AUTOMATED TRANSIT NETWORK

compared to

LIGHT RAIL and BUS RAPID TRANSIT

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INTRODUCTION

Automated transit networks (ATN) are defined by the ASCE Automated People Mover (APM) Standards ANSI/ASCE/T&DI 21-21 as a subset of Automated People Mover (guideway-based driverless transit) that has all stations offline, switching that requires no track-based moving parts and train capacity less than 25 passengers. Various examples of ATN are in public service around the world while numerous suppliers are developing new versions of the technology. This paper compares light rail transit (LRT) and bus rapid transit (BRT) to 4 - 6-passenger ATN. The comparison is based on known attributes of each technology. Some new ATN attributes enabled by recent changes to the ASCE APM Standards are discussed.

Each attribute has been assigned a subjective rating of good, acceptable, or poor as represented by the 🙂 😐 ☹️ emojis respectively. The intent of the ratings is to provide a quick assessment for each attribute. The adjoining narrative can then be considered to develop an understanding of the reasoning behind the assessment.

MOBILITY & PASSENGER SERVICE — ATN LRT BRT

Speed. (ATN 🙂, LRT 😐, BRT ☹️) Because LRT and BRT use large vehicles carrying many passengers there is almost always somebody needing to get on or off at each station. These modes must therefore stop at every station. This slows them down dramatically. A system with a top speed of 55 mph (88 km/h) will typically only average 20 – 30 mph (31 – 48 km/h). Dividing total vehicle revenue miles by total revenue hours we find average revenue speeds of 15.8 mph (25.3 km/h) for LRT and 9.2 (14.7 km/h) for BRT[2].

All ATN stations are offline and can be bypassed at speed. Since vehicles only hold up to six passengers it is possible for all trips to be express with only a few intermediate stops. With a top speed of 50 mph (80 km/h) ATN will average over 40 mph (64 km/h) if it is nonstop, and over 30 mph (48 km/h) if it has a few intermediate stops. Even with 25% empty vehicle movement (considered high), ATN average revenue speed is estimated to be over 20.0 mph (32 km/h).

Figure 1. Offline station

[1] President: Advanced Transit Association, PRT Consulting, Inc.; CTO: Vuba Corp.

[2] NTD 2018 National Transit Summaries and Trends, Office of Budget and Policy, FTA, December 2019

MOBILITY & PASSENGER SERVICE (continued) ATN LRT BRT

Capacity. ATN systems already in public service have demonstrated headways as low as three seconds and speeds up to 43 mph (70 km/h). With six-passenger vehicles, this results in a theoretical maximum capacity of 7,200 passengers per hour per direction (pphpd). This capacity can be increased by platooning (physically or electronically) up to four vehicles together. This results in a maximum theoretical capacity over 20,000 pphpd. New control systems are being developed that will allow one-second headways, like cars on a freeway, based in part on new changes in the ASCE Automated People Movers Standards issued in 2021. This is the preferred way to achieve a maximum theoretical capacity over 20,000 pphpd. Few LRT or BRT systems exceed this capacity.

Waiting times. Many small vehicles result in shorter waiting times. The Heathrow ATN system near London has average waiting times of less than 30 seconds. ATN systems with tiered fares could serve premium fares in about a minute. Economy riders will wait around 5 minutes all day and night. Some LRT and BRT systems may match 5 minutes during peak hours, but none can maintain this level of service off peak.

Walking times. Because stations are offline and do not slow through traffic down and because they can be sized to demand (unlike LRT where every station must be sized to the longest possible train length), they can be closely spaced. In addition, because of the small footprint, guideways can be closely spaced, resulting in stations being close together throughout communities and not just along corridors. This allows almost all homes and businesses within the ATN service area to be within a 5-minute walk of a station. By contrast, it is typical for most LRT or BRT passengers to have to reach suburban stations by modes other than walking.

Reliability. U.S. transit level of service A is the goal for LRT and BRT[3]. It is determined by reliability exceeding 97.5%. By contrast, modern ATN systems in public service have reliability exceeding 99.5% - five times higher than transit level of service A.

Safety. Fatalities and injuries per 100 million vehicle revenue miles are reported as: LRT[4]: 38, 289; BRT[2]: 0, 1732; Monorail/Automated Guideway[2]: 0, 0. ATN belongs in the Monorail/Automated Guideway category. ATN[5] has completed over 300 million injury-free passenger miles (500 million passenger km) worldwide.

Seating. On buses and trains, many passengers must stand – especially during rush hour. This is not only uncomfortable, but also dangerous, leading to many injuries. On ATN the vehicle roof is deliberately low, forcing all adult passengers to be seated. This allows more aggressive acceleration and deceleration while also increasing comfort and safety.

[3] TCRP Transit Capacity and Quality of Service Manual
[4] FTA Rail Safety Data Report, Rail Transit Safety Data 2007-2018, September 2021
[5] PRT Consulting

CLIMATE CHANGE & POLLUTION — ATN — LRT — BRT

Energy use. Passenger miles by mode per gasoline gallon equivalent (GGE) are: Transit Rail: 50; Commuter Rail: 39; Transit Buses 27[6]. At an average passenger load of 1.5, the Masdar ATN system achieves 167 passenger miles per GGE while the Heathrow system achieves 250[7] for an average of 208 – 4 times better than transit rail, 5 times better than commuter rail and 9 times better than transit buses. ATN energy use per passenger mile/km is one quarter LRT and even less compared to BRT.

CO_2 emissions. ATN station & guideway infrastructure is well-suited to solar panel incorporation. Even using grid power like typical electric transit, the emissions will be greatly reduced due to the lower energy use. While all LRT is electrically powered, most BRT is not.

Air pollution. Because of lower energy use ATN will always have lower emissions even when some energy used is polluting

Noise & vibration. Lightweight electric vehicles are quiet with little vibration

Footprint. Elevated guideways & stations have < 1% of LRT or BRT footprint. This is very significant to climate change since transportation utilizes some 30% to 70% of the space in our cities – most of it paved. Cities designed and built around ATN could be dramatically smaller and/or have people living and working in more natural, park-like surroundings.

Visual intrusion. Beauty is in the eye of the beholder and visual intrusion is difficult to evaluate. While ATN is usually elevated it is also much smaller than LRT or BRT. To minimize visual intrusion modern ATN systems should be artistically designed so that they are pleasant to look at – see Figure 2.

Figure 2. Artistically designed ATN

[6] https://afdc.energy.gov/data/10311

[7] http://www.advancedtransit.org/advanced-transit/prt-characteristics/

COSTS **ATN** **LRT** **BRT**

Capital costs per passenger mile. ATN capital costs[8] are $0.35 per passenger mile compared to $4.49 for LRT[9] and $1.14 for BRT[9]. Therefore, ATN capital costs are 1/12 LRT and 1/3 of BRT.

Operating costs per passenger mile. ATN operating costs[8] are $0.21 per passenger mile compared to $0.96 for LRT[9] and $0.84 for BRT[9]. Therefore, ATN operating costs are 1/4 of LRT and BRT.

Revenue. ATN's higher average speed, safety and reliability, coupled with shorter walking and waiting times and tiered fare structure allow it to capture a much higher mode share than conventional transit. Figure 3 below shows the results of numerous studies undertaken by different investigators using different techniques in many cities around the world.

A significant portion of this increased mode share comes from passengers who can afford to pay more for better service, resulting in higher average fare prices and improved profitability.

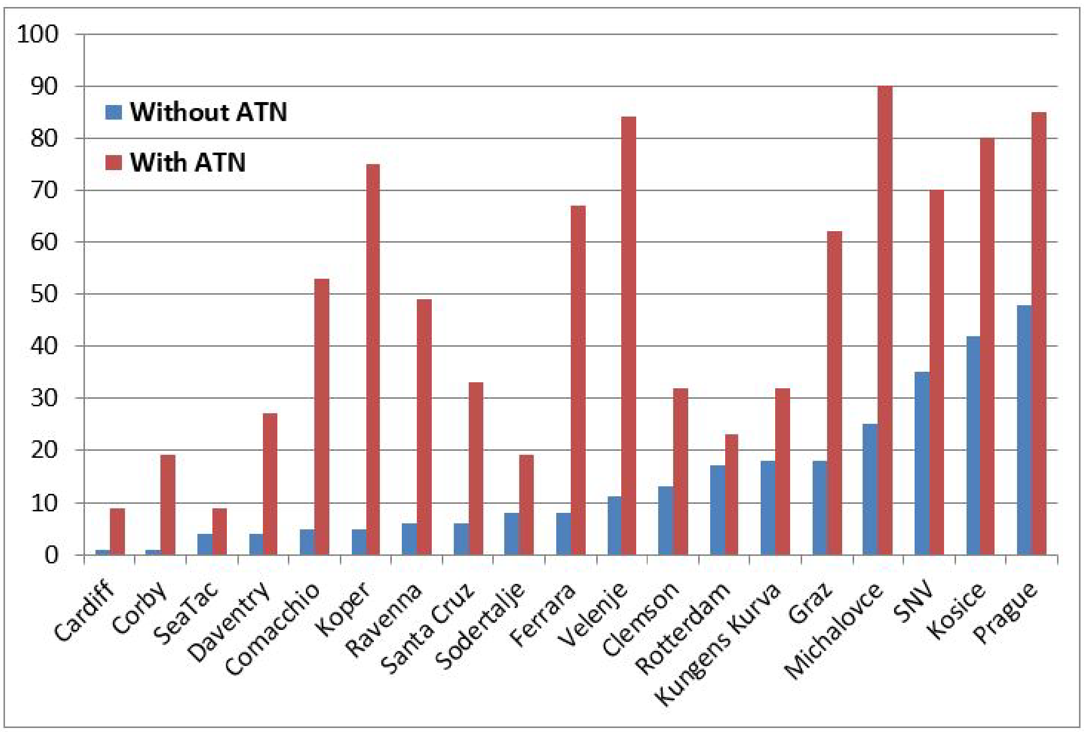

Figure 3. Transit mode share with and without ATN

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[8] PRT Consulting, Automated Transit Network Feasibility Study for Clemson, Greenville and Mauldin, August, 2018

[9] FTA, Current Capital Investment Grant Projects. https://www.transit.dot.gov/funding/grant-programs/capital-investments/current-capital-investment-grant-cig-projects

COSTS (continued)	ATN	LRT	BRT
Subsidies. LRT & BRT require subsidies for all capital plus some operating costs.	☺	☹	☹

Due to the network effect, transit utility (and therefore, ridership) increases approximately as the square of the increase in number of stations. ATN systems will usually become profitable, paying their own costs of capital and O&M, once they have more than about 30 to 50 stations. This is because all stations are interlinked and adding a station does not slow through-traffic down. LRT and BRT, on the other hand, do not benefit much from the network effect because added stations mean slower trips with more transfers.

CONCLUSIONS

Although some ATN attributes considered here are still being perfected, every rating shown above is backed up by an attribute that is already sufficiently functional to support the conclusion (e.g., in the absence of proven one-second headways, proven platooning can be used). The results are significant – a technology that can be shown to be better than LRT or BRT in 15 out of 17 attributes and worse in none. Some commercially available forms of ATN already excel at most of the 17 attributes. Commercial availability of ATN technology is significantly less than that for LRT or BRT technology.

Doctors waited 140 years to act on proof that hand washing was vital to patient health. Similarly, most of the above information has been available since 1978[10] but not adequately acted upon. Transit ridership continues to decline while congestion and climate change cannot afford to wait any longer. The transit industry needs to act on the above information immediately.

[10] Irving, Jack H., Fundamentals of Personal Rapid Transit, Aerospace Corporation, ISBN 0-669-02520-8