Roadmap for Resilience

Leveraging Technology to Adapt and Thrive Post-Pandemic

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CUBIC™ | Transportation Systems

Dear Transportation Community,

Since the onset of the recent pandemic, our priorities have been focused on ensuring the safety of our employees and providing immediate support to our customers around the world. It has not been an easy time for many in our industry who are grieving the loss of life, managing economic challenges at home and at work, and are longing for a more hopeful future.

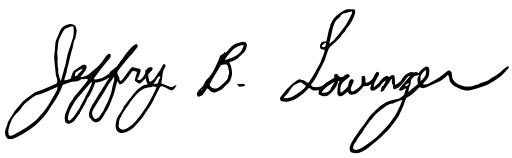
Our core responsibility during this challenging time has been to anticipate your needs so your time can go toward more pressing matters. We've been working side-by-side with our global partners to create and deliver solutions that meet the immediate needs to keep people safe, improve efficiencies and give actionable insights to help customers plan for the unknown. We are listening, learning and adapting in real-time, just as you are.

Through our conversations with customers we have determined that the work we are doing together may be relevant and helpful to those beyond our typical sphere of influence. As a global team of problem-solvers who are engaging with some of the most innovative teams solving transportation challenges in the industry – we feel it is also our duty to share knowledge that may support the greater cause.

While this document is in no way exhaustive of the potential solutions to today's challenges, it does highlight a breadth of technologies that may be as simple as an upgrade of existing hardware or software, to more long-term strategies to allow for the system to become more flexible and equitable. Some solutions discussed may have been created as a response to the pandemic, but also solve for established challenges, including budget constraints, shifting political landscapes, and common operational issues.

The goal is to inspire you, not only to reach out to an industry expert such as Cubic to learn more, but to co-create with industry partners. Now is the time to work together regardless of affiliation. Our industry is evolving, and we must elevate our work to advance transportation's role in creating resilient cities that promote excellence, prosperity and equity.

If you feel inspired to co-create with us – join us. Let's meet the moment together.



Jeff Lowinger
President, Cubic Transportation Systems

THE CHALLENGE

The global disruption of transportation networks due to the impact of a viral pandemic forced governments and agencies to modify, adapt and strategically plan in a way they have rarely done before. Due to the highly infectious nature of this virus, which flourishes in enclosed environments such as planes and trains, public transportation has become a focal point. Whether real or perceived, travelers are wary of their risks of exposure when taking transit creating a simultaneous decrease in transit ridership and subsequent revenues, and an expected increase in traffic congestion.

As cities begin to rebound from the pandemic, they are likely to experience an influx in low occupancy passenger vehicles, scooters, bikes, and pedestrians as commuters return to work but remain reticent of public transportation. Many road networks and intersections in cities aren't designed to protect the most vulnerable users and instead favor maximizing vehicle throughput. With additional vehicles on the network it is inevitable that accidents, congestion and air pollution will rise, accelerating our need for alternative transportation solutions. Even if a vaccine is developed quickly, this situation has demonstrated to the world that business-as-usual is forever changed.

While the pandemic has caused disruption in all industries including transport, it has also exacerbated existing challenges relating to service, access, funding and investment. Now is the time to build a more resilient network that inspires collaboration and takes new approaches for managing mobility systems. The industry must solve for current and future challenges such as:

- Creating safe environments for transport staff and travelers to limit the spread of disease
- Building trust in public transportation beyond public safety measures to encourage ridership
- Adapting systems to be more flexible and scalable to meet ever-changing demands
- Limiting traffic congestion and improving throughput for alternative modes of transportation
- Shaping equitable, sustainable and economically viable transport networks that promote prosperity

Many of the control measures being applied by cities and transport agencies today are based on World Health Organization and Center for Disease Control recommendations and include measures such as sanitization, personal protective equipment and social distancing. This paper focuses on how the latest transportation technologies can also support cities in managing the viral spread while also helping make our networks and services safer, more efficient and more resilient in the long term.

Many of the solutions discussed in this white paper are currently deployed or in development with clients around the world who are our partners and co-creators. We thank them for their inspiration and dedication to excellence during this challenging time.

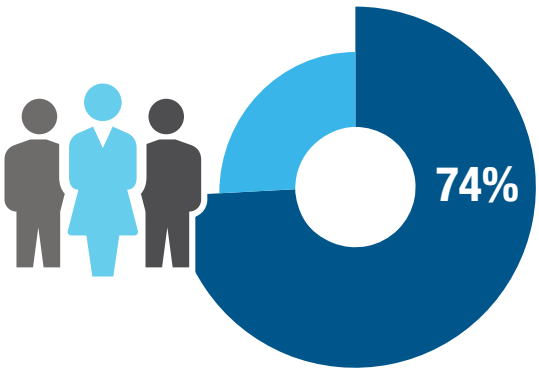
REMOVING TOUCHPOINTS

In a world where viruses can potentially live on surfaces for days, it is imperative that we limit touchpoints in our transportation network. In most public transport systems around the globe, travelers interact with numerous touchpoints in the system, including ticket vending machines, turnstile gates, bus stop buttons, seats, and fare boxes. With each touchpoint, there are additional cleaning protocols and solutions required – which all come at a cost.

Removing touchpoints where possible within our public transportation system is critical. Protecting travelers and minimizing the opportunities for viral spread will be key in building trust back into the system.

Consumer Demand for Contactless Post-COVID-19 has Skyrocketed[1]

46% of global consumers *have swapped out their top-of-wallet card for a card that provides contactless functionality.*



74% of consumers *said they will continue using contactless post-pandemic.*

[1] https://newsroom.mastercard.com/asia-pacific/press-releases/mastercard-study-shows-consumers-moving-to-contactless-payments-for-everyday-purchases-as-they-seek-cleaner--free-options/

TOUCHPASS IS AN ACCOUNT-BASED FARE COLLECTION SYSTEM THAT CAN BE DEPLOYED IN AS LITTLE AS 3 MONTHS

Going Contactless

Contactless, account-based fare collection is one of the primary tools agencies can deploy to support the removal of cash and minimize touchpoints in a transportation fare payment environment. With account-based fare collection, a token in the form of a displayed or printed QR code, smart card, student ID, virtual card, or contactless bank card, is used as a unique identifier for a centrally managed transport account. Once authenticated and linked with an account in the back office, fares are paid using funds or credits such as incentives for the journey. This provides extensive options to reduce or remove onboard cash collection and enables the adoption of open payments.

Retail networks and reseller programs are a modern solution for cash preferred or dependent customers, which enable an individual to purchase fare products and add value to their account at stores and community partners in their city. Using widely adopted gift card reload networks and existing payment systems, merchants can accept cash and electronic payments from passengers to add value to a transit account.

Electronic fare collection allows cities like Sydney to place validators at both front and rear doors of vehicles. Not only does this dramatically reduce dwell times, it has allowed agencies to quickly switch to rear-door boarding to better protect their bus operators.

Cubic Solution

Fare collection is at the foundation of Cubic's long history in transportation and is the dynamic revenue management platform that drives many of the world's complex fare collection and processing systems for transportation. We deliver account based systems in large cities such as London, Sydney and New York - and mid-market cities with Touchpass, an account-based fare collection system that can be deployed in as little as three months. Our solutions greatly reduce the use of cash and fare media such as tokens, paper passes or transfer slips that must be handled by agency personnel.

Open Payments

Open payment systems have gained popularity over the years and are now driving card issuers to distribute contactless credit cards in regions that have been slow to adopt, such as the United States. Transport for London (TfL)'s open fare payment system was deployed in 2012, today 60% of all trips taken on a TfL network are now paid with a contactless credit card or mobile wallet (i.e. Apple Pay)[2] . New York City, London and Sydney reflect large urban systems, yet these same contactless benefits are experienced in smaller cities like Dijon, France.

The technology adoption in more suburban and rural areas is made possible because of recent investments in cloud-based solutions that are easier to scale. The advent of "as-a-service" business models and the commodification of commercial off-the-shelf hardware makes the expansion of open payments an attractive and affordable option for agencies of any size. Additional components of an account-based environment include web based top ups and mobile ticketing. As agencies look for ways to steer travelers away from touchpoints, such as ticket vending machines, open payments become that much more attractive.

[2] https://www.railway-technology.com/features/oyster-card-future/

Cubic Solution

While many large fare collection systems utilize smart cards for payments, open payments with contactless credit cards have quickly become the new standard. Many of the world's most complex fare collection systems are powered by Cubic's account-based Urban Mobility Back Office, which not only supports open payments, it enables seamless multi-modal journeys that integrate payments and information to enhance the traveler experience.

Updating Touchpoints

In transport systems where cities have heavy or light rail options, gates provide a secure method of ensuring payment and preventing overcrowding in stations that are controlled by attendants. Some turnstiles utilized in cities such as New York City, require a person's hand or body to physically allow them to enter the station once payment is made. Installing gates that require minimal contact or integrating technologies like Bluetooth Low Energy and biometric integration allow for seamless, no touch passenger ticket detection[3].

Integrating Digital Assistants into transportation assets is another innovative way for agencies to limit the interaction of travelers with their staff and Ticket Vending Machines. Virtual ticket agents help travelers with planning journeys, processing payments and issuing tickets all in a touch-free, socially distanced environment.

Cubic Solution

Cubic Virtual Ticket Agent (VTA) Module offers touch-free interaction with ticket vending machines. For a full public health solution, the VTA Module can be combined with sanitizing procedures and technology for other surfaces (PIN Entry Device, and the dispensing cup), as well as policy changes that encourage cashless payments. The VTA Module allows a remote ticket agent to provide complete customer service to a traveler at a station, including selling fare cards and tickets, answering questions, and solving problems. The VTA can be part of standalone equipment, fit into a customer service kiosk or built into an existing ticket window in a station to provide a 24/7 customer service option.

[3] Kayhani, N. and Reymann, S. (2018), "Scalable Biometric Travel Token Without Barriers to Access", International Journal of Transport Development and Integration, Vol. 2, No. 2

Leveraging Mobile Technology

Over the last few years, advancements in mobile technology have played a notable role in the evolution of fare payment systems. The digitization of tickets via mobile have moved beyond an aspirational endeavor and is now the preferred method of payment for travelers on public transport. Agencies that have been advancing their fare collection systems to include mobile payments to reduce costs and simplify ticket distribution and delivery for years – now have an additional reason to embrace mobile to help limit touchpoints.

Similarly, wireless positioning technologies such as Radio-Frequency Identification (RFID), Bluetooth Low Energy (BLE), and Ultra-wideband (UWB) enabled smartphones are becoming tickets, allowing travelers to quickly board buses by removing physical touchpoints for access. Frictionless or hands-free access offers travelers greater freedom to board buses and pass through stations easily and quickly without queuing. An app on a smartphone identifies the traveler to the bus or gate as they approach, which then automatically generates a 'tap' based on their location to open a gate or to board onto a bus. For the agency, benefits include faster throughput, limited interaction between staff and travelers, less cleaning and an overall simplification of operations.

Cubic Solution

Cubic's Hands-Free Ticketing enables passengers to board buses, trams and trains without tapping payment cards or smartphones. The need for barcode scanning and NFC tapping is eliminated, offering convenience for the traveler, and for the transportation operator, fast and efficient vehicle boarding and station entry. A range of payment, communication and location identification technologies enables the traveler experience to be tailored for differing needs.

RFID and BLE beacon technology support fully hands-free travel, referred to BiBo (Be-in, Be-out). RFID tags can be worn or attached and offer an ideal solution for travelers with limited mobility and wheelchair users. BLE beacons provide App-based access to any traveler with a BLE-enabled smartphone, and can also be deployed to support semi-automated CiBO (Check-in, Be-out) mode, where the traveler selects their preferred bus, tram or train through the App.

Managing Gates Virtually

In order to provide additional safety measures for station staff, Transport operators can leverage Virtual Station Control Units to maintain gate line safety and control from any location within the station. IP addressable cameras provide live embedded video footage to a tablet, allowing staff to view and manage gates from a safe distance. When staff can control the direction of the gates remotely, it gives them the advantage of being reactive to the station environment to prevent crowding. An example of this would be if a station had two exit gates and six entry gates on a gate line and a few busy trains leave at once, staff could quickly change the entry gates to exit gates to prevent overcrowding.

Cubic Solution

The Cubic Virtual Station Control Unit (vSCU) is a tablet operated, secure remote control for station staff to monitor and control station gate lines from any location within a station. The vSCU reduces common surfaces for station staff and allows for remote intervention of gates to assist the public while promoting social distancing from the public.

Innovation Case Study

City: Leeds, UK

Agency: Northern Trains

Solution: Cubic Virtual Station Control Unit Pilot

Timeline to Deliver: 6 weeks

Like many transport operators, Northern Rail is facing unprecedented challenges in keeping their network operational to ensure access to services. One of the biggest challenges faced at stations is the proximity between staff at gate lines and travelers. When a traveler's ticket doesn't let them through the gate, station staff are essential to maintain revenue protection by validating the ticket and allowing the traveler through the gate by touching their staff pass onto the gate validator.

Cubic worked collaboratively with Northern Rail to create a solution that could be deployed quickly and effectively to ensure the operators at the gate line could remain safe. The solution is a three-month pilot of Cubic's Virtual Station Control Unit which enables staff to continue to operate the gate lines at Leeds station from a tablet device whilst maintaining social distancing and reducing the risk of Covid-19 infections.

MODIFYING BEHAVIOR

Understanding the reasoning behind why people make the transportation choices they make is imperative to the creation of effective transportation networks. Pre-pandemic, perception of safety may have had some influence on traveler behavior, but was significantly less impactful than convenience, cost, distance, time or flexibility. In the current environment, safety holds significant weight for those that have transportation options, as is reflected in the slow return to public transportation.

Instilling trust in transportation systems is now at the forefront of most agency agendas. Although building trust is in no way a simple formula, there are ways to leverage technology to support other important health-focused initiatives. Maximizing the capability for cities and agencies to communicate directly and in real-time with travelers on their mobile devices will be paramount, and is becoming not only a preference, but an expectation for travelers.

Communicating to Travelers

Effective and real-time passenger communication plays a vital role in agencies delivering more responsive and safer transport options to their customers. As agencies modify schedules and adapt more flexible route configurations, alterations will need to be communicated to travelers – ideally in advance or in real-time. Pushing updates to mobile applications and digital signage will be the new standard for communicating to customers in order to meet the unique demands of today.

Adapting fleets to new social distancing policies is proving to be a major challenge for most transport systems. While increasing frequency on major routes is recommended, travelers need to be informed of occupancy status so they can decide to change travel plans based on the number of travelers in the vehicle. This is where a proven and accurate Real-Time Passenger Information (RTPI) system can become a cornerstone for instilling trust back into the system. By leveraging enhanced data analytics models and streamlining passenger counter information, the data can then be communicated to travelers through various mobile channels, including trip planners, map applications, or the agency's RTPI mobile application.

Agencies and operators can also benefit from utilizing passenger information systems for delivering key safety messages and announcements through mobile applications and on electronic messaging displays in terminals and at bus stops. Reinforcing health statements, such as "wash your hands" or "mind your distance" can keep safety top-of-mind for staff and travelers alike.

Cubic Solution

Cubic NextBus is a cloud-based real-time information and transit intelligence platform that delivers rich and contextual information through a suite of open API's and to multiple communications channels, including mobile, energy-conscious and high-resolution displays at stations, bus stops and vehicles. The solution empowers transport operators with an intuitive web-based portal that allows for customer push-messaging to channels and facilitates planning, scheduling and operations with dynamic maps, real-time and historical data, and a dedicated driver application.

Customer Case Study[4]

City: San Francisco, CA
Agency: SFMTA
Solution: Cubic NextBus, Headway Management
Timeline to Deliver: 48 hours

SFMTA was in a difficult position reallocating Muni Transit service to focus limited resources to 17 lines serving a majority of their customers. As the provider of their real-time passenger information system, NextMuni, Cubic had to respond quickly as the agency shifted from time-based schedules to interval-based service, called headway management. In the new system, service would be dispatched according to intervals of time which required a change to the prediction tools we provide to alert customers of when a bus should be expected. This shift solved a different issue of "ghost bus" which occurs when a certain bus is scheduled and therefore predicted to arrive at a certain time, yet never shows up because in reality the bus was never put into service. In headway management, only buses that have been put into service become tracked and predictions are based on the interval.

For Muni customers, this means that arrival time predictions are now only projected once the vehicle has left the terminal. While there are tradeoffs to this arrangement, the agency received a fast solution to a specific problem that arose due to Covid-19. Previously the staff resorted to manually performing 300 individual reassignments per day. This was unsustainable and not an efficient use of staff resources.

[4] https://www.sfmta.com/blog/new-way-generating-prediction-times-0

Journey Planning and Contact Tracing

In the current environment, agencies are reducing onboard capacity to adhere to physical distancing guidelines and implementing policies to protect employees and travelers alike. Around the world, governments are releasing new apps to track Covid-19. We would be remiss if we didn't discuss the potential for transportation to leverage these contact tracing apps if they are deployed more broadly, although we understand that the subject itself is riddled with political, moral and real-life application issues. To regain the trust of the traveling public people must be able to travel safely and conveniently without fear of infection.

Singapore's TraceTogether, the world's first contact tracing app, lets citizens know when it is a good time to go to the supermarket as well as alerting them when they've been in proximity to someone who has tested positive. As of May 14, 2020, Australia's COVIDSafe app has already been downloaded by approximately 25% of the adult population[5], the UK's National Health Service (NHS) is creating their own app and the rest of the world seems to be accepting Apple-Google model, including Singapore who is now building their own app on top of the private platform[6].

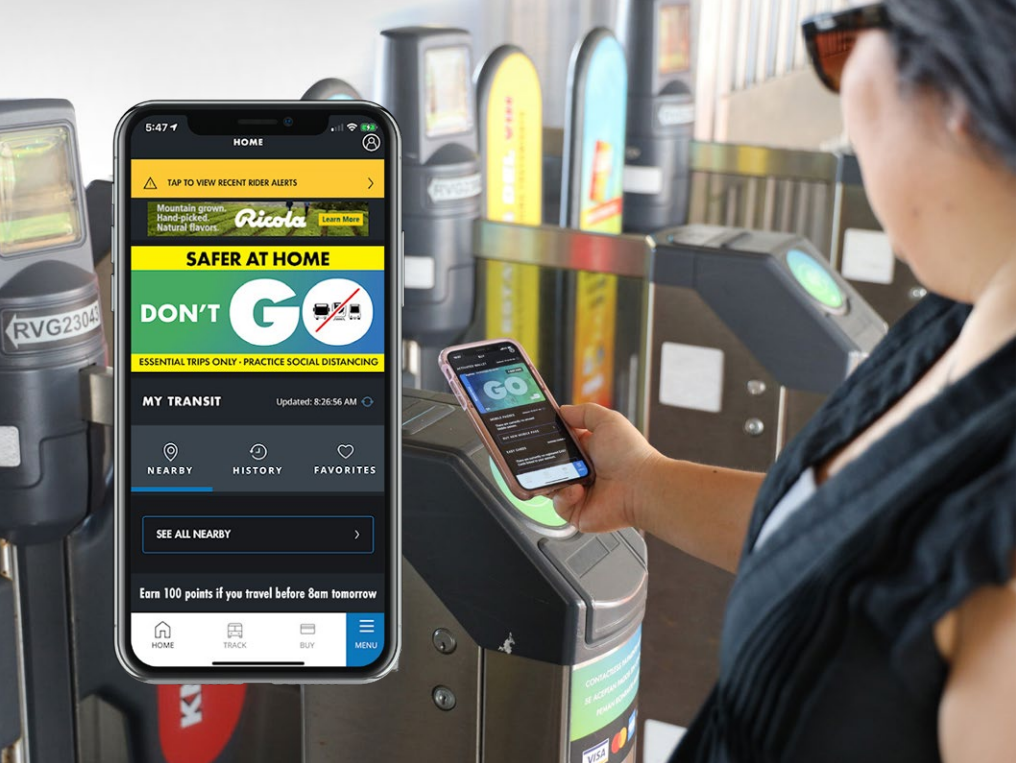
In large cities, this has added a new variable to journey planning. Travelers need to feel confident that they can maintain a healthy social distance when using transport. By utilizing journey planning applications with the appropriate data analytics platform, agencies could add a social distancing feature in the application that would provide agencies with a communications tool to help enforce policy and maintain safety for their travelers.

[5] https://theconversation.com/in-some-places-40-of-us-may-have-downloaded-covidsafe-heres-why-the-government-should-share-what-it-knows-138323

[6] https://www.economist.com/britain/2020/05/09/why-britain-is-ignoring-the-google-apple-protocol-for-its-tracing-app

Cubic Solution

Cubic Mobile for Travelers incorporates clear and direct journey planning capabilities alongside real-time transit tracking, ticketing and account management features. By integrating the features into a single app, it becomes a trusted focal point for all information related to that customer's travels, which is so important in these uncertain times. The Traveler app can integrate with several journey planning services, as selected by the transit agency, but to maximize the benefits to the customer Cubic has partnered with Moovit to better integrate transit offerings between the two businesses. Moovit has established itself as the clear market leader in journey planning through the highest coverage and granularity of services and quality of multi-modal capability.



Incentivizing Behavior

In order to effectively modify traveler behavior, agencies may want to implement an incentives program to influence travelers to take a different bus or mode of transport based on the occupancy of vehicles. For example, if the 8:00am bus is near capacity, incentives can encourage select travelers to shift their time of travel to the 7:45am bus. Promoting a policy that encourages safety, such as social distancing, requires participation.

Today, there are applications that can be easily integrated into any transportation network to incentivize travelers to change their behavior. Additionally, the same incentive program could also be leveraged as a loyalty program to reward travelers for other desired behavior such as the purchase of a monthly pass, or in the event of a delayed vehicle. The loyalty points awarded can even be fully subsidized and cost the agency nothing through advertising and brand sponsorships.

Cubic Solution

Cubic Interactive is a loyalty, incentive and advertising solution that can be leveraged to influence traveler behavior, while generating revenue for agencies. Public transit agencies can build custom loyalty programs that reside within their existing mobile transit apps, or future app innovations, to help shift peak patterns, ease the pressure on the network and promote safe and healthy mobility choices. The loyalty platform can become a revenue generator whereby advertisers and brands not only pay for the cost of loyalty points, but incremental revenue will help transit agencies augment their monthly income.

Innovation Case Study

City: Miami, FL

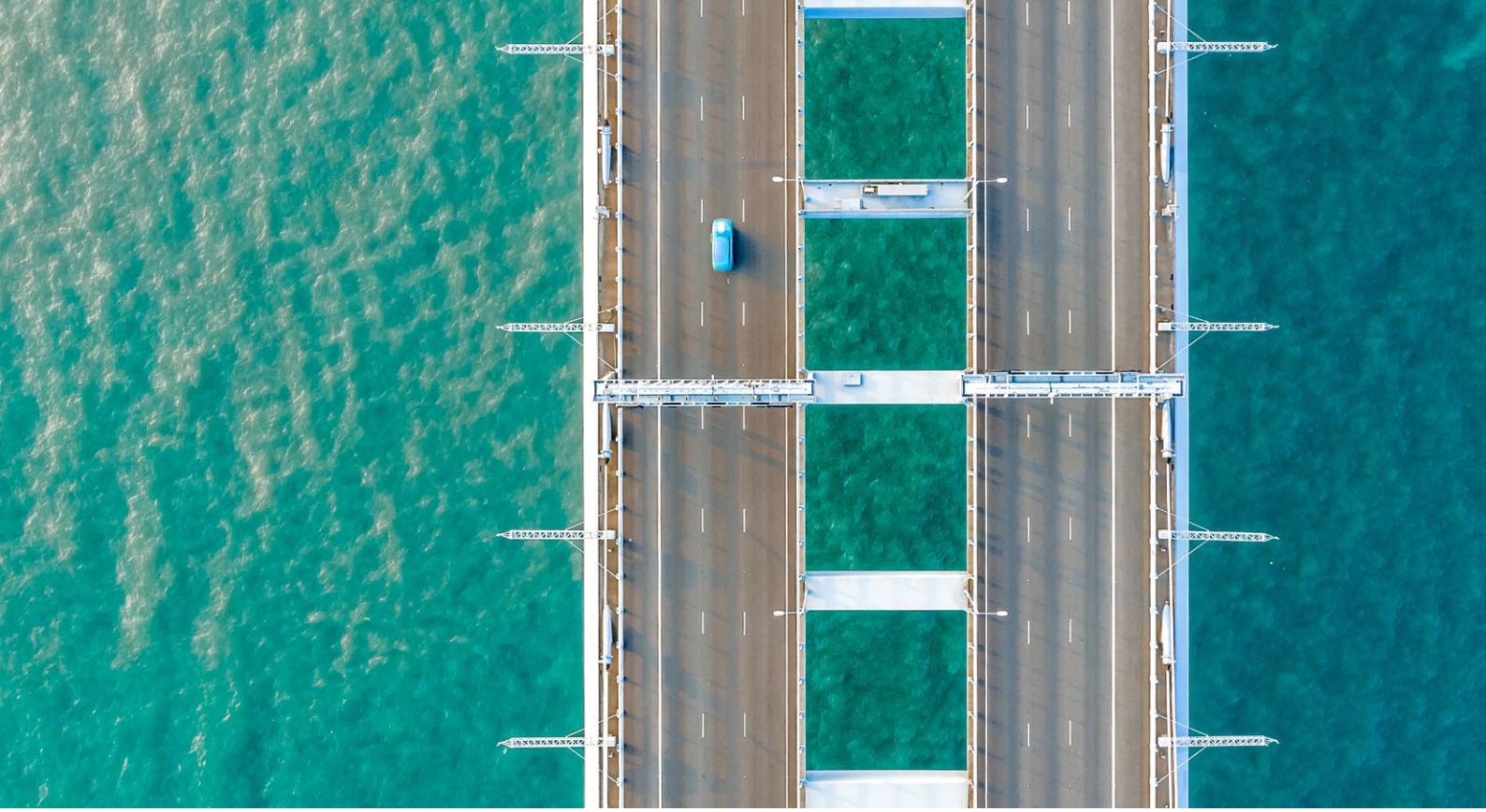
Agency: Miami DTPW

Solution: Cubic Interactive / Cubic DMAP

Timeline to Deliver: 60 days

Like all transit agencies navigating a new world of social distancing, Miami's Department of Transportation and Public Works (DTPW) is facing unprecedented challenges in making mass transit work safely in a way that builds trust in the system. As the agency moves to recommence fare collection in the Fall, our teams are working to ensure travel can be done safely. Peak demand periods during the evening rush place significant stress on DTPW's capacity, especially given new constraints to slow the spread.

Cubic Interactive is live in Miami and later this year additional functionality will enable new insights to incentivize traveler behavior. Cubic's new solution combining analytics insights from Cubic's Data Management and Analytics Platform (DMAP) and distributed through Cubic Interactive, identifies people traveling at peak periods and proactively reaches out to them to offer them incentives such as ticket discounts if they switch to travel at off peak periods. This is all managed virtually through the mobile app and emails, ensuring a broad audience and minimizing costs of delivery.



REDUCING CONGESTION

Congestion on roadways is not a new issue and won't be going away without continued, concerted efforts to mitigate. In 2019, the cost of congestion in America alone was $88 billion, and given the economic challenges facing cities, we cannot afford to see that number increase[7].

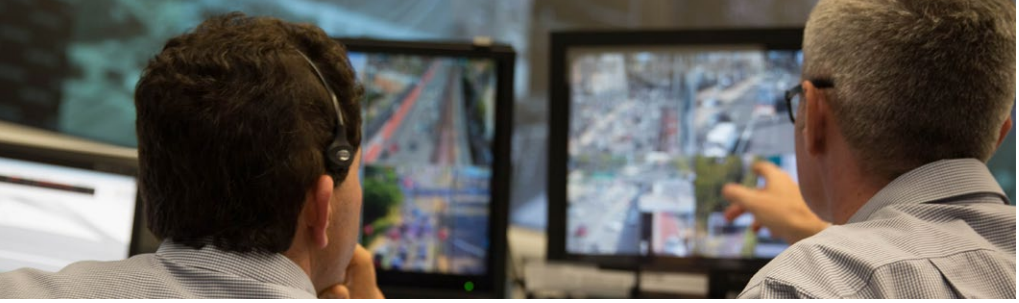
The recent pause in traffic has shed light on multiple approaches to manage gridlock. The benefits of eliminating pollution are visible due to minimized traffic contributing to clear skies for the first time in decades. There is renewed interest in the adoption of electric vehicles, which are a key component of meeting critical environmental goals. Cities are identifying new, critical sources of revenue that shift the costs of maintaining infrastructure to more sustainable means.

Managing congestion effectively is the only way to ensure cities can achieve economic stability while maintaining a safe environment for all users. This can only be achieved by ensuring that travelers pay their fair share of the cost of transportation infrastructure, and in return receive an efficient and safe end-to-end journey.

> "I SAY IN ALL FIRMNESS THAT IT IS OUT OF THE QUESTION THAT WE ALLOW OURSELVES TO BE INVADED BY CARS AND BY POLLUTION…"
>
> **- Anne Hidalgo,**
> *Mayor, Paris, France[8]*

[7] https://www.forbes.com/sites/niallmccarthy/2020/03/10/traffic-congestion-costs-us-cities-billions-of-dollars-every-year-infographic/#3f0011884ff8

[8] https://www.citylab.com/transportation/2020/04/paris-cars-air-pollution-health-public-transit-bike-lanes/610861/



Creating Situational Awareness

Technology is enabling transportation leaders to transform our cities into places where people can plan their multi-modal journeys and move around cities safely and efficiently, according to their personal needs and travel preferences without friction or stress. It also means that freight is part of the mobility equation to keep goods and services coordinated along with the movement of people. Lack of coordinating that activity in the region can bring all other business activity to a halt for hours at a time.

While the implementation of new technologies and mobile applications are essential to solving road network challenges, policy shapes how we use those technologies. Congestion pricing and management business rules and algorithms are used to optimize the network and manage traveler's journeys. In turn, travelers can be financially motivated to shift from dense city centers and high-traffic roadways, to alternative modes of transportation or less concentrated routes.

In this scenario all modes of transportation act as one holistic ecosystem encouraging collaboration to help reduce strain when one mode reaches capacity. Continuing to operate transportation in modal silos will amplify the problems of the past. Citizens expect and deserve the digital transformation that has occurred in other areas of their lives, such as retail and entertainment. To deliver on this vision, city managers require high quality, real-time situational awareness across all modes of transportation and the tools to react quickly and balance the network during times of disruption.

Cubic Solution

Cubic Transportation Management Platform is a cloud-based solution that acts as central data repository for all transport network data, allowing all stakeholders in a city to have a common operating picture of the true state of the network and the predicted demand in the very near future. The platform is interoperable with all the necessary traffic control and CCTV solutions available in the city to give real insights needed at the street level to allow operators to make informed decisions to keep the city moving. Integration with the public transport network allows more informed decisions to optimize traffic flows to assist in keeping the public transport network flowing on schedule.

Customer Case Study

City: Sydney, NSW Australia

Agency: Transport for New South Wales

Solution: Cubic Transportation Management Platform

Timeline to Deliver: Going live in 2020

The Intelligent Congestion Management Program for Transport for New South Wales in Australia will transform Sydney's multimodal Transport Management Centre into a truly predictive, data driven, multimodal operation that optimizes the entire transport network and helps the city manage end-to-end journeys rather than disparate modes.

Cubic's Transport Management Platform (TMP) running on Microsoft's Azure cloud platform, sits at the heart of the ICMP solution. By leveraging the power of the Azure cloud, the TMP ingests numerous data sources and delivers actionable insights to those who need them most, improving the city's overall situational awareness and providing a common operating picture across the state's entire transit network. The system enhances the monitoring and management of the road network across the state, coordinates the public transport network across all modes, improves the management of clearways, planning of major events and incident clearance times.

Creating Safer Roads

Recently the United Kingdom has seen unprecedented levels of walking and cycling, which creates challenges for urban centers designed to move citizens on public transport and in motorized vehicles. As such, the UK government has allocated two billion GBP to create protected bike lanes, wider sidewalks and safer intersections to provide safe alternatives to vehicle transport.

Optimizing corridors means keeping people safe and maximizing freedom of movement for all users. We need to encourage the positive moves to walking and cycling by keeping people safe. Dedicated cycleways are the gold standard but may not be feasible or affordable in many cities which is why a variety of solutions are required for mixed use of roadways demonstrated by pop up bike lanes.

The key to managing city transportation is dealing with the congestion challenge on our roads by optimizing the intersections and key corridors that do the heavy lifting. Intersection technologies must give priority to users and vehicle types that need it (i.e. first responders and high occupancy public transport) and leverage the connected vehicle technology that is ever growing in the marketplace.

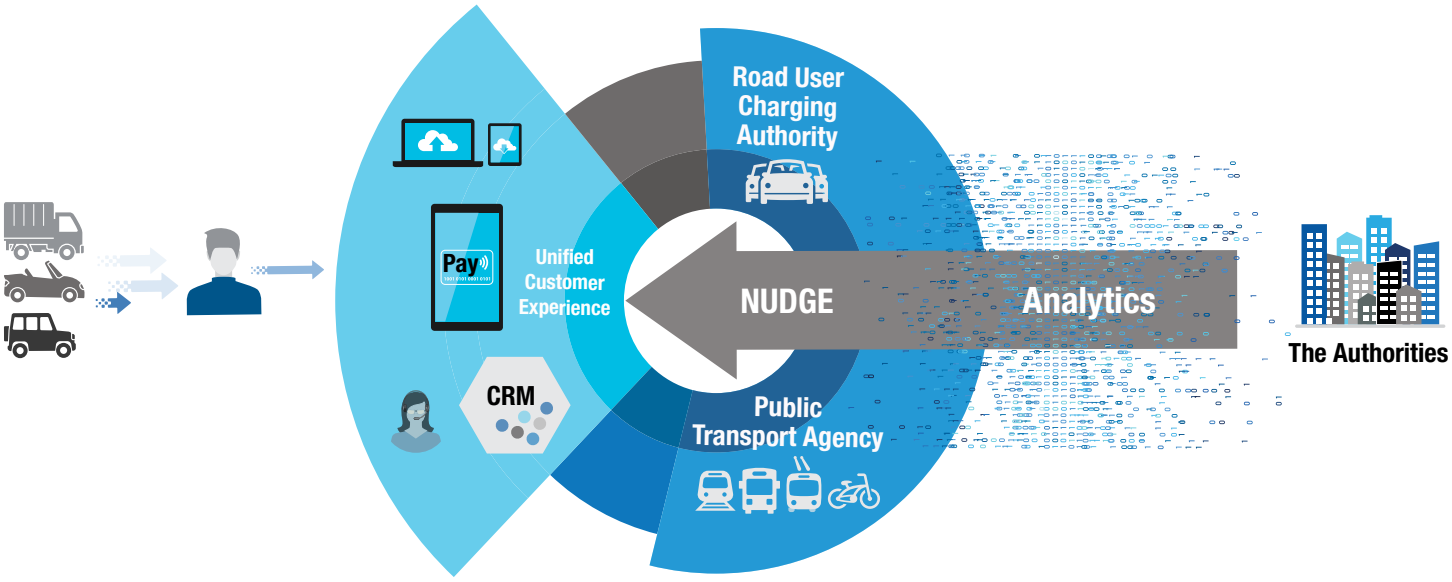
Improving data is fundamental to optimization of intersections and corridors. Many market segments have improved service through collecting and analyzing data and transportation must do the same.

Cubic Solution

Trafficware and GRIDSMART allow the effective and safe control of intersections on the road network and allow advanced optimization of traffic flows to allow greener and more efficient operations. The data collected at the intersections can be used in the Cubic Transportation Management Platform for holistic optimization of the city or can be used locally at the intersection to assess traffic flows and congestion and dynamically change sequencing. The data can also be sent directly to connected vehicles to allow intersection data and alerts to be provided to the driver to assist in safe and efficient driving. Additional data collected by the sensors can also be used to monitor pedestrian and cyclist activity to ensure a fully optimized and safer road operation.

Automated Pedestrian Crossings

To further protect pedestrians and avoid risk of viral transmission when pressing the crossing button at an intersection, several authorities have chosen to automatically run the pedestrian phases irrespective of whether pedestrians are present. Unfortunately, this can lead to a loss of valuable green light time for traffic, causing additional travel time for drivers. To address the throughput issues presented, intelligent traffic systems are being utilized to only run the pedestrian phase when pedestrians are in proximity of the intersection which can be extremely cost effective if a single camera is used in any given intersection for a variety of needs, which is what makes GRIDSMART's camera so unique.



Road User Charging

Maximizing safety and efficiency on roadways generally involves a matrix of "levers" pulled by government agencies to achieve results that are adjusted as things change on the network. In addition to leveraging traffic technologies to adapt to changing circumstances, additional policy levers must motivate drivers to change behavior.

Implementing or updating a road user charging program gives authorities another tool to encourage elasticity of their managed roadways. The backbone technology supporting road user charging has become increasingly sophisticated and more importantly, can be integrated with existing systems to prevent redundancy. For example, an account-based back office enables the use of mobile technology with geofencing capabilities and a connected vehicle in lieu of transponders.

When a common back office is leveraged there are new opportunities for delivering insights from multiple data sources. Real-time information to drivers can nudge them to take another route or even another mode of transportation by providing incentives. Communicating actionable information that considers data from other modes of transportation is useful not only during a pandemic but could be leveraged during natural disasters and other emergency situations.

It is no coincidence that many cities are now considering the implementation of road user charging to support underfunded infrastructure projects. Beyond the impacts of the pandemic, current funding mechanisms such as the gas tax are becoming unsustainable and regions are seeking new ways to pay for infrastructure. Whilst promoting the uptake of electric vehicles to help deal with increasing environmental issues, road user charging can provide cities a way to tax fuel efficient vehicles, charge equitably for specific circumstances and recover expenses from all who use the roadway.

Cubic Solution

Cubic's Road User Charging solution is a robust, integrated and customer-focused congestion management platform that offers efficient, accurate and low-cost collection of revenue in the context of user journeys. It features multi-modal integration, complex pricing models, a single user account for managing all transportation needs. It provides cities with the necessary back office to keep up with today's infrastructure demands, while helping them scale for the future.

Congestion Pricing

As researchers, academics and planners assess the impact of Covid-19 on our streets and transportation networks, we are getting a glimpse into what our busiest city centers look like without traffic. Cities are assessing what is truly essential so they can reprioritize open space and mobility options. Congestion pricing will be an important tool for cities to consider when prioritizing mobility options.

In New York City, the Metropolitan Transportation Authority (MTA) is set to be the first U.S. city to implement congestion pricing in 2021. As the MTA reels from the financial impacts of the pandemic, the additional revenue generated will be a critical lynchpin to updating North America's busiest transport system. Other cities that have already implemented congestion pricing, including London, Singapore, Stockholm and Beijing, have achieved many of their desired impacts within months of implementation. In London, traffic was reduced by 30% in the first year[9] and in Stockholm, estimates show that carbon emissions have been reduced by 2-3% since the introduction of congestion charges in 2006[10].

Cubic's Congestion Pricing Solution Delivers Benefits for Cities and Travelers

- Increased revenue and reduced leakage
- A world-class integrated travel experience
- Enhanced customer engagement
- Centralized data for insight into customers' end-to-end journeys

These are achieved through:

- A focus on customer experience and an ability to influence behaviors
- An open architecture
- A next-generation complex and flexible pricing system
- A cost-effective, low risk approach to achieving scale quickly

[9] https://climate-xchange.org/2019/05/29/investigating-the-impact-of-congestion-pricing-around-the-world/

[10] https://www.itf-oecd.org/sites/default/files/docs/swedish-congestion-charges.pdf

ENHANCING MOBILITY

The pandemic has brought to light the fact that transportation is lacking the ability to execute a strategic, multi-modal and multi-agency response to emergency situations. As more people move to urban areas and new transport modes increase the complexity of our journeys, this issue will only worsen unless cities address the growing need for intelligent, real-time, user-centric and connected transportation management.

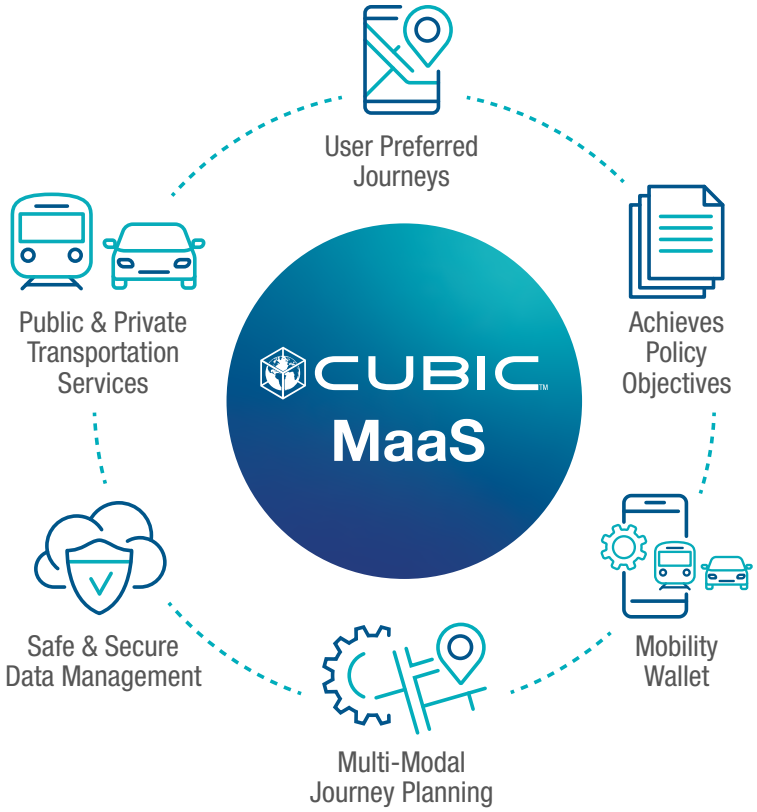
Irrespective of the organizational hierarchy of transportation operators across a city, different modes of travel will always be closely linked and a strategic approach to managing these operations is essential to improving how people travel around a city and how effectively a city can respond when an incident occurs.

Although there are undoubtedly barriers to such an effort, a foundation for collaboration could be established by mobilizing a versatile technology platform that allows for integration of back office software and managed services. By implementing a program that builds toward a more coordinated, on-demand mobility system, agencies would be able to better respond to situations in real-time and enhance safety across the network. A simple example would be if there were overcrowding on a bus or train the ability to communicate and incentivize a move from transport to another mode of transportation, such as bikeshare. This could be done without the need to pay a second fare or subscribe to another fare method since there would be integration on the backend.

Benefits for an integrated system go beyond fare payment. Cities and transport agencies need not scrap existing infrastructure and instead collaborate to build on current investments. Business processes can be automated to reduce workloads and accounting can be streamlined. For travelers, an integrated system provides a seamless experience throughout their journey and when needed, with customer service.

> "PUBLIC TRANSPORTATION MUST GRASP THE OPPORTUNITY TO EMERGE FROM THIS CRISIS STRONGER, MORE RESILIENT, AND MORE CREATIVE TO SERVE THE MOBILITY NEEDS OF OUR FUTURE COMMUNITIES."
>
> **- Therese W. McMillan,**
> *Executive Director, Metropolitan Transportation Commission and Association of Bay Area Governments*[11]

[11] https://www.apta.com/news-publications/press-releases/releases/apta-industry-leaders-discuss-covid-19-challenges-and-need-for-emergency-response-and-recovery-funding/



Mobility as a Service

In cities where stay at home orders have ended, public transport ridership is significantly down. Public perception is that a single occupancy vehicle is safer to travel alone or with friends and family, and government messaging of 'no essential travel' and 'social distancing' is going to have a lingering impact on transport use. Public transport will have challenges to overcome on the perception of public safety and shared ridership, but Mobility as a Service (MaaS) can offer a beneficial alternative and become the flexible operating model for mobility.

While access to public transport has been limited and non-essential ridership discouraged, travelers have engaged with viable multi-modal alternatives out of necessity. Bikeshare companies are reporting higher usage rates, Transportation Network Companies (i.e. the Ubers and Lyfts of the world) are providing late night and demand responsive services to agencies. Cities that had once banned the use of electric scooters on public streets are now working on policies that will recognize them as a practical mode of transport.

Cubic Solution

Mobility as a Service has the unique potential to establish an open ecosystem controlled by a public sector Managing Authority to ensure public policy goals are achieved, while allowing Mobility Service Providers and MaaS Operators access to deliver their commercial solutions and services.

What is Mobility as a Service?

MaaS is the combination of public and private transportation services in a given regional environment that provides holistic, optimal, and people centered travel options to enable end to end journeys paid for by the user as a single charge and which aims to achieve key public policy objectives.

ANALYTICS & INSIGHTS

At the center of all technology solutions that enable flexibility and seek to glean insights to refine and support policy decisions – lies data. Massive streams of data generated in feeds spanning transportation, emergency services, law enforcement and all aspects of the citizen experience combine to tell a compelling story of the inner workings of a city. The challenge is how to interpret the data and turn it into meaningful action while ensuring individual privacy.

During the crisis agencies are operating on tight timescales and must visualize dynamically changing realities to forecast demand. By engaging a data analytics platform, there is expanded oversight into how the systems are used. This can be done by leveraging existing infrastructure such as passenger counters on buses, to traffic management systems on road networks, to provide an overall picture of the ecosystem. The most beneficial use of data is when multiple entities come together in a way that enhances insights for all involved.

Cubic Solution

Cubic's Data Management and Analytics Platform (DMAP) is a transportation-orientated, secure, multi-tenant cloud-based data management and analytics solution, that supports the analysis and visualization of data to augment operations. We equip transportation agencies with readily available tools that answer the toughest industry questions and provide real-time, actionable insight to drive operational excellence, improve service quality, and reduce costs.

"THE GOAL IS TO TURN DATA INTO INFORMATION, AND INFORMATION INTO INSIGHT."

- Carly Fiorina

Former Executive, President, and Chair of Hewlett-Packard Co

CONCLUSION

Covid-19 has illuminated weak points in our transportation systems and brought new challenges to cities and citizen engagement. It has also provided the industry with a unique time for reflection to learn, adapt and grow to be better positioned to address challenges in the future. We will undoubtedly need to be more flexible, better connected, and willing to collaborate in order to provide the level of safety required for those that engage with and support our transportation networks in the future. If anything, the pandemic has inspired us to do better, move faster and provides the industry a compelling reason to leverage investments in technology to create real change.

Technology will no doubt play a pivotal role in providing a safe environment for staff and travelers in tandem with enhanced health protocols which ultimately should be the priority. To that end, no discussion on technology is complete without addressing those in the digital divide, the expanding chasm of those with access and those without. Any new technology must be implemented in a way that accommodates the needs of all.

These challenges offer a compelling case for new approaches in managing an integrated multi-modal system. Travelers have increased user expectations on travel tools, communication and safe and easy user experiences, including the shift toward mobility as a service. Familiar congestion challenges caused by new mobility providers and freight movement in cities create an obligation for data driven integrated congestion management approaches. Public transport remains the most effective way to move people at scale but requires increased flexibility, frequency, and addresses traveler comfort and safety. To remain competitive, the industry must entertain new business models and revenue streams to address shortfalls in traditional funding sources. Now is the time to meet the moment and tackle these challenges together.

We are honored to work alongside some of the most innovative cities and transport agencies from around the world. We will continue to use that status to benefit the entire industry and traveling public to create the beautiful, equitable, sustainable city of tomorrow that has been the goal of NextCity from the outset.

On the following page is a brief summary of a few of the Cubic solutions we've addressed for quick reference.

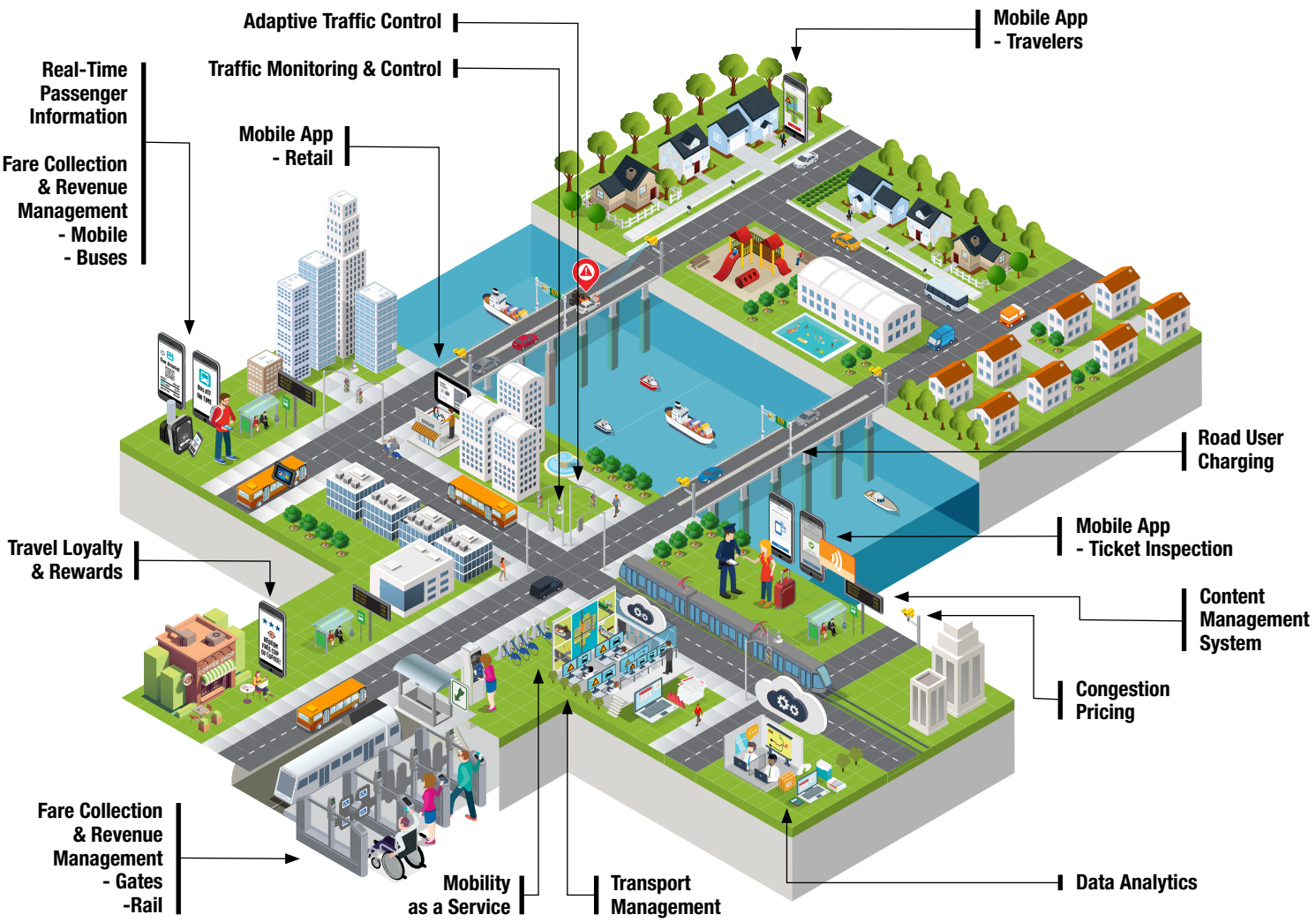
> "TRANSPORTATION MOBILITY AND ACCESS CAN MAKE THE DIFFERENCE BETWEEN POVERTY AND ECONOMIC STABILITY."
>
> **- Ariel Ward**
>
> *Planner, Engineer, San Francisco Municipal Transportation Agency*

CUBIC SOLUTIONS SUMMARY

MARKET NEEDS	SPECIFIC CUSTOMER NEEDS	CUBIC SOLUTIONS
Removing Touchpoints	Going Contactless	Cubic Touchpass
	Going Contactless & Open Payments	Cubic Fare Collection Cubic Urban Mobility Back Office
	Updating Hardware	Cubic Gateless Gateline Cubic Virtual Ticket Agent
	Leveraging Mobile Technology	Cubic Mobile for Travelers Cubic Hands Free Mobile Ticketing
	Managing Gates Virtually	Cubic Virtual Station Control Units
Modifying Behavior	Communicating to Travelers	Cubic NextBus
	Journey Planning	Cubic Mobile for Travelers
	Incentivizing Behavior	Cubic Interactive
Reducing Congestion	Creating Situational Awareness	Cubic Transportation Management Platform
	Creating Safer Roads	Cubic Trafficware Synchogreen Cubic Trafficware Commander Cubic Trafficware Tidal Wave Cubic GRIDSMART
	Automated Pedestrian Crossings	Cubic GRIDSMART
	Road User Charging	Cubic Road User Charging Cubic Urban Mobility Back Office
	Congestion Pricing	Cubic Road User Charging Cubic Urban Mobility Back Office
Enhancing Mobility	Enhancing Mobility	Cubic Urban Mobility Back Office
	Mobility as a Service	Cubic MaaS Marketplace
Analytics & Insights	Data Management & Analytics	Cubic Data Management & Analytics Plaform (DMAP)

Cubic stands ready to work together to deliver all these solutions as the need arises, and to work together with our industry colleagues to create partnerships that bring value to the citizen experience. We ask that each of you join us in this mission as we support each other's needs.

To get more information on any of our solutions or to get in touch with us, please contact us here.



CUBIC NEXTCITY

NextCity, Cubic's vision for city management and integrated traveler payment and information, centers on three core principles: the delivery of an integrated customer experience, one account, and integrated operations and analytics.

As the world's population moves to urban centers, the result is greater traffic congestion, frustrated travelers and lessened productivity. Intelligent and actionable information is the key to ensuring that everything is running as smoothly and efficiently as possible within the travel networks – and will empower travelers to make smarter, more informed decisions based on facts.

NextCity provides a roadmap for a coordinated framework – using legacy and emerging payment methods and information systems to integrate all travel information and payment, customer experience, operations and analytics in the region for all modes of transportation. The NextCity vision is built on a model for real-time data gathered across a transportation network through payments, sensors and other touchpoints, increasing travel efficiencies without losing individual authority flexibility. For travelers, NextCity offers a solution for personalized, actionable information sent directly to their mobile device, all supported by a single account to pay for their entire trip.

CUBIC™ | Transportation Systems

CUBIC – A LEADER IN INTELLIGENT TRAVEL SOLUTIONS

At Cubic, we believe our identity is intrinsically linked with our customers, and the people our customers serve. How they get from one place to the next – how that impacts their lives, their fellow travelers and their cities – and how it feels along the way.

That's why we're passionate about developing transportation solutions that improve the way we move throughout cities. Innovation is in our culture, and our history speaks for itself. In our 45-year history, we've delivered public transport fare collection systems to over 450 operators, including 20 regional back office systems, and traffic and transportation management systems for major cities and regions on four continents.

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