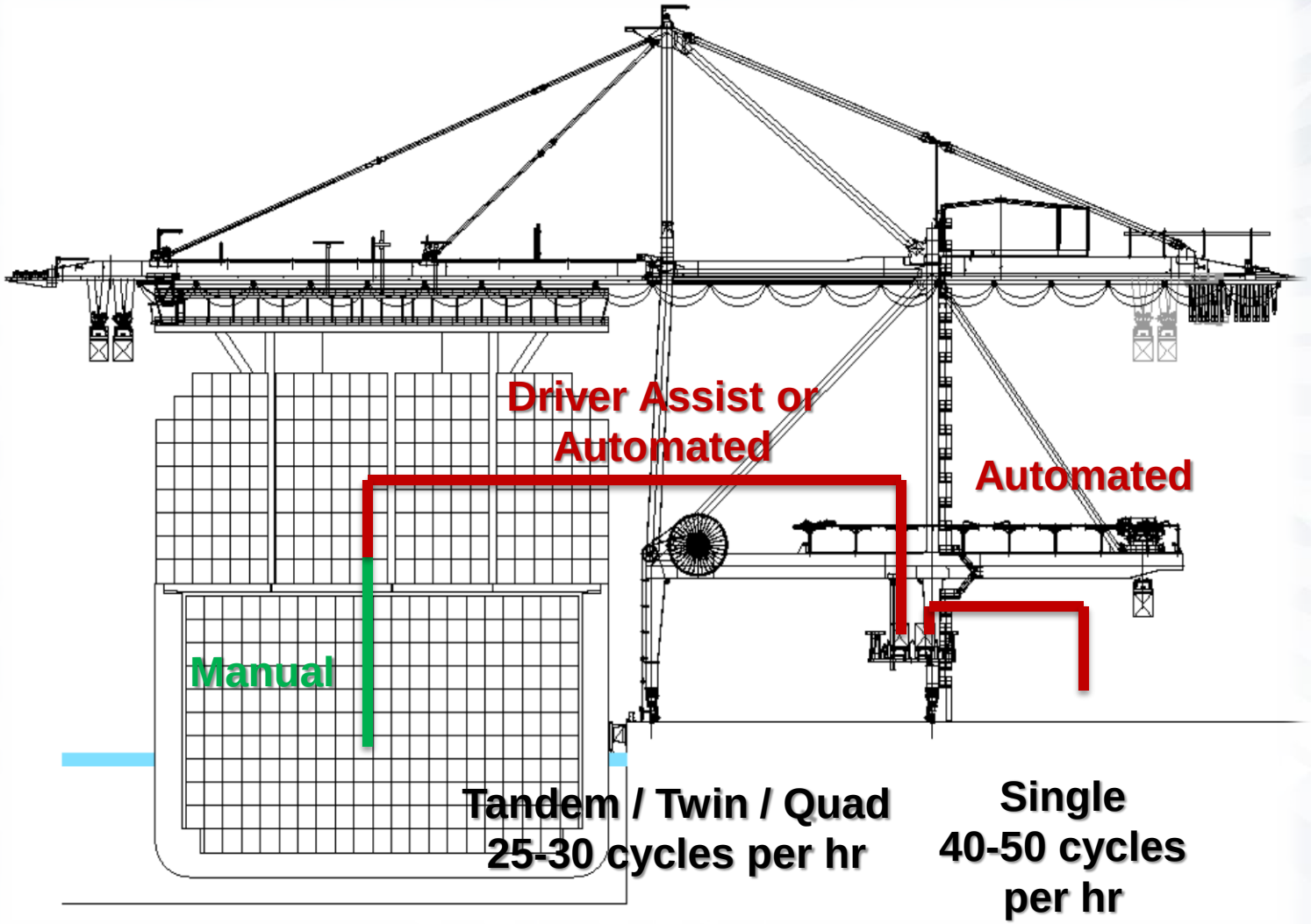

New Generation of Horizontal Transport

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- Detailed gathering and distributing tasks to/from storage
  - Move any box, from any location to any location at any time
- Must be rubber-tired
  - AGV (battery operated)
  - AShC (hybrid diesel)

New Generation of ASC

- End-loaded stacking/retrieval cranes
- Side-loaded stacking / retrieval with landside transfer cranes

Automated Straddle Carriers & RTGS

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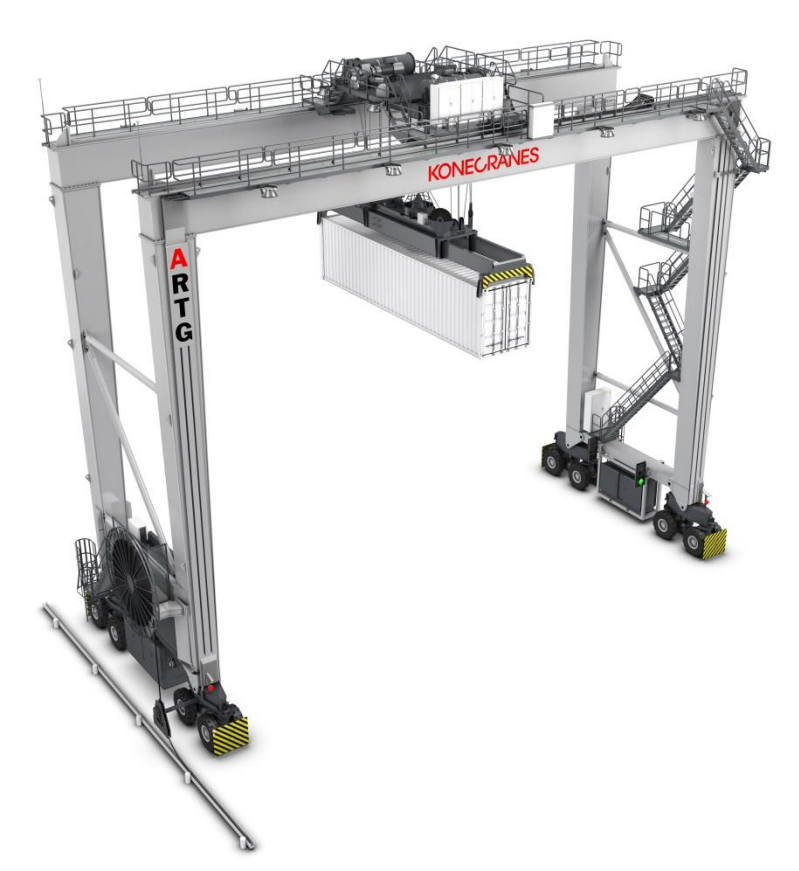
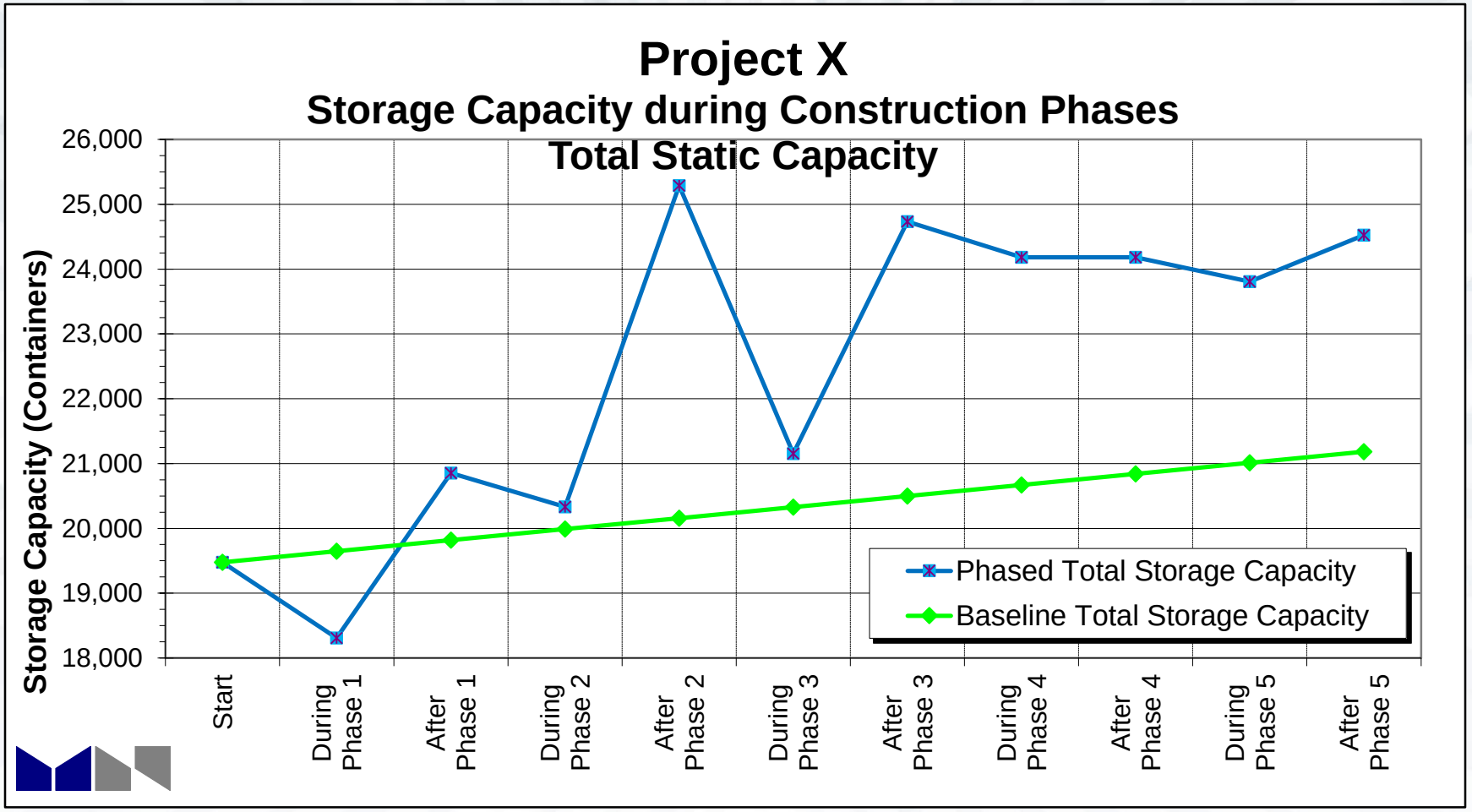


Phased Terminal Development is a Challenge

- To minimize the impact of the first phase
  - Offsite satellite terminal
  - Build expansion area first
  - Increase the density
  - Lose some of the business
- Capacity ahead of demand for subsequent phases

Phased Development is a major challenge and requires a well coordinated plan

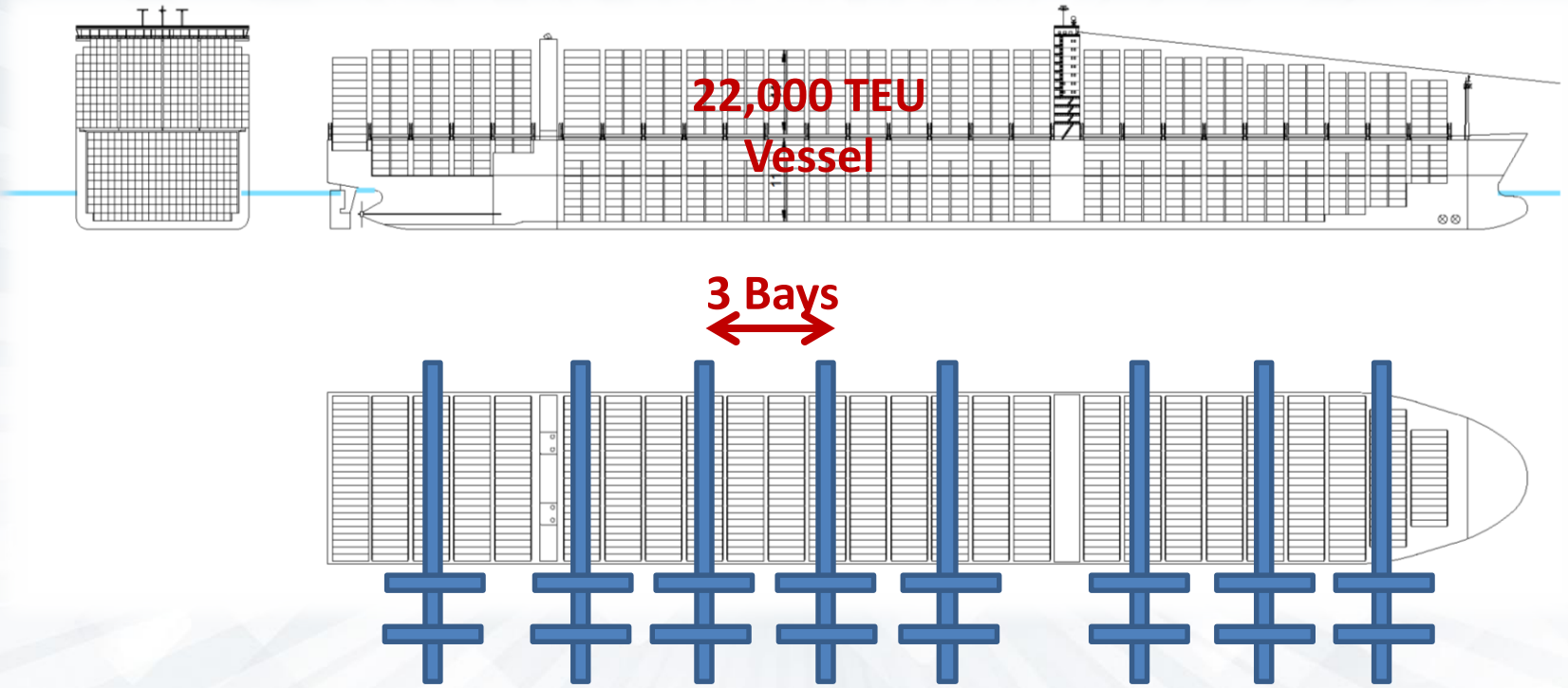
Phased Terminal Development is a Challenge



STS Bumper-to-Bumper Length

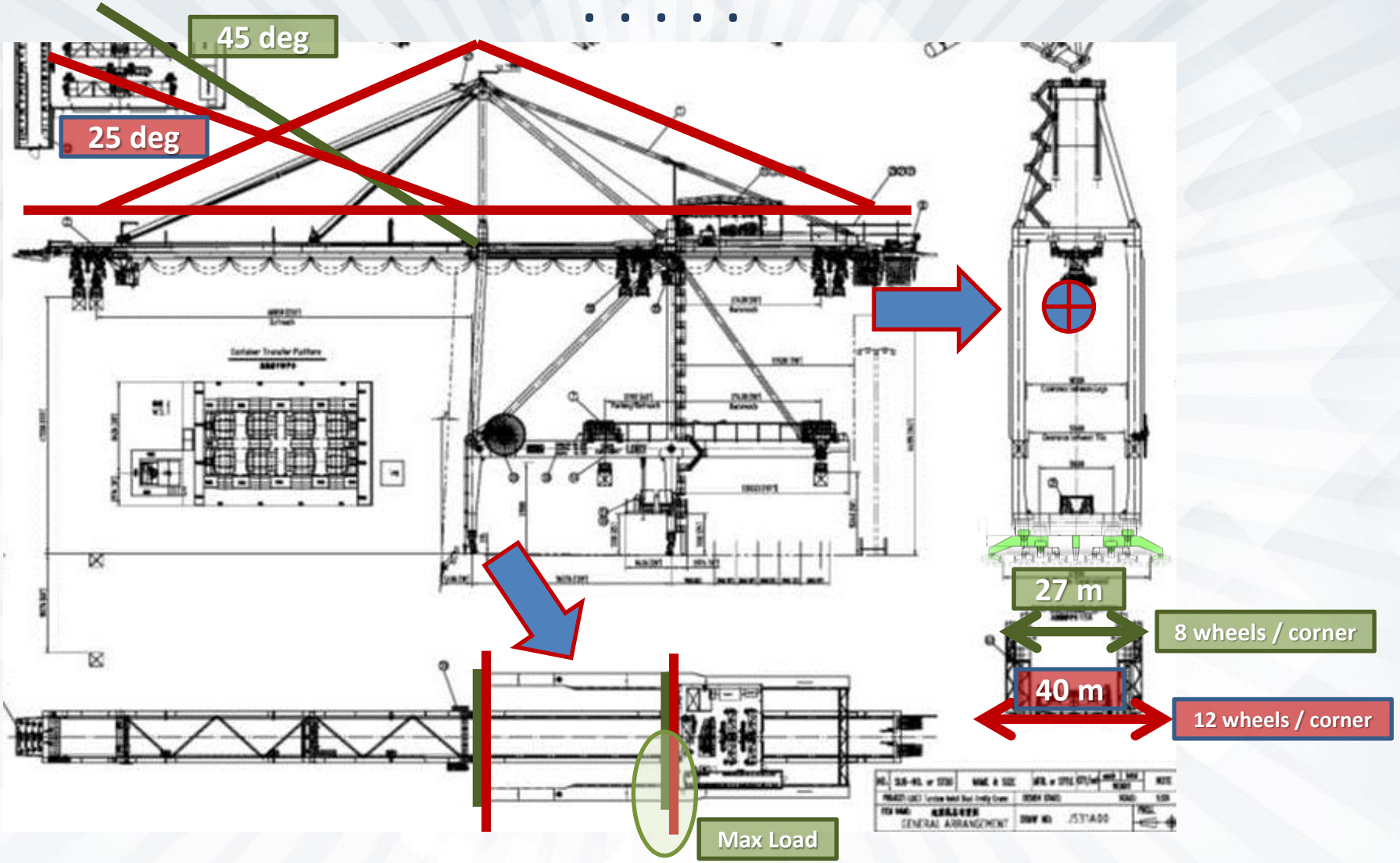
- The current standard of 88.5 feet (27m) was established when vessels were less than 2,000 TEU capacity with 12-14, 40 foot bays
- It allows cranes to be deployed on every - other vessel bay
  - Maximum of four cranes were typically deployed on a heavy port call, 1 per ~3 bays
- Current 14,000 TEU vessels have 22 bays, 18 and 22,000 TEU vessels will have 24 and 26? bays respectively
  - Maximum of 7-8 cranes will be deployed on a heavy port call, 1 per 3 bays
- In SP Bay then, why then should cranes for these large vessels be limited to 88.5 feet?

STS Wheel Loads
"Dedicated" 22K TEU Berth



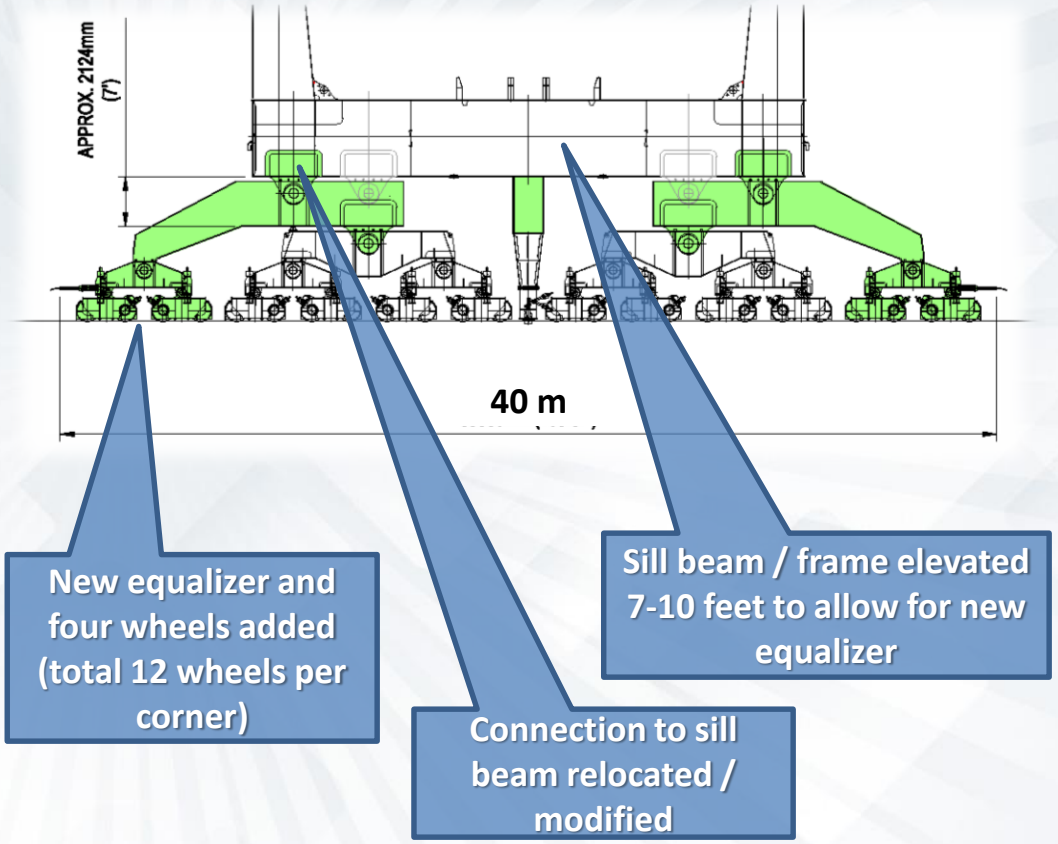
- 26 - 40'bays / 8 STS cranes = 3.25 bays / STS
- Do we have to stay with 88 feet Bumper-Bumper and 8 wheels per corner?
- Why not 133.5' B-B, 10 wheels per corner?

Critical Wheel Load = Wind with Boom Stowed



Modifying a 100’ Gauge STS Crane for 18,000 - 22,000 TEU vessels

- With 7-8 STS cranes and 5-6 day port time, the 22,000 TEU berth is essentially “dedicated” as is its cranes
- Change 88.5’ STS bumper-to-bumper dimension (2 vessel bays) to 132.8’ (3 vessel bays)
  - Add 4 wheels per corner
  - Reduces wheel load by 33%
    - 50 klf becomes ~33.5 klf
    - 65 klf becomes ~44 klf
    - Saves existing wharf?
  - Adding equalizer raises crane about 10 feet without frame modification
    - STS sill beam modification required



Conclusions

- The Panama Canal Third Locks Expansion and the introduction of 18,000 TEU will result in significant changes
  - Some will be almost overnight
  - Some will develop over time
- Total container volume will increase
- Some ports will see larger vessels with increased moves per call
- Port time will be increased, if only by the bay size
  - Change to berth occupancy
- Peak container populations may increase
  - Change to storage yard utilization
- Ports should keenly anticipate and plan for both infrastructure and operational changes