Response to City of San Jose RFI 2019-DOT-PPD-4

New Transit Options:

Airport-Diridon-Stevens Creek Transit Connection

Bombardier manufactures a variety of standalone transit systems, including the *INNOVIA* Monorail, the *INNOVIA* APM, and the *MOVIA* Light Metro. All these systems, or a combination of these systems, could be an excellent basis for the Airport - Diridon - Steven's Creek corridor project(s). Of the three technologies, the *INNOVIA* Monorail appears to best address the objectives of the proposed project in that it is less expensive to construct, can be constructed more rapidly, and operates in a grade-separated, high capacity system. Ultimately the choice of technology depends on a variety of factors, most notably the planned ridership per hour, which are not available at present. As such, Bombardier has submitted information on all three technologies, and looks forward to the opportunity to discuss the best fit solution with the City of San Jose at their convenience. Bombardier anticipates that this project could be delivered as a Design-Build-Operate Maintain Finance (DBFOM) Public Private Partnership (PPP).

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BOMBARDIER

New Transit Options: Airport-Diridon-Stevens Creek Transit Connection

***INNOVIA* 300 APM**

Executive Summary

With Automobile-based transportation reaching saturation in Silicon Valley, the City of San Jose is looking for sustainable transportation solutions which can be deployed quickly and cost effectively. In particular, the connections between San-Jose Diridon station and SJC airport, as well as from San-Jose Diridon station along Stevens Creek, have been identified as key transit corridors for connecting people to jobs, shopping, cultural events, and intermodal transportation.

Bombardier is the world's leading turnkey systems provider, with turnkey solutions available for Monorails, APMs, and light metros. We have the technology and solutions ready, and at our disposal, to address the needs of the City of San Jose. Our technology is best in class and offers the best total cost of ownership in the world today. All three of our turnkey technical solutions could be well suited for use on the Airport-Diridon-Stevens Creek Transit Corridor: The *INNOVIA* 300 Automated People Mover (APM), the *INNOVIA* 300 Monorail, and the *MOVIA* 300 Light Metro.

Of the three technologies, the *INNOVIA* Monorail appears to best address the objectives of the proposed project in that it is less expensive to construct, can be constructed more rapidly, and operates in a grade-separated, high capacity system.

Ultimately, the choice of technology depends a variety of factors, most notably the planned ridership per hour, which are not available at present. In the absence of this information, Bombardier has explored two scenarios: a monorail for the entire alignment, and a combined monorail/APM alignment. Bombardier looks forward to the opportunity to discuss the best fit solution with the City of San Jose at their convenience.

Turnkey transit projects can be procured and deployed in several different ways, ranging from conventional procurements to Public Private Partnerships (PPPs). The choice of procurement model depends on the intended outcome, the intention to expand the project or corridors, as well as the quantum and nature of available funding. If the airport corridor or Steven's Creeks are procured as discrete projects or as a single, they could be good candidates for PPP's.

INNOVIA 300 Monorail

Introduction

Bombardier Transport is excited to respond to the request for information from the City of San Jose. We value the opportunity to leverage our technology, our global know-how, and our leadership as North America's leading operator and maintainer of rail systems.

Bombardier has the technology required to address the needs of the City of San Jose:

- We have the world's leading Automatic People Mover (APM) technology, with the *INNOVIA* APM, currently serving 9 out of the 10 busiest airports in the United States, including San Francisco, Sacramento, Phoenix, New York, New Jersey, Houston, Altanta, Denver, Dallas, Fort Worth, and Seattle. Currently delivering the *INNOVIA* 300 APM at Los Angeles World Airport as a Public Private Partnership (PPP), scheduled for in-service 2023.
- We have the world's leading Monorail technology, with the *INNOVIA* 300 Monorail, part of the *INNOVIA* monorail family currently in service in Las Vegas, Sao Paulo Line 15, and King Abdullah Financial District (Saudia Arabia); more recently, Bomabrdier has won and is constructing projects in Wuhu (China), Cairo, and Bangkok Pink and Yellow lines, as well as other locations around the world.

Unlike other suppliers, Bombardier has had systems in operation for more than 30 years, and we have continued to invest in our technology. The 300 series represents the pinnacle of this investment, providing a vehicle which is at once aesthetically stunning, economical in terms of operation, and excellent in terms of reliability.

As North America's leading operator and maintainer of rail systems, we have the experience required to operate and maintain the proposed system for the Airport-Diridon -Stevens Creek corridor, whether the chosen technology is an APM or a Monorail;

we do so everyday across the United States and around the world, with industry leading safety and availability. We move more people every day in North America than any other private operator. Our reliability and availability figures speak for themselves, with most of our systems above 99%. This industry leading know-how and availability is the type of service offering that will make the Sand Jose-Diridon links a success.

We understand that the key questions to be answered as part of this RFI include:

- Are there new technologies, project delivery, or operating models that can provide grade-separated, high capacity, high-speed transit?
- Do these systems have lower construction, operations, and/or maintenance costs than traditional systems?
- Can these systems be deployed faster than traditional projects?
- Do these systems have viable financial outlooks?
- How will these systems be constructed and deliver service on the specificed corridors?

Our *INNOVIA* 300 APM, *INNOVIA* 300 Monorail, and *MOVIA* 300 Metro meet all these requirements and have been meeting these requirements in existing systems every day, around the world.

Our response to the RFI is structured as follows:

- An Introduction to Bombardier
- An overview of Bombardier's approach to technology selection for the Corridor(s)
- Detailed responses to questions
- Detailed design information with regards to our vehicles and systems
- Photos of our vehicles, systems, and solutions
- Reference project Information.

We look forward to the opportunity to work with the City of San Jose to provide the people of Silicon Valley with a world class, efficient, reliable, and ecological rapid transportation system.

For the avoidance of doubt, this Response to RFI is non-binding on the parties and for informational purposes only. Neither party shall be bound to anything contained herein, nor shall any liability to either party flow from this document.

Company Description

Bombardier Inc. is the world's leading manufacturer of both planes and trains. Looking far ahead while delivering today, Bombardier Inc. is evolving mobility worldwide by answering the call for more efficient, sustainable, and enjoyable transportation everywhere. Our vehicles, services and, most of all, our 69,500 employees are what make us a global leader in transportation. In the USA, Bombardier Inc. employs nearly 7000 employees across 17 states.

With 60 production and engineering sites in 27 countries, Bombardier Transportation, the rail division of Bombardier Inc., is a global leader in the rail industry. In the USA, Bombardier Transportation has 19 operations and maintenance sites, 4 manufacturing sites, and one engineering location. Bombardier Transportation opened our new manufacturing and vehicle overhaul plant located at Pittsburg, CA in June 2019. This plant will complete the final assembly of the BART "Fleet of the Future" as well as other transit vehicle manufacturing and overhauls. We cover the full spectrum of rail solutions, ranging from complete trains to sub-systems, maintenance services, system integration and signaling. Our installed base of rolling stock exceeds 100,000 rail cars and locomotives worldwide. Our 39,850 employees, with over 800 of those located in California, continue a proud tradition of delivering ingenious rail transportation solutions, including:

- Rail vehicles - automated people movers, monorails, light rail vehicles, advanced rapid transit, metros, commuter/regional trains, intercity/high-speed trains, and locomotives
- Propulsion and controls - complete product portfolio for applications ranging from trolley buses to freight locomotives
- Bogies - product portfolio for the entire range of rail vehicles

- Services - fleet maintenance, operations and maintenance (O&M), vehicle refurbishment and modernization, and material management
- Transportation systems - customized “design-build-operate-maintain” transportation system solutions
- Rail control solutions - advanced signaling solutions for mass transit and mainline systems.

Bombardier’s approach to technology selection for the Airport-Diridon-Steven’s Creek corridor

At Bombardier, when selecting a transit technology, we typically begin by identifying the required system capacity in terms of people per hour per direction (pphpd). At present, no estimate of pphpd is available for the San Jose Diridon corridors. In the absence of this information, we have provided developed two scenarios based on the *INNOVIA* APM, and the *INNOVIA* Monorail.

The *INNOVIA* 300 APM, *INNOVIA* 300 Monorail, both have maximum design capacity in excess of 40,000 pphpd, leaving ample room for expansion, if required. Both systems can adapt to variations in ridership through the day, as well, adapting to the varying needs of the City of San Jose during special events, etc.

The *INNOVIA* Monorail 300 System

The *INNOVIA* Monorail 300 system is the culmination of Bombardier’s experience in developing and implementing advanced driverless monorail systems. Fast and cost-effective to build, monorail systems are today’s game changing solution for urban transportation – with capacity to move hundreds of thousands of passengers safely, efficiently, comfortably and reliably to their destinations day after day. The system incorporates the design and operational features required for rigorous urban line-haul service, including full driverless automation, emergency evacuation walkways, high-speed guideway switching, bi-directional operation and compliance with urban transit safety standards.

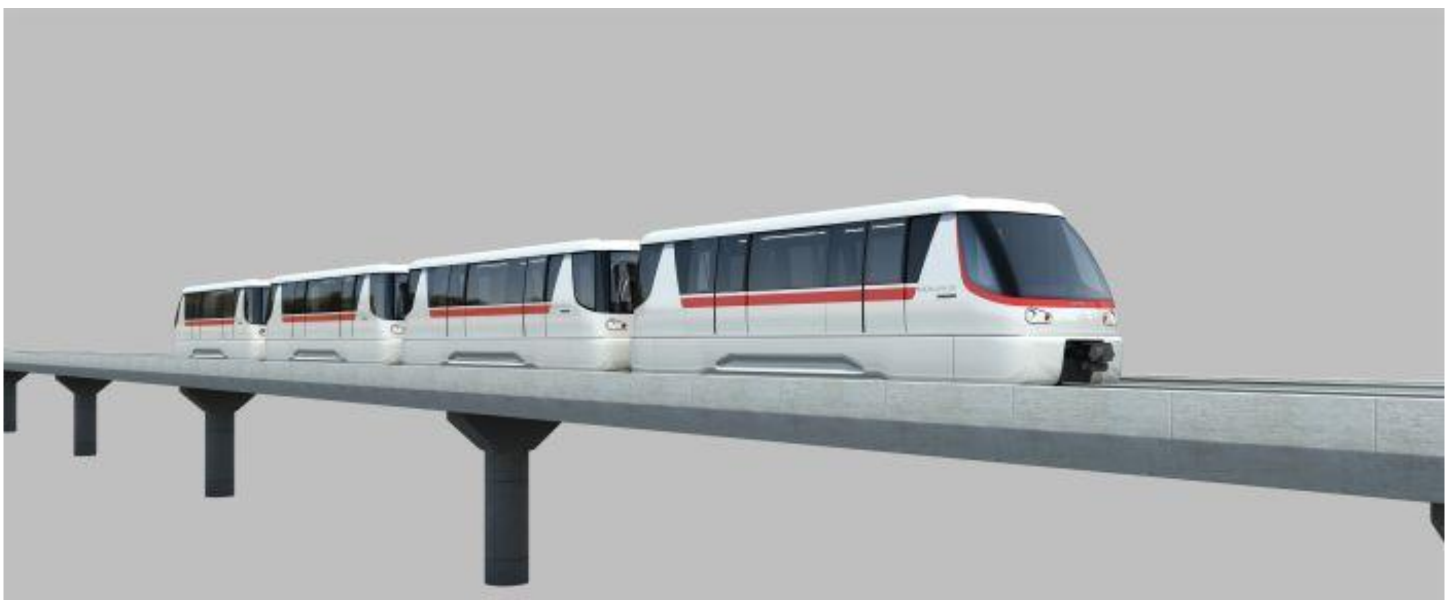
The *INNOVIA* 300 Monorail is a fully automated, self-guided rubber-tired rail vehicle. *INNOVIA* Monorail systems have been installed around the world, and have been providing highly reliable, safe operations for millions of passengers for more than 25 years. They operate on dedicated guide beams and are characterized by exceptional route flexibility, outstanding availability and high efficiency in terms of passenger capacity, energy consumption and land use.

Advantages of the *INNOVIA* 300 Monorail include:

- Quick and easy installation into existing urban environments

- Turnkey solution for fully integrated systems
- Mass transit capability greater than 40,000 passengers per hour per direction (pphpd)
- Speeds up to 80 km/h or 50 m/h
- Lightweight, energy efficient vehicles
- High efficiency permanent magnet motor propulsion with regenerative braking
- Capability of handling sharpest curves (46m or 150 feet radius) for improved urban fit
- Slender, unobtrusive guide beams
- Unobtrusive guideway design
- Efficient and environmentally friendly to operate
- Short headways for superior passenger service.

The *INNOVIA* Monorail technology permits slender contemporary guide beams, which both guide the vehicle and provide its structural support. The *INNOVIA* Monorail system has been developed to minimize the costs and disruption of civil construction. The pre-cast, post-tensioned elevated guideway structure is constructed off-site to permit fast assembly on location. Long beam spans and tight curve capability also contribute towards lower expropriation costs. In addition, the elevated guideways avoid the need for expensive and time-consuming tunneling works, a major advantage when introducing a new transit system in existing dense urban areas.



The INNOVIA 300 APM

The *INNOVIA* 300 APM is a fully automated, self-guided rubber-tired rail vehicle. *INNOVIA* APM systems have been installed around the world, and have been providing highly reliable, safe operations for millions of passengers for more than 50 years. They operate on dedicated guideways and are characterized by exceptional route flexibility, outstanding availability and high efficiency in terms of passenger capacity, energy consumption and land use.

The *INNOVIA* 300 APM is a complete system offering. Bombardier provides the required vehicles, signaling, and communications, power distribution system, and would partner or work with a leading civil engineering company to provide the civil guideway. This turnkey approach limits the risks associated with the project, as it makes a single technology provider responsible for the entire project.

The *INNOVIA* APM 300 vehicle is designed with a state of-the-art extruded aluminum panel construction carbody, resulting in a lightweight, durable, impact and corrosion resistant vehicle with modern styling. This latest generation of *INNOVIA* APM cars features rubber tires, steerable axles, center guidance, and AC traction motors with state-of-the-art insulated gate bipolar transistor (IGBT) inverter controls. A 750 Vdc (or optional 600 Vac 3-phase) power distribution system (PDS) powers all vehicle subsystems through a two-pole power distribution rail and an independent ground rail, all mounted to the guide rail in the center of the guideway.

When combining the service proven nature of the *INNOVIA* 300 with its outstanding safety and reliability track record, along with the turnkey approach which Bombardier can provide, the City of San Jose has access to a low risk, high-capacity, world class solution for moving people along the corridor.

Advantages of the *INNOVIA* 300 APM include:

- Ideal for both urban and airport circulator systems
- Exceptional route flexibility for versatile applications underground, at grade or completely elevated
- Low-profile guideways
- Aerodynamically designed trains with aluminium carbodies and customised end caps
- Rubber-tired bogies for minimized interior and exterior noise and smooth ride
- Capability to handle gradients up to 10% and curves as tight as 22 meters / 72 feet
- Unprecedented track record for safety, reliability and availability
- Low overall capital and life cycle costs with proven systems integration.

We have attached datasheets for the *INNOVIA* 300 APM, and *INNOVIA* 300 Monorail, for your reference, and would welcome the opportunity to review the material with you in greater detail.

We envisage two possible scenarios:

- A monorail alignment for the entire Airport-Diridon-Stevens Creek corridor. This approach provides a one-seat ride from Cupertino to the airport, and saves costs by providing a single maintenance facility for the entire alignment.
- A monorail segment for the Stevens creek- Diridon segment, and an APM for the Diridon- Airport segment. This approach would seek to provide greater integration between Diridon and the Airport, but at the expense of modal transfer at Diridon, and the requirement of an additional maintenance facility. On the positive side, splitting the airport segment from the Stevens Creek segment provides for more straightforward phasing to the project.

MOVIA 300 metro

Congestion, budget constraints, and connectivity are major challenges facing growing cities today. Metros are one of the most efficient means of moving high volumes of people safely, conveniently and cost-effectively to their destinations.

From London to Delhi, New York to Shanghai, MOVIA metros move more than seven billion passengers every year. MOVIA metros are renowned over the world for their operational reliability, appealing design and enhanced safety features – everything that makes a metro an attractive mode of transport.

As part of a new or existing network, fully automated or with a driver, the MOVIA metro family's modular approach ensures the right solution for each customer.

- Bombardier has delivered its MOVIA metro solution to more than 40 cities worldwide, representing some 4,700 cars.
- 775 MOVIA metro vehicles to San Francisco
- 300 MOVIA metro vehicles to New York
- 1,771 MOVIA metro vehicles to London Underground
- 276 fully automated MOVIA metro vehicles for the Singapore Downtown Line
- 776 MOVIA metro vehicles for the Delhi Metro

Our advantages include:

- Best cost per passenger transported
- High flexibility and scalability – The flexible design of the train allows for increased passenger volumes in the future. Configurations range from two to 12 cars, carrying 800 to 5,000 passengers per train.
- Proven technology
- Our selection of standardized systems and components enhances all aspects of performance, from shorter lead times to high availability and low operating costs.
- Maximum reliability and easy maintenance
- Each component ensures maximum reliability and ease of maintenance throughout the lifetime of the train, with:
    - Low energy consumption
    - Optimized performance
    - Up to 95 per cent recyclability

MOVIA metros fully integrate Bombardier's proven sub-systems to maximize performance, including low weight, FLEXX Metro bogies which provide low lifecycle costs, and CITYFLO 650 technology, providing track to train communication via state-of-the-art wireless technology.

The metros can move 120,000 passengers per hour, per direction. Passenger flow is optimized through wide door openings (up to 1.6 m), with up to eight doors per car. For increased passenger safety, the metros feature end detrainment doors for rapid evacuation from train to track.

As a leading metro solutions provider, we're shaping the future of mass transit and daily commutes. Our high-tech, highly efficient MOVIA metros deliver rapid, reliable and cost-effective transport solutions around the globe.

MOVIA 300

Detailed Responses to Questions

A. Respondent Profile

i- vi. Contact Information

Please see cover page for contact information.

vii. High level description of concept

A high-level description of the concept was provided in the previous section.

viii. High level description of business plan

Turnkey transit projects can be procured and deployed in several different ways, ranging from conventional procurements to Public Private Partnerships (PPP / P3). The choice of procurement model depends on the intended project outcome, the intention and timing to expand the project or corridors, as well as the quantum and nature of available funding. In either the case of a single monorail project for the entire alignment, or separate projects for the airport corridor and Steven's Creek, they could be good candidates for PPPs. Bombardier has appetite for PPP projects, and is in a unique position in the industry to provide the vehicle and wayside technology, as well as the operations and maintenance for the term of the concession.

Bombardier recommends that P3 procurements be based on system performance, particularly on the availability of the service, and on meeting system service levels (in terms of either passengers per hour per direction, or train capacity and headway between trains). Bombardier does not recommend a business model which assumes revenue based on ridership risk. System ridership and associated passenger revenue are based on wide variety of variables which are out of control of the concessionaire, including: Availability and performance of competing modes of transportation, economic status of the region, marketing, municipal urban development planning, to name a few. In contrast, a performance based schemed with compensation based on availability and system performance compensates the concessionaire on variables which remain within the concessionaire`s control.

B. Proposed Concept

Bombardier envisages two scenarios for the Airport-Diridon-Stevens Creek corridor, either a single monorail for the entire corridor, or a monorail for Stevens Creek and an APM for the Airport connection.

In the case of a Monorail single system from Cupertino to the Airport, the alignment would follow Stevens Creek it's entire length along the median of the boulevard. It would turn on S Montgomery Street, diverting to Cahill Street, with Diridon station parallel to Diridon train station; likely the station would be located above the existing parking lot, located north of the train station. Diridon station would include a mezzanine spanning the heavy rail tracks.

From Diridon, the alignment would turn along W Santa Clara St, and then north along the Guadalupe Freeway.

At the airport, the Monorail would approach via Skyport drive, then run above the departures approach with elevated walkways to the multilevel parking and terminal buildings. The Monorail would be elevated along the entire alignment.

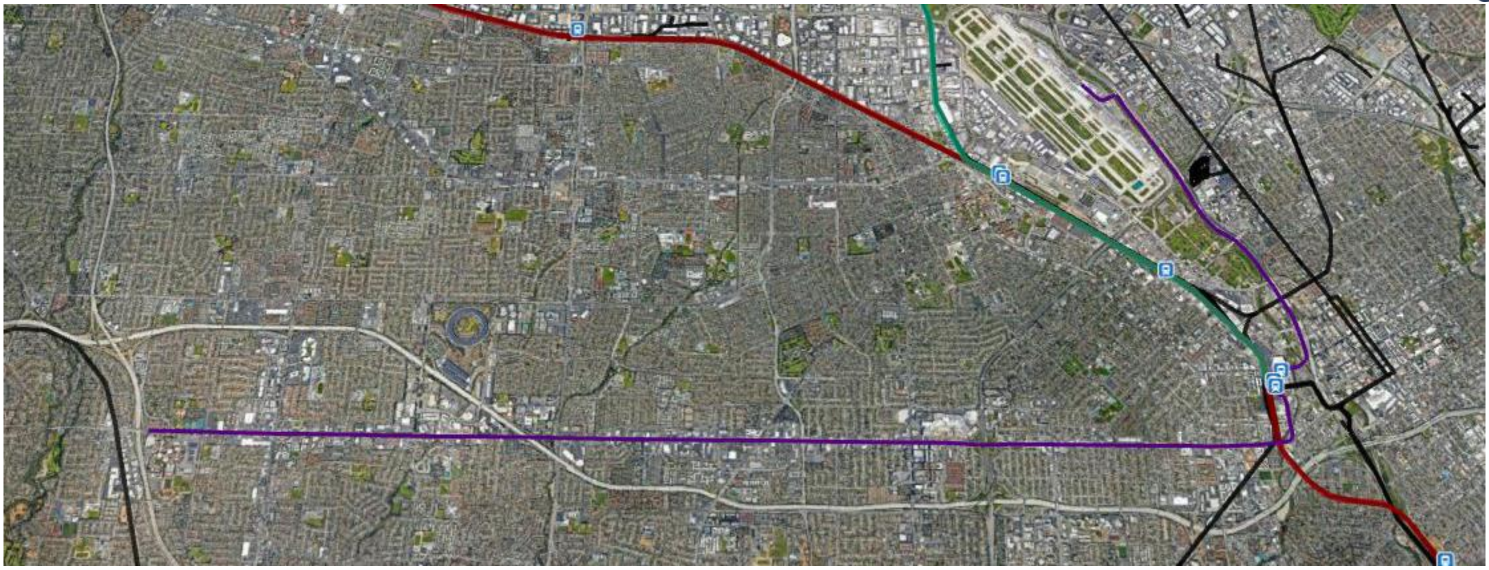


Figure 1: Single System Monorail Alignment

In the case of a combined Monorail APM system, the alignment would proceed as follows:

At Diridon station, Monorail and APM stations could be built stacked one atop the other, with a central mezzanine extending above the Diridon rail platforms. This central mezzanine would act as a connector between all rail modes – passengers disembarking from the heavy rail system could ride an escalator or elevator the mezzanine, then a second elevator or escalator to either the monorail or APM station.

The Monorail as an elevated solution would proceed south to Park Ave., along S Montgomery St, west along San Carlos St, and along Stevens Creek Boulevard. Along Stevens Creek Boulevard, the Monorail would proceed within the center line of the street, aligned with existing medians. Specific attention would be required at highway overpasses, to be evaluated.

The complementary APM system would depart from Diridon station, perpendicular to the monorail alignment along Stover street, connecting to Autumn Street, and then along 87 to the airport. Along Stover and Autumn streets, the alignment would proceed along the center line of the streets. Along I87, the alignment is to be determined; in all likelihood it will be more efficient to proceed along the western edge of the highway to avoid costs of spanning the highway.

At the airport, the APM would approach via Skyport drive, then run above the departures approach with elevated walkways to the multilevel parking and terminal buildings. The APM would be elevated along the entire alignment.

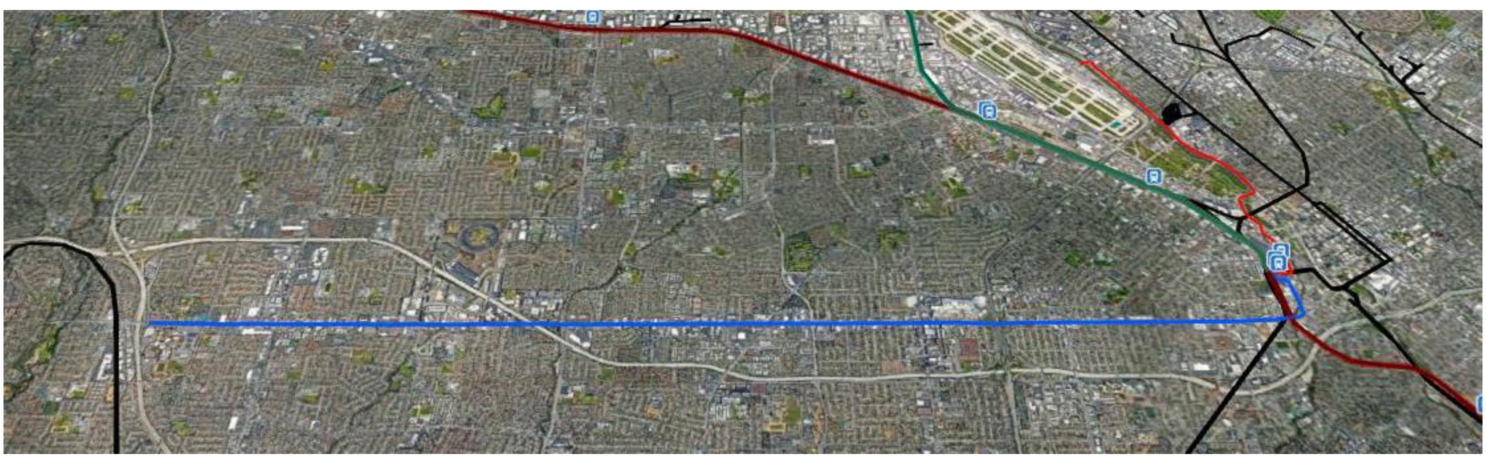


Figure 2 Combined Monorail and APM Alignment

C. Physical Elements

a. <u>Describe the Guideway</u>

i. <u>What does it look like for a person walking by, and for a person using the system?</u>

The monorail is the system which offers the least visual impact of all systems - the guideway consists of two approximately [redacted] wide beams suspended from columns, with a span of up to [redacted] feet between columns. With this efficient design, the monorail guideway allows the maximum amount of light to reach the street surface and offers the least sense of separation from the street. From a passenger perspective, the guideway is only perceivable from the front and rear of the vehicle, provide a maximum sense of light, and of "flying" above the city below.

The APM solution relies on a more conventional elevated guideway deck, with a roadway deck suspended above the roadway. The guideway is typically supported by single columns, though columns and straddle beams may be required in some locations, depending on local conditions. From a passenger perspective, the guideway is visible from the front and rear, as is the adjacent track. One has the impression of operating on an elevated roadway.

Figure 3: View of a Typical APM Guideway

The method of conveyance for each solution is outlined as follows:

<u>The *INNOVIA* Monorail 300 System</u>

The *INNOVIA* Monorail 300 infrastructure is designed to integrate seamlessly into different environments, including through buildings and structures. The system technology permits slender contemporary guide beams, which both guide the vehicle and provide its structural support. Time is short to transform a city's transportation network, but the *INNOVIA* Monorail 300 System permits cost effective, rapid installation in comparison to other mass transit technologies. Bombardier developed its *INNOVIA* Monorail 300 System to minimize the costs and disruption of civil construction. The pre-cast, post-tensioned elevated guideway structure is constructed off-site to allow for exceptionally rapid assembly on location. In addition, the elevated guideways avoid the need for potentially expensive and time-consuming tunneling works, a major advantage when introducing a new transit system in existing dense urban areas.

The *INNOVIA* Monorail 300 System adopts precast concrete beams to form the elevated guideway structure, which provides enhanced traction and reduced maintenance over steel structures. Like the *INNOVIA* APM 300 solution, in locations with lots of available space, owners may choose to build the guideway at-grade which is a less expensive option for the guideway construction.

Although Bombardier recommends a maximum six percent grade for ride comfort, the *INNOVIA* Monorail 300 System vehicle can traverse steeper gradients depending on the train-loading configuration, grade length and system requirements. The *INNOVIA* Monorail 300 System vehicle can also negotiate curves in the guideway with radii as tight as 46m allowing greater flexibility within the urban environment, reduced cost and lower visual impact.

<u>The *INNOVIA* 300 APM</u>

Due to the versatility of the *INNOVIA* APM technology, Bombardier can adapt its car-to-guideway interface to elevated, at grade or underground guideway structures. This also means the layout of the new *INNOVIA* APM 300 system can be adjusted to existing facilities, the terrain of the site, the number of stations, the predicted passenger traffic and the budget. Stations can be located anywhere along the guideway route and even integrated directly into buildings. System expansions, including guideway extensions, additional trains and stations, can be completed with minimal or no disruption to revenue service.

[redacted]

Figure 4: APM Guideway Cross Section

The superstructure and running surfaces are typically built to standard highway tolerances by a civil subcontractor.

On sites with limited space, an elevated guideway allows the customer to continue using the space underneath the guideway superstructure. Planners can also build stations on the upper floors of buildings when using an elevated guideway.

Although designers can use either concrete or steel for an elevated guideway structure, they usually consider climate and geological conditions, as well as aesthetics when they choose a material.

System planners have several options for architectural treatments once they meet the structural requirements. For all types of construction methods, the final running surface material and finish must meet design requirements for ride quality and adhesion.

In locations with plenty of available space, owners may choose to build the guideway at grade. Building at grade consumes land space, but otherwise it is usually the least expensive option for the guideway construction. This option will require a personnel barrier such as fencing.

A below-grade guideway completely frees the ground level for other uses, so in situations where owners have limited space, it may be worth the added investment.

The *INNOVIA* APM 300 vehicle can traverse grades as steep as ten percent (although Bombardier recommends a maximum six percent grade for ride comfort) and can negotiate curves in the guideway with radii as tight as 22 meters / 72 feet. The guideway, which incorporates spiral transitions in curve areas, can safely incorporate up to ten percent super-elevation through curves (although Bombardier also recommends a maximum six percent super elevation for ride comfort).

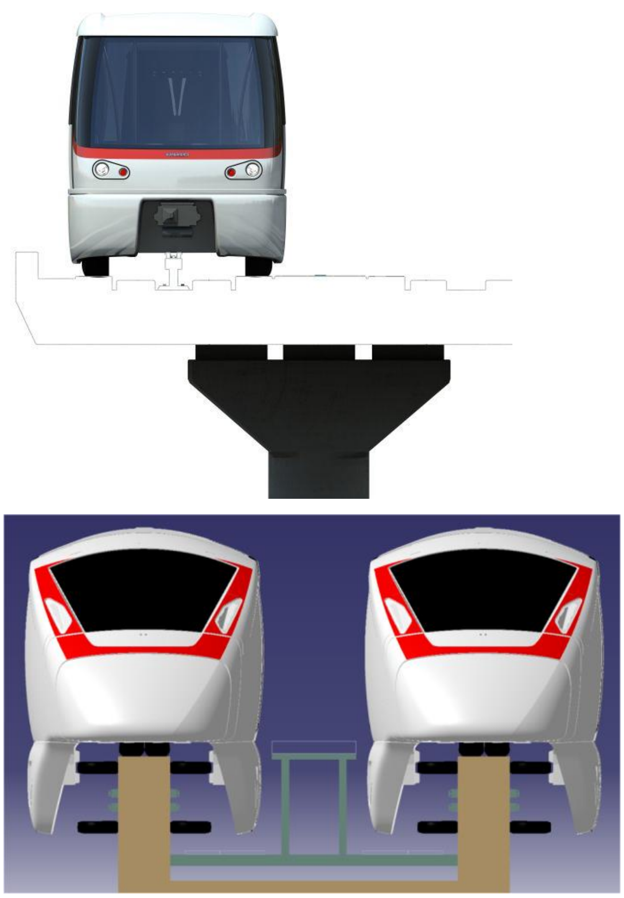


Figure 5: Guideway Cross Sections for APM (above) and Monorail (below)

ii. How is it grade-separated?

Given that the entire alignment runs parallel to existing streets, and that a grade separated system is requested, we have assumed that the entire system must be either elevated or tunneled; given that tunneling is cost prohibitive, we have assumed that the entire alignment is elevated. Both technologies proposed are designed to operate ideally as elevated systems.

iii. What are its right-of-way needs?

In the case of the monorail [redacted] diameter column is required every [redacted] For the APM and Metro options, the diameter of columns varies depending on the configuration for the track and deck. Spans [redacted] are possible, but again depend on the alignment.

b. Describe the stations/passenger access points.

i. What do they look like for a person walking by, and for a person using the system?

Passenger stations for the Monorail, APM, and Metro are typically either center platform or side platform stations. Platforms are adjacent to the guideway, elevated above the street. Typically, a mezzanine level l is located beneath the platform level to allow passengers to access both directions of travel from any station entrance. Station entrances are located at street level, with a variety of options (stairs, elevator, escalator) to access the platforms.

The following images show typical station cross sections; although the monorail is presented as the typical technology, the same concept applies for the APM.

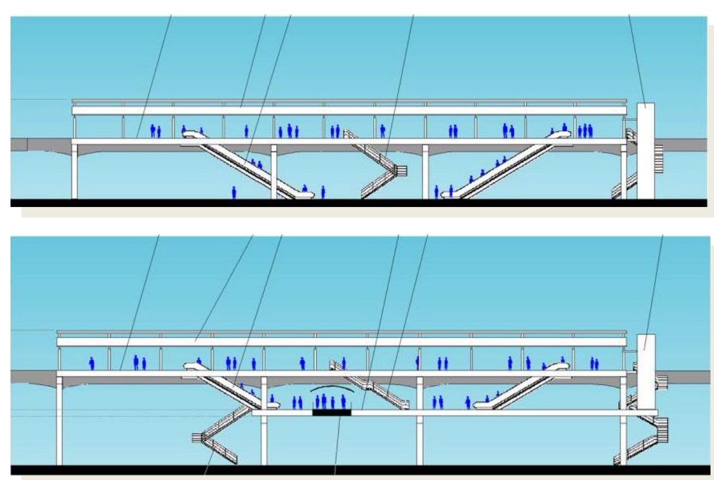


Figure 6: Sample Station Cross Sections

ii. What are the right-of-way and land needs of a station/access point?

Typically, stations are located above an existing road, and occupy the space offered by the road and adjacent sidewalks, as is illustrated in the preceding cross-section images. In the case of the airport, stations would typically be located at the departures level, in an elevated structure connecting to the main airport via a series of walkways.

iii. How will stations/access points integrate with the surrounding urban fabric on the Stevens Creek Line?

Architecturally designed to integrate seamlessly into different environments, including through buildings and structures, the infrastructure requires minimal land expropriation and meets the most stringent urban transit, environmental and safety standards.

The *INNOVIA* Monorail technology permits slender contemporary guide beams, which both guide the vehicle and provide its structural support. Disruption to everyday city life is not an option in today's non-stop commercial environment. The *INNOVIA* Monorail system has been developed to minimize the costs and disruption of civil construction. The pre-cast, post-tensioned elevated guideway structure is constructed off-site to permit fast assembly on location. Long beam spans and tight curve capability also contribute towards lower expropriation costs.

Figure 7: *INNOVIA* Guideway in an Urban Environment

There are several strategies for urban integration available, including

a) Reducing the visual impact of stations by maximizing the amount of glazing in the stations. Bright, airy stations provide a sense of transparency with the surrounding urban environment and offer passengers a sense of safety and transparency.

b) Adopt architectural elements from surrounding architecture. By selecting architectural elements which "echo" the surrounding environment, the station can be seen to blend into the environment.

c) Pursue design excellence as part of station design. Stations will be the focal point of the system in neighborhoods served by the system, and as such, design excellence in architecture will increase passengers' perceived value of the system.

In all the aforementioned cases, stations should be designed by qualified architects and should form a key element of the community outreach program for the project(s).

iv. How will the system integrate with existing transit systems?

Multimodal stations between elevated systems and ground-based systems are common, and a number of best practices are available in terms of reference designs. Typically, intermodal stations can either be designed with overlaid systems separated in elevation, and sharing a common central platform, allowing passengers to circulate from system to system through use of elevator or stairs connecting the two platforms. Alternately, systems which intersect at right angles can be connected by a series of stairs, elevators and escalators in each of the four corners of the intersection, providing a direct connection from any platform to either direction of the connecting system.

v. How will the proposed system connect with rail platforms (either BART or other heavy rai) at Diridon Station?

For connections with BART, see the above description. For heavy rail at Diridon station, the system station could either connect to the station building, or could traverse Diridon at right angles, with a mezzanine below the elevated structure providing dedicated access to each of the platforms at Diridon station.

vi. How will the proposed system connect with airport facilities and parking at SJC?

As described above, the elevated structure could enter the airport, and provide elevated stations which connect with parking and airport structure via walkway. The walkway would be connected to a mezzanine level located beneath the main guideway level.

vii. How do the system's vehicles operate within the network?

All proposed vehicles are fully automated rail vehicles, controlled by Bombardier's Cityflo 650 Communications Based Train Control (CBTC). Vehicles can operate in a few different configurations, depending on the guideway/alignment configuration, including loop, pinched loop, and shuttle operations.

viii. Is there level boarding?

All proposed systems offer level boarding from a dedicated platform.

ix. How will the system be designed to be compatible with "complete streets" if the system is aerial?

All proposed systems minimize the required right of way at street level through use of an elevated structure supported from columns; as such, the impact of the elevated structure on the surface is minimized. Columns may be incorporated into existing medians, if available, or can be accommodated through adaptation to turning lane striping.

Stations can be made transparent through design excellence.

Stations can, and should feature accommodation for multiple modes of transportation, including personal bikes, bike share, e-scooters, and drop off for ride share and taxi services.

By incorporating all these features in station design, the station will be more closely integrated into the surrounding urban fabric. Ultimately, the success of the integration is less a function of the technology selected, and more of the design of the stations.

x. <u>If the main guideway is aerial or underground, how do passengers get to grade level?</u>

As mentioned in previous responses, passengers access platforms via stairs, escalator, and/or elevator.

c. <u>Describe the vehicles</u>

i. <u>What do they look like for a person walking by, and for a person using the system?</u>

Monorail

The *INNOVIA* 300 Monorail is a modern, sleek vehicle which provides a unique, modern brand to any transit system. Its sleek design incorporates classic minimalist design elements, ensuring that the vehicle will continue to remain relevant for decades to come.

Due to their innovative design, monorail systems have great appeal to the travelling public. Because Bombardier recognizes that interior detail is as important to passengers as first visual impressions, the passenger environment of the *INNOVIA* Monorail 300 system offers:

• Spacious interiors with flexible seating arrangements to provide high capacity mass transit capability

• Inter-car walk-through for free passenger flow and enhanced passenger safety

• Accessibility for passengers with disabilities (ADA compliant)

• Evacuation walkways for safe egress that are designed into the system structure to provide the fastest, safest, and most unobtrusive means of evacuation

APM

The spacious and modern interior of the *INNOVIA* APM 300 vehicle has been designed to accommodate high passenger volumes. Large windows create a bright and comfortable aesthetic and provide a scenic view for passengers while allowing an opportunity to identify station stops in advance.

Seating arrangements can be customized to suit the specific system requirements of urban and airport applications. Standing passengers can grip stanchions and handholds throughout the vehicle, while passengers with restricted mobility have their own designated spaces.

In addition to the two end-cap alternatives, customers can conceal the wheels and under-car equipment of their *INNOVIA* APM 300 vehicles with optional side skirting, customizing the vehicle to the aesthetics of the operating environment.

The interior layout of the *INNOVIA* APM 300 vehicle features a large area for standing passengers and a minimum of four two-passenger seats positioned adjacent to each of the vehicle doorways that efficiently uses the available space. Standing passengers can grip stanchions and handholds throughout the vehicle. The vehicle also has designated spaces for passengers with disabilities. As an option, Bombardier can install additional passenger seats or luggage racks.

In addition, *INNOVIA* APM 300 vehicle interiors include options for luggage racks, infotainment screens and CCTV cameras.

INNOVIA APM 300 systems are equipped with advanced communication technology. Passengers can communicate with the central control operator using a speaker/microphone panel available in each car. They can also receive information over several static and dynamic graphic panels incorporated into the standard design of the vehicles.

ii. <u>How many passengers and how much baggage can fit in vehicle?</u>

Please refer to the datasheet section for more information about passenger capacity.

iii. <u>How do passengers board and align from the vehicle? How long does it take?</u>

Passengers board and alight through passenger doors located along the side of the vehicles. Please refer to the datasheet section for more information on each vehicle type.

iv. <u>What is the top speed and how quickly is it achieved?</u>

Please refer to the datasheet section for more information about vehicles dimensions and performance.

v. Are the vehicles autonomously operated?

Yes, all vehicles proposed are fully automated.

Installed in cities throughout the world, the advanced CITYFLO 650 solution brings many benefits including improved safety, high reliability, shorter headways between trains and reduced maintenance costs.

CITYFLO 650 communications-based train control (CBTC) also provides:

- Maximized average train speed
- Minimized train lengths
- Minimized headway for highest frequency of service
- Minimized platform length and civil station costs
- Optimized fleet size
- Reduced energy consumption

The *INNOVIA* Monorail 300 system design incorporates high levels of equipment reliability and redundancy that permits confident operation of the system without the need for on-board attendants thus allowing the operator flexibility in staff utilization.

vi. What do vehicles do when they are not operating?

When out of service, vehicles are stored either at the maintenance facility, or at dedicated staging locations along the line (such as spurs at the end of the alignment).

vii. Do the vehicles require space off the guideway for storage?

Vehicles require storage space which is typically considered as part of the design of the maintenance facility. Please refer to sample photos of maintenance facilities in the System Photos section.

viii. How are the vehicles powered (e.g. battery, catenary, third rail, etc.)?

All vehicles proposed are powered via 750 VDC third rail, or equivalent in the case of the monorail and APM.

ix. Do the vehicles require a maintenance facility? If so, describe the facility requirements (e.g. number of facilities, connection to the system, size of facility, etc.).

Figure 8: APM Maintenance Facility

Bombardier designs all maintenance facilities to accommodate the number of vehicles on an individual system. Not only do we consider the physical size of the maintenance area, but also the architectural style, storage space for tools and spare parts, power supply and demand, and entry and exit points.

The *INNOVIA* 300 APM and Monorail solutions require an operations and maintenance facility. The maintenance accommodates the vehicles, an electrical shop, a machine shop, other equipment areas, a storage area for parts and tools, utility facilities, and personnel and office space.

Depending on the system configuration, planners typically incorporate “on-line” maintenance facilities for a shuttle system, with the vehicles on the active guideway, or “off-line” facilities for loop systems, with the vehicles routed from the active guideway to a separate maintenance area.

Off-line maintenance areas need working pits that run the entire length of the vehicle, giving maintenance crews easy access to mechanical and electrical subsystems. Maintenance facilities need a power source for testing vehicles and subsystems. It is important that in on-line maintenance facilities, there are no obstructions (pipes, ducts, conduits, trays, etc.) within 2.5 meters / 8 feet of the work area. Planners must include design features to accommodate deliveries of large parts, particularly for large facilities.

Both the *INNOVIA* APM 300 and the *INNOVIA* Monorail 300 vehicles incorporate on board health monitoring systems, which provide live performance and system data to the control center. This enables early identification of faults and allows preventative maintenance to be undertaken. All of which helps to maintain the high level of reliability and availability required by a modern transit system. Planners must include design features such as cranes, elevators and floor levelers to accommodate deliveries of large parts.

Yes, all systems proposed require a maintenance facility. The size of the facility depends on the number of vehicles required

x. Do the vehicles need to move or be moved in order to be redistributed to meet demand on a regular basis? Describe how this is performed (by operator, autonomously, by user, etc.) and how often.

The headway between vehicles may vary during service hours in order to meet anticipated demand. This is controlled automatically via the CBTC and can range from as little as [redacted] up to several minutes between trains.

d. Provide pictures or renderings of all physical elements of the system.

Please see the dedicated section with photos of all proposed systems.

D. Operational Elements

a. Describe the operational model.

i. Can the vehicle travel outside the grade separated guideway (e.g. provide a point to point service utilizing city streets?)

No, the vehicle only operates on the guideway.

ii. What is the potential travel time from SJC to Diridon?

To be determined

iii. What is the potential frequency of the service?

The system can operate with headways as short as [redacted], depending on the configuration of the alignment and the system.

iv. What is the potential passenger carrying capacity?

Please refer to the datasheet section for specifics on the capacity (PPHPD) for each technology are provided in the data sheet section.

v. How can capacity scale up if demand exceeds initial supply?

The required capacity (PPHPD) forecast for the project corridors is far below the maximum capacity of all systems proposed. System capacity can be increased either by providing longer trains or by shortening the headway between trains. In either case, additional vehicles are required. This increase to capacity can be performed on the operational system, without impacting current operations.

vi. What is the dwell time for a vehicle at a station?

Dwell time is configurable, but typically varies between 20-60s, as required by the system.

vii. What is the reliability of the service?

System reliability varies depending on maintenance practices; as North America's leading operator and maintainer of rail systems, we pride ourselves of providing an availability above 99% on most systems.

viii. Can the service be ticketless? If so, how will fares be collected?

Bombardier does not normally participate in fare collection systems and leaves this system to our customer's discretion.

E. Current status of Concept Technology

a. Provide a current development status of your concept (e.g. conceptual, design, development, pre-production testing, or production).

All proposed systems are in production, and in service, and project references are provided in the dedicated project references section.

b. Include a schedule for development of a fully deployable system, if applicable, Identify key assumptions for this schedule.

It is impossible to predict a specific schedule for a project without studying the specifics of the project. Generally, *INNOVIA* APM or Monorail projects are achieved in 4-5 years from notice to proceed. Note than any time to develop specifications or perform environmental studies are separate and precede the period.

c. Include examples of successful similar implementations if available.

Please refer to the references section.

d. Identify areas of notable risk that would be investigated further.

Typical areas of risk for a large transit infrastructure project include:

- Utilities: Utility identification and relocation present a significant risk to all projects; it is not uncommon to discover unplanned utilities, and the associated cost and schedule impact of relocating these utilities can be significant.
- Permits: Obtaining the correct permits, for the correct jurisdiction in a timely fashion is a key consideration for such significant projects.
- Geotechnical: Identifying the underlying geotechnical conditions along the alignment can mitigate surprises during construction.
- Environmental: Correctly identifying environmental risks upfront and identifying

adequate mitigations will help to reduce the risk of unforeseen problems during deployment.

- Local community engagement: Transit projects typically only succeed when all stakeholders are aligned and support the project. To obtain this level of engagement requires extensive community outreach to ensure all parties are aligned and clearly understand the project.
- Securing land along the corridor/expropriations: Ensuring that real estate required for the project is available in advance of the project.

F. Concept Requirements

a. Describe key requirements for implementation of the system (e.g., infrastructure, utilities, regulatory, and/or policy) and estimated length of time required to implement the system.

It is impossible to predict a specific schedule for a project without studying the specifics of the project. Generally, *INNOVIA* APM or Monorail projects are achieved in 4-5 years from notice to proceed. Note that any time to develop specifications or perform environmental studies, are separate, and precede the aforementioned period.

b. Could the system function in either an aerial or underground configuration? Could it transition between aerial and underground? What are the maximum allowable grades for the system to ascend/descend?

All proposed systems can operate either on elevated guideway, at grade, or in tunnels. The maximum gradient supported by each technology is provided in the datasheet section of our response.

INNOVIA APM 300 systems are ideally suited to both airport and urban environments. They operate on dedicated guideways and are characterized by exceptional route flexibility, outstanding availability and high efficiency in terms of passenger capacity, energy consumption and land use.

Due to the versatility of the *INNOVIA* APM technology, Bombardier can adapt its car-to-guideway interface to elevated, at grade or underground guideway structures. This also means the layout of the new *INNOVIA* APM 300 system can be adjusted to existing facilities, the terrain of the site, the number of stations, the predicted passenger traffic and the budget. Stations can be located anywhere along the guideway route and even integrated directly into buildings. System expansions, including guideway extensions, additional trains and stations, can be completed with minimal or no disruption to revenue service.

c. Could the system be extended in the future?

Yes, all technologies proposed can be readily extended, and expanded; branches are possible, with trains serving multiple destinations on the same system. System capacity increased up to the maximum capacity of the technology, offering a maximum ridership of approximately 48,000 pphpd.

d. Could stations be added to the system in the future?

Yes, stations can be added in the future, either via expansion, or on the existing alignment. Also, Bombardier's monorail can accommodate "Y" configurations in the alignment, allowing for branches which serve separate destinations, then merge to reach the same terminus.

e. What are the maintenance requirements for the guideway, vehicles, stations, etc.?

Maintenance requirements vary according to the specific quantity of the vehicles, stations, alignment, and will be determined as part of the system design phase.

G. Costs

Unfortunately, Bombardier is not able to provide cost or price data outside of a formal RFP, particularly as response to this RFI will be publicly accessible. In lieu of specific cost information, please refer to the references section which provides reference data from existing projects which may be used as a reference.

As an example of a similar project, please see a link below to the press release for our Cairo project. Note that specific costs vary according to length of the system, system capacity, and local labor rates, amongst other factors.

https://ir.bombardier.com/en/press-releases/press-releases/83293-bombardier-named-preferred-bidder-for-3-billion-cairo-monorail-project

a. What is the cost per mile to deliver the fixed infrastructure to operate the system, not including stations and land acquisition costs?

b. What is the incremental cost of a station and/or access point?

c. What is the cost of the vehicles fleet needed to begin operations?

d. Summarize the capital costs for delivering the full system of each potential project, Airport Connector and Stevens Creek Line. Assume six stations on the Stevens Creek Line and three station on Airport Connector, plus Diridon station for both routes.

e. Provide a high-level estimate of the ongoing operations and maintenance costs, as well as equipment replacement costs and schedules.

H. Business Plan

a. Describe the business plan to deliver and operate the proposed project. The City is looking for innovative ways to fund and operate new transit systems.

With an excellent track record and 40 years of experience of managing systems for its customers, Bombardier provides unrivalled support in maintaining fleet safety, availability, performance and reliability. Bombardier's Services teams are committed to delivering the highest levels of system performance for the life of the system and they provide complete operations and maintenance services, or alternatively, full training and start-up services for the operating authority. As a world leading transit system expert, Bombardier customizes its services to the specific design, capacity and growth requirements of the system. It provides total asset management with a complete lifecycle view, continuously optimizing equipment and resource utilization. Transit systems operated and maintained by Bombardier have an availability rate of over 99%.

Bombardier believes that a Design, Build, Operate, and Maintain (DBFOM) procurement model, or some variable thereof (DBFM, DBOM) could have value for the City of San Jose. With design-build-finance-operate-maintain (DBFOM) or concession contracting, Bombardier plans and implements complete O&M organizations for all types of transit systems. O&M experts participate in the design process and tailor their approach to each specific system. This enables Bombardier to optimize the system design and add value, for example by reducing energy consumption, decreasing fleet mileage, and using less space for O&M workshops and depot buildings; all savings that translate into lower capital and operational costs for customers.

Once a system enters passenger service, full responsibility for the daily operation of the system transfers to the custom-designed O&M organization. Over the life of the system, Bombardier's partnership with the customer continues through consultancy and the provision of technical support packages, system expansions, refurbishments and upgrades as required.

b. Who will operate the system once constructed (VTA, the builder, PPP, other)?

Bombardier can perform O&M and does so for systems around the world.

c. What is the passenger fares strategy?

Under most common PPP arrangements, fare risk is retained by the owner, with the concessionaire provide service according to specified levels and with a given reliability. As mentioned previously, revenue risk from passenger fares is dependent on a number of critical variables which remain outside of the scope of the concessionaire (marketing, regional development plans, competing systems); if the concessionaire were required to assume the ridership revenue, they would potentially identify contingencies to manage the aforementioned factors, and transfer these contingencies to the public sector as part of the system offer. This appears inefficient from the public sector perspective as the project would now include significant financial contingencies which offer little value for the project sponsor.

In lieu of transfer of ridership revenue risk, Bombardier recommends that the ridership revenue risk remains with the project sponsor, and that the concessionaire be compensated based on system availability and performance.

d. What are the expected fares for passengers to use the system?

Please see above.

e. What is the strategy to maximize ridership?

Given that Bombardier is not seeking to share in the fare risk for the alignment, we do not have a specific strategy to propose to maximize ridership; however, we would gladly collaborate with the City of San Jose to develop a strategy. We do, however, recommend that existing bus routes be modified to serve as feeders to the transit system. Also, all stations should include multimodal features for a variety of modes of transportation (ride-share, bike share, scooters) which encourage people to ride to the station, then ride the system to the airport. Finally, using a common payment system (single card, for instance) for all local modes of transportation can help to encourage ridership on the system.

f. Can capital and operations costs be funded through passenger fares?

Given that our approach excludes fare risk, the question does not directly apply to our case. In our experience, most transit systems in the world do not develop a profit based on fares. In the rare cases where transit systems are profitable, the majority of income is developed from real estate development adjacent to the alignment. This approach could be a solution for the City of San Jose as well, Bombardier could participate in the transit-oriented-development (TOD) strategy focused on station design and optimized passenger experience using the system. TOD as a real estate venture is not a core business of Bombardier Transportation.

g. Describe opportunities or strategies to maximize farebox recovery and/or offset operations and maintenance costs.

Typically, the most significant opportunity to offset transit system development costs lie in real estate development, often referred to as Transit Oriented Development (TOD). Given that locations near the transit system become more desirable from a real estate perspective, it is possible to rezone some of these areas, or to promote development in the areas adjacent to stations.

This project is ideal for TOD at each station and adjacent properties similar to the focused development proceeding at Diridon Station and surrounding area.

I. Impact

a. What are potential negative impacts during construction?

Typical negative impacts during construction include road closures, noise, dust, interruptions to traffic; in essence, the nuisances associated with large infrastructure projects; what is unique with regards to a transportation project is the linear nature of the project, i.e. that the project covers several miles at a time.

b. What are potential negative impacts during operations?

The most common complaint is typically noise associated with system operation, as well as the visual impact of the elevated system.

c. How can negative impacts be mitigated?

Most of the negative impacts are mitigated through our proposed technology. Monorail technology can minimize construction time by prefabricating beams and columns away from the project within a fabrication yard then transported to the project as an accelerated building method. This approach reduces the time required for road closures, and associated impacts on the surrounding community. Equally, use of rubber tire technology (as is the case on the APM and Monorail), limits the noise in neighborhood. Please see the following table for representative Monorail noise levels. As can be seen, the noise levels associated with the system are extremely low.

Type		**Monorail 300 Platform Specification**	**Test Conditions**
Interior	Static	[redacted]	Measured 1.6m above the floor as per ISO 3381
	Dynamic	[redacted]	
Exterior	Static	[redacted]	Measured 5m from the centerline of the vehicle, **1.2m above top of beam** as per ISO 3095
	Dynamic	[redacted]	Measured 15m from the centerline of the vehicle, **1.2m above top of beam** as per ISO 3095

With regards to the visual impact of the elevated structure, the monorail offers an elegant compromise – the elevated structure is significantly lighter, casts less shadow, and is aesthetically more satisfying than typical elevated infrastructure.

d. What might the community outreach and engagement strategy look like?

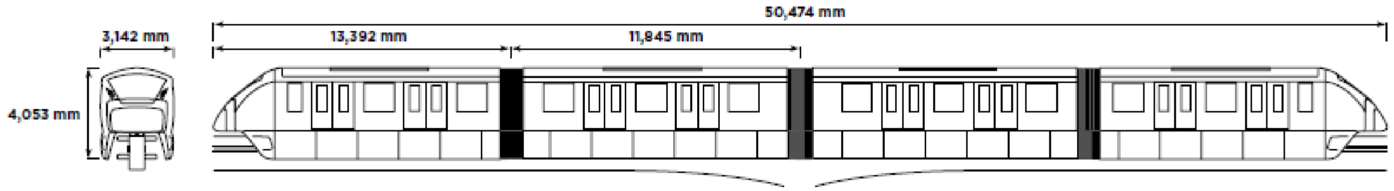
We recommend that the community outreach focus on the benefits that the system will offer to the community, including:

- Reduced travel time
- Increase of real estate value
- Reduced pollution,
- Reduced carbon footprint.

Renderings and videos should be used to communicate the type of technology retained.

Datasheet

TECHNICAL OVERVIEW
INNOVIA Monorail 300 Technology



Vehicle Data

Type of vehicle	*INNOVIA* Monorail 300
Maximum train consist	2- to 8-car trains

Dimensions and Weight

Length (end car overall)	13,392 mm
Length (end car over coupler)	13,032 mm
Length (mid car)	11,845 mm
Width (overall)	3,142 mm
Rooftop to top of running surface	3,019 mm
Floor to top of running surface	450 mm
Doorway width (clear opening)	1,600 mm
Doorway height (at threshold)	1,930 mm
Wheelbase (centreline to centreline)	9,120 mm
Car weight empty (average)	14,000 kg

Technical Characteristics

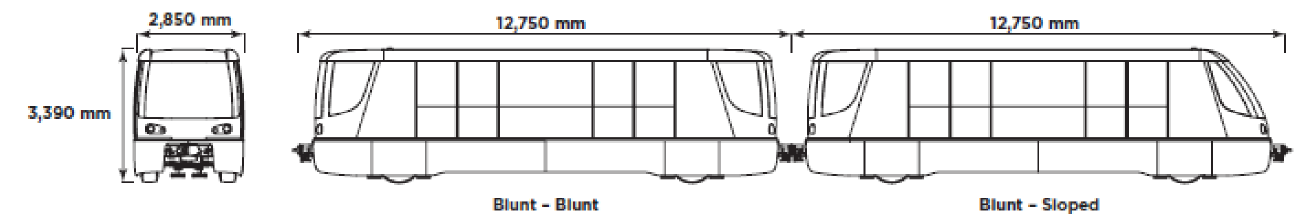
Power distribution	750 Vdc
Propulsion system	permanent magnet bogie mounted
Vehicle guidance	straddle beam monorail
Vehicle operation	bi-directional
Braking	regenerative/friction
Bogie	independent bogie with secondary suspension

Carbody	aluminium carbody, steel underframe, composite end cap
Windows	tinted, laminated safety glass
Doors	2 bi-parting doors per side per car
Air-conditioning	roof-mounted module containing twin HVAC units
Fire safety design	complies with NFPA

Performance and Capacity

Maximum speed	80 km/h
Minimum horizontal curve radius	46 m
Minimum vertical curve radius	457 m
Recommended maximum gradient	6% (based on ride quality)
Maximum gradient	10%
Wheelchair locations	1 per car (flexible)
Passenger seats per car	16 (flexible)
Rated capacity[3] • 2-car trains at 90 sec headways • 4-car trains at 90 sec headways • 8-car trains at 90 sec headways	 11,200 pphpd 22,400 pphpd 45,600 pphpd
Vehicle capacity per 4-car train @ 4 pass./m^2 @ 6 pass./m^2	standees + seated (flexible) 431 + 68 = 499 492 + 68 = 560

TECHNICAL OVERVIEW
INNOVIA APM 300 Technology



Vehicle Data

Type of vehicle	*INNOVIA* APM 300
Maximum train consist	1- to 6-car trains

Dimensions and Weight

Length (over coupler faces)	12,750 mm
Length (carbody)	12,075 mm
Width	2,850 mm
Rooftop to top of running surface	3,390 mm
Floor to top of running surface	1,100 mm
Interior floor to ceiling (minimum)	2,030 mm
Doorway width (clear opening)	1,980 mm
Doorway height (at threshold)	1,960 mm
Doorway spacing (centreline to centreline)	4,570 mm
Wheelbase (centreline to centreline)	7,580 mm
Wheel gauge (centreline to centreline)	2,020 to 2050 mm
Vehicle weight (empty)	15,200 kg

Technical Characteristics

Power distribution	750 Vdc delivered as +/-375 Vdc (optional 600 Vac 3 ph)
Propulsion system	AC traction motors
Vehicle guidance	centre beam
Vehicle operation	bi-directional
Braking	regenerative/dynamic/friction
Suspension	parallel link, pneumatic spring
Bogies	2 steerable axles
Load tires	4 tires per car with internal run-flat

Guide tires	8 per car – urethane
Emergency braking	spring-applied
Carbody	lightweight, aluminium shell modular end caps
Windows	single tinted glazing
Doors	2 bi-parting, outside sliding panels per door per side
Air-conditioning	dual high-capacity units
Fire safety design	floor rating meets ASTM E-119, NFPA-130 compliant

Performance and Capacity

Maximum design speed	80 km/h
Acceleration rate	1.0 m/s^2
Brake rate	1.0 m/s^2
Minimum horizontal curve radius	22 m
Minimum vertical curve radius • sag • crest	 110 m 140 m
Maximum sustained gradient	10%
Recommended maximum gradient	6% (based on ride quality)
Nominal passenger capacity	103
Wheelchair location	2 per car
Seated passengers	8 per car
Design capacity[1] • 2-car trains at 75 sec headways • 4-car trains at 75 sec headways • 6-car trains at 75 sec headways	 14,500 pphpd 29,000 pphpd 43,500 pphpd
Vehicle capacity @ 4 pass./m^2 @ 6 pass./m^2	 95 + 8 = 103 / 93 + 12 = 105 143 + 8 = 151 / 139 + 12 = 151

Movia Metro

Vehicle data	
Type of vehicle	*MOVIA* metro
Maximum train consist	2-car to 8-car trains

Dimensions and weight	
Length (over coupler faces)	16,800 mm to 24,000 mm
Length (carbody)	16,000 mm to 23,000 mm
Width	2,600 mm to 3,200 mm
Rooftop to top of running surface	3,600 mm to 4,100 mm
Floor to top of running surface	1,100 mm
Interior floor to ceiling (minimum)	2,100 mm
Doorway width (clear opening)	1,400 mm (optional 1,600 mm)
Doorway height (at threshold)	1,950 mm
Doorway spacing (centreline to centreline)	Equal spacing within trainset (optional customized)
Wheelbase (bogie pivot distance)	11,000 mm to 16,500 mm
Bogie wheel base (axle to axle)	2,250 mm to 2,300 mm
Vehicle weight (empty)	25 t to 43 t

Technical characteristics	
Power distribution	750 Vdc, 1,500 Vdc, 25 kVac
Propulsion system	AC traction motors
Vehicle guidance	Steel wheels on standard or broad gauge track
Vehicle operation	Bi-directional
Braking	Regenerative/dynamic/friction
Suspension	Helical springs and rubber cones; pneumatic spring
Bogies	Outboard or inboard type with 12 to 17 t axle load
Wheel diameter (new)	860 mm or 825 mm
Carbody	Aluminum or stainless steel
Doors	3, 4, or 5 doors per side
Air-conditioning	1 to 2 per car
Fire safety design	In line with EN 45545 (optional NFPA 130)

Performance and capacity	
Maximum speed	Up to 100 km/h
Acceleration rate	Up to 1.2 m/s²
Brake rate	Up to 1.2 m/s²
Minimum horizontal curve radius	80 m
Minimum vertical curve radius	1,500 m
Maximum sustained gradient	5%
Nominal passenger capacity	200 to 310 @ 6 pass/m²
Wheelchair location	2 per train (optional customized)
Design capacity	25,000 to 80,000 pphpd

Interior arrangement

Your partner for optimal performance
MOVIA metros fully integrate Bombardier's proven sub-systems to maximize performance, including lightweight *BOMBARDIER* FLEXX** Metro bogies, which provide low lifecycle costs, and *BOMBARDIER* CITYFLO** 650 technology, providing track to train communication via state-of-the-art wireless technology.

The metros can move 120,000 passengers per hour, per direction. Configurations range from two to 12 cars, carrying 800 to 5,000 passengers per train. Wide door openings (up to 1.6 m), with up to eight doors per car, optimize passenger flow, making it easier to enter and exit the metro. The flexible design of the train allows operators to accommodate increased ridership in the future.

Safety is always Bombardier's number one priority. *MOVIA* metros feature end detrainment doors for rapid evacuation from train to track. *CITYFLO* 650 technology enables fully-automated driverless operation, omitting human error and increasing safety.

- **AeroEfficient** reduces aerodynamic drag
- **TheromoEfficient intelligent air management** optimises internal climate
- **Energy Management Control System** enables operators to monitor and control fleet energy usage
- **Spacious entrances** enable rapid and smooth exchange of passengers at stations
- **EBI DRIVE 50** optimises speed and traction force
- **FLEXX Bogie** reduces energy consumption, noise emission, reduces track wear and lowers maintenance costs

System Pictures







PHX


THIS TRAIN IS

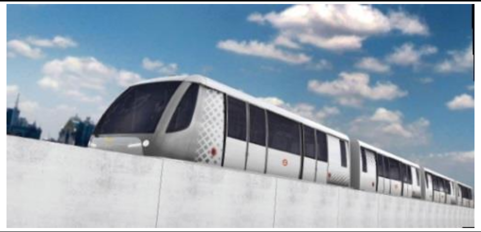
References

Bombardier is the world's leading manufacturer of APMs and monorails. Our products have been in service for more than 50 years, in the case of APMs, and 25 years in the case of monorails. We continue to innovate and improve our products with every project. Please find a collection of reference projects below.

Our APM project reference list has been shortened for sake of brevity; the total list of projects is longer than can be captured in the following report. For monorails, we have provided a complete list of projects. In both cases, we have sought to provide the requested information, namely client name, contact information, capital cost, O&M cost, start and end dates, along with a general description. However, please note that in certain cases, we are not at liberty to disclose contract values, or the Bombardier portion of the scope. In these cases, we have provided an indicative comment in the following tables.

Automated People Movers (APMs)

Shanghai Shentong Metro Co. Ltd
E-mail: Presently Unavailable



O&M (Yes/No): None
Project NTP: 2015
Project Completion: 2018

Bombardier SOW
- Technology of APM300
- ATC: CITYFLO 650

3rd Party SOW (Consortium: CSR Puzhen Rail Co. Ltd./ Puzhen BT System Ltd. (JV) / Shanghai Fuxin Intelligent Transportation Solutions Co. Ltd.)
- Deliver 44 *INNOVIA* APM 300
- Platform Screen Doors, Signaling
- Power rail, Guide beam, Switches
- Communication/ISCS, OCC, Depot Equipment

Project Description:
Dual Lane Elevated Shuttle, 4.1-mile track length. An extension to the existing Shanghai Metro Line 8, connecting Pujiangzhen to the Line 8 interchange at the Shendu Highway Station. *INNOVIA* APM trains will be the first to feature inter-car gangways.
https://www.bombardier.com/en/media/newsList/details.bt-20150619-bombardiers-newly-established-chinese-joint-venture-.bombardiercom.html

Taipei Department of Rapid Transit Systems (DORTS)

O&M (Yes/No): None
Project NTP: 2003
Project Completion: 2009

Bombardier SOW
- Design and Deliver 202 *INNOVIA* APM 256
- Electrical and Mechanical Works.
- Extension of the Neihu Line to Mucha Line.

3rd Party SOW (TAV Tang Eng Vehicles, Taiwan)
- Manufacturing and static testing of 116 *INNOVIA* APM 256 vehicles

Project Description:
Dual Lane Shuttle, Elevated with Tunnel applications, 8-mile track length.
https://www.bombardier.com/en/media/newsList/details.1451-bombardier-finalizes-contract-for-the-supply-of-a-729-million-rapid-transit-system-in-taiwan.bombardiercom.html?filter-bu=transport&f-year=all&f-month=all&f-type=pr&show-by-page=50&page=1

Hillsborough County Aviation Authority (Tampa International Airport APM Extension)

O&M (Yes/No): Yes
Project NTP: 2006
Project Completion: 2006

Bombardier SOW
- Deliver 4 *INNOVIA* APM 100

3rd Party SOW (Partnership: None)

Project Description:
4 Dual Track Elevated Shuttle, 0.9 Mile Length. Five (5) other contracts cumulating 16 vehicles. The first APM-100 was introduced at Tampa in 1971, the first commercial application of automated people mover technology.
https://www.bombardier.com/en/media/newsList/details.1240-bombardier-completes-automated-people-mover-shuttle-at-tampa-international-airport-usa.bombardiercom.html?

Los Angeles World Airports (LAWA/LAX) (current project)

O&M (Yes/No): 25 years of O&M
Project NTP: 2018
Project Completion: 2048

Bombardier SOW
- Design and Deliver 44 *INNOVIA* APM 300
- Systems Integration
- Lead O&M Provider

3rd Party SOW (Partnership: LINXS)
- Fluor: Equity, DBJV and OMJV
- ACS: Equity and OMJV
- Balfour/Beatty: Equity, DBJV and OMJV
- Dragados: DBJV
- Hochtief: Equity and OMJV
- Flatiron: DBJV

Project Description:
Dual Lane Elevated Pinched-Loop system (2.25-Mile Length), six passenger stations, one off-line at-grade MSF., First PPP for an APM system in the United States.
https://www.bombardier.com/en/media/newsList/details.bt_20180611_bombardier-and-consortium-partners-win-contract-for-.bombardiercom.html

Denver International Airport (current project)

O&M (Yes/No): 7-year contract
Project NTP: 2018
Project Completion: 2022

Bombardier SOW
- Design and Deliver 26 *INNOVIA* APM 300R

3rd Party SOW (Partnership: None)

Project Description:
First deployment of the new 300R vehicle on an APM 100 system.

Monorail

Companhia de Metropolitano de Sao Paulo (Sao Paulo Expresso Tiradentes Monorail)

O&M (Yes/No): No
Project NTP: 2010
Project Completion: Phase 1= 2018 / phase 2 = TBD

Bombardier SOW • Deliver 54 Seven-car *INNOVIA* Monorail 300 trainsets, ATC: *CITYFLO* 650	**3rd Party SOW (**Partnership: Queiroz Galvão, OAS) Civil works

Project Description:
Dual Beam Elevated Track. Shuttle, 15-mile length. Design & Build with O&M. Project management, Systems Engineering and Integration, Testing and Commissioning for the new trains, Signaling and Control Center.
Project Status 2018: 27 trainsets delivered as well as signaling, control center and integration package for Phase 1.
https://www.bombardier.com/en/media/newsList/details.762-bombardier-awarded-contract-to-design-and-supply-an-innovia-monorail-system-in-sao-paulo-brazil.bombardiercom.html?filter-bu=transport&f-year=all&f-month=all

Las Vegas Monorail Company (Las Vegas Monorail)

O&M (Yes/No): Yes (2004 - 2015)
Project NTP: 2000
Project Completion: 2004

Bombardier SOW • Deliver 36 *INNOVIA* Monorail 200 • ATC: *CITYFLO* 550	**3rd Party SOW (**Partnership: None)

Project Description:
Dual Lane Elevated Track. Shuttle, 4-mile length. Design & Build with O&M. Project Management, System Engineering and Integration, Comms, PS&D, AFC, Guideway guidance, Platform doors, T&C, Workshop Equipment, Training and Manuals.
https://www.bombardier.com/en/media/newsList/details.1406-bombardier-awarded-cdn-292-million-190-million-euro-contracts-for-an-extension-to-the-las-vegas-automated-monorail-system.bombardiercom.html?filter-bu=tran

Northern Bangkok Monorail Co. & Eastern Bangkok Monorail Co. (current project

O&M (Yes/No): O&M for 20 years
Project NTP: 2017
Project Completion: 2022

Bombardier SOW • Deliver 288 *INNOVIA* Monorail 300 • ATC: *CITYFLO* 650	**3rd Party SOW** (Partnership: None) Civil works performed by Northern Bangkok Monorail Co, and Eastern Bangkok Monorail Co.

Project Description:
Dual Beam Elevated Track concerning the 30-km Line 1 (Yellow Line between Lat Phrao and Samrong) and 34-km Line 2 (Pink Line between Min Buri and Khae Rai). The project includes design & build with O&M (vehicles, switches and depot equipment for both lines), project management, systems engineering and integration, testing and commissioning for the new trains, and signaling.
https://www.bombardier.com/en/media/newsList/details.bt_20170814_-bombardier-wins-contracts-for-the-first-monorails-i.bombardiercom.html

Wuhu Urban Rail Transit Construction Management Office Monorail (current project)

O&M (Yes/No): Pending
Project NTP: 2017
Project Completion: 2020

P3 composed of **Wuhu Urban Rail Transit Construction Management Office / CRRC Corporation Ltd / China Railway Group Ltd (CEC),** [both CRRC and CEC form the China Railway Group Limited Wuhu Yunda Rail Transit Construction Operation Co. Ltd] • Project integration	**3rd Party SOW** System developed by Bombardier's JV, PBTS

Project Description:
Dual Beam Elevated Track. Line 1 = 30 km; Line 2 = 15 km. Design & Build with O&M. Systems Engineering and Integration, Testing and Commissioning for the new trains, Signaling.
https://www.bombardier.com/en/media/newsList/details.bt-20171218-bombardiers-chinese-joint-venture-wins-its-first-mon.bombardiercom.html?

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