

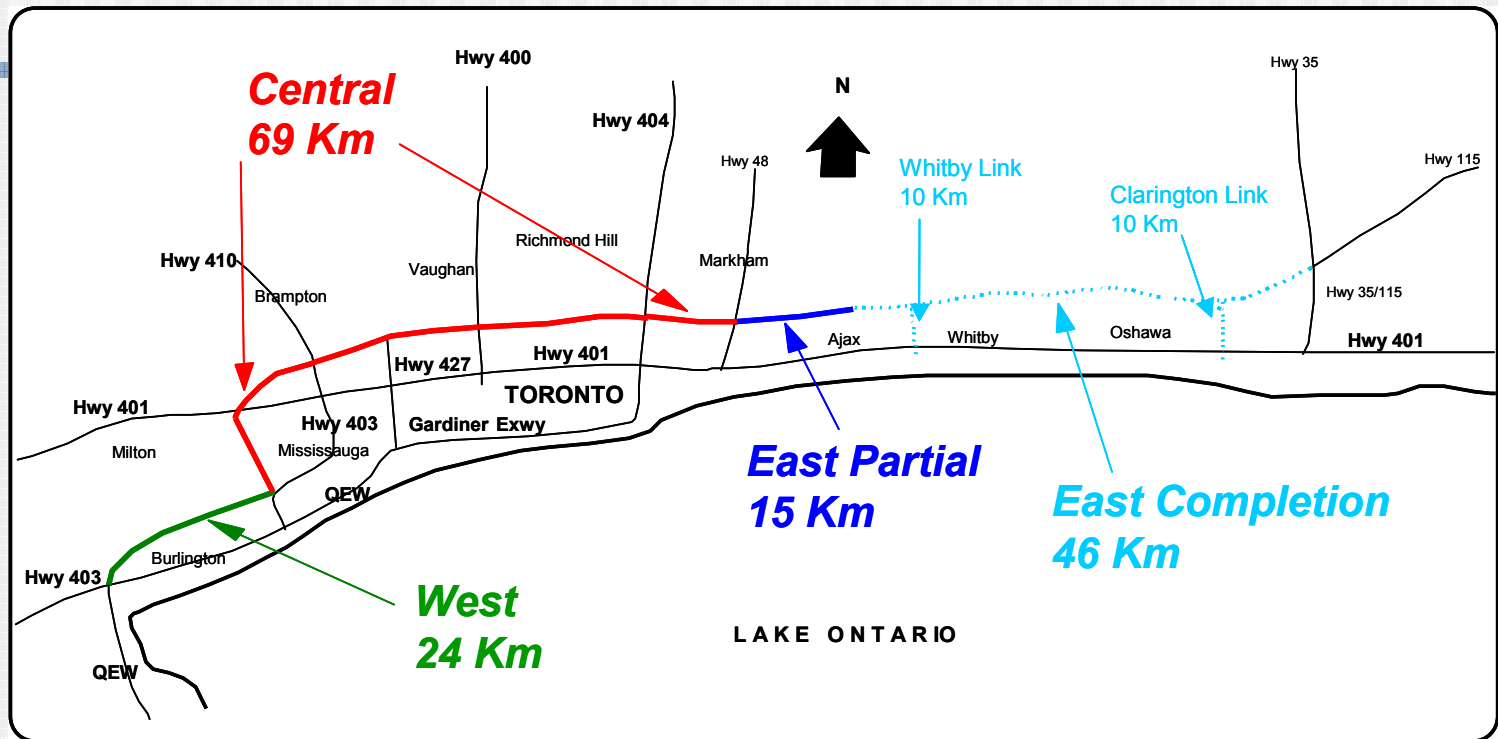
407 Express Toll Route

The world's first all-electronic, open access toll highway.



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Highway 407



Highway 407 is a controlled access highway passing along the northern portion of the Greater Toronto Area (GTA) providing an alternative route to the principal freeway, Highway 401, which is one of the busiest highways in North America.

Highway 407

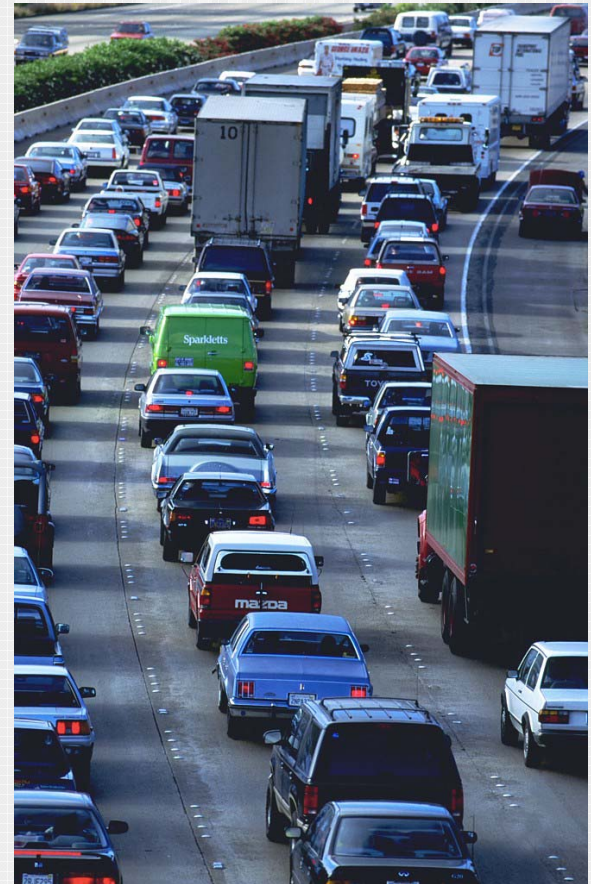
General Information

- Opened in June of 1997, with the first day of tolling on October 14, 1997.
- Current span is 108.081km in length.
- Connects with 7 interchanges on the 400 series highways (400, 401, 403, 404, 410, 427, and QEW).
- The first road project in Canada to have a road safety audit.
- Its technology is a renown model in electronic tolling worldwide.

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The Reason Behind the 407

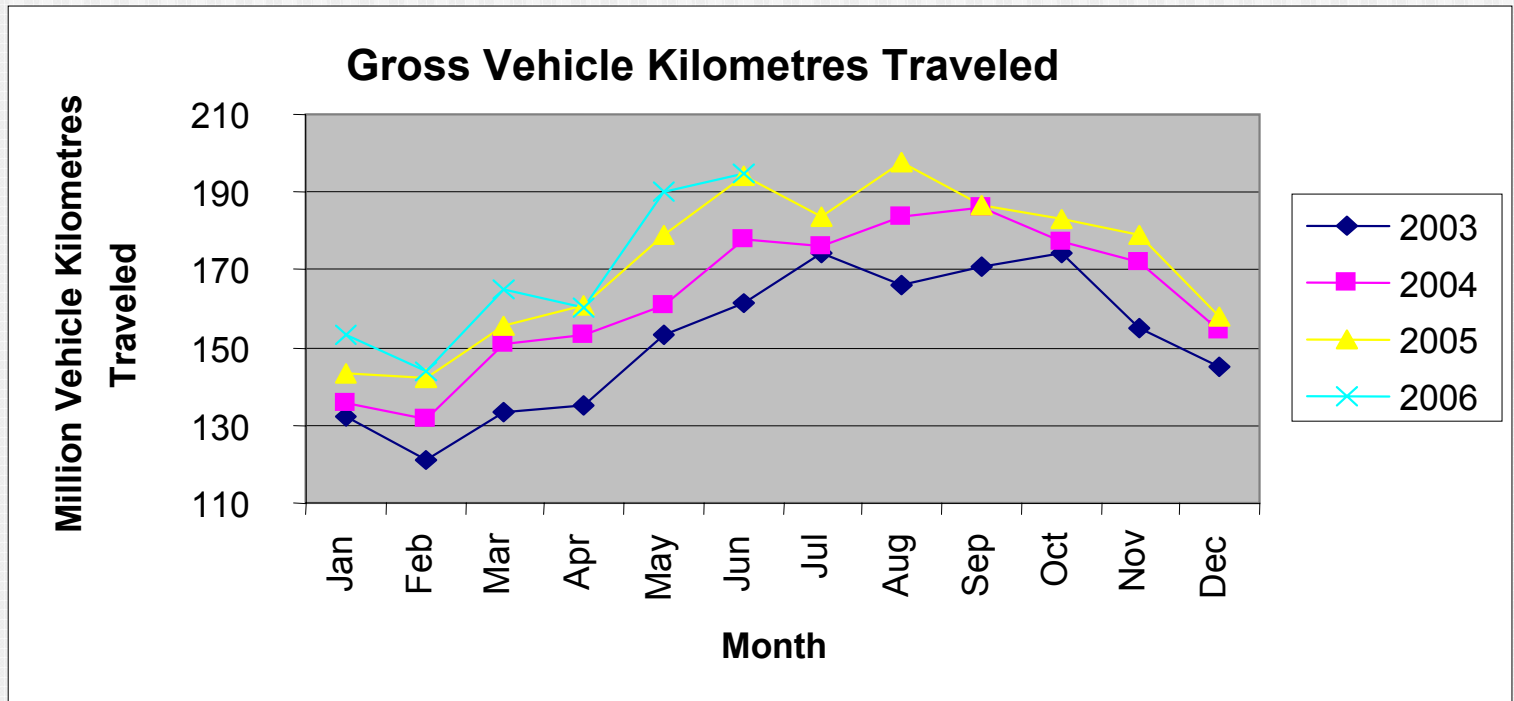
- Highway 407 was originally identified as a future bypass of the metropolitan Toronto area by the Ontario Ministry of Transportation (MTO) planners in the early 1950s.
- Traffic congestion costs Ontario businesses upwards of an estimated \$2 billion per year.
- The highway was built to create additional highway capacity in the area of the GTA.



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Traffic Trends

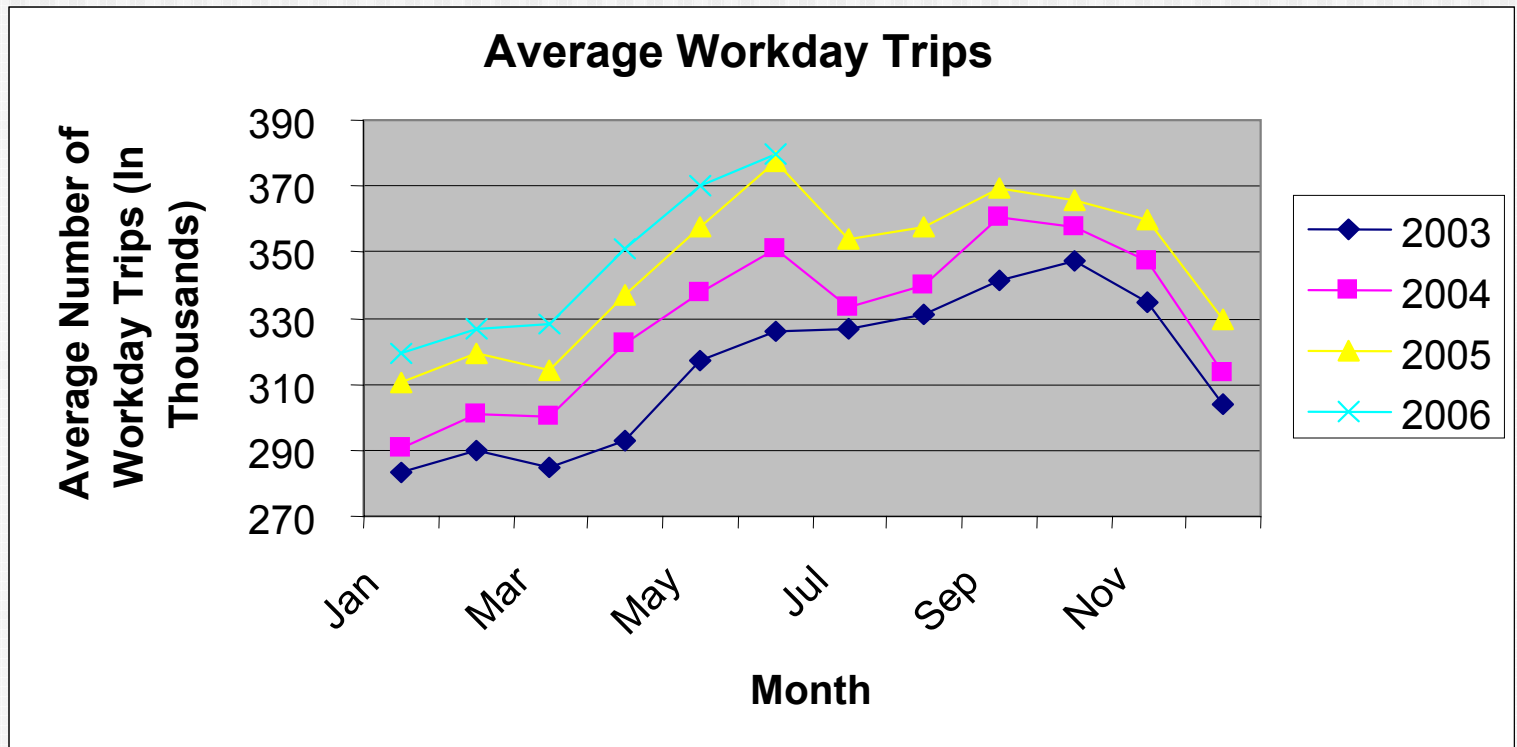
- As population continues to grow in the GTA, the importance of the highway is proven through increasing traffic volumes.



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Traffic Trends

- The 407 serves on average a minimum of 320,000 commuters each weekday.



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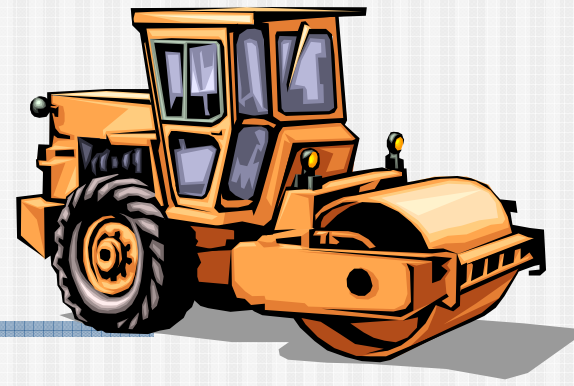
Free Flow System

Highway 407 was designed as the first free flow electronic toll road in the world.

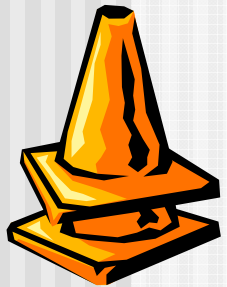


- No toll plazas, lane restrictions, or barriers to the use of the road.
- Cars are not required to carry transponders, nor are drivers required to open an account or purchase any sort of pass.

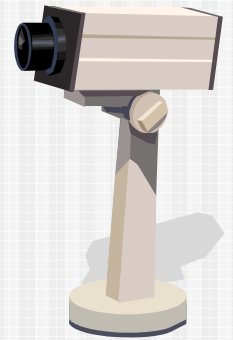
Highway 407 Tolling System



- The decision to involve the private sector was prompted by the desire to accelerate the completion of construction.
- Electronic tolling was the only feasible tolling method for the 407.



Highway 407 Tolling System

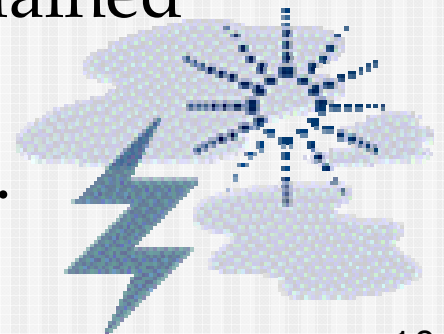


- The system is transponder based with a secondary video imaging system which collects rear license plate information through Optical Character Recognition (OCR).
- Privacy issues were the basis of choice for this method of tolling.



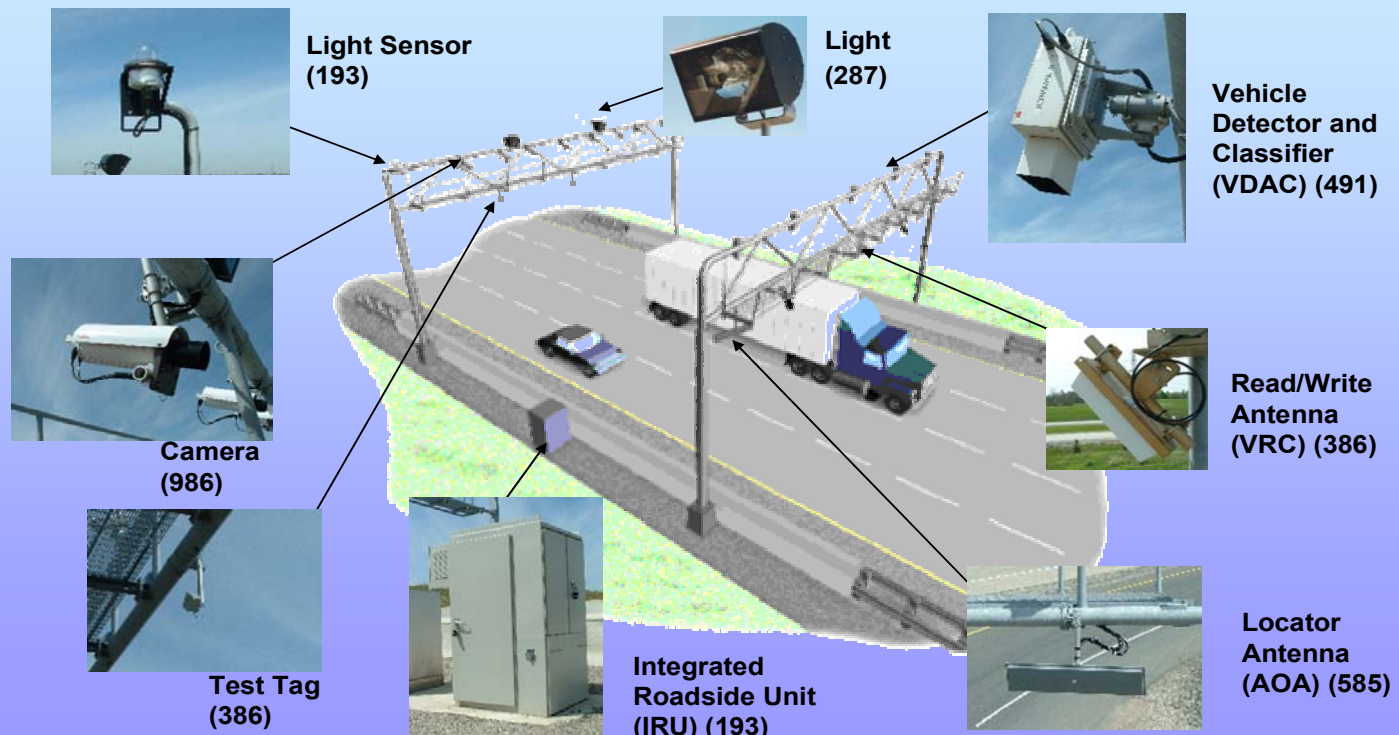
Highway 407 Tolling System

- Automatic processing of transactions.
- The system also allows for out of province vehicles through collaboration with virtually all Canadian DOTs and six US states.
- Out of province vehicles are treated the same as Ontario registered vehicles (excluding plate denial mechanism, which will be explained shortly).
- Operational in all weather conditions.



Highway 407 Tolling – Sub-System

Typical Open Road Installation



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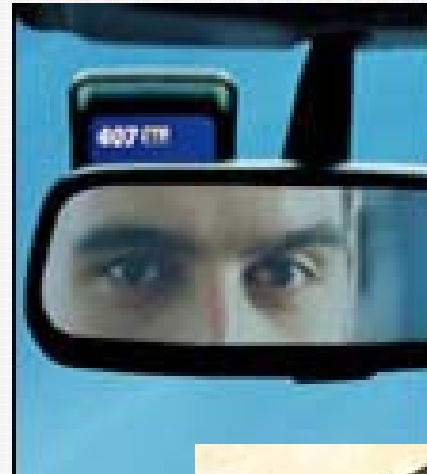
Transponders - Technology

- The tolling system and transponders function on a Time Division Multiple Access (TDMA) protocol.
- Other techniques were considered for the system but were ruled out due to unsatisfactory performance levels.

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The Transponder

- The transponder is a small electronic device that is attached to the interior of the windshield behind the rear-view mirror.



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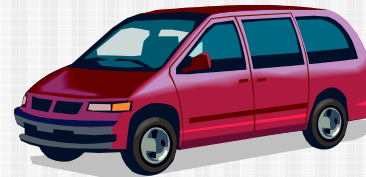
Transponder Operation

- For transponder users, the electronic sensors located on each overhead gantry log the 407 ETR entry and exit points.
- When a transponder signal is read (by the antenna), a green light on the transponder and four short beeps indicate the toll transaction has been successful.
- A transponder may not work if it is not mounted properly or if the vehicle has a windshield that interferes with the transponder, such as:
 - Solar ray glass
 - Compass/Temperature in rear-view mirror

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Transponder Types

- **Light Vehicle Transponder**
 - For use in cars, vans, limousines, pick-ups and sport utility vehicles.
 - Registered gross weight of 5,000 kilograms (five tonnes) and under.



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Transponder Types



- **Heavy Vehicle Transponder**
 - For use in single unit trucks, tractors, school buses, transit buses, inter-city buses, and trucks or tractors with one or more trailers
 - Registered gross weight of over 5,000 kilograms (five tonnes).
- Heavy vehicles are required by law to have a valid heavy vehicle transponder or they may be subject to enforcement.

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Intro to Trip Mechanics

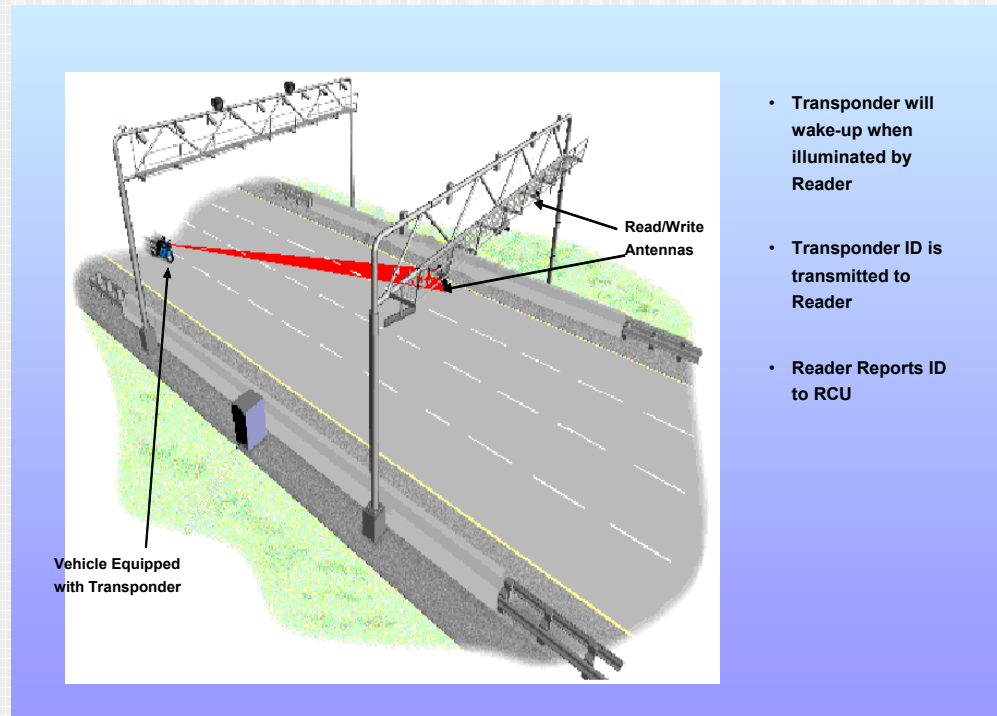
- Vehicles are identified (by license plate) and classified (light or heavy vehicle) entering and exiting the highway.
- If the vehicle does not have a transponder, then its license plate is photographed.
- Entry and exit trip data is sent to the Operations Centre where it is later matched for billing.

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Trip Mechanics

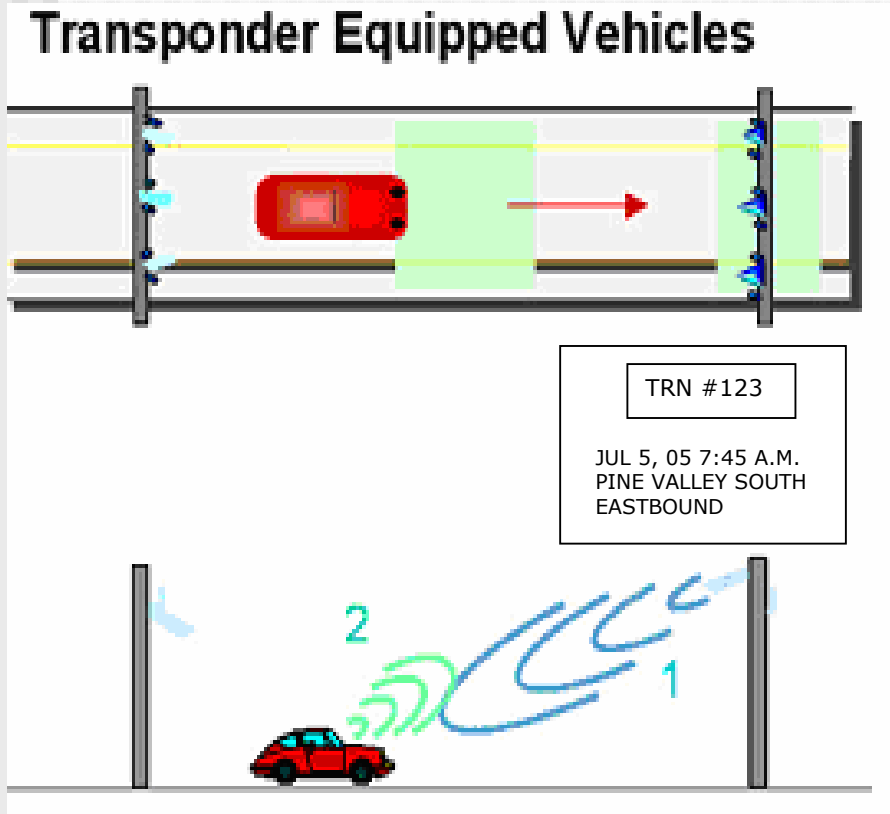
Transponder-equipped vehicles

- Once a series of vehicles has entered the highway, they approach a set of twin gantry gates that serve to locate, identify and classify a vehicle.
- The second gantry's antennae is constantly broadcasting to communicate with the approaching transponders.



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Trip Mechanics Cont'd

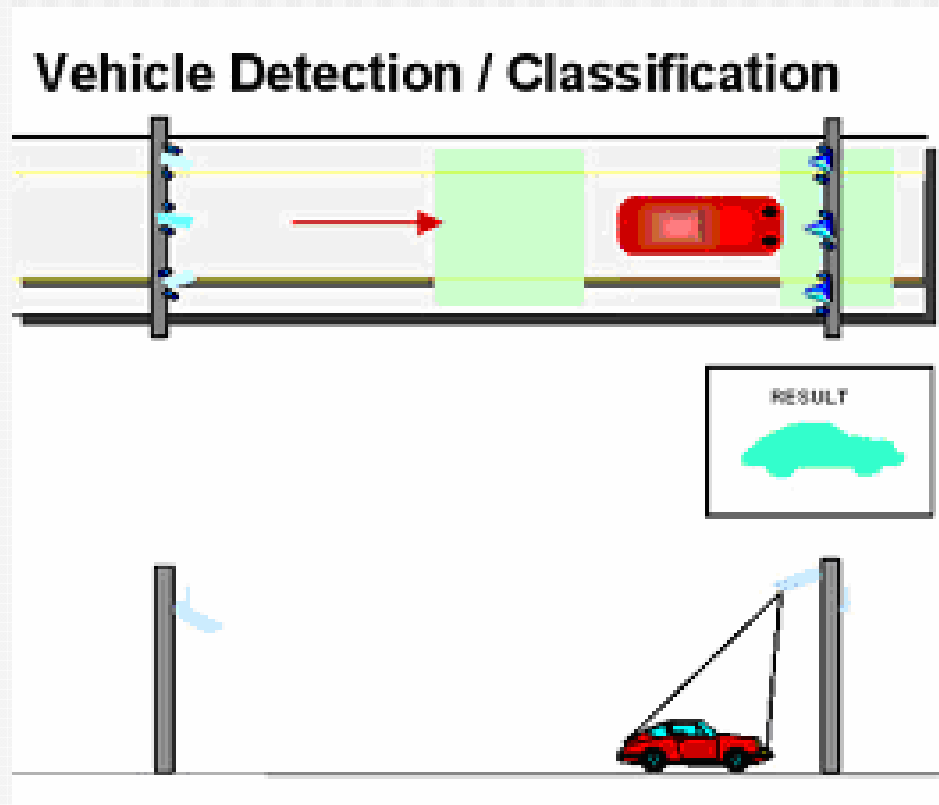


- A connection is made with the transponder and a unique identification tag is sent back to the tolling system.
- The entry time, date stamp, direction of travel and vehicle classification are compiled and transferred to the transponder's read/write storage area.

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Trip Mechanics Cont'd

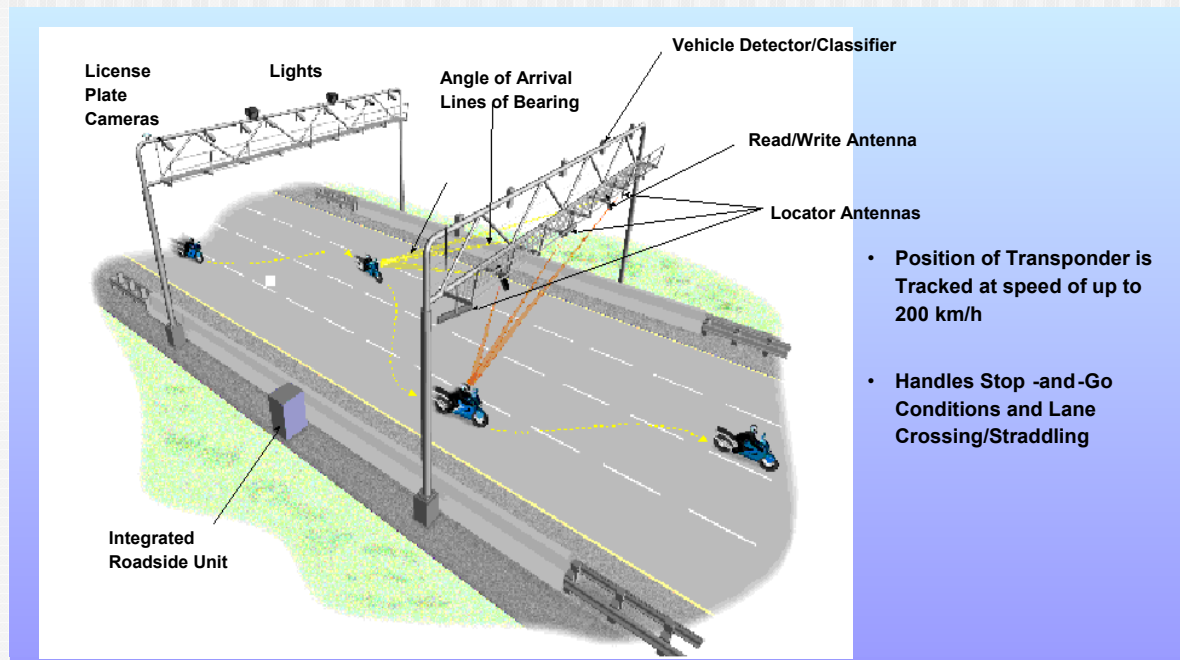
- As the vehicle approaches the second gantry, the VDAC unit scans the road and acquires the dimensions of the vehicle's shape, using a laser curtain.
- This is done to determine the vehicle class in order to ensure a match with the vehicle class indicated by the transponder.



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Trip Mechanics Cont'd

- The vehicle location is tracked through triangulation and by determination of an angle of approach.
- The locator antennae on the second gantry communicates with the transponder continuously throughout the communications zone.



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Trip Mechanics Cont'd

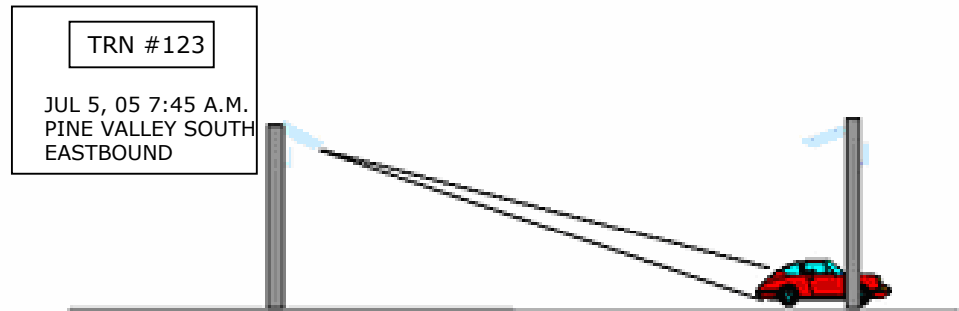
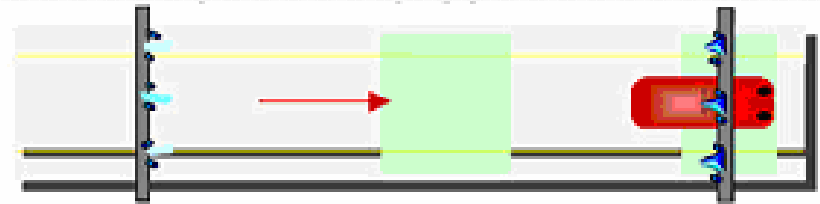
- As a vehicle exits the 407, the same process is repeated.
- Once the exit gantry is reached, the transponder sends exit information along with the vehicle's identification data to the Operations Centre, where it is matched with the entry data and the complete trip is recorded for the invoice.

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Trip Mechanics Cont'd

Non-transponder-equipped vehicles

- The vehicle enters the communications zone and no signal is sent from the vehicle.
- The VDAC system recognizes the approaching vehicle, determines its profile and dimensions, defines location of license plate, then activates the camera.
- An image of the rear license plate is taken and stored.





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Compiling the Trip Data



- Operations Centre receives data along fibre optic network from each of the roadside units.
- Any entry and exit data or video reads are sent to the Toll Transaction Processor (TTP) and matches of the entry and exit records are made for both transponder and video trips.
- If the TTP is unable to read a license plate, that plate is flagged and sent to Video Exception Processing (VEP) where human operators perform the read.
- Complete trips are sent to the Revenue Management System where the trip is rated.
- Invoices are then issued (monthly basis) to transponder account holders or license plate holders.

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Enforcement

- 3 functions
 - Rules of the Road – Traffic Violations
 - Enforcing Payments – Invoices
 - Enforcing Heavy Vehicle Transponder Usage



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Heavy Vehicle Enforcement



- Police vehicles are equipped with special “enforcement” transponders.
- As a heavy vehicle transponder communicates with the antenna, the gantry in turn communicates with the enforcement transponder which emits an audible and visible signal for the police officer.
- The officer can then identify the heavy vehicles that are operating without a valid transponder (either they don't have a transponder or they are using a transponder meant for light vehicles).
- Violating vehicles are stopped and the driver of the vehicle is fined.

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Tolling Fees

- Trip costs depend on:
 - Range of time (peak or off-peak)
 - Vehicle class (light or heavy)
 - Distance travelled
 - Transponder or Video Trip.

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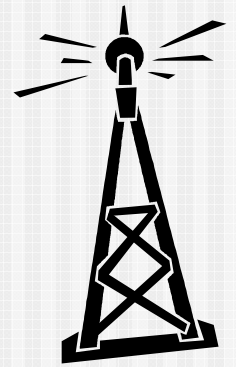
Benefits of the Use of ITS

- Availability of data:
 - Traffic volumes
 - Travel frequency
 - Average speeds
 - Average trip length
- Numerous innovative technological advances have arisen.



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Future ITS Technology

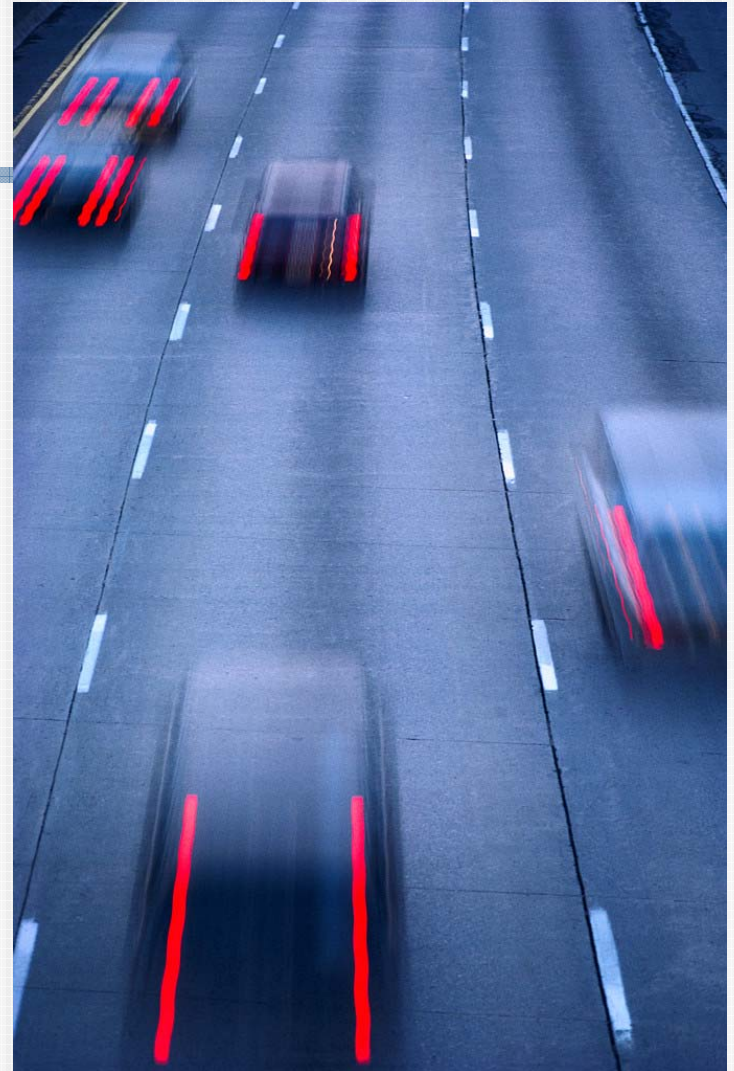


- Continued spread of transponder use and availability in new cars.
- DSRCs may soon be used on highway 407, providing the following benefits:
 - Short to medium range communications (of up to 1km)
 - High data transfer rate (27 MBPS)
 - Wireless data transfer between vehicles (ideal for enforcement)
 - Can also be applied in intersection collision avoidance, work zone warnings, road condition warnings, electronic toll collection, electronic payments (gas, fast food, parking, power and device identification protocols).

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Helpful Links

- www.407ETR.com
- Raytheon Canada



Any questions?

