The bridge to possible

TfNSW leverages the Edge and AI in congestion-busting trials transforming the future of transport

TfNSW uses AI, IoT edge computing, and Wi-Fi technology to manage congestion, increase safety, and provide more reliable road services

The customer summary

Customer name
Transport for New South Wales (TfNSW)

Industry
Transportation

Location
Sydney, Australia

Number of employees
25,000

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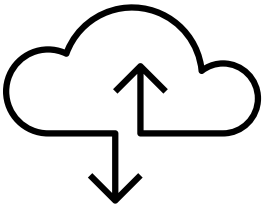
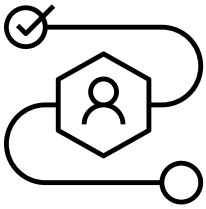
Business challenge

- Lack of capability to identify high-risk behaviour at intersections and to prioritise those that require intervention
- Inability to provide insights to rising congestion events and changing travel patterns
- High data backhaul and cloud costs when scaling out across a large number of intersections



Network solution

- A world-first AI application developed by Cisco using real-time camera footage from the intersection to understand behaviour and the relationships between objects
- IoT edge computing ensured data costs were minimized by processing data as close to the sensor as possible at the intersection
- Leveraged Cohda Wireless LocateIQ Wi-Fi solution to detect and report on the movement of objects around intersections



Business results

- Successfully identified and collected new automated insights into high-risk behaviour at intersections, enabling prioritized intervention and creating safer roads for customers
- Reduced overall data backhaul and cloud costs by filtering non-interesting data directly at the intersection
- Real-time queue length and queue time at the lane level enables early identification of potential rising congestion events
- Across the drive tests, the ingress lane is correctly inferred by the algorithm 81.25% of the time, while the egress lane estimates result in 75% accuracy
- With the general population of vehicles, LocateIQ was able to track vehicles out to ranges of 400m in some cases, proving LocateIQ's non-line-of-sight sensing capabilities

In shoulder times, when all drive tests were performed between 9 a.m and 11 a.m, LocateIQ was seeing vehicles at a rate of 4.5/min. This dropped slightly in off-peak and is expected to be slightly higher in peak times. In shoulder times, there was always at least one vehicle being tracked with a peak of 20 vehicles being tracked at any given instant.

Technology partners

Cohda Wireless – LocateIQ; Innovation Central (a joint partnership between Data61, the University of New South Wales [UNSW], and Cisco®)

"We are also using advanced sensors on buses, ferries, and light rail to provide instant feedback on the comfort of customer journeys and improve real-time customer information. Buses fitted with this technology can also monitor asset and road conditions, and provide us with real-time information on vehicles."

Joost de Kock
Deputy Secretary Customer Strategy and Technology
at Transport for NSW

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Figure 1. Pitt Street, Sydney @ The Edge

Business challenge

With a population of just over 8.18 million in New South Wales and rising, an efficient transportation system is essential to move people safety across the city and state. However, incidents at intersections continue also to increase, including jeopardising vulnerable road users such as pedestrians and cyclists. The challenge is being able to identify high-risk near misses and behaviour trends at intersections in an automated fashion, which can then lead to prioritised early intervention before incidents occur.

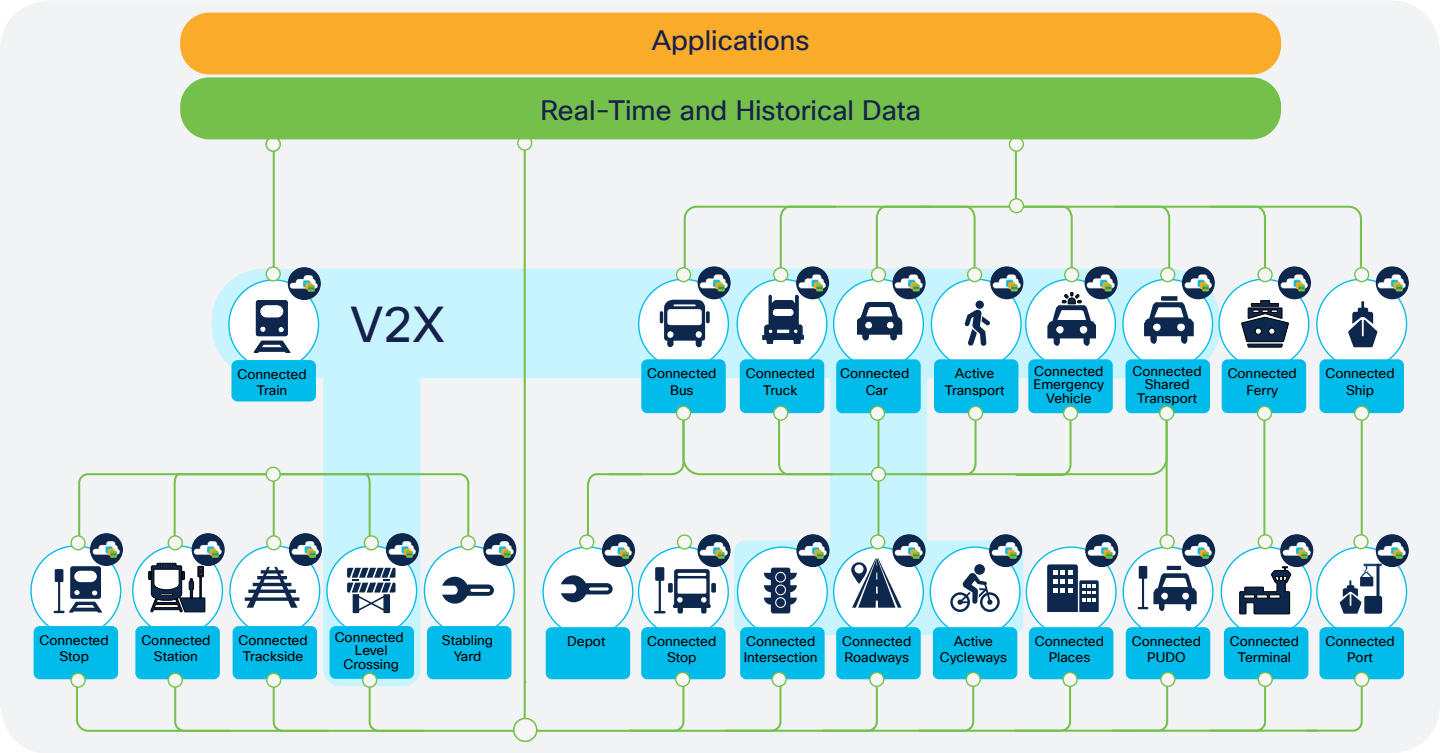
Understanding road user behaviour in a granular and timely manner is imperative in identifying and reducing the impact of congestion for the road user. Current solutions such as cameras, radar, and Light Detection and Ranging (LIDAR) do not cover a broad enough area of the intersection, while legacy solutions such as ground loops identify only a vehicle at the head of the queue and not the wider environment.

Deploying data-intensive solutions can often become expensive in terms of the amount of data required to be transmitted from the intersection to the data centre and cloud. It therefore becomes important that the solution optimises the amount of data transmitted to enable it to scale efficiently and support remote locations.

Network solution

Three key technologies played a major role in enabling this solution: Internet of Things (IoT), edge computing, and Artificial Intelligence (AI).

IoT is a key component of the trials enabling all manner of physical objects to be “digitised” and connected to the network via sensors. Two types of sensors were used in this instance: first, existing CCTV cameras at the intersection to feed data into the AI-enabled Reasoning Engine. The second solution, LocateIQ from Cisco partner Cohda Wireless, detected Wi-Fi devices with a high degree of fidelity to the lane level.



Firstly, let's look at the AI-enabled Machine Reasoning Engine. Unlike existing AI solutions, the goal of this Reasoning Engine is to understand the relationship between objects and behaviour in an unsupervised manner. What this means is that unlike existing AI systems, the Reasoning Engine learns by itself and tries to find anomalies. In the trial we fed it live video from the traffic intersection cameras and told it to look for incidents of jaywalking, speeding, and near misses. The system then processed the data and reported the number of incidents it identified over a period of time.

This information can then be used to help identify rising high-risk intersections based on the trend of incidents and therefore enable prioritized early intervention.

However, this strategy fulfills only some of TfNSW's requirements, as the video data has its own limitations in scope due to coverage available at the intersection. For example, you certainly can't see incidents around the intersection and through walls! This is where a Wi-Fi device detection technology from Cohda Wireless was utilized. Leveraging a number of Cohda Wireless Wi-Fi Road Side Units (RSUs) installed at the intersection, the sensor detects the presence of a Wi-Fi device (e.g. mobile phone, tablet, vehicle, watch, etc.). The Cohda Wireless application then can pinpoint the location of that device down to the lane level in real time.

Edge computing provides the "glue," taking the connected objects and managing the real-time data as close to the object as possible. The entirety of this process leads to faster decision making (safety events); legacy communications (protocol translation); and significant cost savings (data management). In the trial, edge computing played the additional role of supporting application agility through hosting of lightweight applications such as Cohda Wireless LocateIQ at the roadside, ensuring data cost savings and privacy needs are met.

Business results

Through the testing undertaken during the trial, the data from the system enabled insights including lane-level queue length, average speed to transition across the intersection, and even average wait time. Other details could also be gleaned, including the presence of pedestrians waiting at lights. Of most interest was the fact that a broad visibility view of the intersection could be achieved with devices being able to be seen over 400m in around the whole intersection.

The AI-enabled Reasoning Engine was able to infer and record several incidents that occurred at the intersection including jaywalking and speeding. Of most surprise was the ability of the system to record several near misses that occurred, which included a cyclist weaving through passing traffic.

The trial demonstrated that technology has the potential to provide new insights into road user behaviour and in turn to solve some of the most difficult and pressing challenges in the transport space dealing with congestion and safety. These new insights are even more important now as we face a post-pandemic world and changing travel patterns, offering the potential to assist with longer-term planning and community benefits.

The Australian Road Research Board (ARRB) has also completed an independent report on the trial and results, including the value that the system will provide to transport agencies and the broader community.

Finally, the trial highlighted how application agility can lead to improved total cost of ownership. Using a single hardware platform enables changes to be made through software and therefore eliminates bespoke solutions with a standards-based north bound interface, cybersecurity, and common applications support.

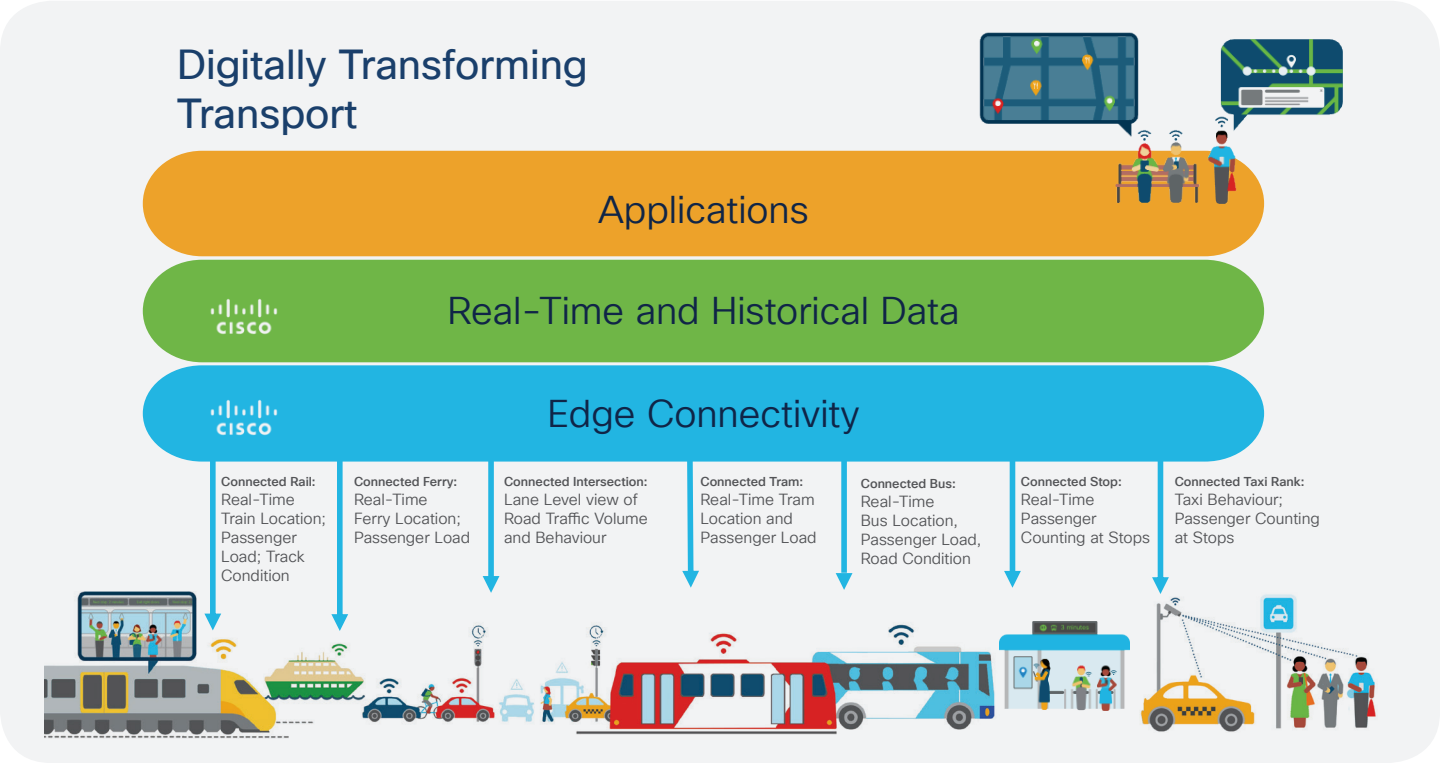
Going forward

The work done during this trial demonstrates a broader view of digitising the transport space and the benefits it can bring to transport agencies, operators, and community. Through a technology-led IoT approach, the results of this study demonstrate hyperawareness of asset performance and customer behaviour in real-time leads to reduced congestion, increasedsafety, and provides more reliable transport services for customers.

This approach also provides a platform to evolve and bring together a truly multi-modal transport system. Though the digitization of transport, it also enables innovation and development of new services through the release of data to the developer community.

One way to understand this is by taking an “outside-in” approach. In order to begin the digitisation process, everything needs to be connected from assets to customers. Once connected, data can then be unlocked to understand asset performance and customer behaviour. This process can be as simple as providing insight into the real-time location of a bus, or the number of customers waiting at a bus stop queue, which in turn enables a better understanding of the supply and demand model. However, it can be extended further to more elaborate data sets, including vehicle telemetry and the details of road surface conditions. This ability to be able to react and adjust to changing situations and support a dynamic integrated transport system creates connected safer journeys for the community.

This concept is illustrated in the diagram below, where unlocked data can then be ingested by existing or future applications or even published to an open data platform for third parties to consume and further innovate.



This type of insight from intelligent sensors can then drive intelligent decision making which ultimately leads to an integrated and elastic transport system and a whole new customer experience for the community.

Technical implementation

The work being done with these trials seeks to transform the transport system in New South Wales by digitising assets across multiple transport modes. Through leveraging world-leading Cisco technologies in the areas of IoT, edge computing, and Artificial Intelligence, the results demonstrate the ability to reduce congestion, increase safety, and provide more reliable transport services for customers.

Internet of Things: Connecting the unconnected

Internet of Things (IoT) is a key component of the trials, enabling all manner of physical objects to be “digitised” and connected to the network via sensors. IoT enables the broader system and applications to be hyperaware of asset performance and customer behaviour in real time, unlocking data through a multitude of sensors such as cameras, Wi-Fi, gyroscopes, telemetry, and accelerometers.

In the trials, IoT enables TfNSW to understand where the objects are located within the physical world and to break down the barriers that may exist between the modes, enabling them to then exist in a digital representation.

The trial leveraged two types of sensors: Existing CCTV traffic monitoring cameras as provided via TFNSW, and also a solution via partner Cohda Wireless, which used the Wi-Fi signals from mobile devices to determine the location of objects at a granular lane-based level.

Edge Computing – Extending the cloud to where the things are

Edge computing provides the "glue," taking the connected objects and managing the real-time data as close to the object as possible. Implementing edge computing leads to faster decision making (safety events); legacy communications (protocol translation); and significant cost savings (data management). The edge plays an important role in the solution with the following benefits:

- Filtering: sending only what you need and conserving valuable bandwidth and reduce operating costs
- Event capture: collecting and sending data in response to a specific trigger of interest
- Aggregation and fusion of data sources
- Providing a consistent interface and abstraction layer to data across diverse assets
- Application hosting

The unique capability of Cisco to enable edge computing on IoT routers and switches provides the additional value of reducing the footprint and power consumption of industrial hardware installed at the roadside. The ability to execute business applications at the edge is supported through the Cisco IOx application environment, which combines Cisco IOS® and the Linux OS. It enabled the team to execute IoT applications with secure connectivity with and powerful services for rapid, reliable integration with IoT sensors and the cloud.

Next Generation AI .. It's about computers and machines thinking like a human brain!

So, what can you do when you have all this data? First, we started with one of many transport challenges: how can we identify near misses on roads and therefore identify high-risk intersections that could lead to early priority intervention? Working with Innovation Central and TfNSW, it became clear that there are similarities between transport networks and communications networks. Thus, we began an exercise where we took our early development communications tools and worked on how we could apply them to the transport network realm.

One of those tools was an early development application of next-generation AI that we refer to as the Reasoning Engine. The AI-Reasoning Engine was designed to identify and predict failures on a communication network. This AI does not have some of the limitations of existing systems, such as:

1. Long, complex training times
2. Exponential increase in storage and compute resources
3. Inability to process what it has never seen before

When applied to a transport network, the system understands and learns behaviour and relationships between objects, which is ideally what is required when identifying road user behaviour at intersections.

What's unique is that for the first time we have an Artificial Intelligence system from Cisco that learns and adapts on its own. When it sees something it hasn't seen before, it asks itself a series of questions about the environment and then uses ongoing data to solve the problems… all by itself.

AI-Reasoning Engine is an early development software that overcomes many previous limitations and autonomously learns/adapts salient features and new environments in an unsupervised manner.

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Learn more

https://www.cisco.com/c/m/en_au/cda.html

https://www.cisco.com/c/en_au/solutions/industries/transportation.html

https://www.cisco.com/c/en_au/solutions/industries/transportation/new-south-wales.html

https://www.cisco.com/c/en/us/solutions/industries.html

https://developer.cisco.com/site/iox/

Product list

IoT Routing and Switching

- Cisco Catalyst® IR1101 Rugged Series Router
- Cisco IC3000 Industrial Compute Gateway
- Cisco Catalyst IE3400 Rugged Series Switches
- Cisco Edge Intelligence – Edge to Multicloud IoT Data Flow
- Cisco IOx

Data Center

- Cisco UCS® and Cisco HyperFlex™ with NVIDIA Tesla T4 GPUs

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