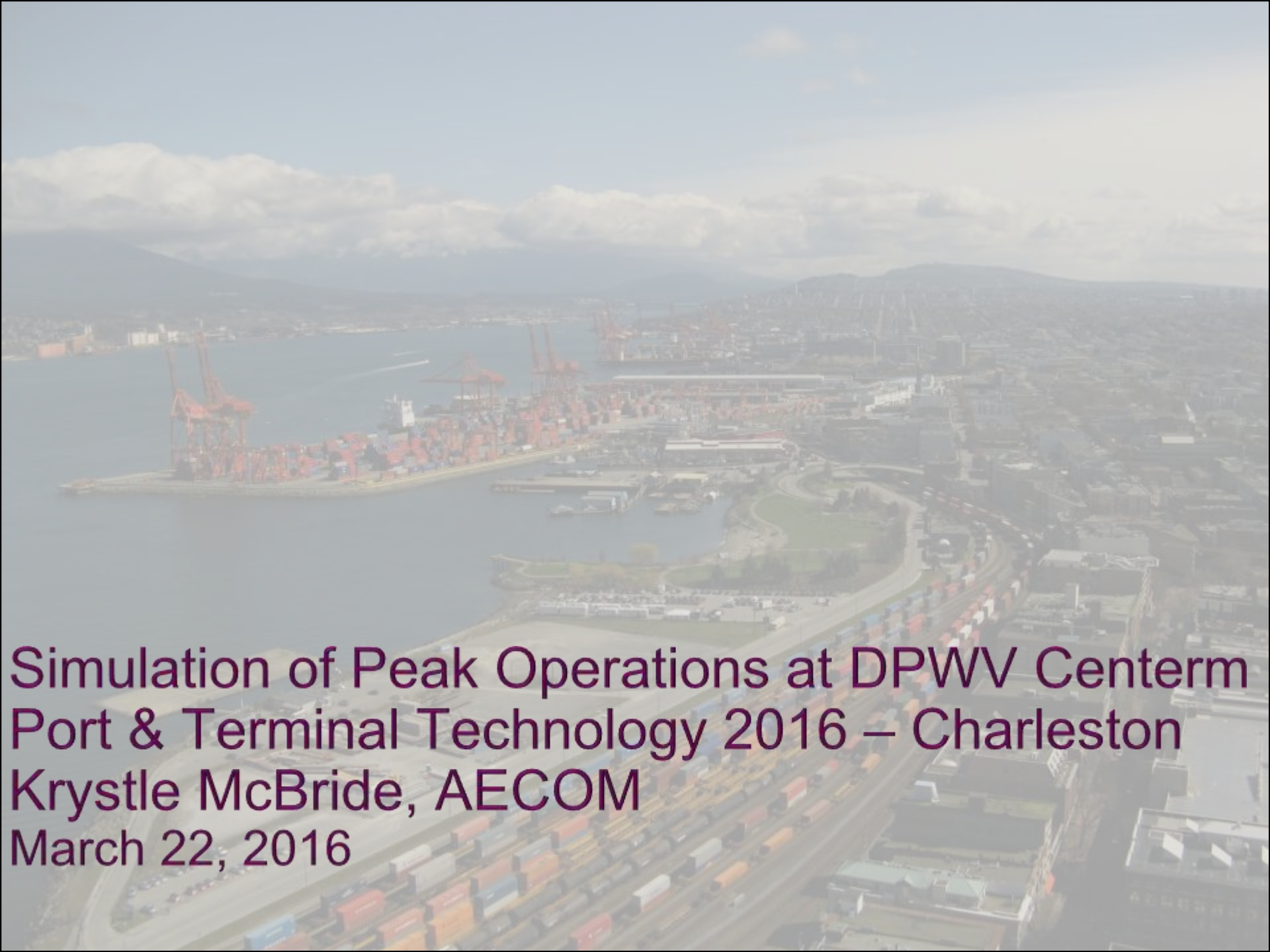

Simulation of Peak Operations at DPWV Centerm

Port & Terminal Technology 2016 – Charleston

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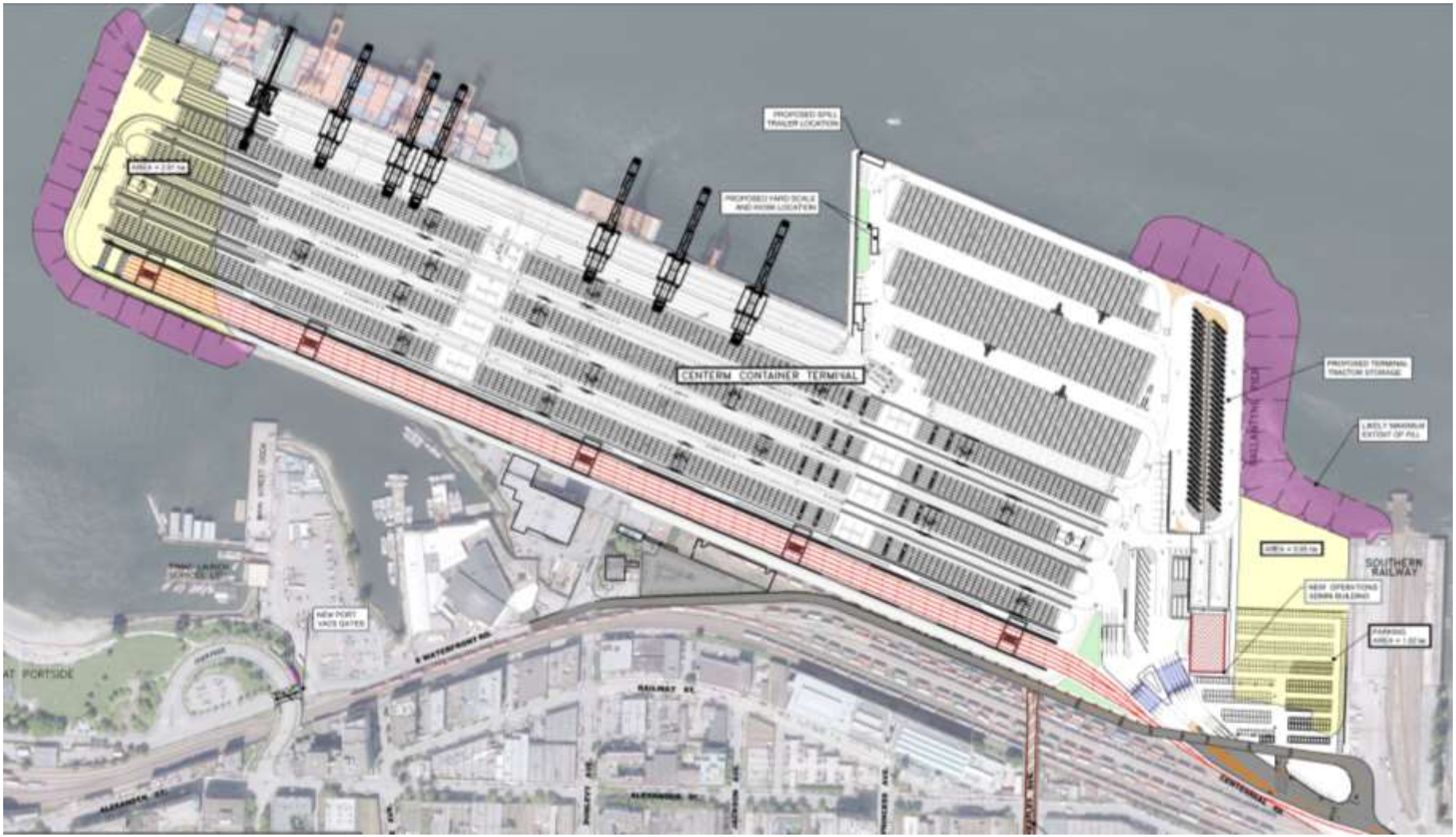
March 22, 2016

Overview

- Project site: DPW Vancouver's Centerm Facility
- Planning, capacity and simulation analysis
- Key Challenge: Project how will the facility perform at more than twice today's volume
- Simulation analysis of future operation at capacity: "stress analysis" of peak loadings:
  - Berth
  - Gate
  - Container Yard
  - Intermodal Yard

Preliminary Future Terminal Plan



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Berth Analysis Goals

- Will the relatively modest (by modern standards) future berth length be able to accommodate the target future terminal capacity?
- The effects of container yard congestion will result in reduced productivity when two vessels are present (and all cranes are working): how did this impact capacity as it becomes more frequent?

BERTHA Model

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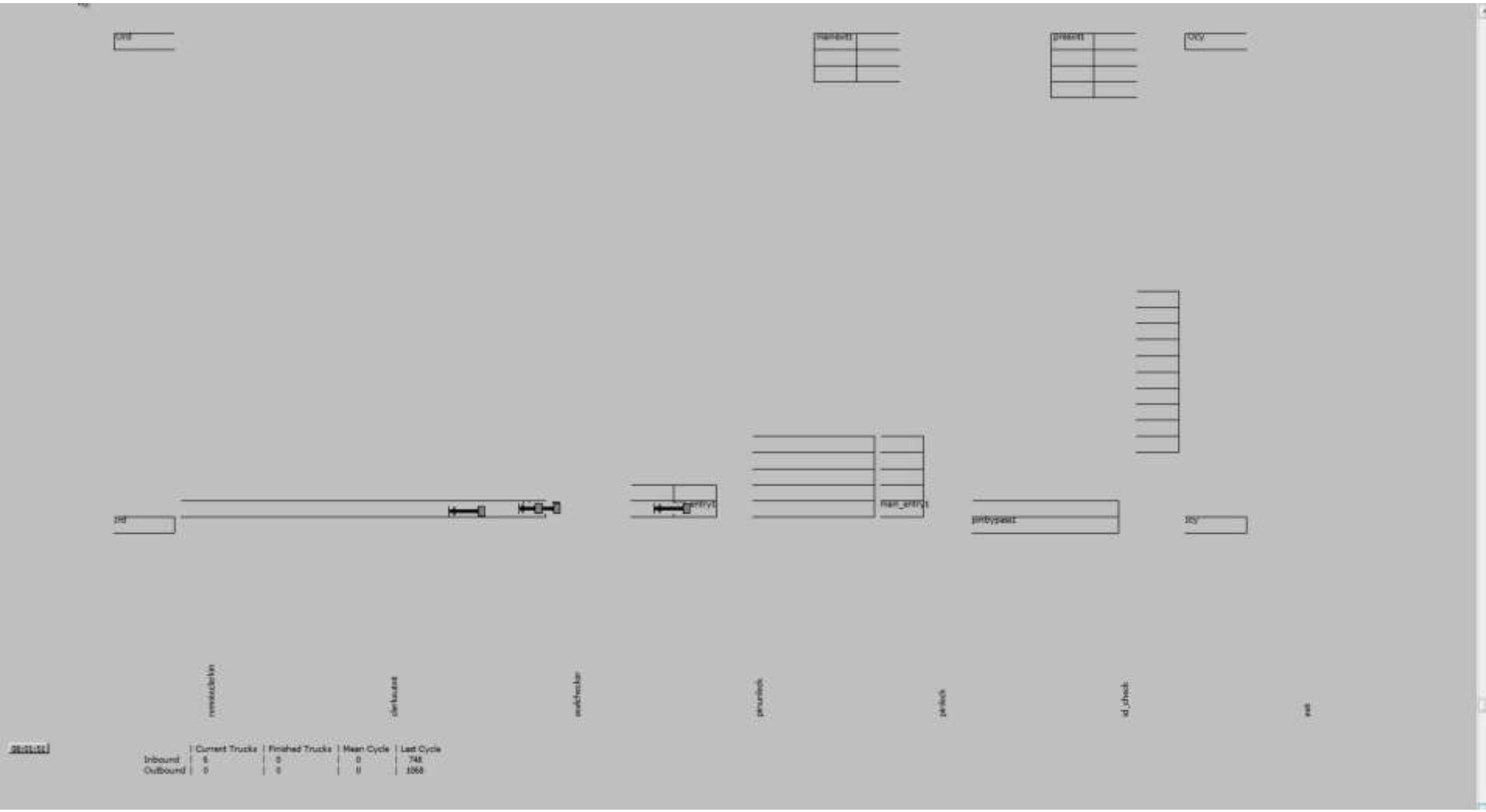
Key Berth Analysis Sensitivity Cases & Results

- Vessel arrival sizes: many small calls, or few large calls (in some cases, large vessel combinations make Centerm effectively a one-berth facility)
- Total quay cranes available, maximum assigned per call, productivity, and potential productivity reductions when several cranes are in operation (congestion effects)
- Vessel lateness (modest vs. high)
- Conclusions:
  - Overall, Centerm will not be limited by berth capacity
  - In worst-case scenarios, there may be some, but not excessive, vessel queuing at-capacity
  - If necessary, Centerm can mitigate queuing by increasing crane assignments per call, or purchasing an additional crane

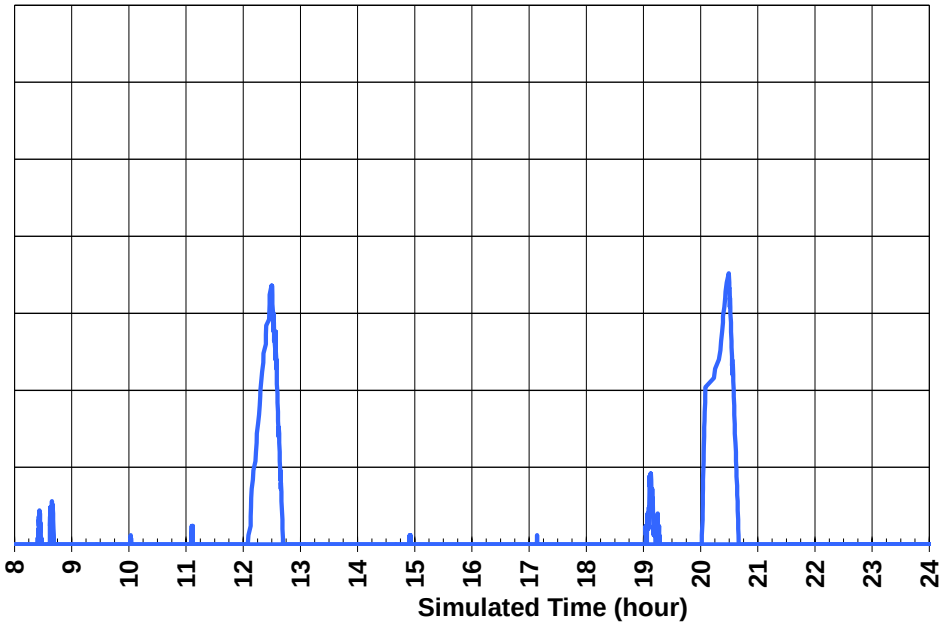
Gate Analysis

- Centerm is a land-constrained terminal: the gate was designed to occupy as little footprint as possible without impeding performance in order to maximize storage capacity
- Simulation purpose:
  - Validate proposed gate design & modify if necessary
  - Determine whether off-site roadway improvements are necessary (e.g. an overpass to separate road and rail)

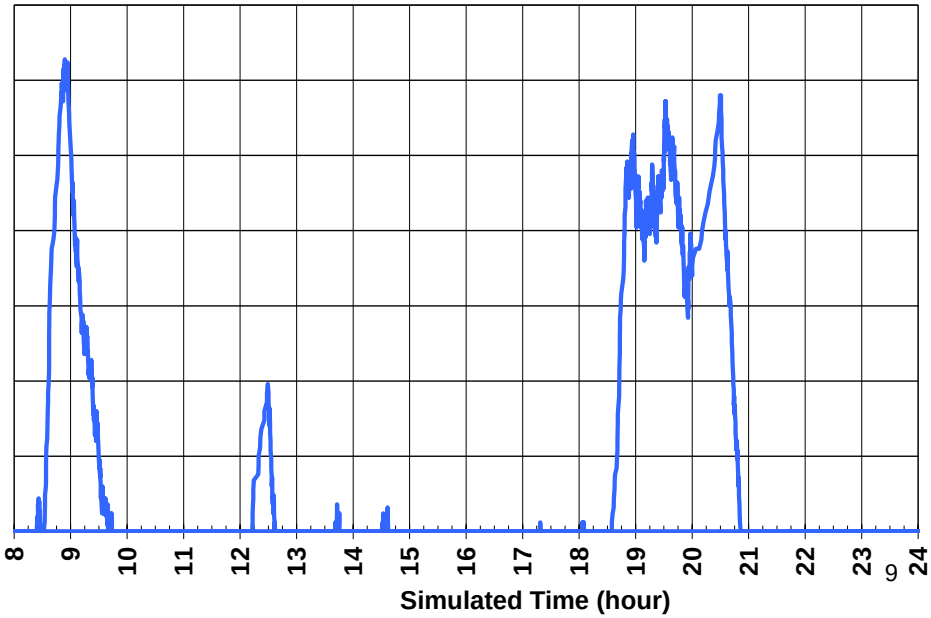
GENTRY Simulation Video



Example Gate Simulation Street Queue Length Charts



Above: Peak day queuing with no rail interference



Below: Worst-Case scenario with rail blockages during the busiest hours on peak days

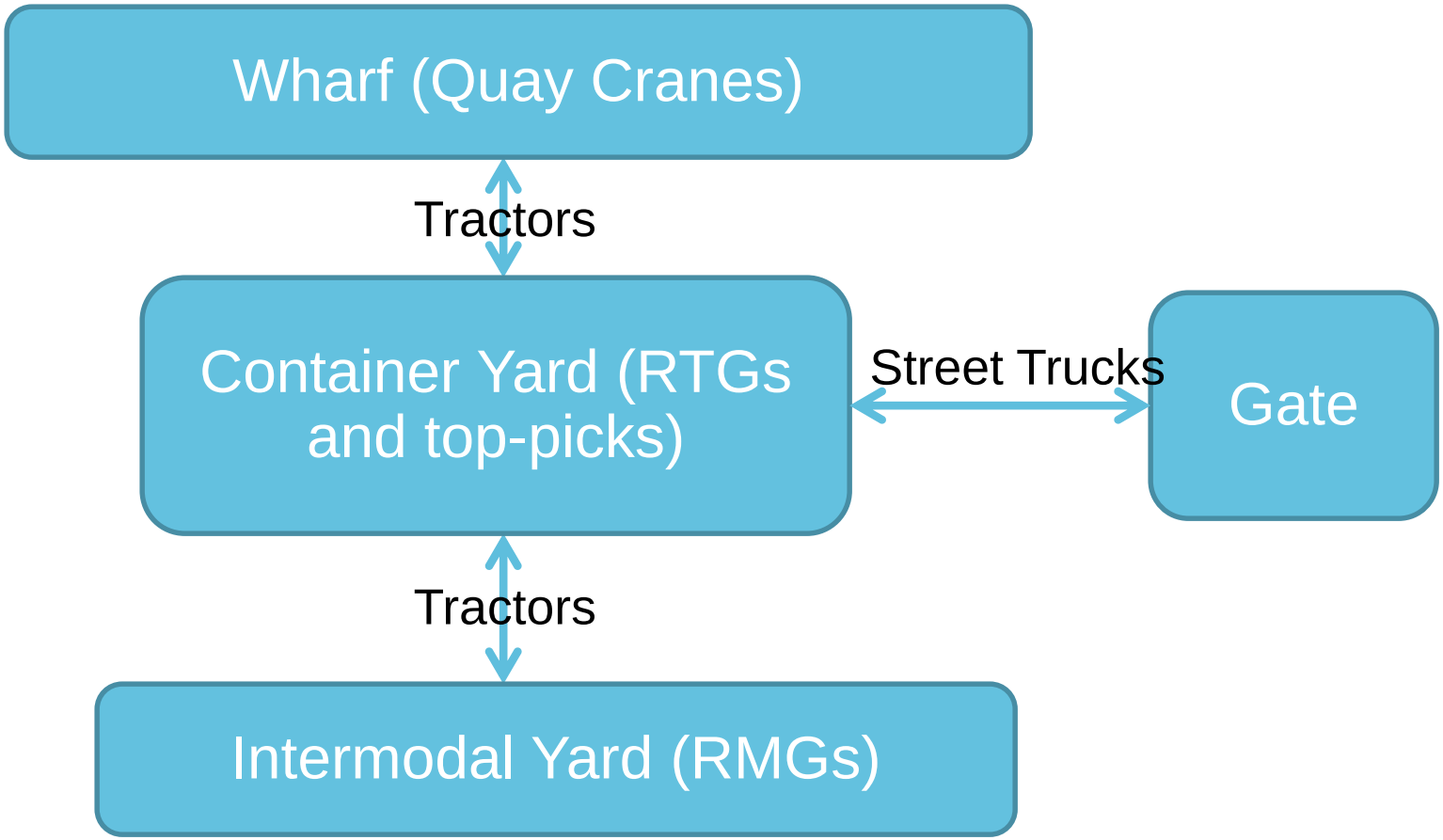
Key Gate Analysis Results

- The initial proposed gate design was found to be imbalanced; lanes were added at key stages based on model results to ensure sufficient capacity at each stage
- Recommend increasing automatic data transfer with appointments to minimize verbal exchange of information and reduce remote clerk interaction time
- Eventually, empty inspections at the exit stage will likely need to be phased out, but this is likely many years out
- Separation of road and rail traffic with an overpass will help reduce truck queuing on busy downtown Vancouver roadways, especially at future volumes

Terminal Simulation Goals

- Analyze how the terminal performs under peak loadings
- Determine if a fixed level of container yard equipment (RTGs and Top-Picks) will be able to serve quay cranes and IYRMGS sufficiently well to achieve target productivities
- Determine if street trucks can be served sufficiently quickly by CY equipment during busy rail and vessel days

CY Capacity (RTGs especially) is the Primary Limiting Factor on Productivity



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General Marine Terminal Simulation (GMTS)

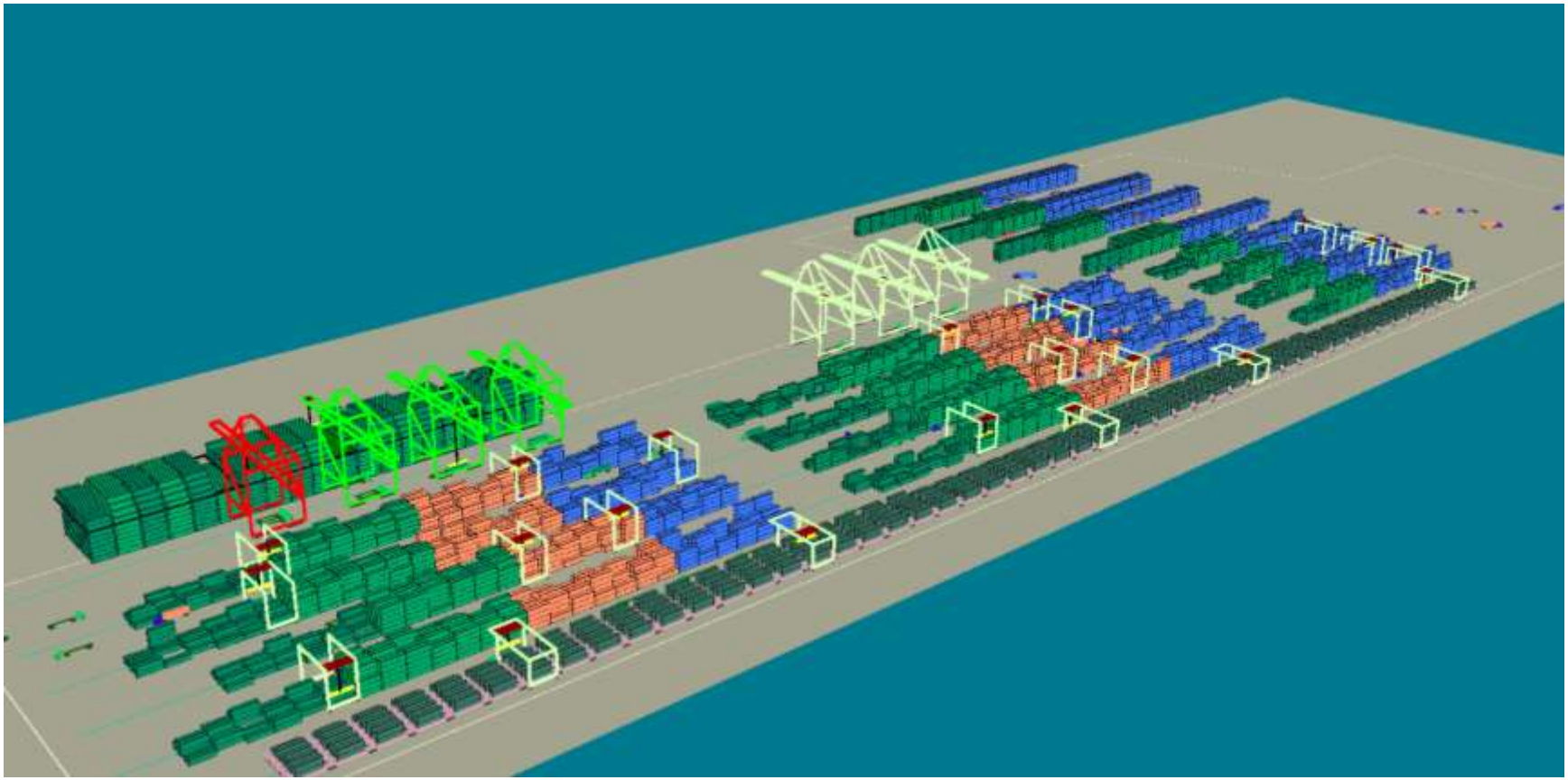
Inputs

- Terminal layout
  - Storage blocks
  - Tractor travel direction
- Peak shift load
  - Vessel
  - Gate
  - Rail
- Equipment performance specs (hoist speed, pick/set times etc.)
- Amount of equipment in use

Outputs

- Net equipment productivity
  - Dock cranes
  - Yard cranes
  - IY cranes
- Work cycle detail (lifting, moving, idle etc.)
- Street truck service time (not including gate process)
- Street truck population

Example GMTS 3D Animation View



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Initial Terminal Performance Analysis Procedure

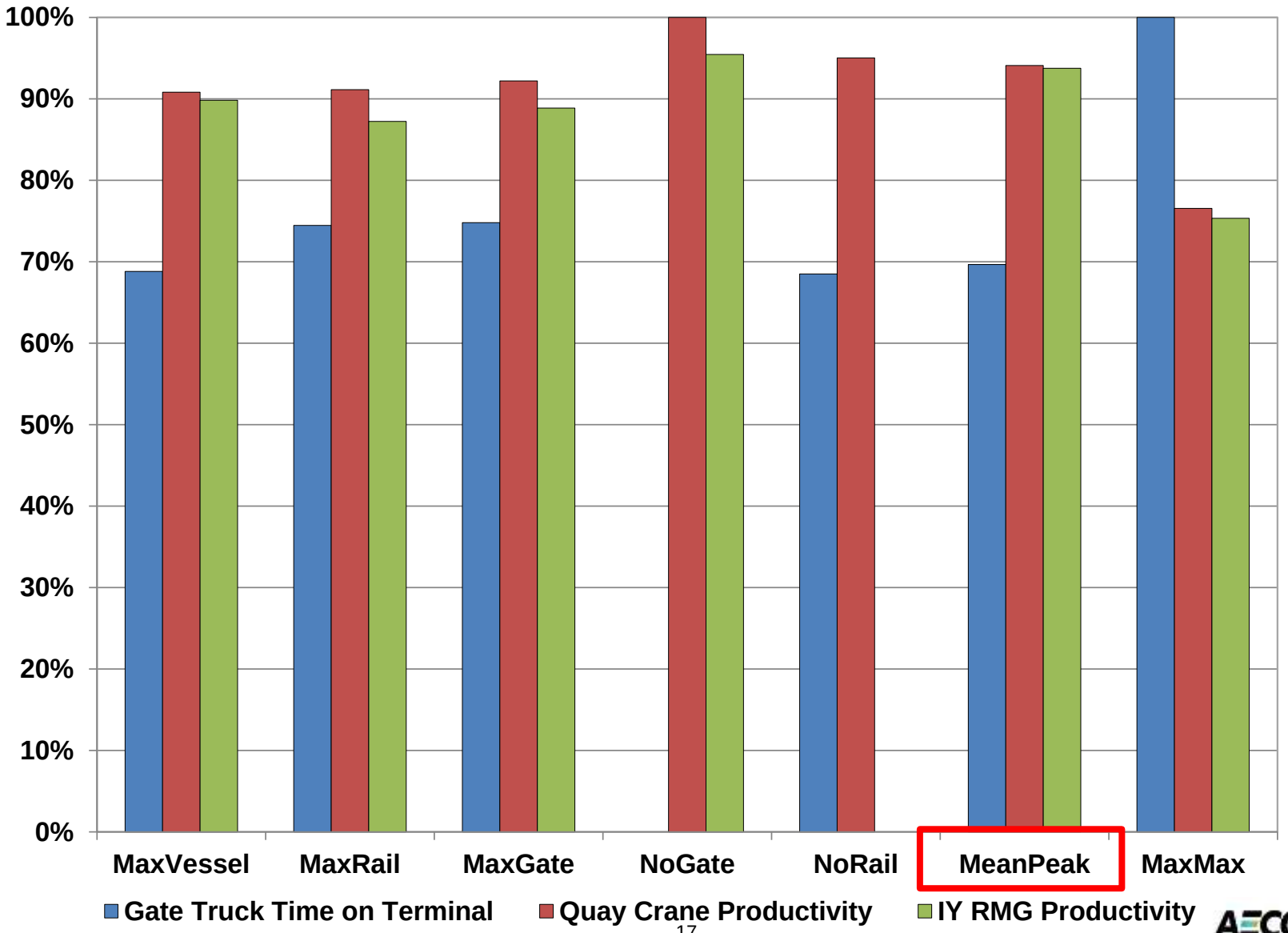
- First, consider the worst-case scenario peak shift loading:
  - Two vessels at berth with all dock cranes in operation
  - All IY RMGs in operation
  - A busy weekday gate day within the busy season
- What happens?
- Unsurprisingly, quay crane and IYRMG target productivities were not met, and street truck turn times were above DPWV's acceptable standard
- However, results were not "catastrophically" bad; the terminal was able to operate under these conditions, but not at desired levels

Alternative Cases: Peak Loading Combinations

- The busiest potential shift (MaxMax below) is a rare occurrence far above a mean day shift
- Different aspects of the terminal may peak in various combinations, either naturally or through strategically shifting gate or rail activity, as delineated below:

Combination	1	2	3	4	5	6	7	8
	Max Vessel	Max Rail	Max Gate	No Gate	No Vessel	No Rail	Mean Peak	Max Max
Vessel	7	5	5	7	-	7	4	7
Rail	3	5	3	5	5	-	3	5
Gate (% of Max Peak)	75%	75%	100%	-	100%	100%	90%	100%
% of Mean Shift CY Moves	220%	210%	200%	180%	150%	200%	180%	260%

Comparative Results

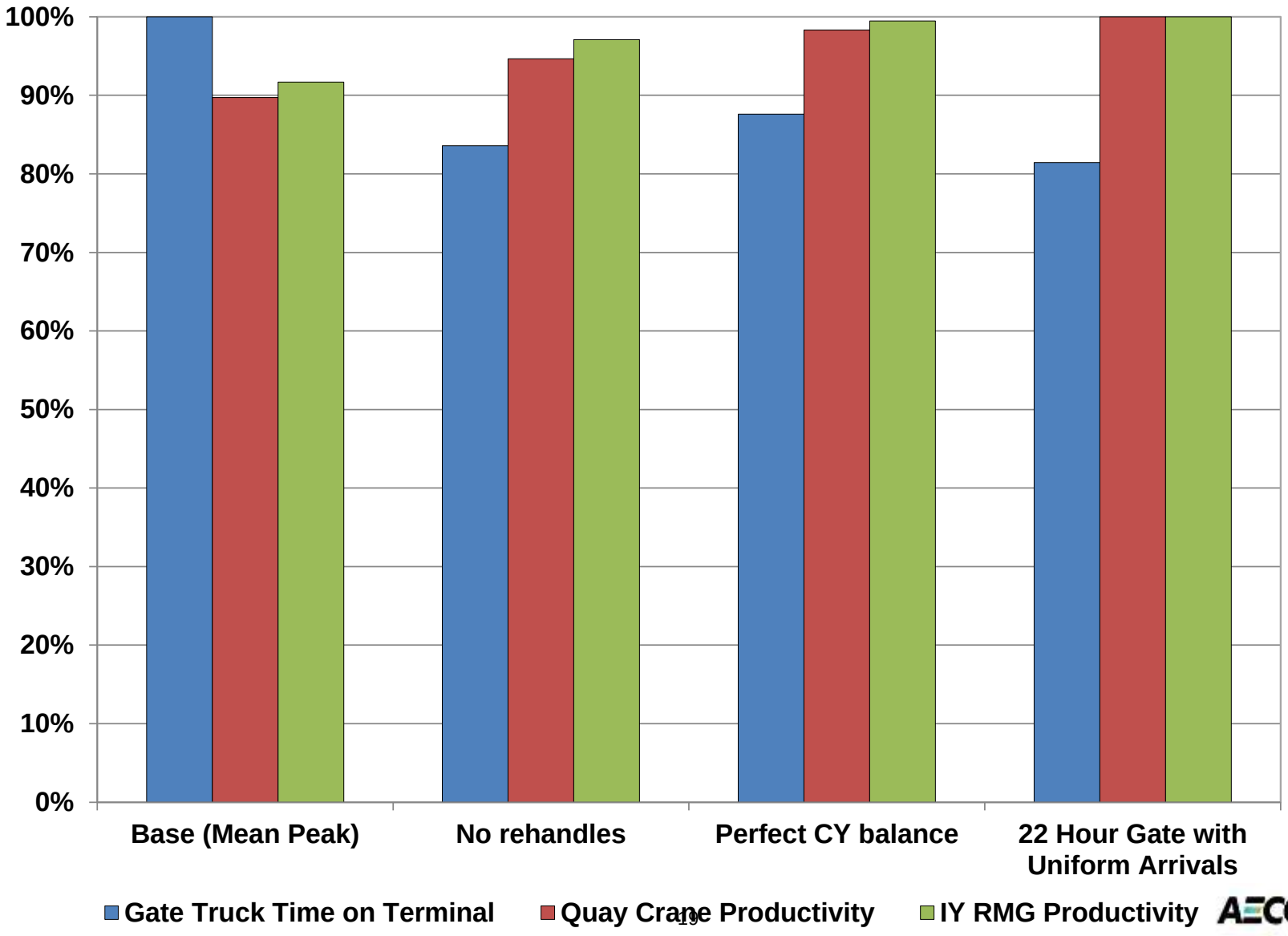


Optimal Combination Case

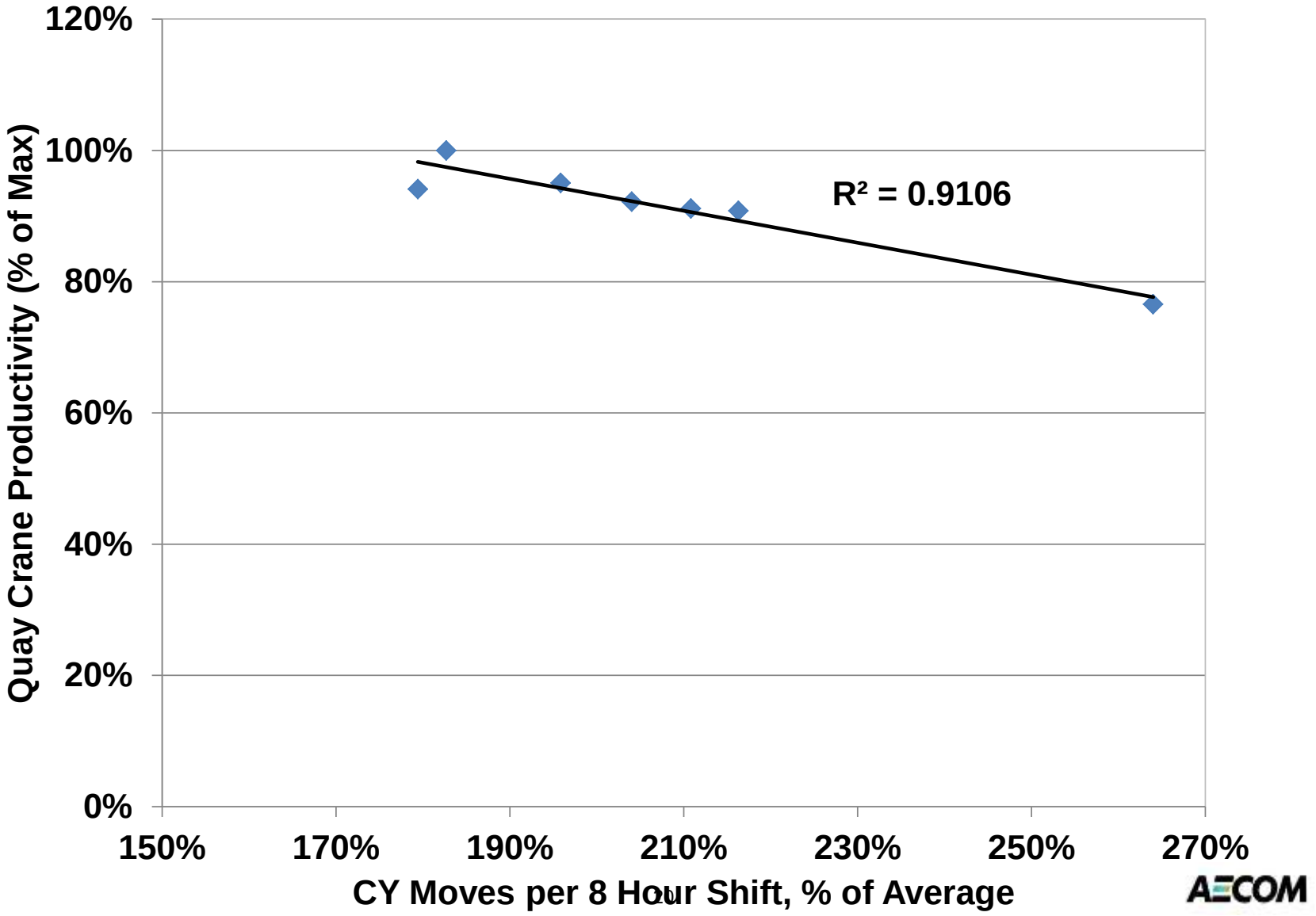
Other Strategies to Address Peak Conditions

- Extended gate hours
- More uniform gate appointments
- Advanced rehandling for gate imports
- Optimized container yard load balance (i.e. all RTGs are top-picks are equally stressed, rather than concentrating work)
- If necessary, add container yard equipment

Impact of Alternative Tactics vs. Mean Peak Case



What about an average, non-peak day?
Productivity corresponds strongly to total CY moves



Conclusions

- Overall, the terminal will be able to perform well during most peak situations
- Rare, unavoidable extremely busy days may pose a challenge, but DPWV can work around them, and actively prevent them from occurring
- Off-terminal infrastructure needs also have to be considered in advance
- Robust IT systems are critical to enable congestion mitigation techniques to be enacted (e.g. appointment systems, TOS optimized for advanced rehandling)

Thank You

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