



Memorandum

TO: TRANSPORTATION AND
ENVIRONMENT COMMITTEE

FROM: Hans F. Larsen

**SUBJECT: AUTOMATED TRANSIT NETWORK
FEASIBILITY STUDY**

DATE: October 17, 2012

Approved /s/ (Ed Shikada)

Date 10/26/12

RECOMMENDATION

Accept staff report and presentation on the Automated Transit Network (ATN) Feasibility Study.

BACKGROUND

In November 2000, the voters in Santa Clara County approved Measure A, a 30-year half cent sales tax devoted to specified public transit capital improvement projects and operations, including the extension of BART to Santa Clara County and various other Countywide transit improvements. Among the projects to be funded by Measure A was construction of a rail connection linking airport passenger terminals at San Jose International Airport to BART, Caltrain and light rail. A subsequent study of an Automated People Mover (APM) that sought to serve that purpose identified a project cost of \$665 million (in 2007 dollars).

Following adoption of the San José Green Vision in 2007, developers of an emerging new transit technology approached City officials about deploying the new technology as a means to advance the City's green mobility goals, help spawn a new clean tech industry, and enhance the City's reputation as an innovation leader. If the claims made for the technology were true, it could offer a more cost-effective means to provide a rail connection to the Airport. It could also help the City realize far broader transportation and land use goals, such as those incorporated in the City's updated General Plan, Envision 2040. San José came to call this new transit technology "Automated Transit Network" or ATN in recognition of one of its defining characteristics, its network configuration. Others call it Personal Rapid Transit, Group Rapid Transit, or Podcars.

Like APMs, now commonplace at many major airports, ATNs are driverless vehicles operated on a separated guideway, typically elevated. But here the analogy ends. APMs, like other conventional transit systems, are designed as a loop or line. Vehicles travel their route according to a fixed schedule, typically stopping at every station along the way. ATNs, in contrast, serve multiple destinations over a larger service area via a variety of paths – a network. Vehicles travel point-to-point in response to passenger needs and network loads, skipping stations along

the way. ATNs respond to real-time fluctuations in system capacity by routing vehicles headed to the same destination via the most efficient route available. Sometimes those routes may differ. Generally there are no schedules. Vehicles typically wait at stations or are routed to stations on demand.

ATN proponents have asserted that ATNs would be less expensive to build than traditional rail due to smaller tracks, stations, vehicles, and right of way requirements and less expensive (and more environmentally-friendly) to operate due to automation and electrically-powered vehicles. But this was supposition, rather than proven fact.

In 2009, only a handful of ATN systems were in operation or under construction in the world, including: at West Virginia University, at London-Heathrow Airport; and in Masdar City, in the United Arab Emirates. That year a Swedish-Korean consortium signed an agreement to build a new ATN in Suncheon, South Korea. A year later, the British ATN firm that built the London project signed an agreement to build another project in India.

Examples of ATN Systems (Morgantown, West Virginia and Heathrow-London Airport)



Although ATNs looked promising, and the industry seemed to be gaining momentum, the City chose to conduct a rigorous, comprehensive analysis of the technology before determining whether to consider building a system here. In June 2010, the San José City Council authorized staff to hire a team of experts to analyze the technological readiness and financial feasibility of building an ATN. San José's ATN study was funded with VTA Measure A funds, which enabled the City to conduct its analysis, but restricted its scope. The City could only consider an ATN configuration that linked the Airport to two proximate transit stations.

The City's Project team included Arup North America Ltd., a global planning and engineering consultancy, and The Aerospace Corporation, which operates a Congressionally-authorized Federally Funded Research and Development Center that provides objective technical and scientific research and programmatic advisory services to the federal government and other public agencies. Arup was responsible for transportation planning activities such as demand and revenue estimation, detailed infrastructure alignment, cost estimates, and the business case analysis and risk assessment. Aerospace focused on developing a general understanding of the ATN concept with respect to the City's overall goals and objectives and the Airport project more specifically. This included the development of detailed requirements (in which they were supported by Arup) researching and characterizing the state of the art and state of the modern ATN industry, identifying technical and non-technical gaps in capabilities and suggesting approaches for mitigating risks.

ANALYSIS

In January 2011, the City issued a detailed Request for Information (RFI) to ATN vendors, authored principally by Aerospace. The RFI process revealed that a tremendous amount of progress has been made in the emerging field of ATN design and that it may, in fact, be possible for an ATN to deliver an attractive level of transit service to Airport customers. The level of detail provided in the responses varied widely. In general, proprietary concerns, and perhaps the relatively short time allotted for responses to the RFI, limited the amount of detail ATN developers provided to the City. As a result, Aerospace was unable to conclusively determine the industry's ability to meet the system requirements for San José or to verify the level of testing developers had performed.

Aerospace concluded that, technically, the City could probably build an ATN at the Airport that would nominally meet most of its needs. Passenger volume is fairly low within and to the Airport. The exception is between the Airport's Terminal A and the rental car facility opposite Terminal B. Long-term projections for passenger travel between these two points are quite high during peak periods, higher than it appeared from the information provided that current ATN designs would be able to support. Aerospace devised a solution that would allow the system to meet the Airport's inter-terminal travel requirements. In fact, the solution may provide service comparable to a conventional APM while offering greater flexibility. But, it must still be verified conceptually and physically.

Aerospace's high capacity solution was integrated into the 6.4 linear-mile 10-station ATN concept the City developed, based on input from the Project team as well as the Project's prime stakeholders – VTA and the Airport. Attached is a map of the proposed ATN system and project renderings. The system connects the Airport to rail lines on either side of the Airport as well as terminals, a rental car center, and parking facilities within the Airport. Despite the inclusion of sizable risk contingencies to account for unknown aspects of the technology, Arup concluded that the estimated capital cost of the Airport ATN Project would be less than the APM system the City and VTA had considered. They also determined that the estimated operating cost of the Airport ATN Project would be comparable to the savings that would be achieved by discontinuing the VTA and Airport bus shuttles. (Note: this comparison was based on 2011-12 budget figures. The 2012-13 Airport budget reduced the Airport's shuttle bus (service levels) and costs by \$2.6 million. Consequently, the estimated operating costs for the ATN would exceed current shuttle operating expenses.)

Nevertheless, Aerospace cautioned that moving immediately to a conventional design/build process would expose the City to a high level of risk given the number of questions that remain unanswered. This does not mean that an ATN system that meets the City's requirements could not be built in the near future. None of the issues raised by the City's ATN Team are insurmountable. Further information from ATN developers could also alter some of the Team's conclusions.

The City's decision to conduct this study has gained international interest. The report highlights some of the issues that must be resolved or solutions that must be verified to realize the potential of this unique and intriguing form of transit service. Should the City wish to continue to pursue construction of an ATN system, there are strategies it could take, at minimal risk and in partnership with other public agencies in the U.S. and abroad, to achieve that goal.

Examples of Outstanding Questions

Below are a few examples of the types of uncertainties Aerospace identified based on information provided in the RFI responses, from other ATN technical research and on original analyses performed by Arup and Aerospace.

- **Station Capacity/Throughput:** ATNs have long been criticized for their perceived inability to quickly process large numbers of passengers through stations. This limitation could seriously jeopardize public acceptance of ATNs if used in applications with large traffic surges. The rush hour peaks in demand between Terminal A and the rental car facility opposite Terminal B represents just such a case. Several ATN developers have proposed using a station layout very similar to angled vehicular parking to resolve this problem. Angled-berths, they reasoned, would provide unlimited capacity because vehicles would be able to move independent of each other, enabling traffic to flow unimpeded. The more angled berths, the greater station throughput. Instead, Aerospace found that after adding five to eight berths throughput leveled off and, as more berths were added, in some cases

throughput decreased. This finding was central to the solution Aerospace devised for the Airport's high-demand stations.

- **Network Capacity & Throughput:** Typical estimates of ATN passenger-carrying capacity are expressed as the maximum throughput on an isolated guideway segment under ideal conditions using formulas more appropriate for line-haul, fixed-schedule transit services, such as buses, trains and APMs. But estimates based on individual segments are not a true representation of the throughput of an entire ATN system. This is due to the inherent complexity of offering a service that seeks to provide express service with minimal wait time in response to passenger demand. Realistically, throughput for an ATN is likely to be much less—perhaps even less than half—of what would be indicated from an idealized capacity calculation derived from simple line-haul formulas.
- **Power Requirements:** Heating, ventilation and air conditioning (HVAC) battery-powered vehicles is a major challenge for automobile engineers. The power required to drive an on-vehicle HVAC subsystem can be comparable to that for propulsion, reducing the range of battery-powered vehicles. In ATN systems based on battery-powered vehicles, range reduction could mean that more vehicles would have to be purchased to have a sufficient number of charged vehicles on hand to service peak demand.
- **Regulatory Issues:** The regulatory effort that would be associated with qualifying ATNs for use within the State is difficult to estimate and predict. The California Public Utilities Commission (CPUC) will have regulatory authority over an ATN in San José. Other authorities such as Cal-OSHA would likely also have a significant role. The CPUC's standard certification process was developed for the safe design, construction and operation of *conventional* systems. The initial qualification of a new technology like ATNs would require a different type of effort, similar to the 1960's certification of BART's automatic train control system. No standard process exists for an effort of this type. It would almost certainly mean that the CPUC will need to author an entirely new set of regulations or "General Order". The General Order would be based on extensive interactions with industry, including physical demonstrations of safe operations over a wide range of operating conditions and performance levels in a process similar to what appears to be taking place overseas.

The level of technical uncertainty and unknowns illuminated by Aerospace also had implications for the business case.

- **Estimated Costs:** Arup had to estimate the cost of building and operating an ATN when such systems have not yet been standardized, without the benefit of knowing what the CPUC would require, and where there are few operating examples from which to extrapolate. Consequently, its cost estimates for the Project are necessarily preliminary. Using industry best practices, Arup developed conservative base cost estimates and added a sizeable risk contingency (134% of the base cost) to account for the as yet unknown factors. Arup has estimated that it would cost approximately \$758 million (in 2012 dollars) to construct the

ATN system, versus \$967 million for the APM (escalated to 2012 dollars and including a 40% risk contingency, as APM technology is proven and has regulatory approval in the U.S.).

- **Private Financing:** Arup's assessment is that private financiers would be willing to enter into a public-private partnership to fund the construction, operation, or maintenance of the project. But this will not occur until ATN developers can demonstrate that the technology can effectively meet the City's project requirements and reduce the cost and schedule risks identified to a level deemed bankable by the market.

Summary of Major Findings

Below is a summary of the major findings of San Jose's Airport-Area ATN Feasibility Study. More details are provided in the City's ATN Team reports and appendices available at the following weblink(s):

Aerospace Report:

[http://www.sanjoseca.gov/transportation/SupportFiles/admin/ATR-2012\(5629\)-1.pdf](http://www.sanjoseca.gov/transportation/SupportFiles/admin/ATR-2012(5629)-1.pdf)

Arup Report (plus appendices):

http://www.sanjoseca.gov/transportation/SupportFiles/admin/Arup_Final_Report_2012_10_19_RevB.pdf

http://www.sanjoseca.gov/transportation/SupportFiles/admin/Arup_Report_Appendix_A.pdf

http://www.sanjoseca.gov/transportation/SupportFiles/admin/Arup_Report_Appendix_B.pdf

http://www.sanjoseca.gov/transportation/SupportFiles/admin/Arup_Report_Appendix_C.pdf

http://www.sanjoseca.gov/transportation/SupportFiles/admin/Arup_Report_Appendix_D.pdf

http://www.sanjoseca.gov/transportation/SupportFiles/admin/Arup_Report_Appendix_E_Rev10_22_12.pdf

The ATN Project Team found that:

1. Conceptually, an ATN could offer a higher quality passenger service than the shuttle bus services currently offered at the Airport due to shorter walking distance to stations, minimal wait times for service, quicker travel times, and direct point-to-point service. Because the ATN system is grade-separated, patrons would avoid the traffic congestion the Airport shuttles must contend with. However, in some cases using the ATN will require passengers to make an additional trip up or down an elevator, escalator or stairs.
2. The recommended alignment indicates that at least one ATN guideway configuration could be constructed, consistent with Measure A, that would connect the Airport terminals to BART, Caltrain, and Light Rail given the locations the ATN would need to serve, physical restrictions within the study area, and generalized ATN design constraints. (Regulatory requirements could result in changes to the design, operation, and alignment of the system)

3. The City could likely build an ATN at the Airport today that would nominally meet most of its needs. The possible exception is the link between the Airport's Terminal A and the rental car facility opposite Terminal B. Long-term projections for passenger travel between these two points are quite high during peak periods, higher than it appeared from the information provided that current ATN designs would be able to support.
4. It would be possible to configure an ATN system that can accommodate high passenger demand, such as the Airport's peak period inter-terminal traffic. One such configuration, devised and confirmed analytically by Aerospace, may provide service comparable to a conventional APM while offering greater flexibility. But it must still be verified conceptually and physically. Other approaches may also be feasible.

Arup found that:

5. Despite including a very high contingency to capture the risks associated with an emerging technology, the estimated capital cost of the Airport ATN Project is less than the cost of the proposed Airport APM system, using a similar cost estimating methodology.
6. The estimated operating cost of the Airport ATN Project is comparable to the savings that would be achieved by discontinuing the VTA and Airport bus shuttles, based on 2011-12 Airport shuttle bus costs. However, since Arup completed its analysis, the Airport cut its shuttle service and costs due to continuing revenue shortfalls. Airport revenues are not expected to rebound for at least a decade. Consequently, there is a gap of at least \$2.6 million between the 2012-13 Airport shuttle budget and the assumed savings from the shuttle buses.

Aerospace found that:

7. The technical requirements associated with the Airport-area ATN project range from those that are consistent with the capabilities of existing designs, those that would likely require performance upgrades, and those that may exceed current capabilities by a considerable margin.
8. While the CPUC has regulatory authority over ATNs in California, there is no established regulatory path for certifying new transportation technologies, particularly one as complex as this. By continuing to pursue construction of an ATN, San José could serve as a catalyst, prompting ATN developers and the CPUC to define and actuate that process.

Conclusion

Given the level of technical and regulatory uncertainty, it would be too risky for the City to proceed immediately to a conventional design/build process to build the Airport ATN. More information is needed to definitively ascertain the capabilities and flaws of current ATN designs and means to overcome those weaknesses. Growing global interest in ATN as well as projects in development and under construction may help to resolve some of these technical issues. But, even if this were the case, practical considerations recommend against moving forward with the Airport project in the short term. The two primary concerns are the Airport's financial situation and the anticipated decade or more that may be required before BART is extended to downtown San José and Santa Clara.

Even then, if the City moved forward with the Airport ATN system, it would likely be more cost effective to connect to Diridon, rather than the Santa Clara BART station. Doing so would link both BART and California High Speed Rail passengers to the Airport as well as, potentially, to an off-site parking garage located between the Airport and Diridon facilities. However, High Speed Rail is also not expected to arrive in San Jose until 2027.

Staff concurs with its experts that ATN technology appears to have merit and is worth continued pursuit. If San José is interested in doing so, there are steps the City could take, at minimal risk, to continue to exercise national leadership, advance ATN technology, encourage the industry's development, and ultimately build a system that furthers its transportation goals. San José could pursue these in partnership with other like-minded agencies.

The Federal Transit Administration (FTA) has expressed interest in working with the City, private industry, research institutions, and the Swedish government via a Memorandum of Cooperation signed by both countries, to accelerate the development and deployment of ATN technology. Other cities in the Bay Area and elsewhere in the nation have indicated interest in ATNs, as have universities. The Mechanical Engineering Department at San Jose State University is helping to lead a newly-formed multi-disciplinary team of students that seeks to advance ATN technology by building a prototype system. City staff have been asked to serve as advisors to the team.

Suggested Next Steps

Staff recommends that the City defer active development of a San José ATN project and instead focus in the near-term on supporting overall ATN industry development by pursuing the following steps:

1. Share the findings of the City's study with others, particularly other public agencies.
2. Coordinate with the FTA, Swedish governmental agencies, and other key stakeholders to map out a collective path forward and to secure funding to support ATN development.
3. Initiate a dialogue with ATN developers and the CPUC regarding establishing a process to develop regulations for building ATN systems in California.

4. Provide mentorship to San Jose State University for their research and development efforts related to ATN systems
5. Identify a more financially, and possibly technically, viable San José's ATN project. One possibility could be linking the Airport to North San José and Downtown, including Diridon Station, with project implementation aligned with BART and/or California High Speed Rail service at Diridon Station.

COORDINATION

Preparation of this report was coordinated with the City Attorney's Office and the Airport.

/s/

HANS F. LARSEN
Director of Transportation

For questions please contact Laura Stuchinsky, DOT Sustainability Officer, at 975-3226.

Attachments

- ATN Alignment Map
- ATN Project Renderings at Airport