Build the Business Case for

VIDEO ANALYTICS IN THE TRANSPORT SECTOR

Start with a POC and Prototype to Accelerate Your Video Analytics Capabilities

MAY 2021

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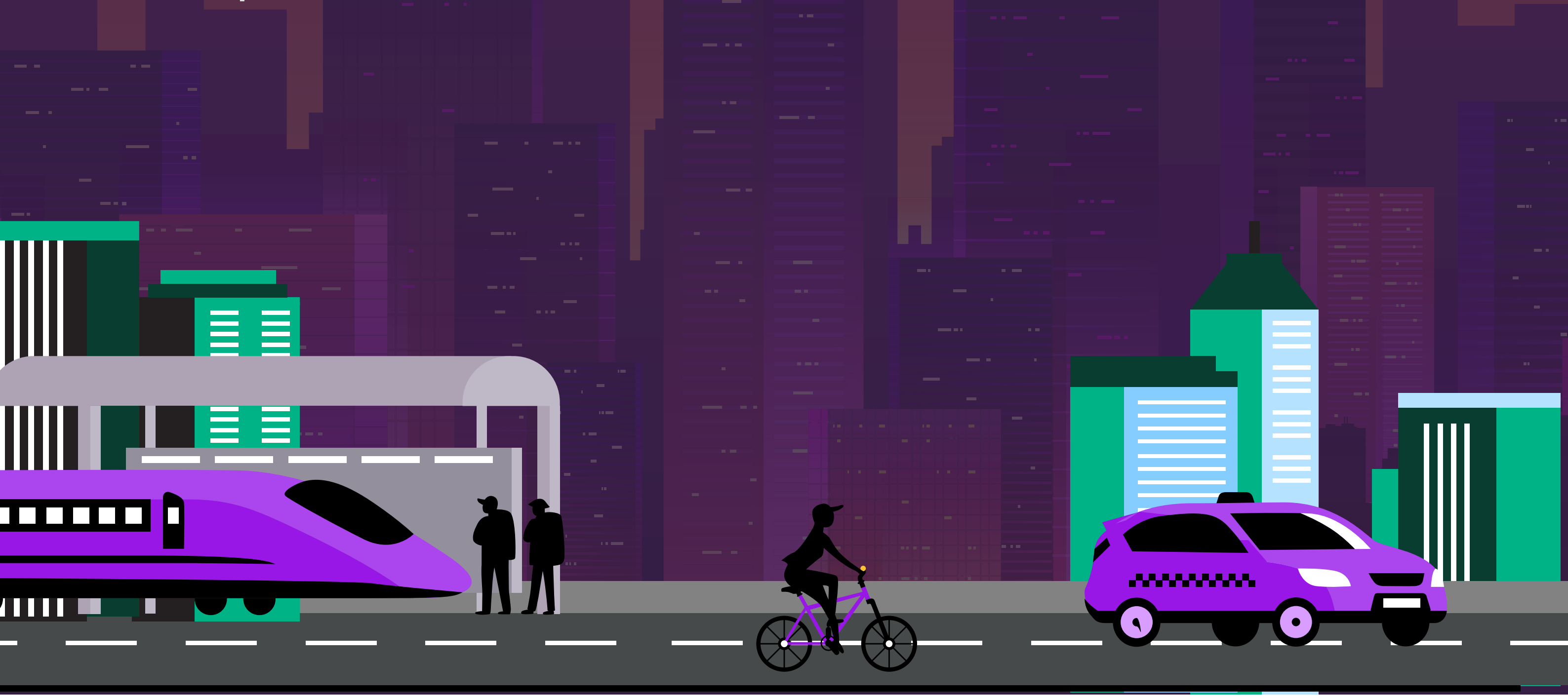


Introduction

Video analytics (VA) and computer vision capabilities are beginning to gain traction in transport agencies and providers across Australia and New Zealand.

These organisations want to enrich their existing data and capture new data from video streams to provide better services for customers and make their transport network smarter and more efficient. However, many technology and business professionals in these agencies find it hard to build the business case for investing in VA-based systems as they don't have the supporting data.

Business cases require great data to improve their chances of success – both in the selection process and the actual implementation. Transportation providers and agencies are turning to Proofs of Concept (POCs) and prototypes to collect this data and prove that the technology and solution is fit for purpose.

Before agencies build their video analytics capabilities at scale, they need to decide on an architecture and a desired sourcing model, as these will impact both the shorter-term strategy and the longer-term vision and capabilities within their business in driving smart transportation services.

This paper will help you understand best practices in building a POC and prototype for your next video analytics investments. It provides advice and guidance on the better architectures for VA along with some examples of business outcomes and revenue opportunities that transport agencies in ANZ have already provided their customers and business through the smart use of VA.

There is a Growing Expectation that your Transport Service will be Smart

Transport agencies and providers are quickly transforming their businesses – from reactive providers of transportation infrastructure to proactive managers of the movement of people and goods around cities, towns, and countries.

Every week brings news of new, smart engagements – trials of on-demand transport services, the use of Quantum Computing to better manage network disruptions, using video to understand passenger movements, partnering with private organisations to provide more timely and accurate data, and the use of weather, special events, and real-time customer data to better cope with sudden changes across the public transport network.

The Smart Cities that were described 15 years ago are being delivered – just not in the way that we had initially imagined. For the most part, the infrastructure itself is not much smarter than it has been in the past. But the addition of sensors and cameras are creating a tidal wave of data that is helping to drive better, smarter outcomes for customers. Transport agencies are able to make better decisions to keep transportation networks functioning and customers happy.

Building the Business Case for Smart Transport is Hard

> **Interviews with many senior transport professionals have demonstrated that the move towards smarter transport systems is challenging.**

An obvious opportunity area, and one of significant interest to every agency, is video analytics (or 'computer vision' as some prefer to call it). Transportation businesses and agencies have made deep investments in the video capture technology and infrastructure – using insights from the video feeds to automate actions and drive better decisions is the next step in the evolution of this infrastructure.

Today many video streams are monitored by humans – which is not only expensive but significantly limits the ability to increase monitoring or add additional alerts or data points. For example, humans are unlikely to be counting passengers on buses or train stations, or monitoring bus and transit lanes. Humans are not monitoring cameras in stations for people falling onto or crossing railway tracks. And they are not measuring journey times through transit terminals or directing passengers in real time around busy/overcrowded areas.

With the broader aim of transport agencies to create seamless travel across multiple systems and formats, video will be an important input in providing the data which will drive these smarter systems. Video analytics-based systems have the capability to enrich information that is already being captured with actionable data. And to build the business case, transport agencies need **supporting data** and to understand **their desired target video analytics architecture.**

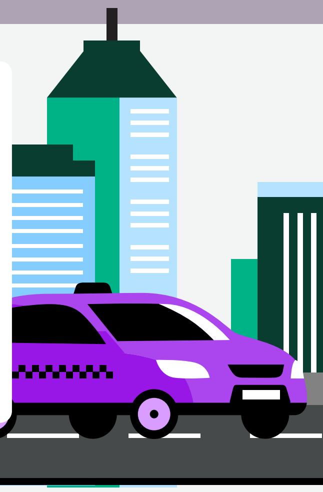
Use Cases of Video Analytics

Transport network

1. Network planning and modelling
2. Monitoring journey times
3. Object detection (landslides on railway tracks, abandoned parcels, objects on roads etc)
4. After hours movement at transport headquarters
5. Graffiti detection
6. Crowd detection
7. People counting
8. Traffic/people flow (at pinch points)
9. Facility capacity management (such as the number of people in and around stations)
10. Predictive maintenance

Roads

1. Monitoring special vehicle lanes (bus, transit lanes)
2. Monitoring cycle lanes
3. Red light running
4. Number plate recognition
5. Mobile phone usage while driving
6. Vehicle classification
7. Tunnel analytics
8. Wrong way drivers/ stationary or abandoned vehicles
9. Congestion monitoring
10. Queue length detection
11. Vulnerable road users
12. Gated parking management

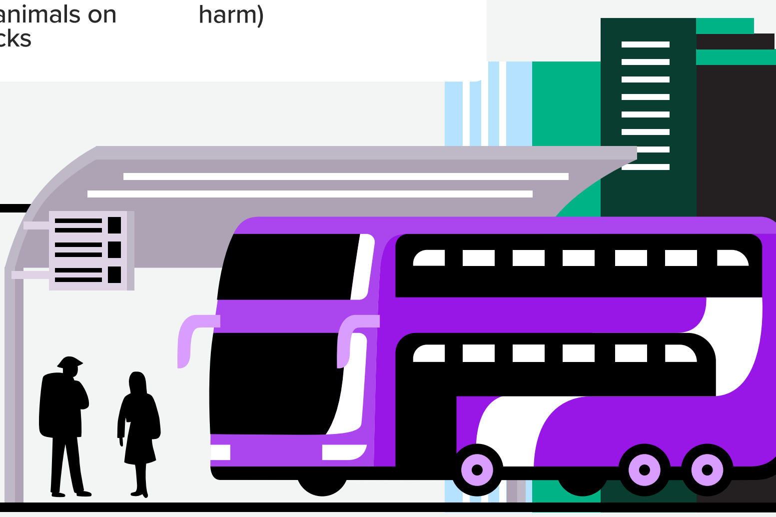


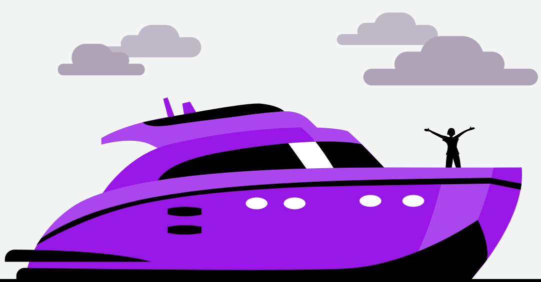
Rail

1. Railway level crossing monitoring
2. People or animals on railway tracks
3. Safety on stations (slips/trips/falls along with assaults and self harm)

Buses

1. Fare evasion
2. Fare reduction (tap on/off early or late)
3. Type/demographics of users
4. Use of prams, wheelchairs





Ferries/waterways

1. Unauthorised watercraft berthing at piers
2. Detecting swimmers in ferry lanes
3. Monitoring speed and type of water traffic and its impact on the waterways
4. Monitoring pollution and litter in waterways

Examples of Benefits of Video Analytics to Transport Providers

As demonstrated above, there are many different use cases for video analytics in transport providers and agencies to reduce costs, improve safety, increase revenue, improve planning, reduce pollution and litter, and drive better passenger outcomes.

But all of these use cases require a business case to get up and running, and business cases require data. Using publicly available data from across Australia, we have built the following models that demonstrate a possible ROI for investing in video analytics solutions for these two use cases.

USE CASE 1

Fare Evasion on Buses

With the move away from cash on buses towards tap-and-go style payments, the levels of fare evasion have increased. Different bus service providers across Australia and New Zealand estimate that between 3-20% of customers decline to tap on when boarding. An unknown percentage tap on late or tap off early – effectively reducing their fares. A recent trial of a video analytics solution by one bus company actually demonstrated the percentage of customers evading or reducing fares in their operating locality was actually closer to 50%.

In this scenario, cameras on buses can monitor the number of passengers, the percentage that tap on and off at the correct and incorrect time, the demographics of fare evaders and other customer details that might help companies better allocate the right buses to the right routes at the right times, with the right resources for the use of prams, wheelchairs, surfboards, oversized luggage and so on.

We developed the following model with these assumptions:

- 20% of customers do not tap on (a conservative proportion compared to the recent finding by the bus company that trialled the solution)
- 10% of customers shorten their fare, reducing the overall fare by 20%
- Average revenue per passenger per route is AUD 1.37 (this takes into consideration the high number of non-paying students and those with reduced fares – such as youth, pensioners)
- Average of 30 passengers per scheduled service

FIGURE 1:

Revenue Loss on Buses Due to Fare Evasion and Reduction

Number of passengers	Lost revenue
50,000,000	AUD 17,745,000
100,000,000	AUD 35,490,000
150,000,000	AUD 53,235,000

Number of scheduled services	Lost revenue
500,000	AUD 4,504,500
1,000,000	AUD 9,009,000
1,500,000	AUD 13,513,500

Source: Public Transport Data and Ecosystm Modelling

USE CASE 2

Using Video Analytics to Match Event Buses with Passenger Needs

Some transport agencies are considering monitoring foot traffic on and off buses, in and out of events and stadiums, and the direction of that traffic to determine the need for event buses. This data can not only help bus companies plan for future needs based on crowd sizes, but also allocate the right number of buses to the appropriate routes, along with the possibility of sending some buses home early to reduce costs. Monitoring the direction of crowds and the number of people can indicate which service they are looking for. This can also help inform future wayfinding requirements.

Using published data we have created the following model to estimate the possible savings per event per day if the number of buses is reduced by 10%, 15% and 20%. There are some clear customer benefits of moving passengers to their final destination faster, along with the safety benefits of smaller crowds.

We used the following assumptions:

9 special event routes

25 buses per route

60 passengers per bus (120 return passengers)

FIGURE 2:

Revenue Loss on Buses Due to Fare Evasion and Reduction

Projected Reduction in Bus Capacity	Potential Savings Per Event Per Day
10%	AUD 12,711
15%	AUD 19,067
20%	AUD 25,422

Source: Public Transport Data and Ecosystm Modelling

Successful Video Analytics-Based Solutions Start with a Proof of Concept and Prototype

Very few agencies or transportation providers we interviewed went straight to the business case – they don’t have the data or evidence of success to justify the deeper investments to roll a solution out across an entire network.

Even the smaller scale investments often require evidence before the investment – even if just to prove the technology works and the appropriate algorithm can be created to measure and monitor with an acceptable degree of accuracy.

Most successful VA implementations started with a POC and a prototype. A POC is designed to check the feasibility of a single or many concepts; a prototype considers all factors a product might have to deal with in the real world. A POC and prototype will help your business to:

- Demonstrate that the solution can be built
- Identify technical issues and provide solutions or suggestions to overcome these issues
- Test the idea or assumption behind the solution and provide real-world data for a potential business case

9 Steps to a Successful POC & Prototype

STEP 1:
Define Business Needs – Develop an Assumption and Use Case

STEP 2:
Research Prior Art Before you Design your POC

STEP 3:
Create a List of Technical Possibilities and Determine your End-State Architecture

STEP 4:
Discover your Current Performance Baselines

STEP 5:
Prototype the Solution

STEP 6:
Create the Minimum Viable Product or Prototype

STEP 7:
Collect the Data

STEP 8:
Scale Up the Solution

STEP 9:
Design a Roadmap Towards a Network-Wide Solution

Step 1: Define Business Needs – Develop an Assumption and Use Case

Video analytics-based solutions typically exist to solve a problem – sometimes a known problem (e.g. customers aren't tapping on when they board a bus) or an unknown one (e.g. buses speeding in a bus only motorway). So the first step in the POC and prototype process is to state the problem or define what you want to learn. From here, you need to start collecting all the internal data and use those assumptions to see if the potential business case data stacks up. For example, if you are measuring lost revenue through an assumed percentage of passengers not tapping on, or tapping on late/tapping out late, then you should start making the calculations at this stage to get an understanding of when the business case might stack up. Create models like the ones earlier in this paper to help understand possible outcomes. For example, if you assume that revenue can increase by AUD 12 million a year, then that gives an idea of the financials and the ROI required for any larger investment.

Step 2: Research Prior Art Before you Design your POC

As previously demonstrated, many transportation agencies and departments across Australia and New Zealand have already made forays into the video analytics space. Sometimes the algorithm already exists to identify specific actions or items. Sometimes it has been deployed on video capture technology similar to what is already deployed in your network. If your VA architecture already exists (edge, cloud or centralised computing, ML engine, communications network, data storage and analysis) then perhaps a POC is not required. But one of the real challenges to video analytics-based solutions is the lack of standards at most steps in the process – which means that nearly every deployment is unique, and even if you have a VA infrastructure in place, a prototype is likely still necessary.

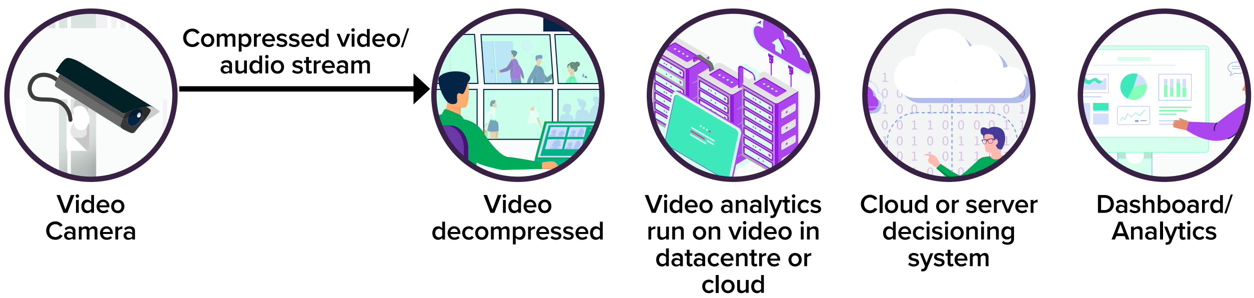
Step 3: Create a List of Technical Possibilities and Determine your End-State Architecture

It is likely that you have some of the technical components in place – some may be negotiable for change, others are not. Your camera infrastructure and communications between the cameras and the cloud or your data centre will dictate much of what is possible – although some projects may be able to fund camera upgrades. Your ideal end-state architecture will dictate where you will need to invest. There are a number of approaches for video analytics architectures, but they are mostly variations on two major themes.

Server or cloud-based

Where video is streamed from the camera across public or private networks and the analytics take place on the servers in your data centre or in the cloud. The VA intelligence is located on the server or in the cloud.

Server or Cloud-based Video Analytics Architecture



Source: Ecosystm, 2021

Challenges

Video is typically compressed when it is transported – and details are lost at this stage. It also requires extra server power to decompress the video data. The cost of sending significant volumes of data across public networks can be prohibitively expensive, even with the falling cost of network transmission on fixed and mobile networks. As camera numbers and quality increase, it may also require upgrades of central equipment or cloud capacity. Latency introduced through sending large volumes of data, conducting analysis at a distance, and sending actions back also mean that server or cloud-based VA isn't a practical solution for any actions that need real-time, or near real-time guidance. Privacy principles may also come into play – some state laws specifically mandate that people cannot be recorded in certain locations or on certain transport services. This means cameras that record and send video cannot be an option.

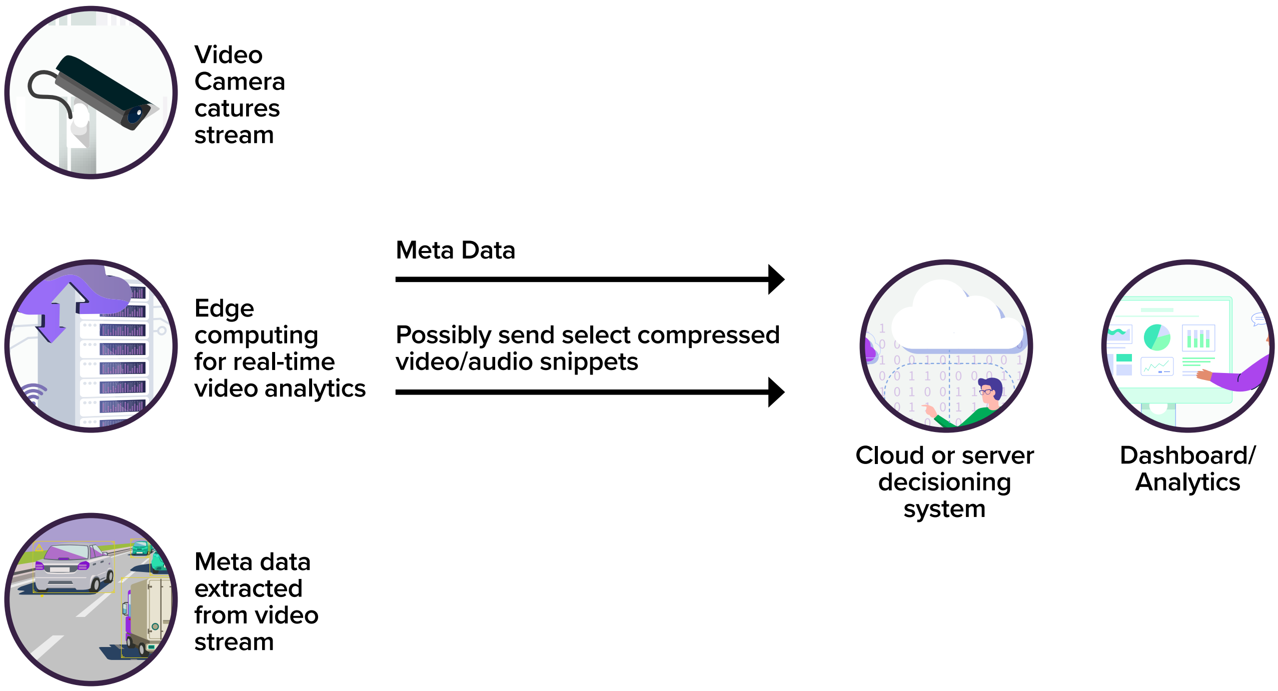
Benefits

The real benefit of a server or cloud-based architecture for VA is when the number of algorithms that you want to run on a video stream gets beyond the capability of the camera or the edge server. But even in this situation, upgrading every edge server might still be more cost-effective than the ongoing telecommunications costs of sending hundreds or thousands of high definition or greater resolution video streams over public networks. The other major benefit is the easier access to and management of hardware – particularly when run in your own data centre.

Edge-based

Where the video analytics happens on or near the camera. Actions are driven directly from the edge server, and/ or metadata is sent back to a server or the cloud to drive the decisions or actions.

Edge-based Video Analytics Architecture



Source: Ecosystm, 2021

Challenges

There is typically a greater upfront cost to an edge-based system – deploying servers in the field often means they need to be weatherproof, installed away from the public, or physically secured. They require access to power and need to be nearly maintenance-free. On-camera systems (without a near-edge server) tend to have lower processor capacity and less memory and therefore can run a limited number of algorithms.

Benefits

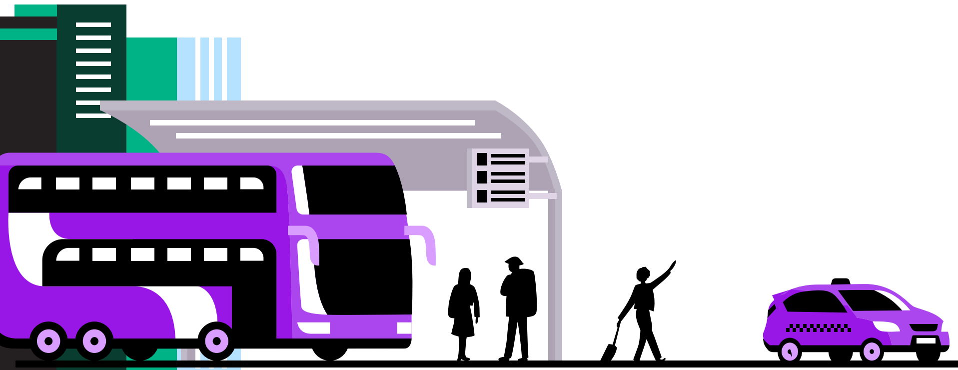
A major advantage of video analytics on the edge over a server or cloud model is the VA algorithm has direct access to high-resolution, raw, uncompressed video – which means the analysis can be made at a finer level on higher quality, higher frame rate video streams. Many transportation agencies that choose the edge-based architecture for VA will take the opportunity to upgrade cameras to a latest generation, HD or UHD digital cameras so that they can benefit from the raw video quality. The proximity to the video source means that analysis can be made in real-time or near-real-time – which is essential for safety applications (such as self-driving vehicles or traffic systems). With systems that only send metadata back to central analysis engines, the network transport costs are significantly lower, and the privacy and security of information can be greater as video is often never actually stored or transported. Even when video is sent, the system can be set up to send the content just before and after the event that triggered the need to send the video – again, providing significant network transportation costs.

Recent deployments favour edge-based systems as they provide a greater opportunity to conduct granular analysis as well as open future opportunities to conduct video analytics using the same infrastructure. Some agencies might also run a hybrid solution – where real-time analytics are conducted on the edge, along with the analytics which requires access to the raw video feed, and further analysis is made on the stored video or the video snippets sent back to a centralised server or cloud location.

Ideally, you will want all of your video analytics applications to use the same architecture – as mixing approaches can be expensive to manage and maintain, and complex to design.

Step 4: Discover your Current Performance Baselines

Sometimes a POC and prototype start with no data at all – as you are making an assumption and trying to prove it right or wrong. But other times you have some data that points you to a certain conclusion and the POC and prototype are designed to prove that data is accurate (or not). So make sure this information is collected and documented in the POC process.



Step 5: Prototype the Solution

At this stage, you want to build a mock-up of the solution to determine if taking it to a minimum viable product (MVP) makes sense. For a video analytics solution, you want to understand what can or cannot potentially be captured (can a camera be located where required?); what systems and processes will be required to analyse the data; and what actions might be driven by the analytics. Ask the question “how will knowing X change the business or customer process?”. At this stage you may learn that even if the algorithm can be created, the actions off the back of the solution might be unrealistic. For example, a tram service might consider using VA to discover if passengers are tapping on and off - but fare enforcement could be owned by another agency, and that agency won’t put any more enforcement officers on your trams to change passenger behaviour. Understanding how the data will be used and what investments or process changes will be required to drive desired outcomes is just as important as understanding the capability of the video analytics systems and platforms.

Step 6: Create the Minimum Viable Product or Prototype

This is the step where most transport providers and agencies go to market to discover what options are available to meet the needs of the engagement. The objective of this stage is to understand if the solution can be built and if so, can it monitor or measure what it was designed to monitor or measure.

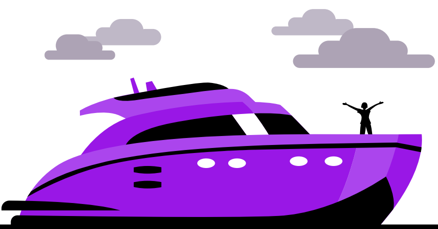
The questions that will be answered at this stage are:

- Can an algorithm be trained to recognise what you need to recognise?
- Is the accuracy at an acceptable level?
- How difficult or complex is it to deploy the solution?
- Will the solution work with existing video capture technology?
- Can the solution be built using the desired architecture?
- What are the maintenance requirements for the solution?
- Are insights delivered in the desired time frame?
- What skills are required to manage and maintain the solution?

Other optional factors to consider at this stage are:

- Can the solution adapt to changing circumstances?
- Will human operators and analysts trust the data coming from the VA system?
- Can the solution integrate with existing data sources to provide richer insights and analysis?
- What are the possibilities or limitations when operating the solution at scale?

Depending on the technical requirements of the solution, your RFP could be distributed to known partners who have worked on similar solutions in the past, or could be a broader sweep of the market, hoping to uncover unknown or emerging suppliers. The lack of standards and an heterogenous equipment market often slow down this step in the process – as many prototypes or MVPs need to be built from scratch – sometimes requiring vendors to find new partners who can provide specific components to the solution.



Step 7: Collect the Data

Everything you have done up until this stage is in support of collecting the data you need to build a full business case. You should have all of the external data that you need to either prove or disprove the original premise or assumption/s from the MVP/prototype stage. And the original internal data you used to test your assumption will provide much of the detail to create the business case. Depending on your business needs, the investment patterns and the likely ROI, you can either move straight to the complete business case for a fully scaled solution, or can take a more conservative approach and move to step 8.

Step 8: Scale Up the Solution

If the solution ticks all the boxes – it is technically feasible; proves the assumptions; and provides a business, customer and/or passenger benefit beyond the projected costs, then the next stage could be to scale the solution up. This might mean moving from two roads to ten, three buses to an entire bus area, or one station to all major stations. This may be an extension of the existing engagement, or part of a broader solution. Some transport agencies have added video analytics onto buses when they get upgraded; others have added video analytics into stations or interchanges when they are built or refurbished. Sometimes the goal is not to build a business case for a video analytics solution, but to prove that adding video analytics into an existing or planned investment will improve that investment.

Step 9: Design a Roadmap Towards a Network-Wide Solution

Moving to a network-wide solution is usually significantly more complex than the POC and prototype. Some equipment will need to be upgraded or replaced. Some locations might need to be added, others removed, others relocated. Often the findings from the POC and prototype are not exactly as expected – sometimes you can even expand the VA capabilities beyond the initial scope – and this might change the scope of the entire engagement. A system that recognises car numberplates in a car park might also detect pedestrian safety issues – and therefore could be expanded beyond the car park entry and exits.

You should also consider scoping for current and future implementations. It is likely that you will run multiple algorithms on the video feed – so building for that scenario today will be the most cost effective in the longer term.

Should You Insource or Outsource Video Analytics?

Often this question is answered before it is asked. Some government agencies tend towards insourcing, while others outsource everything. Regardless of the desire to insource or outsource, you will need to go to market for the infrastructure and software to run your solution. You will often find that the trained algorithms already exist and can do much of what you want, and this significantly accelerates the design and deployment of the prototype solution.

Our research indicated that the most successful and advanced video analytics usage by transport providers and agencies was by those who insourced their VA capability. They have built an infrastructure, architecture and internal team who could design new solutions and capabilities. This included the technology, data science and analytics skills required to design and train the systems to identify new items or activities. New VA capabilities can be tested and rolled out in weeks, not months or years. These agencies clearly had to invest in the infrastructure behind the solution – and update this infrastructure as required – but they then took the development of the VA capabilities in-house.

However, maintaining these skills and team has a significant cost – and this cost drives other agencies to outsource the design and build of their VA solutions – and sometimes even the management. With the right relationships in place (technology services is still a relationship business!) transport agencies can drive the VA capabilities at the same speed as those who insource. Running VA as a managed service might even give you access to the buying power of the large IT services businesses – meaning the equipment and software is upgraded and improved at a faster rate and lower cost than if you owned and/or managed it yourself.

As the number of use cases – and business cases – for video analytics accelerates within your business, you need to consider which option makes the most sense – as that will also dictate the ability of your organisation to provider better passenger outcomes and move closer towards being a smart transport provider.

About the Author

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Tim brings more than 20 years of experience in designing and implementing Cloud, AI, CX and Automation strategies to the Ecosystm network, to support businesses in their IT decisions.

In his previous role, Tim spent 12 years at Forrester Research, most recently as a Principal Analyst, helping IT leaders improve their digital capabilities. Prior to this, he was Research Director for IT Solutions at IDC in Australia, where he assisted IT vendors in designing solutions to better fit market requirements and IT buyers in improving the effectiveness of their IT functions.

Beyond the office, Tim boasts an international reputation as an entertaining and informative public speaker on the key trends in the IT market.

Tim graduated from the University of Technology Sydney with a BA majoring in Marketing and Research. In his free time, Tim enjoys playing football (badly!) and tennis and watching rugby. But while he may enjoy that, he spends most of his time driving his two children to various sporting and social activities.

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