



Cost-Benefit Analysis: Accelerated Replacement of the SFMTA Light Rail Fleet Updated March 2019

BACKGROUND

In 2012, the San Francisco Municipal Transportation Agency (SFMTA) broke ground on the first major subway system expansion in decades. The Central Subway project connects the existing T-Third light rail line to a new subway tunnel at 4th & King and will bring subway service to three new subway stations: Yerba Buena/Moscone Center, Union Square, and Chinatown. To support the increased service demand for the Central Subway project as well as system-wide growth along the Mission Bay corridor, we selected Siemens Mobility to provide 24 expansion vehicles and to provide a critically-needed replacement fleet of 151 existing vehicles, which will reach the end of their useful life beginning in 2021. The SFMTA has since optioned an additional 40 expansion vehicles to support increased ridership along the T-Third corridor and purchased an additional 4 cars funded out of the Mission Bay Transportation Improvement Fund to better serve the new Chase Event Center. This represents a total of 68 expansion cars, the last of which is expected to enter revenue service by summer 2019, six months ahead of the anticipated opening of the Central Subway tunnel.

In selecting Siemens Mobility, we exceeded all our procurement objectives. Central to this procurement was the need to integrate lessons learned from prior procurements and make improvements on deficiencies on our existing fleet. We utilized a performance-based specification that allowed car builders to provide proven designs that addressed our concerns. Siemens has a long and solid history of producing and delivering quality cars on time, and went above and beyond in numerous categories:

- The vehicles are being manufactured locally at the Sacramento, California plant, providing local reinvestment of public resources.
- The anticipated 30-year life span exceeds the 25-year expectation of the Federal Transit Administration (FTA).
- The vehicles' predicted reliability metrics will exceed the specifications of the RFP.
- Siemens provided the opportunity for faster delivery—which they have met.

This was all accomplished at a very competitive price: their bid was nearly 20% below the engineer's estimate and the next-most-competitive bidder.

The SFMTA pursued a very aggressive manufacturing and delivery schedule: the SFMTA issued Notice to Proceed on September 30, 2014. The first vehicle was delivered in January 2017 and entered service in November 2017. To support this effort, the SFMTA created an Acceptance Team comprised of knowledgeable operations, engineering, and maintenance staff. This team spent the majority of 2017 working to ensure the smooth acceptance and safety certification of this new fleet. This involved developing and implementing an operator training program, surveying the existing right of way and making modifications to the dynamic envelope where required, ensuring the vehicles communicated with our existing train control systems, and configuring and implementing a new on-board passenger

information system. The SFMTA obtained California Public Utilities Commission (CPUC) safety certification approval on the first application—something peer agencies have failed to achieve.

PROGRESS TO DATE

Since entering revenue service, the public support for this new fleet, often referred to as “LRV4,” has only grown. The car body features wider gangways with increased space for wheelchairs and strollers. The side-running seating has expanded the space available for all riders, reducing rush hour crowding. The on-board signage provides new color displays with improved wayfinding and system-wide visual and auditory stop announcements. The cars are lighter than their predecessors and quietly move through the city’s neighborhoods. The vehicles are designed for up to four-car consists, permitting an increased flexibility for future fleet deployment. Most importantly for operations are the improved crashworthy design, which meets updated safety standards, and the improved reliability and maintenance program. The fleet will be far more reliable and far easier to maintain than the legacy Breda (also referred to as LRV2 and/or LRV3) fleet. The time and energy spent incorporating lessons learned into the vehicle specifications have ultimately paid off. Siemens Mobility has been a collaborative partner: we’re able to receive and incorporate feedback on an iterative basis.

In January 2019, the SFMTA performed a Passenger Satisfaction Survey and hosted two focus groups to gather feedback on the public satisfaction with the new Siemens vehicles. The vast majority of riders surveyed—two-thirds—are satisfied with the vehicles, with less than a quarter reporting overall dissatisfaction. The improvements made to the interior vehicle design, which were based on a previous 2014 survey of riders, all resulted in positive marks. Passengers agreed that there are plenty of places to stand (87%), the trains are attractive (85%), and the vehicles are easy to enter and exit (83%). There were areas for improvement as well: based on rider feedback, we are working to improve the interior seating and stanchion design to increase passenger comfort. We are also working to make other less visible mechanical improvements using lessons learned for the next phase of the procurement. The primary feedback we now receive from the public is: Why aren’t there more of these vehicles entering service sooner?

As of the time of writing—March 2019—49 of the total 68 expansion fleet have entered service, with another dozen cars in various stages of delivery, acceptance, and burn-in. Our dedicated Acceptance Team has become familiar with the vehicles and works collaboratively with Siemens Mobility to address manufacturing issues and ensure the vehicles are in top shape ahead of acceptance. Developing this process took substantial time and energy and has produced an expert staff on both the Siemens Mobility and the SFMTA sides.

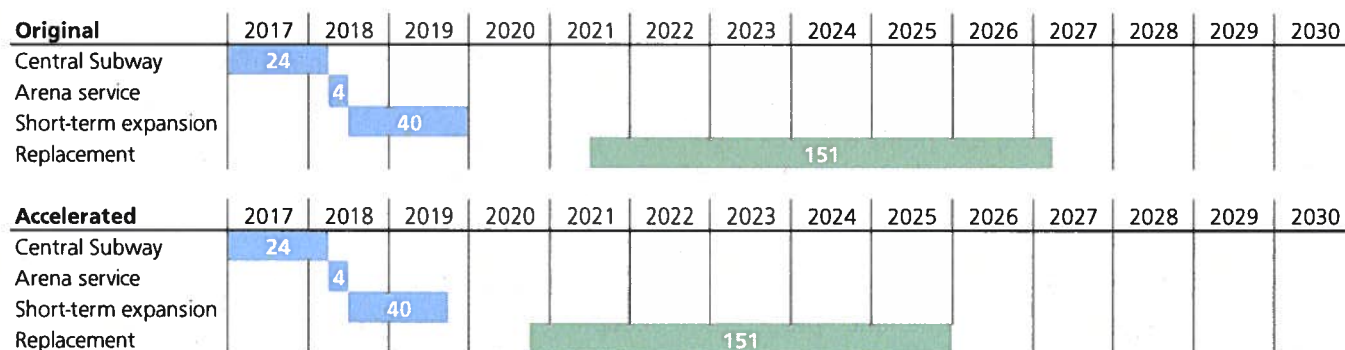
MOTIVATION

Over recent years, the volume of revenue miles for the Muni light rail operation has grown significantly. The number of annual miles travelled by the legacy Breda fleet has increased by over 20% in the last five years alone. This increased service has strained performance of the Muni rail fleet, especially as the Breda fleet enter their last years of life. At present, vehicle mechanical failures account for more than 50% of all subway delay time. Considering the diminishing reliability and increasing costs of continuing to operate the Breda fleet, we decided to assess the benefits derived by the early retirement of the Breda fleet. We reviewed the projected costs associated with the continued operation of the Breda fleet through the end of their 25-year life. We have a unique opportunity to replace this aging fleet early to save both

staff time and Agency funds while simultaneously improving the passenger experience through improved reliability and upgraded facilities. While not all costs or benefits can be easily monetized, we have summarized our areas of examination below.

Working collaboratively with Siemens Mobility, we have developed an updated replacement schedule proposal that maximizes resources and benefits. This timeline both accelerates the delivery of the first replacement vehicle by as many as 6 months and compresses the delivery window from six and a half years to five. This change would continue the current expansion fleet delivery pace Siemens Mobility has successfully accelerated of approximately two vehicles per month through 2023, at which point Siemens would increase the delivery pace to three vehicles per month through the end of the replacement vehicle phase.

Figure 1: Original vs. Accelerated Replacement Schedule



BENEFITS

There are several benefits that can be derived from the acceleration of the Siemens contract and the early retirement of the Breda fleet. The benefits examined are:

1. Direct financial:
 - a. Reduction in contract escalation costs
 - b. Deferred costs for the current Breda fleet that could be put to more beneficial use
2. Indirect financial: improved efficiencies resulting in staff time and Agency resource savings
3. Operational efficiencies: improved operations outcomes from less complex service and maintenance environment

Direct financial

Escalation

Large long-term contracts typically encounter variability due to cost escalation over time. However, the light rail vehicle (LRV) procurement is largely insulated from variable cost escalation due to the structure of the contract. The Base contract calls for the purchase of 24 LRVs (Phase I) and the subsequent replacement of 151 LRVs (Phase II). The escalation rate for the purchase price of the vehicles is outlined in the contract, and is enacted only once at the execution of Phase II. Once this vehicle price is negotiated according to the terms in the contract, there is no further cost escalation in contract payments. Because the contract payments account for approximately 85% of Phase II project expenditures, costs will remain very stable regardless of the final delivery pace. An earlier execution of replacement will result in a slightly lower per-vehicle price as the price index has increased during the

last two quarters and is expected to continue to increase. However, there is no substantial benefit or dis-benefit to the overall project cost by controlling escalation costs through an accelerated schedule.

Deferred heavy overhauls

Over the next few years, the Agency will be required to replace several key systems on the Breda vehicles to ensure they continue to operate as needed through the end of their useful lives. Without these major overhauls, the vehicles will experience an increasingly frequent rate of operating failures and result in a reduced quality of service to Muni patrons. The Air Compressors, Propulsion Inverter module (GTO), Truck Overhaul and Train Control System all require heavy overhauls. Preliminary engineering estimates for these system overhauls exceed \$85 million over the next four years.

While this work will be necessary to ensure that equipment can operate safely and last long enough to reach retirement, such expenditures fleetwide are uneconomical as there will be minimal remaining value left when the equipment is finally retired. Unlike the rubber-tire fleet, there is no aftermarket for LRVs, and therefore no opportunity to defray the costs of this investment. Furthermore, parts are becoming increasingly difficult to procure as more and more systems cease to be manufactured. The parts are also becoming increasingly expensive: between 2011 and 2015 the cost of LRV parts doubled. Instead, investing limited capital funds towards the vehicle procurement and acceleration will provide a better return-on-investment through the improved vehicle performance discussed below.

Indirect financial

The preventive maintenance of the Breda fleet is very labor intensive. In procuring the Siemens fleet, we sought a less labor-intensive maintenance program. In accepting and utilizing our new fleet, we have been able to assess both the reliability predictions as well as the actual time savings associated with fleet replacement. Mean Distance Between Failures (MDBF) is the performance metric used to assess the state of good repair of a transit fleet. It demonstrates the number of miles traveled, on average, by a fleet before it encounters a mechanical failure resulting in delayed service. Our legacy light rail fleet currently has an MDBF of approximately 5,000 miles. The Siemens vehicles are contractually required to average 25,000 between failures—meaning the vehicles could more than travel five times the distance before encountering a failure resulting in a service impact.

The improved design of the Siemens vehicle has also reduced both time and cost of the vehicle maintenance. An example of this is illustrated in the maintenance of the step assembly unit. Doors and steps are the top two causes of vehicle delays in service, and their maintenance is complex: During the quarterly preventive maintenance interval (PMI) on the Breda fleet, mechanics must disassemble multiple components to access the linkage system where they must manually clean and lubricate the gears. This process compounds not only the time required to complete this PMI, but also introduces the possibility of human error during reassembly. The Siemens cars simply require a function check and visual inspections for wear or damage and cleaning as needed. With several other main assemblies following this pattern, the overall time saved for major inspections increase. If we continue to utilize the fleet at a rate of 40,000 miles per year, SFMTA staff can expect to save 182 labor hours per vehicle per year. Between 2021 and 2025, the compounding savings provided by the new Siemens fleet, for preventive maintenance alone, is approximately \$6 million.

Operational efficiencies

In addition to these financial benefits, there is a real complexity to operating a mixed rail fleet. At present, the SFMTA operates rail service out of the Green Yard near Balboa Park and the Muni Metro East (MME) Yard along the T-Third line in the Dogpatch neighborhood. Procuring and stocking progressively obsolete parts at both locations will become an increasingly difficult challenge. Ensuring mechanics are fully trained across both fleets will prove difficult and will no doubt represent a serious training and staffing challenge, particularly as mechanics experienced in maintaining the Breda fleet retire. While this transition period exists with any new fleet procurement—rail or rubber-tire—the length of time our staff faces this dual fleet maintenance will have dramatic impact on our ability to successfully navigate these challenges.

Under the original contract pace, the first Siemens vehicle entered service in November 2017. Under the original schedule, the last Breda vehicle would be retired in 2027—10 years of operating a mixed fleet. In addition to the continued challenges of locating critical parts, utilizing a dual fleet for a decade will serve as a major operational challenge. All operators must become certified on each unique vehicle type before they can regularly operate the vehicle in service. Continuing to dual-certify operators will lengthen the amount of time each operator must spend in training before they become available for revenue service. Under the accelerated plan, the final Breda would be retired in fall 2025, reducing the mixed operations window by almost two years.

COSTS

There are several costs associated with the accelerated procurement and early retirement. The costs examined are:

1. Direct financial:
 - a. Contract modification costs
 - b. Financing costs associated with faster procurement
2. Indirect financial:
 - a. Alternative uses of local funds
 - b. Remaining federal interest on Breda fleet

Direct financial

Contract modification

We are currently negotiating contract modification costs with Siemens to facilitate the accelerated delivery of the replacement fleet. There are two types of contract modifications currently being considered: 1. Vehicle improvements and 2. Acceleration modifications. During the past 18 months of vehicle operations, SFMTA staff has identified desired alterations to the vehicles that will result in a contract modification ahead of initiating the replacement phase. These improvements primarily address vehicle maintainability and passenger comfort, and will be negotiated with Siemens for additional cost regardless of the pacing of the schedule. There is one cost associated directly with the acceleration timeline: to enable the pacing outlined in this memo, Siemens will need to add production capacity, which requires the retooling of production facilities. We anticipate this will result in a one-time cost of \$20-25M.

Financing costs

Consolidating the funds required for vehicle replacement on an accelerated timeline requires financing against future local funds. We have worked with the Metropolitan Transportation Commission (MTC) and the San Francisco County Transportation Authority (SFCTA) to develop a funding plan to support the proposed accelerated schedule. The SFCTA contributions are inclusive of SFCTA's anticipated financing costs and are within the Proposition K Vehicles category's available capacity which was approved by the SFCTA in 2018. Funding this project will largely exhaust the Muni Vehicles category through the end of the local sales tax authorization in 2033. At present, the SFMTA does not expect to need to finance against Federal funds. However, as part of the funding plan, we have included Regional Measure 3 (RM3) Bridge Toll funds; these funds are currently the subject of litigation. In the event that these funds are not available in the required timeframe, or become entirely unavailable, we plan to finance against future federal funds. The estimated cost of this financing is expected to be in the range of \$0-40 million. Financing against future federal funds requires MTC's approval and a Letter of No Prejudice (LONP) from FTA. Based on cash flow projections, financing would be needed starting in 2022. Debt could be issued by either MTC or SFMTA.

Indirect financial

Funding for Future Vehicle Replacements

Exhausting the Prop K Muni Vehicles category will nearly fully draw down the SFMTA's most reliable source of "matching" local funds for federally-supported fleet procurements. The SFMTA expects to be required to contribute approximately 25% in local funds of the cost of any future revenue vehicle replacement. Between 2019 and 2033, the SFMTA expects to replace the entirety of its rubber-tire fleet—the 30' fleet is currently at the end of its useful life and will be replaced within the next five years. The 40' and 60' Motor and Trolley coach fleets will become eligible for replacement beginning in 2025. The SFMTA will need to identify another large source of local funds ahead of the next major fleet procurement.

Federal Interest and Early Retirement

On February 22, 2019, the SFMTA obtained a waiver from the FTA for the early retirement of the Breda fleet. When a transit service provider retires their revenue fleet ahead of the end of useful life, they must calculate the remaining federal interest for each vehicle (based on the percentage of federal funds that were used to pay for that vehicle and the number length of time remaining in the FTA useful life—25 years for LRVs). In accordance with FTA policies, the remaining federal interest in the Breda vehicles will be invested in a future SFMTA vehicle procurement. This is not a direct payment to the FTA, but instead, SFMTA will account for this remaining federal interest by providing local match in excess of 20 percent to a future vehicle procurement in an amount equal to the remaining federal interest. As the Breda vehicles are retired, we will work collaboratively with the FTA to calculate the specific amount of federal interest remaining--currently estimated at up to \$30 million--and the future procurements to which that will be applied. It is also possible that the remaining federal interest could be applied to the Siemens LRVs, which has local funds in excess of FTA's requirement (\$384 million total local match which is approximately 50 percent of the replacement car procurement cost).

Direct costs and savings associated with contract acceleration

Activity	Estimated Savings (Costs)
Prop K Financing (SFCTA)	(\$24 million)
FTA Financing (MTC/SFMTA)	(\$0-40 million)
Contract Modification	(\$20-25 million)
System Overhauls	\$75 million
Maintenance Costs	\$6 million
TOTAL SAVINGS (COSTS)	\$37-(\$8) million

SUMMARY

It is quite rare that a transit agency would procure an expansion fleet ahead of a replacement fleet. However, spurred on by the Central Subway timeline, the SFMTA has now initiated, executed, and accepted the majority of the 68 expansion vehicles. With the complex work of design and safety certification behind us, we could choose to execute the replacement portion of the contract immediately and benefit sooner from the improved operations and maintenance that the Siemens fleet offers.

CONCLUSION

The Siemens fleet procurement has been an incredible success story: we successfully executed a performance-based contract to improve on our past experiences operating and maintaining a light rail fleet; the bid price came in far below engineering expectations; Siemens has exceeded original production timelines; and the public has embraced the fleet and wants more of the new vehicles in service.

Facing diminishing performance from our legacy fleet and reviewing the many hard and soft benefits of the early retirement, we strongly believe that the accelerated delivery of the new Siemens fleet is the best choice for our riding public. It allows us to continue to build on a highly successful project and for the public to benefit sooner from this success.

