



Tolling Technology

TARGET ACQUISITION TAKEN TO THE NEXT LEVEL

As a developer of innovative, high accuracy, intelligent transport solutions, Red Fox ID (RedfoxID) has unique and specialist skills specifically focused on tolling applications. The skill set covers sensor technology development with a particular speciality in automatic vehicle classification (AVC), lane controller design, automatic vehicle identification (AVI), lane system design and installation. With a view toward the long-term success of its customers, RedfoxID installs operationally-proven solutions and works closely with system integrators and road operators to ensure that they extract the full value from their intelligent transport system.

Vehicle presence & classification

Quantum software analyses vehicle signatures provided by in-ground sensors, in real-time, to track and produce information on all vehicle types, including motorcycles, passing across the detection zone. The final vehicle message (FVM) includes the classification of each vehicle, placing the vehicle in the correct lane, and recording the speed and direction of travel.

Additional, optional, sensors provide triggers for front and rear ANPR cameras. A sophisticated correlation engine, together with algorithms that track vehicles throughout their transition through the tolling zone, allows additional sensor data, for example tag reads, to be combined with the vehicle data to provide a single, comprehensive transaction for each vehicle.

Quantum's unique software offers superior and accurate trajectory prediction (tracking), exceeding any current market leading AVC solution, thereby improving the tracking ability of vehicles through the detection zone. This capability allows integrators to design cost effective, single or multi gantry tolling solutions, yet still maintain the association between front and rear ANPR image sets with the vehicle transaction.

Patented Quantum algorithms ensure accurate vehicle separation, even with poor lane discipline, stop and go, or tailgating traffic in multi-lane free-flow installations. Quantum has demonstrated the ability to separate, count and classify accurately vehicles towing or tailgating at speeds under 5kph to speeds in excess of 200kph regardless of presentation to the detection zone.

AVI Correlation: Quantum provides a sophisticated sensor integration platform resulting in a very efficient methodology to merge multiple sensor streams together (AVI, laser, camera, WIM, axles detection). Quantum maintains a very accurate time/position map that is used to precisely allocate sensor data to the correct vehicle. This integration platform simplifies lane controller design, reduces project risk in a complex part of the system design and yields greater placement accuracy than can be achieved with simplistic time based mapping. Quantum is the only sensor that knows exactly where the vehicle is at any instant in time, this unique knowledge underpins our ability to achieve such high correlation accuracies.

Patented technology

A Quantum installation is based around a unique detection array (patent pending) suitable for any road layout, single or multi-lane. The technology has been created to improve the accuracy in stop-start / congested traffic sites, simplify site selection and accommodate poor lane discipline. Quantum vehicle class tables are defined using a rules based engine and are easily modified to suit customer requirements allowing tailor made vehicle classification solutions.

Irrespective of weather conditions, in live traffic environments Quantum technology will consistently achieve accuracies required for tolling agencies. Tolling applications are typically looking for detection count accuracies in excess of 99.9% with commensurate classification accuracy - statistics that Quantum is exceeding (99.96% detection accuracy and 99.9% axle classification).

The Quantum Array is designed to make installation simpler and site selection less constrained. Using a Quantum array means installation and closure times are reduced in comparison with other in-ground sensor installation times. Subject to site survey there may be the ability to install the Quantum Array below the wearing course for increased operational life span of the system. Installation operations are simplified with all slot cuts at the same depth and all loops wound in the same way.

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Quantum standard functions

- Classification: profile or axle based
- Trigger for ANPR / video format
- Reversible lane configurations
- Automatic vehicle identification correlation
- Tracking for single gantry optimisation

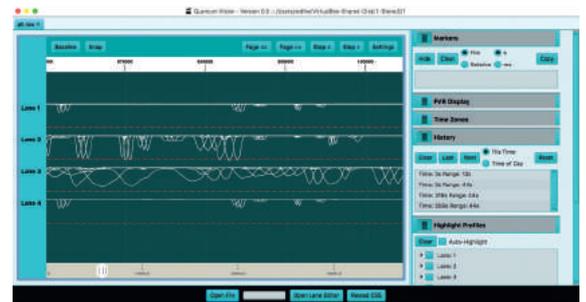
Target accuracy for Quantum
Performance accuracies of Quantum TA

Count accuracy in all traffic conditions	99.96% or better
Axle Classification accuracy in all traffic conditions*	99.9% or better
Length accuracy	+/- 5%
Speed accuracy	+/- 3kph (below 100kph) +/- 3% (above 100kph)

*All vehicle types including motorcycles

Quantum Toolkit Suite

The software licence package comes complete with the tools to set-up, support and maintain all Quantum products. Analysis tools for site configuration, data analysis and error resolution are provided in both web browser and stand-alone format with full training offered.



ABOVE: Quantum Vision

```

redfox@Red2-MAC:~$ cat /dev/tty
Jul 06 13:21:56.512 id: 2894749 Lane: 3 speed: 39.97 mph len: 387 class: 1 axles: 2 nt off: 0 :: 1264
Jul 06 13:21:57.585 id: 2894750 Lane: 3 speed: 39.86 mph len: 313 class: 6 axles: 2 nt off: 0 :: 41
Jul 06 13:21:58.299 id: 2894753 Lane: 3 speed: 38.56 mph len: 407 class: 1 axles: 2 tg off: 0 :: 760
Jul 06 13:21:59.12 id: 2894754 Lane: 4 speed: 50.58 mph len: 388 class: 1 axles: 2 nt off: -118 :: 856
Jul 06 13:21:57.866 id: 2894752 Lane: 1 speed: 44.94 mph len: 2595 class: 3 axles: 3 nt off: 0 :: 156
Jul 06 13:21:57.833 id: 2894751 Lane: 2 speed: 30.58 mph len: 1810 class: 2 axles: 2 nt off: 0 :: 552
Jul 06 13:22:01.158 id: 2894757 Lane: 3 speed: 44.0 mph len: 441 class: 1 axles: 2 tg off: 164 :: 182
Jul 06 13:22:01.183 id: 2894756 Lane: 2 speed: 33.55 mph len: 421 class: 1 axles: 2 tg off: 0 :: 933
Jul 06 13:22:02.529 id: 2894758 Lane: 3 speed: 41.52 mph len: 428 class: 1 axles: 2 nt off: -102 :: 369
Jul 06 13:22:03.160 id: 2894761 Lane: 2 speed: 46.91 mph len: 278 class: 6 axles: 2 nt off: -155 ::
Jul 06 13:22:03.183 id: 2894760 Lane: 1 speed: 44.94 mph len: 278 class: 6 axles: 2 nt off: 155 ::
Jul 06 13:22:03.281 id: 2894759 Lane: 3 speed: 42.48 mph len: 638 class: 2 axles: 2 nt off: 84 :: 641
Jul 06 13:22:04.773 id: 2894764 Lane: 3 speed: 42.61 mph len: 421 class: 1 axles: 2 nt off: 0 :: 720
Jul 06 13:22:04.620 id: 2894763 Lane: 1 speed: 29.53 mph len: 293 class: 6 axles: 2 nt off: 0 :: 28
Jul 06 13:22:06.107 id: 2894765 Lane: 1 speed: 40.44 mph len: 428 class: 1 axles: 2 nt off: 0 :: 1015
Jul 06 13:22:06.187 id: 2894765 Lane: 3 speed: 40.44 mph len: 428 class: 1 axles: 2 nt off: 0 :: 1227
Jul 06 13:22:07.988 id: 2894766 Lane: 2 speed: 33.89 mph len: 429 class: 1 axles: 2 tg off: 0 :: 1227
Jul 06 13:22:09.47 id: 2894767 Lane: 1 speed: 46.26 mph len: 414 class: 1 axles: 2 tg off: 147 :: 193
Jul 06 13:22:09.932 id: 2894768 Lane: 3 speed: 35.46 mph len: 520 class: 1 axles: 2 tg off: 0 :: 621
Jul 06 13:22:10.791 id: 2894769 Lane: 2 speed: 42.23 mph len: 449 class: 1 axles: 2 tg off: 0 :: 621
Jul 06 13:22:10.964 id: 2894770 Lane: 1 speed: 33.22 mph len: 266 class: 1 axles: 2 tg off: 0 :: 621
Jul 06 13:22:11.945 id: 2894771 Lane: 3 speed: 37.89 mph len: 428 class: 1 axles: 2 tg off: 0 :: 621
Jul 06 13:22:13.258 id: 2894772 Lane: 1 speed: 46.44 mph len: 395 class: 1 axles: 2 tg off: 0 :: 621
Jul 00 13:22:13.557 id: 2894773 Lane: 2 speed: 37.22 mph len: 402 class: 1 axles: 2 tg off: 0 :: 621
Jul 06 13:22:14.447 id: 2894774 Lane: 3 speed: 41.25 mph len: 383 class: 1 axles: 2 tg off: 0 :: 621
Jul 06 13:22:14.887 id: 2894775 Lane: 2 speed: 38.16 mph len: 381 class: 1 axles: 2 tg off: 0 :: 621
  
```

LEFT: Quantum Toolkit Suite application - Quantum Format, showing the data contained in the Final Vehicle Messages (FVM)

BELOW: Quantum Final Vehicle Message shows detection of two motorcycles by Quantum which would not have been detected by a main loop system

```

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```

Quantum at work: Motorcycle Detection

Motorcycle detection has long been a challenge for the automatic vehicle detection systems, main loop only systems leave gaps in the detection zone sufficiently large enough for motorcycles to pass through completely undetected.

The Quantum Array coupled with Quantum's improved detection capabilities

enables accurate detection of all vehicles including motorcycles with a 99.96% or better detection rate. Motorcyclists, until now, could avoid detection by travelling between lanes or close to other vehicles. No longer can they do this with Quantum installations.

On a site using the Quantum Array where 55,000 vehicles were recorded, 4,550 of those vehicles were motorcycles (8% of

the traffic using the road) and Quantum detected them all. It was also noted that 919 of the vehicles could not have been detected by any other loop based system.

The functionality of Quantum will help road operators and back office facilitators create more specific tolling tables and financially fair rates for their road users.