

Project Title»

# DELTAPORT VEHICULAR ACCESS CONTROL SYSTEM



Applicant»

## PBX Engineering

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**PBX**  
ENGINEERING



ASSOCIATION OF CONSULTING  
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## 1. CHALLENGE: Throughput

The Deltaport container terminal is the largest container terminal in Western Canada and it is continually expanding with increasing throughput needs each year. On an average day, approximately 2500 commercial vehicles are processed at Deltaport and thus even slight delays in processing and surges in traffic volume can increase truck turn times dramatically. Additionally, strict security requirements, regulated by Transport Canada, require all vehicles to be screened prior to entry to the terminal. In addition, operational mandates of the terminal require commercial vehicle arrivals to be confirmed against the terminal reservation system. The screening process was performed manually, introducing sub-optimal throughput, and no mechanism existed to automatically manage congestion or to turn unauthorized drivers away from the main gates prior to arrival, causing additional processing delays.

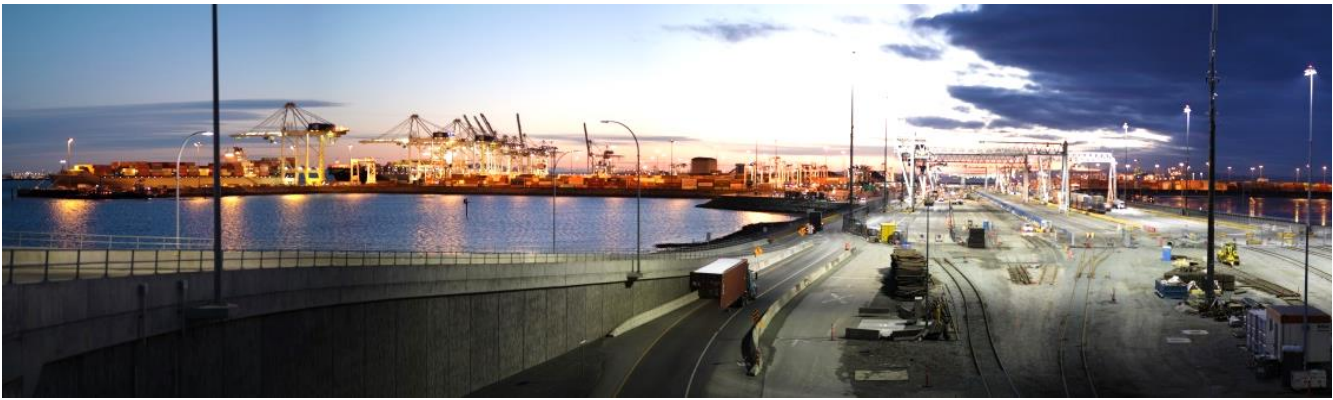


Figure 1: Deltaport Container Terminal

With the Vancouver Fraser Port Authority's (VFPA) operation center located at Canada Place in Vancouver, limited supervision was available from Port Operations. Observational surveillance of the Deltaport causeway in Delta, BC was limited to two low-resolution cameras which produced grainy images due to the limited network connectivity at site.

## 2. SOLUTION: Vehicular Access Control System

A solution was needed that could improve efficiency, while maintaining security. The Deltaport Vehicular Access Control System (VACS) was implemented to address these challenges. The Deltaport VACS is a sophisticated security and access control system overlaid on an active transportation corridor, with significant Intelligent Transportation System components. It serves as a means to effectively monitor, manage, and control all vehicular traffic entering and exiting the 4km long Deltaport causeway.

PBX was responsible for the complete system design, from the planning and preliminary design phase, through the construction and commissioning of the systems. To support construction, a highly detailed design package consisting of more than 400 site plans, installation details, system block diagrams, communication risers, and wiring diagrams was developed along with a 110 page technical specification and engineering cost estimate. Due to the high traffic volumes, the construction staging was very complex and necessitated close coordination with stakeholder groups. This project was part of a multi-jurisdictional environment and it was necessary to coordinate closely with regional transportation agencies.

During the construction phase, the project team worked closely with the contractor to commission the systems and was ultimately responsible for the integration of the various systems into Port Metro Vancouver's command and control software. The figure below depicts an aerial view of the Deltaport and Westshore terminals along with the 4km (2.5 mile) Roberts Bank Way, the Deltaport causeway





**Figure 2: Monitoring and Control of All Vehicular Traffic through the 4km Roberts Bank Way in Delta**

Vehicles attempting to access Deltaport are directed by dynamic messaging into appropriate lanes, designated by vehicle type for efficient processing. Lane assignments can be controlled remotely to optimize performance based on real-time traffic volumes. Security credentials are presented and automatically analyzed. Commercial vehicles enter reservation appointment codes to verify appropriate arrival times. Automated gates open to permit authorized vehicles access, while unauthorized vehicles are directed to exit the facility.

The VACS utilizes an extensive array of technology. Important technical aspects of the project include static and dynamic signage, CCTV surveillance, automated security credentialing, vehicular access control, automation of commercial vehicle staging, integration with the container terminal reservation system, and full command-control system integration. The technology is supported by extensive infrastructure, including power and communication duct banks, equipment islands, traffic signal poles, and roadway lighting. To support the remote operation of the system, a fibre optic network was installed between Deltaport and Canada Place, requiring multi-jurisdictional coordination.

### ***Driver Experience***

Significant design effort was put towards simplifying the interactions various users would have with the system. To be a success, the system would need to be efficient and intuitive for all users. Considerations were made for all vehicle types using the Deltaport causeway, including lost travelers trying to access BC Ferries. If not addressed promptly, these wayward vehicles could cause significant delays to the commercial operations.

As a commercial vehicle approaches the VACS system, they are directed to an inbound processing lane through the use of dynamic message signs.



**Figure 3: Deltaport VACS Primary Gates**

Prior to the lift gate, the driver interfaces with a screen on the card reader cabinet. The sun-light readable screen provides direction to the driver to enter their terminal reservation code on the keypad, and then swipe their Port Pass on the card reader. Once the reservation and pass are verified the gate opens and the signal turns green. In the event their credentials are not verified, the driver communicates with a Port Operations Coordinator through a high-fidelity intercom. The conversation is supported by an interview camera in the cabinet which allows the Port Operator to verify pass details and driver's licenses. Following the conversation, the vehicle will be granted access, or requested to exit the facility by means of the denied lane route.



**Figure 4: Deltaport VACS Lane 1 and 2**

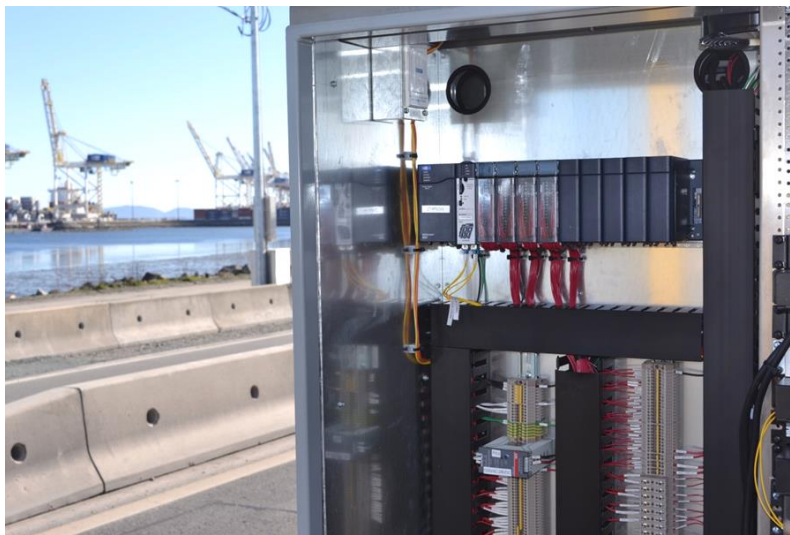
On average, a commercial vehicle is processed through the system in 25 seconds; a significant decrease from the manual process.

### ***Behind the Scenes***

In order to make the driver experience intuitive, a sophisticated array of devices and complex software logic are operating behind the scenes. A unique combination of technologies were used to design the overall system; borrowing technology from the Security, Transportation, Communication, and Industrial Control markets.

#### **System Controls**

The ‘brains’ behind the system largely resides within the Programmable Logic Controller (PLC), which collects inputs from all the field devices and controls outputs. The PLC does everything from classifying vehicles based on length, to detecting vehicle queues, to changing traffic signals and opening gates. The Deltaport VACS system has over 700 input and output points allowing it to obtain data and control devices in six operational lanes and two queue management points.



**Figure 4: Programmable Logic Controllers**

The software running in the PLC is a complex array of state machines which was developed by PBX to determine the processing requirements for each type of vehicle. Extensive workshops were held with VFPA’s Operations and Security Departments to formulate the system response to each unique situation. These workshops needed to find a balance between the two department mandates, as Security’s preference is to verify all vehicle credentials, while Operation’s preference is to allow the unimpeded movement of commercial vehicles. The workshops, and ultimately the system, found a balance between Operations and Security to manage this important freight corridor.

In addition to normal operating procedures, the system must also respond effectively to infrequent scenarios. In the event of an emergency on the terminal, the security procedures can be eliminated to freely allow emergency vehicles to enter and for evacuating vehicles to exit. Conversely, if Transport Canada increases the Maritime Security level to MARSEC II, the system can react by requiring all entering and exiting vehicles to be interviewed by Port staff regardless of their credential results.

### Driver Interface

The driver interface is performed through the card reader cabinet located between the yellow bollard and the operator booth. In order to optimize the height of the equipment, PBX took measurements of all trucks entering the terminal in an afternoon. Ergonomics were considered including height of equipment from grade based on truck window height and available reach range of drivers. The result was a dual-height interface that was optimized for commercial trucks and passenger vehicles.



Figure 5: Two different card reader heights to accommodate various vehicles and users

To correctly credential each vehicle, the VACS system interfaces with VFPA's Port Pass database, as well as exchanges information with the terminal reservation system. By keeping this business logic within pre-existing databases, the Port can effectively manage the information that the VACS relies on to make decisions.

### System Automation

In order to further optimize throughput, the system has multiple points of automation beyond the individual vehicle processing. During the terminal's shift change the system's priority moves away from commercial vehicles and over to passenger vehicles. The shift change windows are entered into the system in advance and the system automatically dedicates an inbound lane to passenger vehicles. This dedicated lane has an average of eight seconds processing time during the shift change window, efficiently processing these vehicles.

Delays within the terminal can cause vehicles to back up at the terminal's main gates. Through the use of vehicle detection sensors, the system can determine the length of the queue at the main gate and provide a warning to VFPA's Ops Center when a backup is occurring. If the queue reaches a maximum capacity the system automatically restricts all commercial vehicles to a single VACS lane and stops processing trucks. This allows a lane to be dedicated to passenger vehicles and ensures that the commercial vehicle congestion does not impede access to the terminal for non-commercial vehicles. Once the queue subsides the system automatically starts processing trucks again.



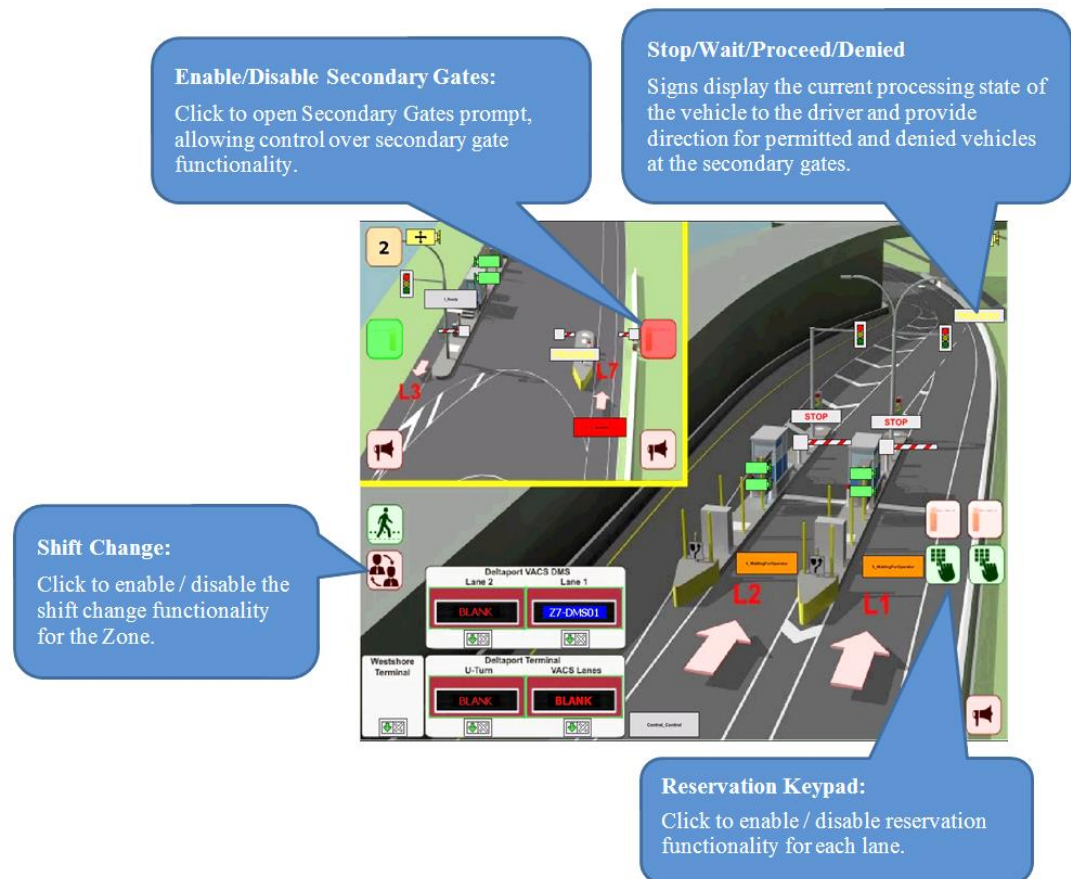


Figure 6: ATMS Map of the Deltaport Entry, Exit, and Secondary Gates

### Field Devices

To achieve the objectives of the project, an array of field devices were required, including; 70 CCTV cameras, 48 card access and intercom stations, 4 Dynamic Message Signs, 12 vehicle gates, as well as 3 operator control booths, 6 control kiosk, and 19 control cabinets. The field devices are supported by extensive infrastructure.

A new BC Hydro service was also required to support the devices. As local power was limited, lengthy coordination was required with BC Hydro to develop an extension of their high voltage line. This line was limited to single phase power, which brought further design complications due to the distributed nature of the system. The final design also included full power backup accomplished through a 100kW generator and multiple uninterruptable power sources.

### Network

In order to allow remote operation of the system from Canada Place, a high-bandwidth network connection was required. Included in the project was a fibre-optic cable installation between Deltaport (Delta) and Canada Place (Vancouver). The installation of this cable required multi-jurisdictional coordination, both during the design and construction phases.

The fibre-optic extension of VFPA's network to Deltaport allowed for instantaneous system response and real-time high resolution video for situational awareness. The extension also positions VFPA for future projects in the area, including the planned Roberts Bank Terminal 2 project.



Figure 7: Canada Place - Operator Interface

### Construction Staging

As the system was being developed on an active freight corridor, the entire system was constructed without disrupting terminal operations. Design aspects allowed for the minimizing of lane closures, and completion of intrusive works in evening hours.

The deployment of the system included an extensive outreach campaign for terminal staff and commercial drivers, informing them of the expectations of the system. In addition, VFPA, with support from PBX, were on site for two weeks following the role-out of the system to educate users on their first interaction with the system.

### PBX's Role

PBX was responsible for the complete electrical and systems design, as well as construction oversight. In addition, PBX completed all software development and programming for the PLCs and command and control software. All system commissioning and training was performed by PBX.

To detail this complex project, a design package of over 500 drawings and a 100 page specification was developed. Internal resources were utilized across all our company's industry sectors to complete this unique design.



### 3. RESULTS: Balance of Security & Operations

The Deltaport VACS effectively supports strict security requirements, while optimizing operational throughput. To the user, the system is intuitive and effective. Behind the scenes, the system consists of a unique array of devices selected from the Security, Transportation, Communication, and Industrial Control markets. A complex software program unifies all the equipment to make a cohesive system. The Vehicular Access Control System has proven to yield the following improvements

- Improved efficiency of this important commercial goods roadway, benefiting thousands of motorists each day
- Reduction in manual processing and on-site resources
- Enhanced traffic management and incident response capabilities
- Expanded Port operations centre capabilities

#### *Other Benefits of the System*

The automated and fully integrated Deltaport VACS significantly lowers truck turn times and thereby increase throughput at the Port. Ease of processing lowers wait times and increases scheduling accuracy for commercial operators of both vehicles and container ships moored at the terminal.

Through automated reservation confirmation, the terminal is notified in advance of a container arrival, as well as ensuring that trucks are arriving within their designated timeframe. This increased scrutiny prior to arrival at the terminal gates allows for increased efficiency.

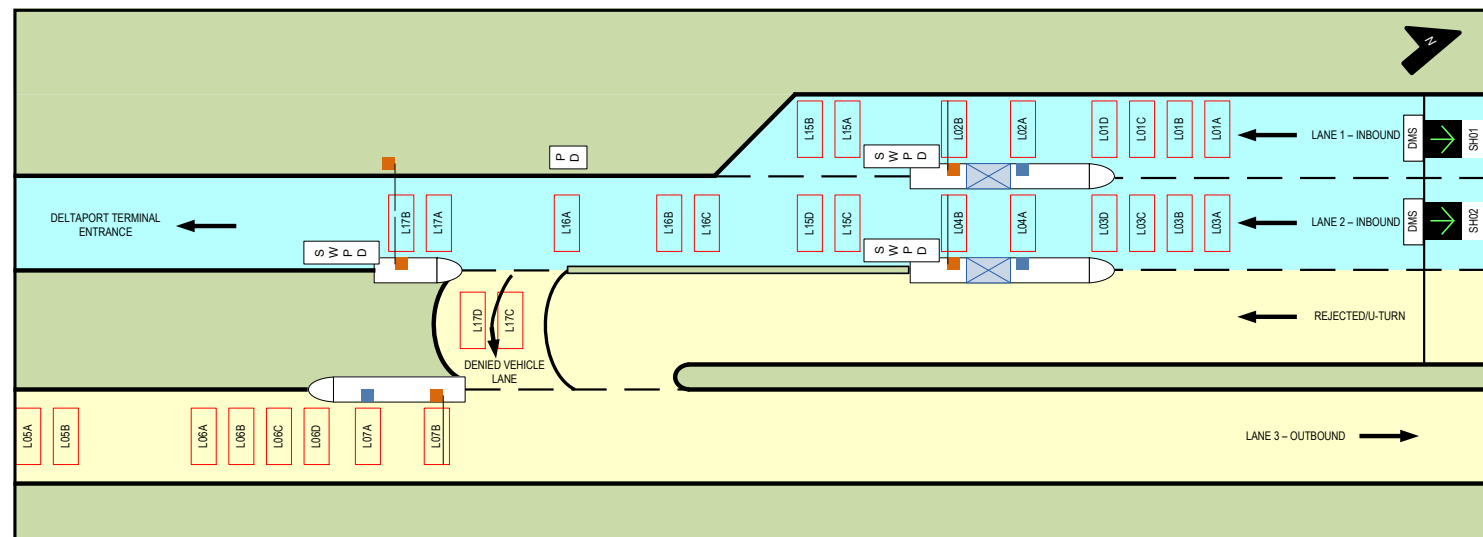
Commercial vehicles waiting for processing were often backed-up for several miles obstructing local thoroughfares. Now, with the efficient processing of commercial vehicles on the Deltaport Causeway, a significantly positive impact is noted on the surrounding transportation corridors, having reduced traffic for local commuters.

Prior to the implementation of the VACS, the screening process for each commercial vehicle was performed manually, introducing sub-optimal throughput. Congestion on the Deltaport Causeway was common, resulting in numerous idling vehicles waiting to be processed. The implementation of the Deltaport VACS system has increased this operational throughput to reduce overall congestion on the roadway, thereby decreasing vehicle emissions and Greenhouse Gas (GHG) release into the atmosphere substantially.

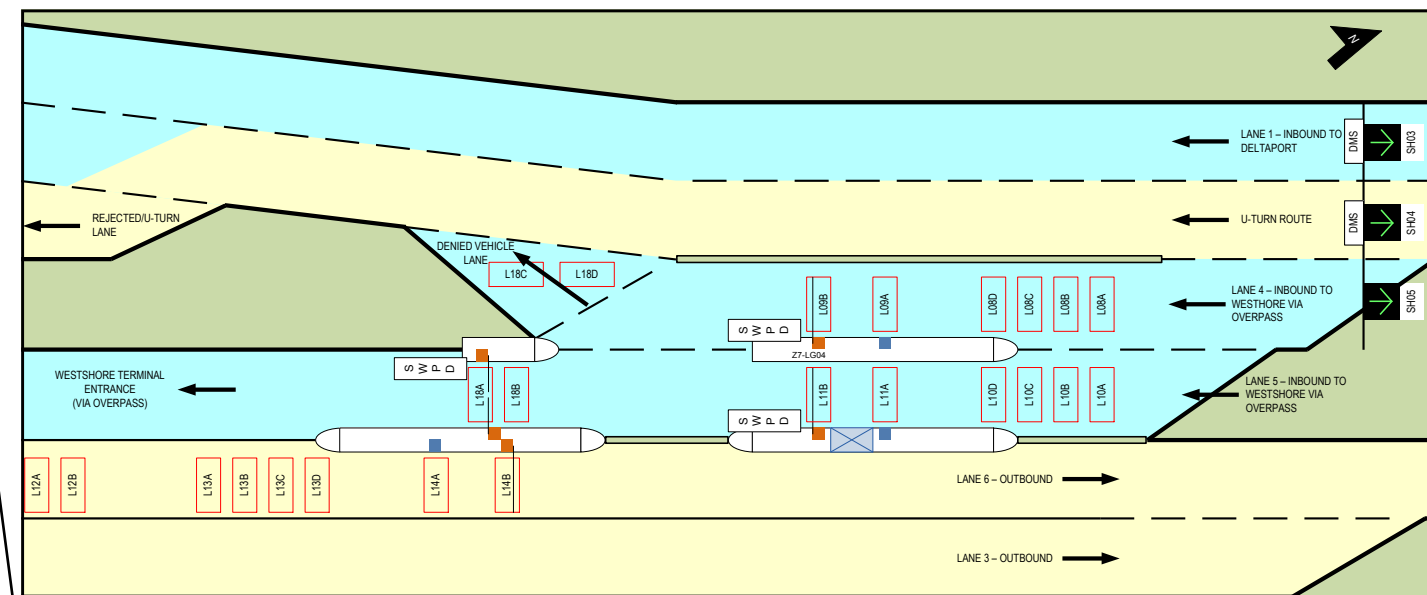
The Deltaport VACS system also includes a traffic management system both upstream and downstream from the gates. This management system further reduces the effects of idling vehicles by releasing vehicles in waves, allowing drivers to move forward and turn their engines off until the next wave. Delays within the terminal can also cause vehicles to back up at the terminal's main gates. If the queue reaches a maximum capacity the system automatically restricts all commercial vehicles to a single VACS lane and stops processing trucks. This allows a lane to be dedicated to passenger vehicles and ensures that the commercial vehicle congestion does not impede access to the terminal for non-commercial vehicles. Once the queue subsides the system automatically starts processing trucks again. This results in enhanced traffic management and incident response capabilities, while also reducing the effects of idling vehicles.

Sustainability initiatives were taken into consideration by maximizing the utilization of existing infrastructure, reducing costs and harmful disruptions in the area caused by construction activities. Instead of an additional command centre at Deltaport the system is connected to the Port's remote Command Centre, at Canada Place, via a high speed fibre network.

## DELTAPORT VACS OPERATIONAL FLOW

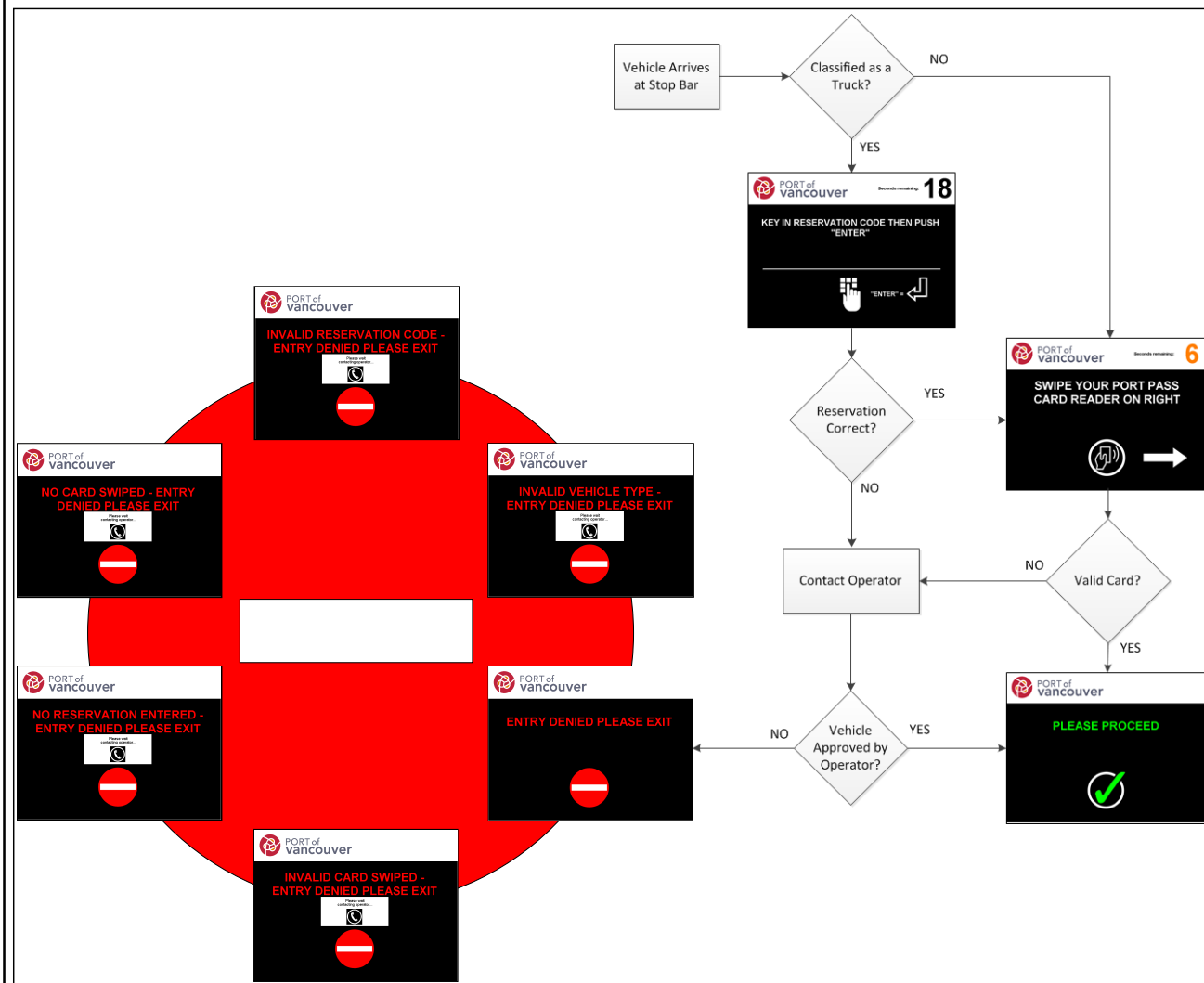


DELTAPORT VACS GATES



## WESTSHORE VACS GATES

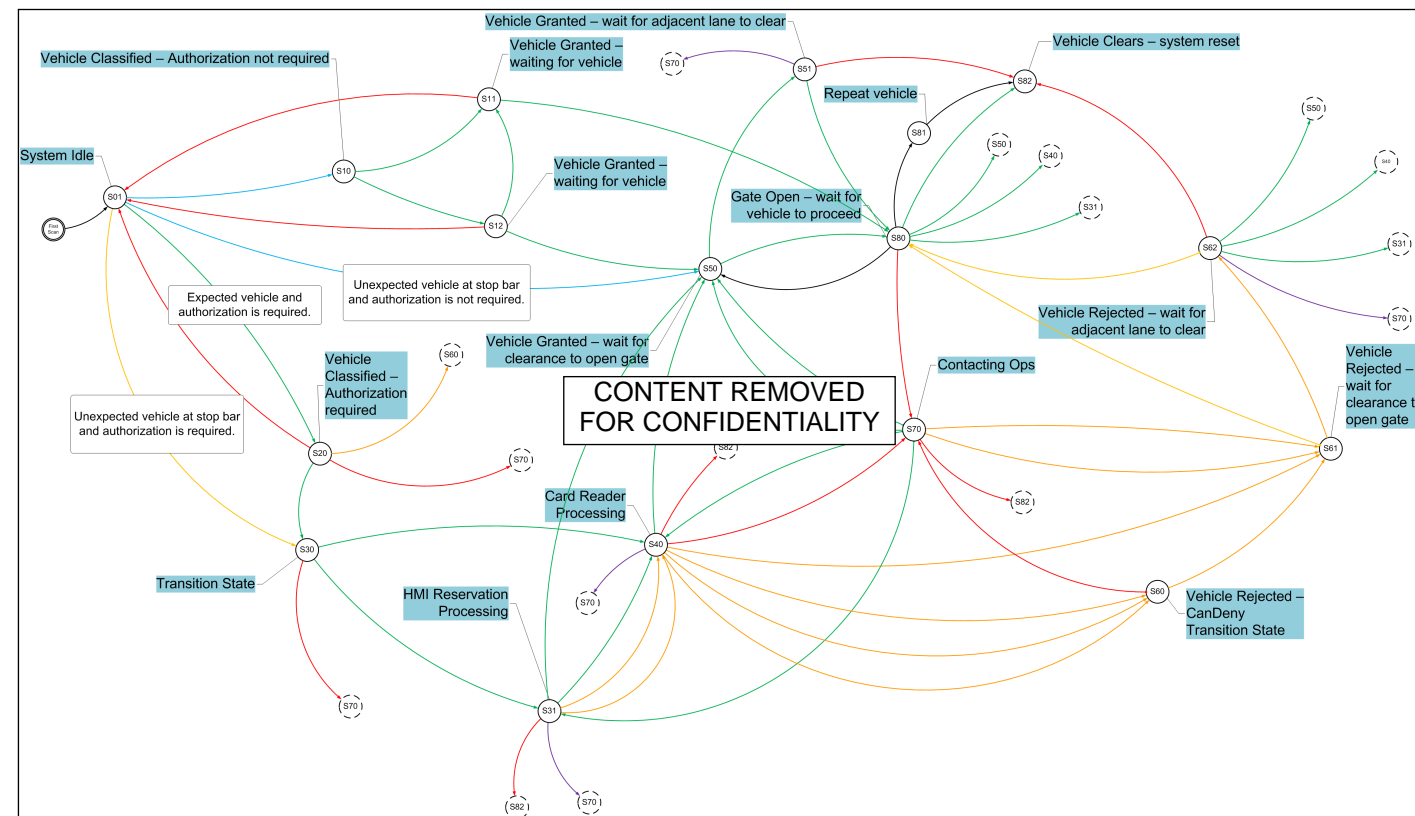
## DELTAPORT VACS FLOW CHART



**Deltaport VACS Software**  
An extensive amount of field devices are utilized to feed in the information required to autonomously make decisions in the software, then actuate devices to control the movement of vehicles. The 'Operational Flow' diagram depicts the high level layout of the processing lanes, as well as key field devices required for the system operation.

Significant design effort was put towards simplifying the driver experience. At the surface, the driver's interactions can be simplified as shown in the 'Flow Chart' on the left. Behind the scenes, sophisticated software is running the automation of the system. The software responds differently to each driver based on the vehicle classification, the processing mode of the lane, and the operating security level of the terminal. The 'State Machine Diagram' on the right is one of seven state machines which determines the processing of the system. State information and transition requirements have been removed for confidentiality.

## SYSTEM STATE MACHINE DIAGRAM

[illegible]



# DELTAPORT VACS

VEHICULAR ACCESS CONTROL SYSTEM DESIGN  
FOR COMMERCIAL FREIGHT CORRIDOR.

PBX  
ENGINEERING

## CHALLENGE: THROUGHPUT

Each day, thousands of commercial and passenger vehicles travel on the Deltaport causeway to reach the Deltaport container terminal. **Strict security and operational policies require vehicles to be individually verified to gain access** - a process undertaken manually, introducing sub-optimal throughput. Additionally, no mechanism existed to automatically manage congestion or to turn unauthorized drivers away from the main gates prior to arrival, causing additional processing delays.

## SOLUTION: VACS

A solution was needed that could improve efficiency, while maintaining security. The *Deltaport Vehicular Access Control System (VACS)* was implemented to address these challenges. **The Deltaport VACS is a sophisticated security and access control system overlaid on an active transportation corridor, with significant Intelligent Transportation System components.** It serves as a means to effectively monitor, manage, and control all vehicular traffic entering and exiting the 4km long Deltaport causeway.

Vehicles attempting to access Deltaport are directed by dynamic messaging into appropriate lanes, designated by vehicle type for efficient processing. Lane assignments can be controlled remotely to optimize performance based on real-time traffic volumes. Security credentials are presented and automatically analyzed. Commercial vehicles enter reservation appointment codes to verify appropriate arrival times. Automated gates open to permit authorized vehicles access, while unauthorized vehicles are directed to exit the facility.

**The VACS utilizes an extensive array of infrastructure and technology.** Important technical aspects of the project include traffic signals, static and dynamic signage, CCTV surveillance, automated security credentialing, vehicular access control, automation of commercial vehicle staging, integration with the container terminal reservation system, and full command-control system integration. To support the remote operation of the system, a fibre optic network was installed between Deltaport and Canada Place, requiring multi-jurisdictional coordination.

**PBX was responsible for the complete electrical and systems design, programming, construction oversight, and testing of the VACS.** Key project challenges included a complex, multi-disciplinary design and a demanding construction staging environment – the entire system was constructed without disrupting terminal operations. Unique innovations included the adaptation, application, and integration of sensors and systems from different industries and complex integration that unifies operations in a cohesive command-control environment.

## RESULTS: BALANCE OF SECURITY & OPERATIONS

The Deltaport VACS **effectively supports strict security requirements, while optimizing operational throughput.** Benefits of the system include:

- Improved efficiency of this important commercial goods roadway, benefiting thousands of motorists each day
- Reduction in manual processing and on-site resources
- Enhanced traffic management and incident response capabilities
- Expanded Port operations centre capabilities

Lead Electrical / System / Software Consultant: **PBX Engineering Ltd.**

Civil Consultant: **Parsons**

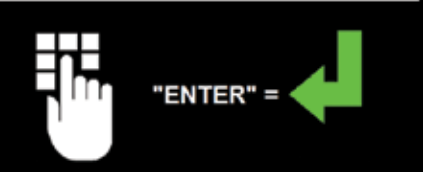
Project Owner & Client: **Vancouver Fraser Port Authority**

Electrical Contractor: **Houle Electric**

SWIPE YOUR PORT PASS  
CARD READER ON RIGHT



KEY IN RESERVATION CODE THEN PUSH  
"ENTER"



AUTHORIZED?

PLEASE PROCEED



ENTRY DENIED - PORT  
SECURITY ADVISED



PORT AUTHORITY  
OPERATIONS

