WORLD BANK GROUP
Transport & ICT

Imperial College London

Railway and Transport Strategy Centre

The Operator's Story

Appendix:
Washington DC's Story

Community of Metros
CoMET

Nova
Group of metros

The Operator's Story: Notes from Washington DC Case Study Interviews

March 2017

Purpose

The purpose of this document is to provide a permanent record for the researchers of what was said by people interviewed for 'The Operator's Story' in Washington DC. These notes are based upon meetings between 13th – 16th June 2016. This document will ultimately form an appendix to the final report for 'The Operator's Story' piece Although the findings have been arranged and structured by Imperial College London, they remain a collation of thoughts and statements from interviewees, and continue to be the opinions of those interviewed, rather than of Imperial College London. Prefacing the notes is a summary of Imperial College's key findings based on comments made, which will be drawn out further in the final report for 'The Operator's Story'.

Method

This content is a collation in note form of views expressed in the interviews that were conducted for this study. Comments are not attributed to specific individuals, as agreed with the interviewees and WMATA. However, in some cases it is noted that a comment was made by an individual external not employed by WMATA ('external commentator'), where it is appropriate to draw a distinction between views expressed by WMATA themselves and those expressed about their organisation.

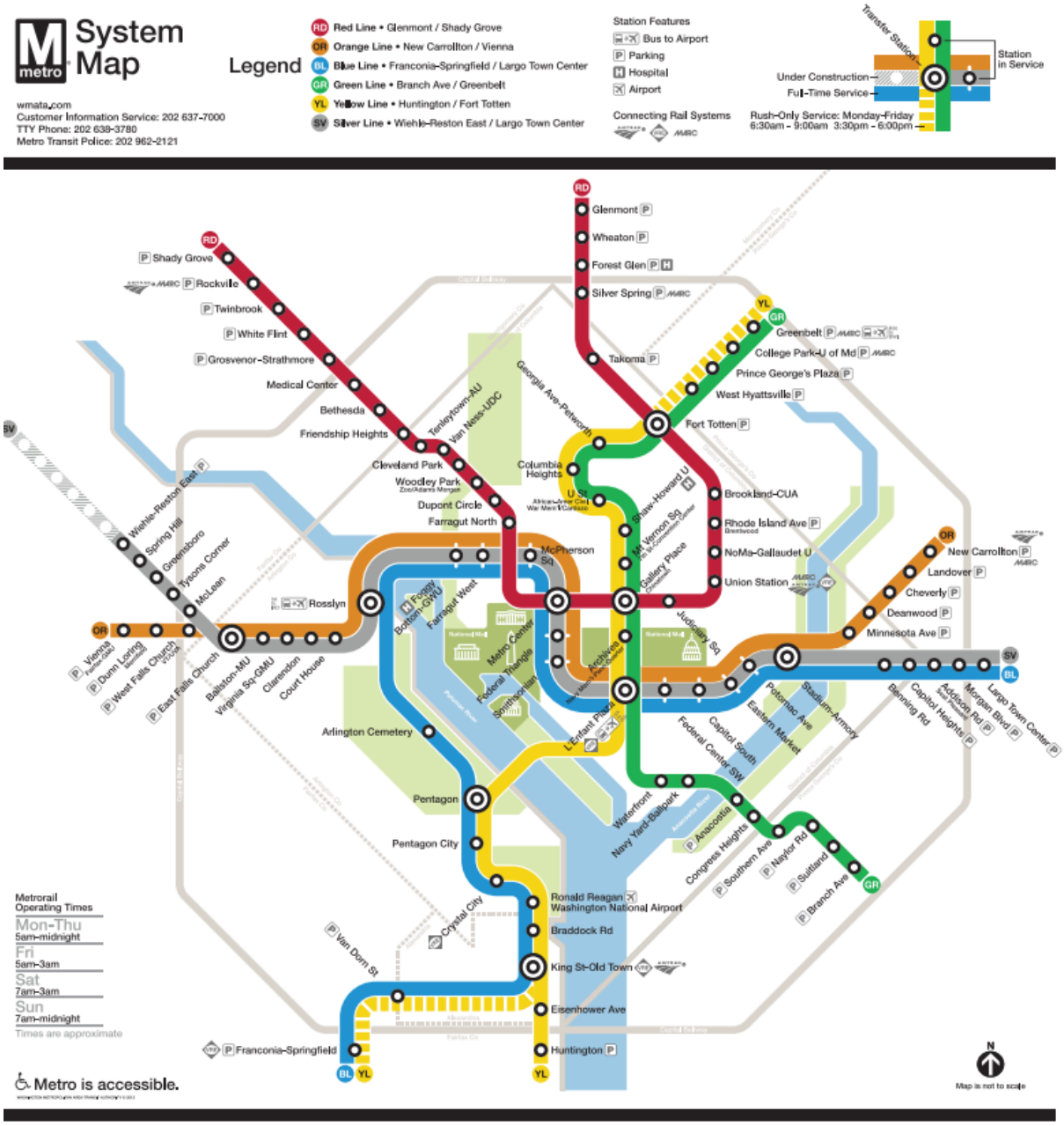
Key Messages: Relevance to International Learning about Metro Operators

This case study illustrates a large variety of international lessons about metro operations. Key lessons for operators include:

- WMATA's experience demonstrate the critical importance of **a sound asset management plan** in place when the system is designed, incorporating good asset information, preventative and corrective maintenance plans and forecasting renewal, to ensure it is fit-for-purpose in the future. To support this, a dedicated overnight maintenance window allows ongoing maintenance and should be protected when setting operational hours.
- An organization must be **adaptable to both construction and operation** of metro systems if it is to succeed in the long-term. This requires expertise in both areas, a predictable pipeline of projects to retain talent, and an organizational culture based on both areas. Despite this, it is important to note also that talent in both areas needs to be retained as the system starts operations. Systems that expand incrementally as projects are proposed and approved will continue to need this expertise, which is likely to become more refined with experience. Human capital is also an asset to the operator alongside its physical assets, and neither should be allowed to degrade.
- **Organizational leadership** is critical in setting the direction for the operator. An overly politicized environment will result in long-term costly implications for the metro which cannot easily be undone. Objectivity and longevity appear to be key for Board leadership. Focusing on short-term issues or delving too deeply into detail will risk the strategic direction a successful metro operator needs.
- Long-term consideration should be given as much to the operator's **governance structure** as it is to other operational areas. WMATA have ultimately outgrown the governance structure set out for them, established at the greenfield stage. WMATA are now in a position to materially influence the region and support its economic, social and environmental welfare. Their existing governance structure does not provide WMATA with the autonomy needed to plan such a system and disincentivises regional thinking fundamental to sustainable metro development.
- **Annualized funding arrangements** will not likely result in sustainable metro operations. Rarely is a single funding cycle adequate to fund major programs, particularly when this cycle includes both operating subsidy and capital funding, and the necessity of asking for funding annually may leave the metro vulnerable to wider financial pressures, threaten level of service and makes it very difficult to plan major, value-creating metro projects.
- An accountable, pervasive **safety culture** from the outset of the metro's creation should be the operator's first priority. WMATA demonstrate that responding to incidents must be strategic as well as technical, to encompass the technical failures at play but examining more widely institutional issues that contribute to the operational failure, such as investment in assets and maintenance for example. A regulator with experience in overseeing metro operations will likely strengthen this culture.
- Coupled **metro development with TOD** and walkability to stations will maximize the potential ridership catchment and generate long-term demand. Urban areas are competing for talent, economic development and quality of life and a successful metro encourages all three. A legal framework for value capture that aligns the interests of the local authority and the metro towards TOD (e.g. the operator captures the value increase and the local authority captures tax increase) is valuable in prioritizing integrated development.
- A **distance + base fare regime** in areas with commuter-oriented travel patterns. This responds to the additional costs of operating a more widely-distributed metro.

- **Service quality** has a strong effect on demand and this must be taken into account when searching for cost efficiencies. Alongside existing service quality challenges, proposed service cutbacks on WMATA's network commencing in the 2018 financial year risks making the metro significantly less attractive to customers, particularly those with access to private cars, and this will be an ongoing area to monitor.

Transit Map

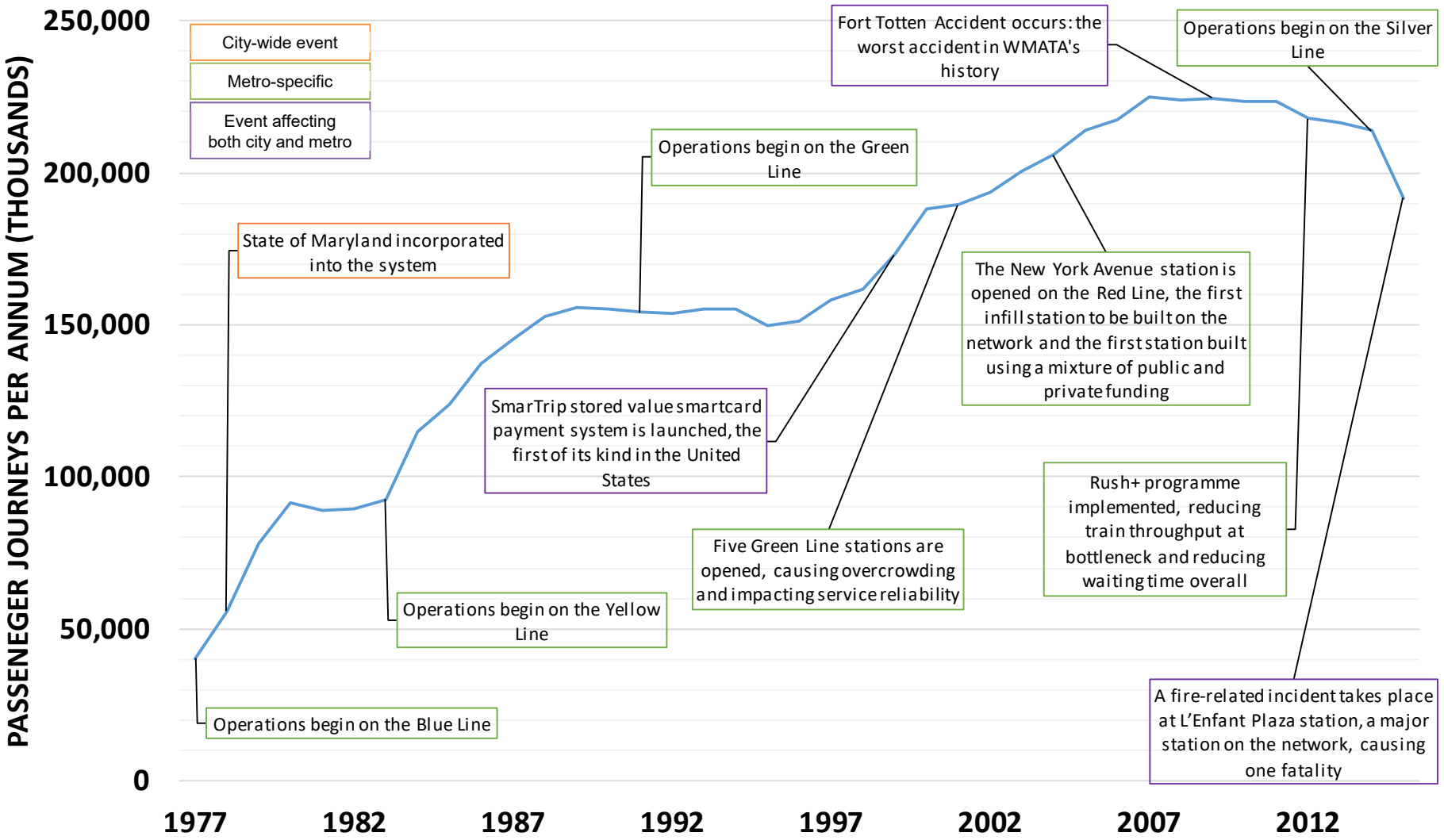

System Map
Legend
RD Red Line • Glenmont / Shady Grove
OR Orange Line • New Carrollton / Vienna
BL Blue Line • Franconia-Springfield / Largo Town Center
GR Green Line • Branch Ave / Greenbelt
YL Yellow Line • Huntington / Fort Totten
SV Silver Line • Wiehle-Reston East / Largo Town Center
Station Features
Bus to Airport
Parking
Hospital
Airport
Connecting Rail Systems
Transfer Station
Station in Service
Under Construction
Full-Time Service
Rush-Only Service: Monday-Friday 6:30am – 9:00am 3:30pm – 6:00pm
wmata.com
Customer Information Service: 202 637-7000
TTY Phone: 202 638-3780
Metro Transit Police: 202 962-2121
Glenmont
Wheaton
Forest Glen
Silver Spring
Takoma
Greenbelt
College Park-U of Md
Prince George's Plaza
West Hyattsville
Fort Totten
Shady Grove
Rockville
Twinbrook
White Flint
Grosvenor-Strathmore
Medical Center
Bethesda
Friendship Heights
Tenleytown-AU
Van Ness-UDC
Cleveland Park
Woodley Park
Dupont Circle
Farragut North
Georgia Ave-Petworth
Columbia Heights
U St
Shaw-Howard U
Brookland-CUA
Rhode Island Ave
NoMa-Gallaudet U
Union Station
Mt Vernon Sq
Gallery Place
McPherson Sq
Judiciary Sq
Wiehle-Reston East
Spring Hill
Greensboro
Tysons Corner
McLean
Rosslyn
Foggy Bottom-GWU
Farragut West
Metro Center
Federal Triangle
Smithsonian
Archives
L'Enfant Plaza
New Carrollton
Landover
Cheverly
Deanwood
Minnesota Ave
Vienna
Dunn Loring
West Falls Church
East Falls Church
Ballston-MU
Virginia Sq-GMU
Clarendon
Court House
Arlington Cemetery
Pentagon
Pentagon City
Crystal City
Ronald Reagan Washington National Airport
Braddock Rd
King St-Old Town
Eisenhower Ave
Huntington
Van Dorn St
Franconia-Springfield
Potomac Ave
Stadium-Armory
Eastern Market
Capitol South
Federal Center SW
Waterfront
Navy Yard-Ballpark
Anacostia
Congress Heights
Southern Ave
Naylor Rd
Suitland
Branch Ave
Benning Rd
Capitol Heights
Addison Rd
Morgan Blvd
Largo Town Center
Metrorail Operating Times
Mon-Thu 5am–midnight
Fri 5am–3am
Sat 7am–3am
Sun 7am–midnight
Times are approximate
Metro is accessible.
N
Map is not to scale

Growth in Passenger Boardings and Key Events in Washington DC

The following graph demonstrates WMATA's growth in passenger boardings from 1977-2015 and includes selected key surrounding events that took place in Washington DC or nationally in the United States, and selected events in the history of WMATA.

This graph shows annual average weekday boardings, calculated by applying an annualisation factor of 300 to WMATA's average daily weekday boarding data.

Washington DC: Passenger Journey Profile and Key Events



General Summary of Washington Metrorail

GENERAL SUMMARY		
Background and history	▪ WMATA was established in 1966 with a mandate from the Federal Government to develop a regional public transport system. ▪ The first section of the system, the central part of the Red Line, opened in 1976. Subsequent line openings took place in 1977 (Blue), 1978 (Orange), 1983 (Yellow), 1991 (Green) and 2015 (Silver, Phase 1). The Phase 2 extension of the Silver Line is scheduled to be open in 2019. ▪ WMATA have constructed and operated all lines apart from the Silver Line, which is sponsored by the Metropolitan Washington Airports Authority, and operated by WMATA.	
Key dates and why they matter	1955	Mass Transportation Survey takes place to estimate the highway and public transport needs for 1980. The study recommends two rail rapid transit lines in Washington's downtown core.
	1960 - 1962	National Capital Transportation Agency is created in 1960 by the Federal Government to develop a rail-based public transport system. In 1962, the "Transportation in the National Capital Region" report is published, including a similar alignment to the current Red, Blue, Yellow, Green and Orange Lines. Funding for the metro system was partly sourced from a previous plan to construct an inner ring road in Washington DC.
	1965-1966	Washington Metropolitan Area Transit Authority is created through a dedicated WMATA Compact (1965) with a mandate to plan the rail-based public transport system initiated by the National Capital Transportation Agency. System planning is devolved into this regional company overseen by representatives from Maryland and Virginia.
	1968	The "Adopted Regional System" as defined within the National Capital Transportation Act (1965) is approved by WMATA's board.
	1968	Rioting takes place in Washington DC following the death of Martin Luther King. This impacted a large proportion of the commercial district in Washington DC and transport planners for the Green Line added a new station on the proposed alignment to stimulate regeneration. The Green Line more widely was conceptualised as connecting disadvantaged neighbourhoods in Washington DC.
	1976	System begins operations in the District of Columbia with the opening of the first segment of the Red Line. The Red Line comprises 7.4km across five stations. The construction of this line and stations had faced some challenges: on environmental grounds requiring the deeper tunnelling of two stations, a station court order regarding accessibility, and a challenge by local residents which was eventually overcome.
	1977	Operations begin on the Blue Line between Arlington County, Virginia and Washington DC.
	1978	The state of Maryland is incorporated into the system, in Montgomery County and Prince George's County.

	1980	WMATA announce that inflation has caused a $16 million deficit in its budget.
	1982	The first incident takes place on the WMATA network: a derailment occurs on the Orange Line during peak hour in January, causing three passenger fatalities. It was ruled that an incorrectly closed rail switch caused the train to derail as the front and back wheelsets of the train followed different track. Emergency services in Washington DC were tending to an aeroplane crash which happened shortly before the derailment. The National Transportation Safety Board rule that the derailment was caused by operator error in the areas of monitoring the rail switch, driver error when passing through the rail switch and failures in the operational control centre.
	1983	Operations begin on the Yellow Line between Huntington and Archives.
	1984	William T Coleman Junior is hired by WMATA to resolve ongoing issues with the Green Line construction and funding through the United States District Court. WMATA also propose new funding plans for completing the construction of the planned system. This necessary funding was secured through legislation passed by the House and Senate committees for the full system length.
	1988-1991	WMATA acknowledge a train car shortage, when planning for Green Line service capacity and through faults in the existing fleet. WMATA begin to operate trains at 12 minute headways during rush hour because of this shortage.
	1991	Operations begin on the first segment of the Green Line, five years after it was originally scheduled to start. Planning for the Green Line had been subject to several realignments based on pressures from the Federal Government and local jurisdictions, lawsuits from business groups, and potential alignment conflicts with parkland and a cemetery. A bus route rationalisation is also proposed around the Green Line Anacostia station (a topic of much controversy during planning), sparking protests by the area's African American community. The Board agree to cancel all planned bus route changes in the area, although this is estimated to cost WMATA $200,000 monthly in expected metro fares.
	1999	SmarTrip, a stored-value smartcard payment system for fares on the metro, is launched: the first smartcard system for fare payment in the US. The acceptance of SmarTrip cards is gradually expanded over time to incorporate the other non-WMATA public transport systems in the region, allowing easy multi-operator or multi-modal journeys. The card is also compatible with Maryland's CharmCard smartcard system: either card is valid on participating transport systems in the metropolitan region.
	2000	5 Green Line stations open in January, completing the scope of the original construction plan for the metro but exacerbating overcrowding on the Green Line.

	2001	5 Green Line stations open in January, completing the scope of the original construction plan for the metro but exacerbating overcrowding on the Green Line. This causes overcrowding and impacts service reliability on the Green Line. It is estimated that approximately 20,000 new passengers began using the system when these stations opened, causing crowding further down the line. WMATA suggest that this over-demand could have been caused by free parking at Green Line stations, opening the stations before adding new car capacity and using outdated ridership projections.
	2001	Congress rule that changing a metro station's name, if requested, is a condition of receiving federal funding. This ruling came following the name change of National Airport to Ronald Reagan Washington National Airport, where at the time, authorities were required to fund the changing of signs (e.g. on highways) to accommodate the airport's new name.
	2004	The New York Avenue station (later renamed NoMa-Gallaudet U station in 2012) is opened on the Red Line, the first infill station to be built on the network and the first station built using a mixture of public and private funding. Private contributions were sourced from property owners through direct contributions or a tax on other commercial property owners and totalled almost half of the station cost.
	2004	An out-of-service Red Line train rolls backwards into a station, colliding with an operational train at the platform. 20 people were injured and an investigation established that the likely cause was driver inattention. WMATA agreed to add rollback protection to their fleet as a result of this accident.
	2008	WMATA records its highest ever ridership on the day of President Barack Obama's inauguration, with 1.1 million journeys made.
	2009-2010	A train collides with the back of a stationery train on the Red Line in June. This is the worst accident in the history of WMATA, resulting in 9 fatalities and over 70 injuries. The National Transportation Safety Board (NTSB) carry out an investigation and attribute the accident to a faulty track circuit and the Automatic Train Control system.
	2012	President Obama signs the Moving Ahead for Progress in the 21st Century Act, initiating changes to the existing statutes authorising federal public transport programmes. The Act requires the Federal Transit Administration (FTA) to certify safety oversight agencies as a condition of receiving federal funding. To gain certification, safety oversight agencies must prove they are independent of the system it oversees and is organisationally capable of overseeing the system in question.
	2012	SmarTrip vending machines are available at all metro stations.

	2012	WMATA's "Rush+" programme comes into effect, the largest service change for passengers since the system's completion. This involved changing the destinations of several trains to reduce train throughput at a tunnel bottleneck and to facilitate the Silver Line, and the rebranding of trains to create more Yellow and Orange Line trains, and fewer Blue Line trains running at peak times. This caused some longer waits for Blue Line passengers. It also included metro map changes for enhanced legibility and passenger information, destination changes.
	2014	The Silver Line begins operations, constructed as the first phase of the "Dulles Corridor Metrorail Project". The project is sponsored by the Metropolitan Washington Airports Authority (MWAA) with WMATA acting as the Operator. The second phase is estimated to open in 2019. This project is the largest addition of route to the network since the original metro network was conceptualised.
	2015	An incident takes place at L'Enfant Plaza station, a major station on the network. Smoke appeared in the station causing one death. The Blue, Orange and Silver Line trains continued in service, while Green and Yellow Line trains were suspended.
	2016	A metro train derailment occurs on the Silver Line. The train derailed on a crossover section, causing three injuries. Deteriorated crossties were the attributable cause of the derailment; WMATA's standards did not appear to have been followed and the FTA did not have minimum standards for track safety.
	2016	Paper tickets are no longer accepted on the metro and all fares must be paid by SmartTrip.
	2016	The FTA publish the "SSO Program final rule" which allows the FTA to review and approve states' safety oversight programmes and initiate enforcement proceedings against states with no, or noncompliant, safety oversight. It is expected that all states with rail systems receiving federal funds will comply with this rule by 2019.
	2017	WMATA experience its second-highest recorded ridership in January, coinciding with the National Women's March on Washington.
Current ownership and oversight	▪ WMATA is a government agency created by the US Congress as an interstate compact between Washington DC (District of Columbia), Maryland and Virginia.	

Complementary public transport and non-motorised transport services	▪ ***Buses:*** Metrobus is a regional bus system operated by WMATA and serves Washington DC and suburban counties in Maryland and Virginia. The system consists of 176 bus lines and is strongly routed to serve metro stations. There are also commuter bus services, a circulator bus system, intercity buses and express services to universities and the airport, all of which are not operated by WMATA. The DC Circulator service is a PPP project between the District Department of Transportation (DDOT), WMATA and DC Surface Transit. ▪ ***Pedestrian infrastructure:*** DDOT is responsible for public space in Washington DC. The Pedestrian Master Plan (2009) analyses walking conditions and road safety, recommends policies and schemes for implementation. ▪ ***Cycling:*** Bike sharing is provided by SmartBike DC and Capital Bikeshare. There are approximately 72km of cycle lanes in the city catering for an approximate cycling mode share of 3.3% in Washington DC. ▪ ***Taxis and other ride sharing schemes:*** Uber and Lyft operate throughout Washington DC. Metro have a partnership with Flexcar who provide cars at some metro stations and are available by the hour. Car2Go vehicles also operate in Washington DC and charge rentals per minute. The Department of For-Hire Vehicles regulates the taxi industry through licensing, adjudication and enforcement of taxi companies which operate privately. ▪ ***Surface trains:*** Amtrak connect Washington DC to several major American cities, including New York City, New Orleans, Boston and Chicago, as well as several other states and cities. Commuter rail is provided by the Maryland Area Regional Commuter (MARC) system, administered by the Maryland Transit Administration (MTA), and the Virginia Railway Express (VRE) operated by the Northern Virginia Transportation Commission and the Potomac and Rappahannock Transportation Commission This connects Washington DC to West Virginia, Baltimore and Perryville, Maryland over three lines. Washington DC is on the Northeast Corridor, the busiest rail line in the US, providing connectivity to major east coast cities such as Boston, New York City, Philadelphia and Baltimore. ▪ ***Trams:*** The DC Streetcar is a surface streetcar network in Washington DC owned by the District of Columbia Department of Transportation and RATP Group. The system opened in 2016 consisting of a 2.2 mile on-street track in the north-east of the city. Streetcars previously existed in Washington DC until 1962, closing due to increasing car ownership and bus transport.

Technical and operational summary as of 2015	▪ 189.5km under management - 43% underground, 8% elevated, 49% at grade ▪ 18.4km of new lines under development ▪ 91 stations ▪ 1150 train cars, approximately 1550 buses under management ▪ 450km of bus routes managed directly ▪ 321 million passenger boardings per year (including all WMATA modes) ▪ USD 725 million in annual farebox revenues (2015/16) ▪ USD 871 million in total rev. / yr (2015/16) ▪ Approximately 13,000 employees ▪ £3,354 million (USD 4,245 million equ.) in capital expenditures over past 5 years (2012-2016)
Regulatory, oversight, and policy bodies:	*Virginia Department of Transportation (VDOT):* This agency is responsible for transportation projects in the state of Virginia. *Commonwealth Transportation Board:* Funds transportation projects, including airports, seaports, rail and public transport projects, in the state of Virginia and overseas the Virginia Department of Transportation (VDOT). *Federal Transit Administration (FTA):* This national body has had safety oversight for WMATA since 2015. Its official role is to oversee compliance to ensure safe, reliable and equitable transport services. *National Transportation Safety Board (NTSB):* Although not linked to WMATA specifically, the NTSB is an independent government body responsible for investigation into incidents that take place on transportation networks, including across road, air, water and public transport. The NTSB have assessed incidents on WMATA's network leading to recommendations for safety improvements that WMATA is obligated to implement. *WMATA Office of the Inspector General, established 2007:* The Inspector General reports directly to the WMATA Board and is independent from WMATA management. The Inspector General advises the Board and organisational leadership to find economies, efficiencies and increased effectiveness, by carrying out independent audits and reviews of Metro activities.

Summary of legal and policy framework:	*National Capital Transportation Act, 1960 (amended 1965, 1980, 1990 and 2005)*: Acknowledges that a coordinated public transport system is necessary in the National Capital Region. This policy allowed the District of Columbia, Maryland and Virginia to create an interstate compact to establish an agency to provide this system. *WMATA Compact, 1967 (amended 2009):* This interstate compact created a regional transit agency, WMATA, to essentially plan, develop, finance and manage operations of public transport in the defined transit zone. The Compact defines WMATAs Board and governance structure, planning process, revenue and borrowing arrangements, labour policy, etc. *Analysis of Alternatives*: A law requiring at least three alternatives to any proposal are analysed before costly investment decisions are made. This applied in particular to the Silver Line development to Dulles airport and alternatives included bus lanes and a "do minimum" option. *Mass Transit Plan:* A requirement under the WMATA Compact. This Mass Transit plan should include transport facilities, design, a delivery plan (e.g. land acquisition required), capital and operating costs and business cases for schemes. The Board is responsible for accepting and overseeing the development of the Plan alongside other national and regional agencies with an interest. *Metro Transit Police Department:* The dedicated policing organization of WMATA, established under the WMATA Compact. This is the only US policing organization with powers in three jurisdictions. Police operate on the metro and bus system and are able to arrest in the event of crime on the transport network. Approximately 550 staff work for the Police Department.
Key stakeholders:	▪ *District Department for Transportation (DDOT):* Creates policy for publicly owned transport infrastructure in Washington DC, as well as managing and maintaining infrastructure. DDOT particularly focus on the surface transport network. ▪ *Metropolitan Washington Airports Authority (MWAA):* The MWAA is the project sponsor for the Silver Line, while WMATA operate the line. MWAA is an independent public body and oversees management, operations and development of Dulles and Ronald Reagan airports. ▪ *Unions:* The Amalgamated Transport Union is a North American Union with a local chapter covering the Washington DC public transport region.

Summary of WMATA and Key Views from Interviews

Introduction

The Washington Metropolitan Area Transit Authority (WMATA) is a crucial case study to understand the importance of governance and political structures to the operational success of a metro. Over the last 10 years, WMATA has experienced safety and reliability problems which can be partly attributed to the politics of the local region.

The overall view is of an organisation operating within a complex political environment that makes it difficult to make good operational decisions. WMATA is governed by a Board which includes representatives from individual jurisdictions and the federal government. As such, the board is not necessarily incentivised to act for the good of the metro system as a whole regional entity. Whilst daily service delivery is prioritised, the necessity of preventative maintenance has been deprioritised in favour of allocating funding to other transit actions, such as keeping bus fares low. WMATA's metro system has fallen into disrepair as a result.

WMATA was originally focused on developing metro lines. As lines have opened and the system has aged, WMATA is faced with moving from a building organisation to an operating and maintaining (O&M) organisation, with implications for organisational structure, culture, staff skills, and funding/spending arrangements. This change in organisational culture, however, has not yet fully materialized.

Despite challenges, WMATA also displays some areas of world-class good practice:

- Fares policy is based on world best practice, with distance and time-based fares that are consistently adjusted with inflation every two years (although that is currently at risk owing to poor operational performance, which caused the Board to forgo 2016's inflationary fare rise);
- The system design is for high capacity, capable of running 8-car, 183m trains. WMATA's stations generally incorporate good interchange layouts with features such as entry/exits at both ends of the station (increasing the walkable catchment area) and short interchange distances (e.g. with lines crossing each other);
- WMATA has historically achieved positive planning-related outcomes, including last mile access planning and very high-quality Transit Oriented Development (TOD);
- Customer-focused performance measurement: WMATA measure customer on-time performance using smartcard data, and have made personal on time experience available to individual users via their website.

WMATA's future will be strongly influenced by whether its regional stakeholders can align around a vision of WMATA as an essential collaborative investment that is needed to make the region as a whole competitive in the global marketplace. The same collaboration that created WMATA initially in the 1960s and committed to the initial metro system is needed to renew the system and restore a state of good repair. Alternatively, if this outcome is politically impossible, an alternative approach could entail a wholesale reform of WMATA's governance and funding structure to reduce the impact of political considerations.

Political Setup in Washington DC

WMATA is in a unique position politically, due to the governance structure of the US capital region. Washington DC (District of Columbia) is a 'federal district' which is not a state, and is

controlled directly by the Congress (similar in legal structure to a federal department). The Congress also is a stakeholder in the District's affairs by virtue of location and has a history of direct intervention in local infrastructure services. The District of Columbia is bounded by the state of Maryland to the north-east and Virginia to the south-west. The metro system spans all three jurisdictions: the black and pink dotted line on the annotated system map below highlights the boundaries of the District, whilst the solid black lines show the state boundaries.

Washington Metrorail System showing jurisdiction boundaries

This geography means that the metro system is necessarily a joint consideration between three different state / district jurisdictions in addition to numerous local government jurisdictions. WMATA was created by a compact between Maryland, DC, and Virginia, as well as Congress, which set out WMATA's responsibilities to build and operate the metro and its overall governance structure for doing so. Furthermore, the Federal Government is essentially a fourth stakeholder; as a major landholder and employer throughout the region, it exerts influence beyond simply its oversight of the District of Columbia. Geography, combined with the fact that the federal district is administered differently from the states, and that Maryland and Virginia often have different political leanings, means that metro funding and governance is intensely politicised.

One interviewee said that "*the region came together to build Metro,"* the implication being that building the metro was perhaps the only thing the region has ever collaborated on. The multi-party relationship between four governmental units of the State of Maryland, Commonwealth

of Virginia, City of the District of Columbia, and the federal government, seem to leave WMATA without strategic direction or support.

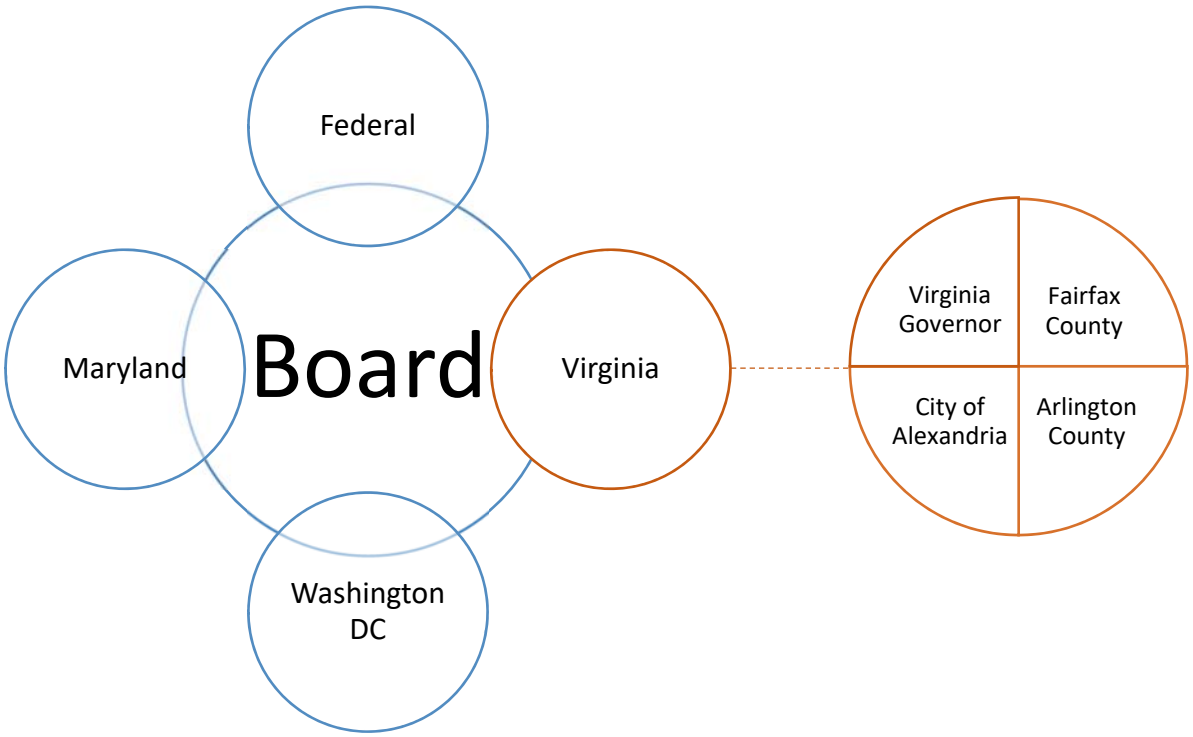
Board Composition and Impact

WMATA's Board, as defined by the WMATA Compact (amended 2009) is made up of 8 Directors. The 8 Directors are drawn as follows:

- Two members from Washington DC, who are appointed by the Council of the District of Columbia;
- Two members from Maryland, who are appointed from the Washington Suburban Transport Commission;
- Two members for Virginia, who are appointed from the Northern Virginia Transportation Commission; and
- Two members for the Federal Government, who are appointed by the Administrator of General Services. It is stated in the WMATA Compact that at least one of the members from the Federal Government should be a regular public transport user in the area.

There are also 8 alternate Directors (allocated in the same format as the main Directors), who are able to act in the absence of the voting Director.

Each Director is entrusted with representing the "Laws of the State or political jurisdiction from which I was appointed" (WMATA Compact, 2009, p3). This definition leads to the emergence of political differences between jurisdictions, alongside potential political differences amongst the jurisdictions.



Makeup of WMATA's Board with an example of membership from the state of Virginia

Ultimately the Board operates as a Board of representatives, rather than Directors. The Board is primarily accountable for their political actions rather than direction in the best interest of the organisation, and has historically struggled with compelling WMATA's Directors to act in the interests of WMATA and the public transport system, regardless of political boundary. The Board's political appointment has a number of impacts, including a general shortage of metro-

specific knowledge and a high turnover of individuals, limiting the potential for gaining long-term metro expertise. There is currently no qualification or requirement for related knowledge to sit on the Board. Whilst many individuals on the Board do have experience in transit or aviation, examples of decisions such as the lack of a preventative maintenance programme, and the organisational change in culture required to meet its operations and maintenance needs, demonstrates this shortage.

The WMATA Compact has already had amendments; further change would require political will from all parties and a successful passage through Congress[1]. There is also a bill in Congress currently, put forward by Maryland, which proposes that Board members must be qualified, for example with a transport, business, or financial background.

WMATA's Funding

WMATA has no dedicated source of funding. Metro fare revenues cover 73% of operating costs, and the remaining subsidy is the basis of annual negotiations between the funding jurisdictions, as set out in the Compact:

"As far as possible, the payment of all costs shall be borne by the persons using or benefiting from the Authority's facilities and services and any remaining costs shall be equitably shared among the federal, District of Columbia and participating local governments in the Zone. The allocation among such governments of such remaining costs shall be determined by agreement among them"

The subsidy requirement is currently $250m for Metrorail only, but is expected to grow to $400m by 2040 owing to increasing operating costs (a quality associated with metros as they age) alongside declining ridership. The total subsidy for the 2016 financial year was $861.7 million for metro, bus and paratransit, (which is legally required): this represents 48% of 2016's total proposed operating budget[2].

WMATA's staff need to negotiate funding on two levels: first with the Board, to agree what they are willing to request, and second with the jurisdictions. The Board's direction depends on the individual members and so may change with the composition of the Board. For example, some years a member is very clear that there will be no fare increase or no service cuts. The rest of the Board has to either consent to their demand, or the budget may be vetoed.

Negotiations with the jurisdictions are complex because each has differing priorities and prioritises benefit to its own constituents over the system as a whole, and furthermore there can be significant differences of opinion within each jurisdiction as to how funding should be allocated. For example:

- Virginia's funding comes from 5 separate sub-jurisdictions, each with a different funding mechanism, and their interest is generally focused on system extensions;
- Maryland's money comes from a centralised fund, but the current Republican government prefers to invest in roads; and
- DC is led by Democrats who support public transport but do not want fare increases and also have interests that traditionally align closely with those of WMATA's labour unions.

[1] The idea that changes would have to go through Congress was considered by WMATA staff to be a key barrier. Lawmaking for the public transport system of a nation's capital is not unprecedented: for example, the creation of the Greater London Authority and Transport for London was by an act of the UK Parliament.

[2] As detailed in WMATA's Operating Budget Analysis in 2016.

Ultimately, the Board allocates the requirement to fund operating expenditure amongst the jurisdictions based on the following formula:

- 33% population/population density based on census data;
    - 50% population
    - 50% density weighted population (population x density)
- 33% average weekday ridership based on rail passenger survey; and
- 33% based on number of rail stations in each jurisdiction.

Funding Maintenance and Renewal Projects

For the public transport system to function in each jurisdiction, it has to function in the other jurisdictions too. For example, whilst Virginia's passengers may live in Virginia, the vast majority are travelling to destinations in DC, so the usefulness of the Virginia sections are dependent on the availability and reliability of the DC sections. Equally, four of the six lines pass through all three jurisdictions. If an incident in any one jurisdiction stops traffic on the line, all three jurisdictions suffer.

When it comes to funding maintenance and renewal projects, the jurisdictions trade funding for decision making input. This can include suggesting specific projects or requiring that funds they provide are spent on maintenance projects within their jurisdiction. This process has disadvantages for metro maintenance, which should be prioritised as objectively as possible according to need, safety, and cost-effectiveness: "*If WMATA was making these decisions… we could be more global, more rational in the cash allocation*".

Other Funding Sources: "We need all the help we can get."

WMATA recognise that the first step to sustainable funding is to perform better and demonstrate prudent financial stewardship. The Metropolitan Washington Council of Governments (WashCOG), an independent, non-profit co-ordination body aiming to bring together the various public services in the region (e.g. transport, clean air, water supply, etc). WashCOG is supported by officials representing 23 local governments, the Maryland and Virginia state legislatures and the US Congress; all participants in WMATA's governance. It is possible that WashCOG could be a potential future source of funding for WMATA as a means of supporting projects that facilitate sustainable growth, and considering all the other non-metro and non-transit needs, could:

- 'Flex' funding designated for roads to rail; and
- Make regional applications for federal 'Tiger Grants.' These applications currently suffer from being uncoordinated separate bids from Maryland, Virginia and Washington DC, whereas evidence from elsewhere in the US suggests a single coordinated and targeted regional bid would be more successful.

Another potential source of funding is air quality grants: Washington DC currently spends their allocations on bicycle lanes, but investing in WMATA could potentially have far greater air quality impact by improving service and increasing the mode share on metro.

According to interviews, if there were to be a tax to fund the metro, it is key that the tax is based on a factor that will increase with growth, such as a sales tax, as metro costs increase with growth.

Fares and Ticketing

WMATA has benefitted from a world class fares policy: their metro farebox recovery ratio of 73% for is one of the highest in the country. The policy and regularity of increasing fares every two years is perceived as important to public acceptance.

Fare Regime

Fares are distance and time-based. From the customer perspective, there is an appeal for flat fares or a zonal system because it is simpler. However, WMATA do not believe that the economics of flat fares are prudent, as it dissociates the cost of buying the service from the cost of providing it[3]. They also note that if a metro starts with a distance-based fare it is always possible to move to a flat fare (which would usually be lower on average), but to move from flat to distance-based fares would be almost impossible as average fares would increase. Furthermore, distance-based fares require 'tap out', which is a valuable source of data for service planning and trip quality monitoring.

Inflation is used as a starting point for fare raises, and then the exact fare proposal is tweaked based on budgetary and political realities. In 2016, the expected biannual fare increase was not done because it was considered that the quality of service is currently too poor to justify charging more.

The metro fare consists of a base fare (approximately equivalent to the flat bus fare) plus a distance element, which is capped ($5.90 peak, $3.60 off peak) to avoid the longest-distance fares being too expensive. The average metro fare paid across all distances and time periods is $3.10 per journey. Rail fares are set alongside bus fares, with flat bus fares that are intentionally lower to cater for customers on lower incomes. Peak fares are used to manage demand, helping to limit congestion in the peak and fill up trains in the off-peak.

The main difficulty with distance-and-time-based fares is complexity, but this is mainly an issue for WMATA's customers.

Fare and Ticketing Innovations: Previous and Current

In August 2010, WMATA implemented a 'peak of the peak' surcharge of $0.20 between 7:30 and 9:00am and between 4:30 and 6:00pm on weekdays to manage demand. This was scrapped after approximately two years because commuters who could not change their schedules felt exploited and complained to their representatives, and also because this simply added another layer of complexity on an already very complex fare structure.

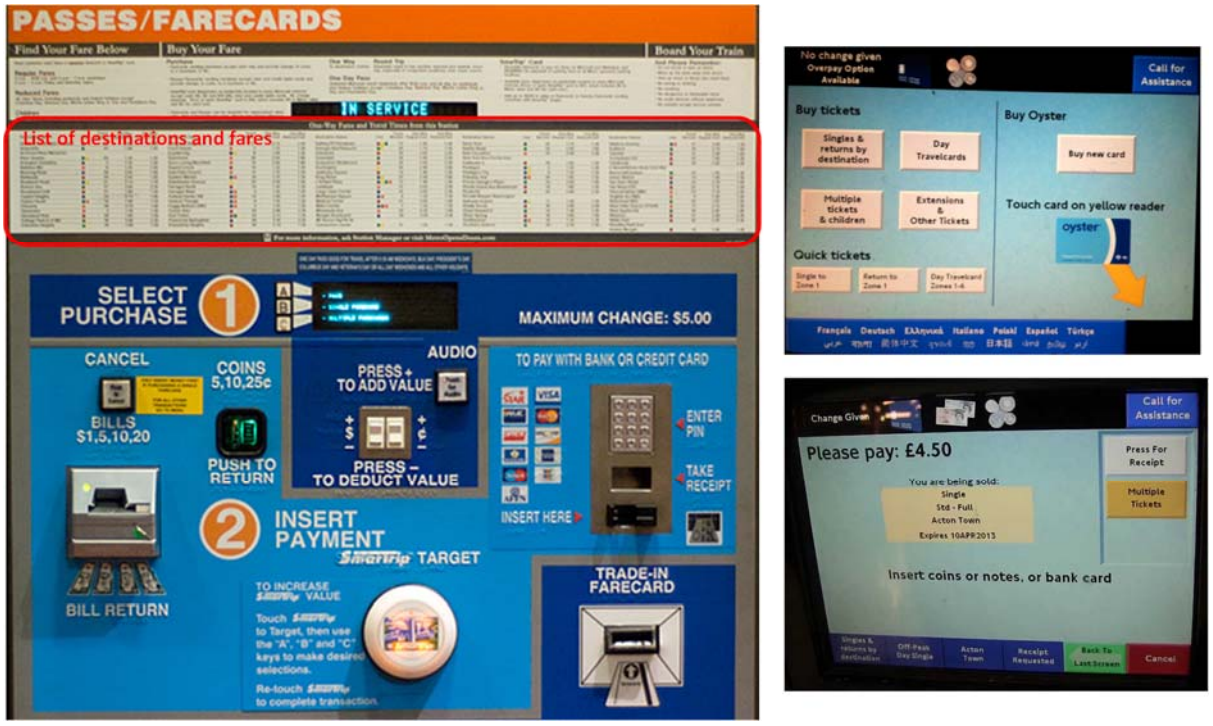
An innovation recently implemented is a 15 minute 'grace period' whereby if a passenger enters a station, discovers there is a delay (which are common), and leaves again within 15 minutes they are not charged. This is intended to manage crowding during disruptions and to respond to customers paying their fare only to choose not to use the service in the event of disruption. Before this incentive, approximately 1000 passengers per day were entering a station and leaving without making their trip.

WMATA was the first US metro to have a smartcard. They migrated away from paper tickets due to the additional administrative and maintenance costs. Even after this change, the cost of collection of revenue is 20% of the revenue. WMATA achieved the migration by incentivising smartcard use, making some tickets (e.g. rail to bus transfer, 7 day bus pass) only available

[3] WMATA acknowledge that social policy may trump metro economics in cities where people far from the centre are less capable of paying – but this is not the case in Washington DC where suburban dwellers tend to have more disposable income than those living closer to the centre.

on smartcards. Once 90% of bus and rail trips were on smartcards, they were able to remove paper tickets entirely from the metro.

Two further opportunities for WMATA are the modernisation of ticketing stations to enable easier navigation of the fare system at the point of buying a fare, and smarter ticket machines combined with smartcards that could also enable other types of dynamic pricing, such as charging an off-peak fare for people travelling in the opposite direction to the main commuter flow.



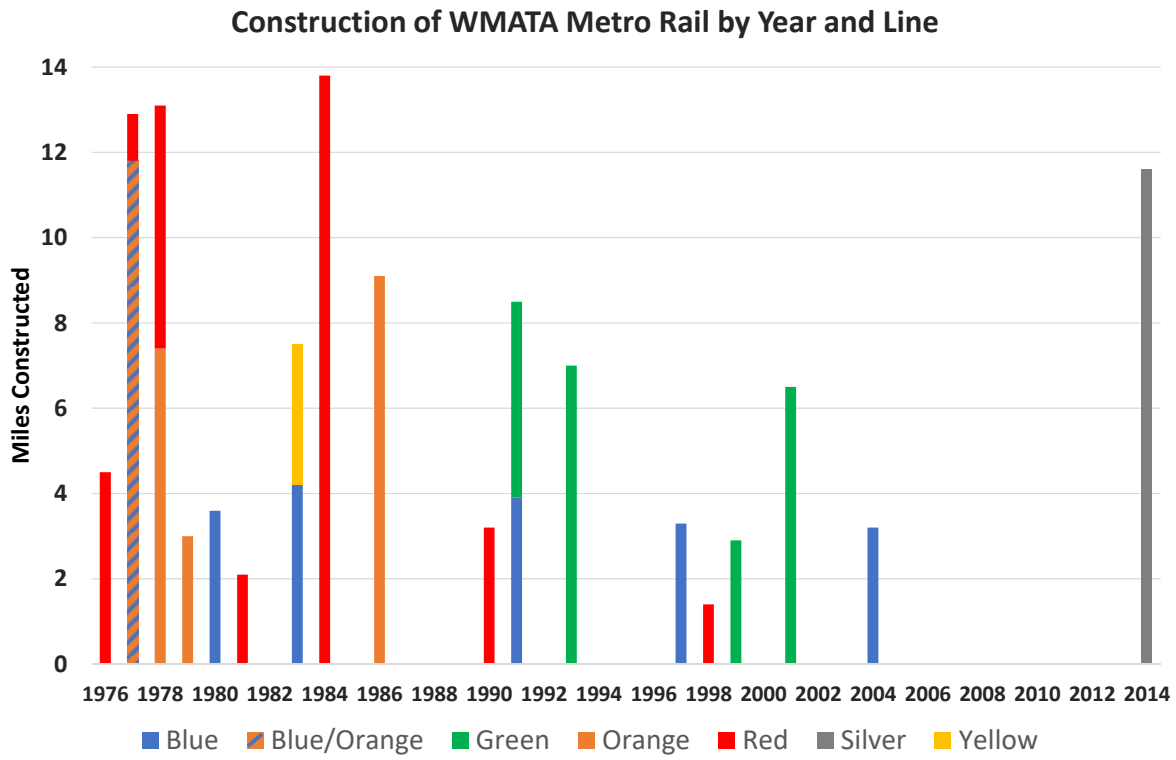
Ticket machine interfaces in Washington (left) vs. London (right)

Operations

From Construction to Operations

"We were a construction company for 25 years. The staff had a mantra of building a 103 mile system. …The world has changed but the culture here doesn't reflect that. …We're a department of public works type agency now"

The initial plan for the 103-mile system was approved in 1968, and this was followed nearly to the letter with openings over segments until 2001. There was a small additional extension to the system in 2004, and the new Silver Line. The first section opened in 2014 and the second part that includes Dulles Airport is currently under construction.



WMATA's focus on construction has perpetuated in the company, given the complete planned system took a considerable number of years to achieve. The long period over which the initial system was built is also a contributing factor in why the perception continued well into the 2000s that the system was new and did not need maintenance or renewals, even when the initial segments were over 25 years old.

Attempts have been made to shift the culture of the organisation from construction-based to operations-focused, including an organisational restructure in 2007-2008. This appears to have not fully embedded however, and is one cause of WMATA's operational challenges.

Operational Performance

WMATA's operational performance has been problematic. Examples of performance against planned targets include:

- Rail on time performance was 84%[4] in 2015 due to problems with rolling stock, power, and track equipment, compared with a target of 90%. The average in 2013/14 was approximately 91%;
- The 2016 Q1 'vital signs' WMATA report records rail fleet reliability at 48,000 miles between 3-minute delays, below the target of 65,000; and
- Customer satisfaction is 68%, compared with a target of 85%.

Service reductions have been made, with weekday off-peak headways being widened from 12 to 15 minutes and weekend headways being widened from 15 to 20 minutes for parts of the day. Off-peak service has also been severely impacted by maintenance work, which often requires single-tracking, leading to longer journeys and long headways. Peak headways on the red line were widened from 2.5 to 3 minutes (central section) and 5 to 6 minutes (end

[4] Measured as within 2 minutes during peak hours, and within 150% of scheduled headway during non-peak hours

section). These cuts have a cumulative effect of making the metro less attractive to customers, particularly those who have the option of driving.

Goals and Target-Setting

The 'vital signs' report sets targets for individual KPIs, but organisationally, WMATA does not have a clear mandate or long-term goals. RapidRail in Kuala Lumpur, for example, are tasked with achieving the government's objective of 40% public transport mode share. This links to the fact that WMATA was clearly established 'to build the system' but not necessarily to maintain sustainable operations: "*It's very, very difficult to get people to think strategically here*."

The new General Manager has introduced a Customer Accountability Report (CARe) which sets out 42 actions to improve the customer experience.[5] These range from safety and maintenance actions to provision of better travel information and KPIs monitoring the customer experience.

Labour

Public transit is one of the few remaining industries in the US where someone can get a reasonably well-paying and stable job for life without a college degree: "*It's hard to drive efficiencies forward due to the strong labour environment*". The workforce is strongly unionised, and a no strike clause means that pay deals routinely go to binding arbitration, which generally compromises between the WMATA and union proposals, taking into account benchmarks from other agencies. This decision is taken on a numerical basis without a view to policy. WMATA acknowledges that because arbitration has become routine, they do perhaps not prepare as heavily for these negotiations as they might, and it follows that opportunities are missed to improve productivity, for example through split shifts or performance-based pay, alongside pay-rises. Workforce-management relations are tense and are a key challenge to overcome if performance is to be improved. Safety culture is undoubtedly linked with this[6].

WMATA acknowledge the significant challenges faced in managing a large, diverse workforce. For instance, the combination of unions and public sector bureaucracy make it difficult to promote people, so managers work around this by creating a new job and then recruiting to it in lieu of a promotion, proliferating numbers of jobs. As a result, WMATA have 1540 job codes for 4000 positions, which makes it difficult to manage the organisation as a whole. For example, having 1540 different job specifications makes it difficult to standardise and efficiently manage IT security, access controls and permissions.

Measuring Performance

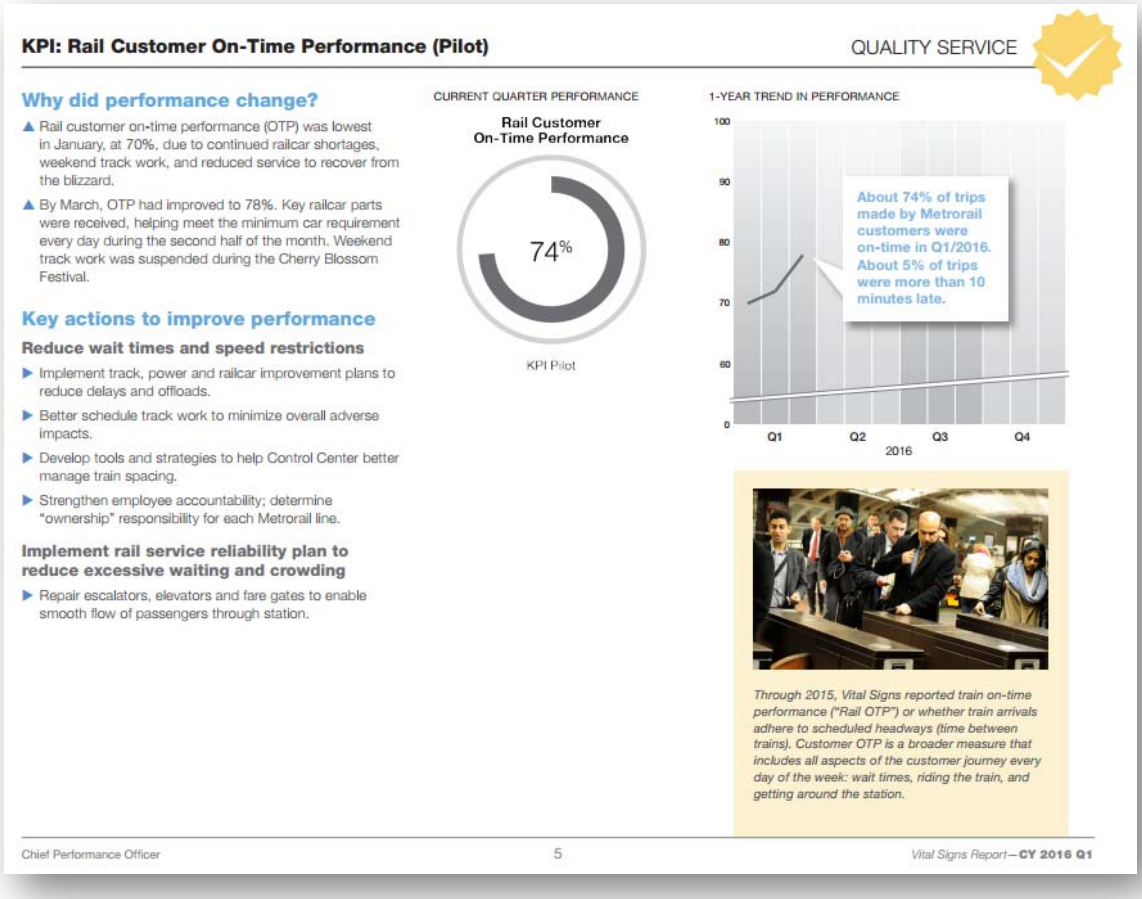
WMATA is at the leading edge in the field of using smartcard data for performance monitoring and management. Ticketing is 100% smartcard based, and WMATA are able to effectively calculate passenger journey times. They have now set up the big data systems required to automate this and are able to measure 'Customer On Time Performance' taking into account:

1. Time spent on escalators and lifts (reflects queuing or time to walk if facilities are out of service)
2. Time spent waiting for trains (reflecting both scheduled service intervals and delays)

[5] http://wmata.com/about_metro/general_manager/performance/CARe.pdf (Accessed 1/8/2016)
[6] Union Leader's address to the Board on safety culture: https://www.wmata.com/about_metro/board_of_directors/board_docs/042315_3BATULocal689Briefing.pdf

3. Time spent on trains ← *the only element captured by more outdated 'trains on time' performance metrics*
4. Time spent moving around the station including queuing to enter/exit platform, time walking through interchange passages etc. (reflecting station design and impacts of crowding)

WMATA's data analytics improve upon the more standard Train On Time Performance metrics because they include more elements of the passenger journey that affect satisfaction. Furthermore, it is weighted by the numbers of passengers travelling, so a delay in the peak affects the score more than an off-peak delay when fewer people are affected.



KPI: Rail Customer On-Time Performance (Pilot)

QUALITY SERVICE

Why did performance change?

- ▲ Rail customer on-time performance (OTP) was lowest in January, at 70%, due to continued railcar shortages, weekend track work, and reduced service to recover from the blizzard.
- ▲ By March, OTP had improved to 78%. Key railcar parts were received, helping meet the minimum car requirement every day during the second half of the month. Weekend track work was suspended during the Cherry Blossom Festival.

Key actions to improve performance

Reduce wait times and speed restrictions

- ▶ Implement track, power and railcar improvement plans to reduce delays and offloads.
- ▶ Better schedule track work to minimize overall adverse impacts.
- ▶ Develop tools and strategies to help Control Center better manage train spacing.
- ▶ Strengthen employee accountability; determine "ownership" responsibility for each Metrorail line.

Implement rail service reliability plan to reduce excessive waiting and crowding

- ▶ Repair escalators, elevators and fare gates to enable smooth flow of passengers through station.

CURRENT QUARTER PERFORMANCE

Rail Customer On-Time Performance

74%

KPI Pilot

1-YEAR TREND IN PERFORMANCE

Through 2015, Vital Signs reported train on-time performance ("Rail OTP") or whether train arrivals adhere to scheduled headways (time between trains). Customer OTP is a broader measure that includes all aspects of the customer journey every day of the week: wait times, riding the train, and getting around the station.

Chief Performance Officer 5 *Vital Signs Report*—**CY 2016 Q1**

Safety Culture

Problems with WMATA's safety culture were first highlighted by the National Transportation Safety Board (NTSB) in a 1982 report after a derailment that caused three fatalities[7]. Of the 12 NTSB investigations carried out, 4 have been derailments, which could be linked to the lack of preventative maintenance undertaken. A 2010 safety culture survey[8] found that:

- *"Day-to-day work environment within metro naturally discourages employees from reporting unsafe behavior of their peers* [fear of retaliation, unsure if WMATA would protect staff who report]
- *"Reported safety issues are not consistently addressed across metro* [resource constraints cited as an issue]

A crash in the 1990s occurred because the Automatic Train Operation (ATO) was switched on during snow, and WMATA's 1970s-era ATO could not take account of the snow for the stopping distance, so one train rear-ended another. This type of situation could be designed for, or if not there should have been a clear set of procedures to identify risky weather conditions and drive in manual mode until safe to use ATO, but this risk had not been foreseen and the procedure was not in place. Either design or procedures could have prevented this operational incident, but neither type of action was taken.

Furthermore, the investigation after the Fort Totten crash in 2009 could have considered other areas for risk management, for example. This incident caused 9 fatalities and 52 injuries, and after the event there was a narrow focus on the specific problem (signalling/ATO) that caused the crash, rather than recognising that there were broader institutional issues. However, making improvements of this nature to NTSB's scope of authority requires greater consideration of the role of the federal Government in the regulation of public transport and in Washington DC specifically.

The impact of these safety issues, alongside an accumulated maintenance deficit, has been that WMATA is undertaking a programme of works called "SafeTrack" to catch up on essential safety-critical track maintenance on outdoor sections. The aim of this program is to accelerate three years' worth of track work into approximately one year. These are being achieved by shutting down one track at a time in phases, and running a single-track service along those sections, continuously for a period of multiple days (including peak hours). There are a total of 15 "surges" planned, ranging from seven to 42 days in length. The result is longer travel times and reduced capacity – which risks harming ridership in both the short and the long term.

WMATA is in the process of trying to change the safety culture of the whole organisation. This starts with clear messaging to all employees that safety rises above all other priorities. WMATA's experience highlights the importance for new metros of ensuring that safety is considered by all staff, at all times, and that the right safety culture and environment is established from the start and maintained over time.

[7] List of NTSB investigations 1982-2015: http://www.ntsb.gov/news/speeches/CHart/Documents/Attachment%20NTSB%20Investigations%20Involving%20WMATA%20Metrorail%201982-2015.docx (accessed 9/8/2016)

[8] https://www.wmata.com/about_metro/Board_of_directors/Board_docs/102810_WMATASafetyCultureExecutiveSummaryCEB.pdf (accessed 9/8/2016)

Safety Regulation

Safety at WMATA was previously overseen by the Tristate Oversight Committee (TOC). However, they had neither the metro-specific expertise nor the power to enforce changes, partly because it would require three matching laws in Maryland, Virginia and DC to give them those powers. After the L'Enfant Plaza smoke incident which killed one passenger in January 2015, responsibility for safety oversight was given to the Federal Transit Administration (FTA). This was the outcome of a recommendation by the NTSB that safety regulation should be handed to the Federal Railroad Administration (FRA). The NTSB's primary role is to investigate accidents and other safety issues in an independent, objective manner that lead to recommendations to improve safety. The NTSB's 12 investigations has led to many of the recommendations that WMATA is obligated to implement.

Although NTSB recommended FRA take over safety regulation, FRA did not at the time have the legal powers to do this, and to arrange this would have required congressional action. Responsibility was therefore given to the FTA, with the ability to enforce. However, their expertise is in financial regulation of transit agencies. According to interviews, the FRA would have been better placed technically as it has an established railroad safety function, although its expertise is specific to mainline and commuter rail. Regulation by the FRA may still not address issues arising from intensive service levels which are fundamental to metros.

In short, interviewees suggested that the regulatory environment is disorganised and it appears there is no safety regulator in the US with the expertise or power to regulate metros in the wider country. Governments and authorities setting up new metros need to be able to answer the fundamental question of who will be accountable for safety, what powers they will be equipped with, and how best to embed appropriate expertise.

Asset Management and Renewals

It is an established issue that focusing strategy and funding towards sustaining, not visibly "improving" a metro is a challenge for operators and authorities. Documents are available from the mid-1980s suggesting the need for renewals, which were not acted upon. The number, scope, and depth of these various reports from senior management and other local groups is striking. This adds to the sense that somehow a construction organisation was given the task to operate a metro, without an institutional understanding of what operations and maintenance entailed or the resources to undertake them.

Underinvestment in renewal is a key issue in Washington, but it appears that lack of funds has not always been the primary constraint. WMATA report that in the recent past they routinely were only able to spend 60-70% of available capital funding, due to issues including:

- Delayed contracts;
- Project overruns;
- FTA oversight;
- Inability to arrange track access possessions;
- Delayed rail car delivery;
- Delay in obtaining construction permits (e.g. for building or extending depots);
- Insufficient project management expertise.

A recurring theme in the interviews was that timelines were unrealistic, possibly a combined result of missing project management expertise and political pressures. WMATA is now moving towards achieving 90% of spend, which is an acceptable target because budgets are

based on maximum possible spend. Spending slightly less implies that not all contingency is being used, which is a positive thing.

Maintenance

WMATA's operational history has been characterised by a lack of preventative maintenance. There were no regular track inspections undertaken until after a derailment in 2006. Until the Fort Totten crash in 2009, there was a sense of optimism that the system was new and did not need preventative maintenance. It was thought that 'sometime in the future' they would need to close tracks to maintain or work single-tracking, but there was no specific plan to do this. This could have been a result of comparing WMATA (opened 1976) to the much older nearby systems in New York, Chicago and Philadelphia. This created a perception of WMATA as 'new', whereas a global perspective would identify a metro of 25-30 years old as 'middle-aged'.

A common view in Washington, both within and outside WMATA, is that the metro is severely hindered by being a two-track system, and that this is a key cause of its problems with track maintenance. This view has arisen because of the legacy of much older metro systems in the US with multi-track segments, such as New York's many three- or four-track lines, the four-track North Side El in Chicago, or the four-track Broad Street Subway in Philadelphia. However, it is important to note that 40% of the subway system in New York has only two tracks, as does the vast majority of the Chicago El and other lines in Philadelphia. Furthermore, the existence of more than one track in each direction is an extreme rarity worldwide; of the 6,000 network-km of the 33 members of the Community of Metros, 95% is 2-track, with New York being the primary exception. This global perspective tells us that, although extra tracks might make maintenance easier, it is certainly not a requirement, and nearly every other metro system worldwide manages with similar constraints.

Metros around the world maintain their tracks and trackside equipment during an overnight maintenance window, commonly between around midnight and 5am. Scheduling maintenance during this window is logistically challenging, but the full possibilities of the overnight maintenance window appear not to be fully used in Washington, and the maintenance window on weekends is shorter than in most metros due to a 3am closing time on Friday and Saturday nights. WMATA have recently proposed to close at midnight 6 days a week and 10pm on Sunday on a permanent basis, which will restore the overnight maintenance window in line with global norms.

Asset Information Management

WMATA currently operates a very traditional records and controls process that is not fully fit for purpose. Different departments have their own system and there is little connection or efficiency between them. For example, there are 23 instances of the Maximo maintenance software, but are now trying to consolidate down to 4.

System Design

The original system in the 1970s was built with what managers feel are insufficient mid-line crossovers, particularly in the busy city-centre section. As a result, the system lacks operational resilience for single-tracking or early turning of trains. This is having operational consequences today in dictating the low level of single-track service that can be provided during the 'safety surge' single tracking, as well as more long-term impacts in terms of sub-optimal access to the tracks for maintainers. These consequences highlight a clear need for metro developers to think about maintenance while doing the initial design, such as to enable quick set-up times during the night-time maintenance window.

The money for these was available, but the system's developers incorrectly decided the features were not needed, due to the perception that a new and, at the time, very modern system would essentially not fail. The lesson learned from this was to establish at the time of design what degraded mode options there will be, for example, to run shuttle services if one track is blocked or one set of points fails.

The multi-jurisdictional nature of expanding the transit network in Washington DC becomes clear again through the development of the Silver Line, as several aspects of "value" engineering amongst jurisdictions removed useful features and will have long-term negative operational consequences:

- Not as many traction substations as needed to provide resilience;
- Airport station will be a long walk from the terminal because it is cheaper to build, but therefore much less attractive to passengers.

Designing for Long-Term Maintenance

WMATA staff pointed out that a key issue for project developers is to ensure that design elements (such as architectural features) do not compromise functionality, in terms of not only daily operations but also long-term maintenance. For example, the design of WMATA's architecturally noteworthy stations makes it difficult to access light bulbs and ceiling panels, and lighting levels are notably darker than elsewhere in the world. WMATA's advice to others is that designing in maintainability and operability should be paramount, with the total cost of ownership being the prime consideration.

A WMATA station with lighting levels and round ceiling panels, making maintainability difficult

Maintenance of vertical passenger transportation is a key issue. WMATA regret installing so many short escalators between the mezzanine and platform levels because it dramatically increases the number of escalators to run and maintain, as well as reducing passenger flow in stations where escalators run at slow speeds for safety purposes or where escalators offer insufficient capacity for demand. WMATA's view now is that they should use stairs rather than escalators for vertical distances of less than 4.5/5m (plus a lift for accessibility). At a minimum, there should always be stairs to complement escalators; in WMATA's case there are no stairs at all between mezzanines and platforms in most older stations, creating major problems when escalators are not working or are under maintenance or replacement.

Since 2004 WMATA have been putting in extra lifts as per the ADA Standards for Accessible Design: wherever they need one, they install two. They believe this is worthwhile because then one can be taken out of service for maintenance during service hours, making maintenance cheaper. This is also partly because they have to provide a bus alternative if the lift is unavailable, which changes the cost of having a lift out of service. Certainly at well-used locations such as interchanges and destination stations this is a good practice. They also note that designing in accessibility should be done from the start, so that overall costs can be optimised (such as needing only one/one pair of lifts for an island platform rather than two being needed for side platforms).

A final example of the importance of foreseeing maintenance liabilities is in WMATA's tunnel construction. The blasting method of tunnel construction for older tunnels has resulted in severe issues around leakage and water ingress, which impacts upon life of other assets such as cables. This could have been prevented if a tunnel liner had been installed. The liner could be retrofitted but now the cables are in the way and cannot be removed. This might have been avoided, or at least mitigated, if the cables had just been arranged better in the tunnel. Newer parts of the WMATA system don't have these problems because of the newer tunnel methods used (e.g. NATM - the New Austrian Tunnelling Method). Although this particular issue is not likely to recur with new tunnelling today, this example reinforces the lesson that future maintainability and needs must be foreseen, and that efforts to save money during construction should be carefully considered to ensure that they don't ultimately cost more in mitigation in the future (e.g. don't save $25m in construction to cost $50m later).

ATO

WMATA's train control system is 1970s-era analogue ATO and after the Fort Totten accident in 2009, a strategic decision was made to operate the metro in manual mode. The management team at the time reviewed the circumstances and determined that operating in manual mode was the safer option as opposed to automatic mode. Since then, consistency of technology across the network was valued more highly than upgrading the wider infrastructure, and so the Silver Line has been equipped with the same ATO technology.

The ATO system itself has some notable operational limitations, such as:

- Speed restrictions must be manually entered by someone physically present in a local machine room, with no remote option available;
- There is currently no active two-way communication system between track workers and trains. WMATA have carried out trials but no system has yet met their standard for offering positive and dynamic communication, and have so far only offered general warning systems.

Replacing this system with a modern, flexible Communications-Based Train Control (CBTC) system is unlikely to happen given more urgent investment priorities, and it is estimated that

a move to CBTC would only provide an increase of approximately 7% in capacity (excluding other capacity-building measures such as improving turnaround times, etc). Maryland Transit Administration (MTA) in Baltimore will be installing CBTC on their network, and WMATA expect to observe how this performs in practice.

WMATA's key recommendation about incorporating automation into a new system is to have a good understanding of asset degradation from the outset, and the potential failures associated with each asset. Avoid the trap of believing that new assets will not fail or break: *"anything that can happen will happen eventually".* Scenario planning for a range of operational circumstances, degradation and failure will help to identify actions to reduce the risk of these events occurring and result in an improved recovery time if these events do occur.

Planning and Transit-Oriented Development (TOD)

WMATA is a regional transit agency and the original investment in building a metro was specifically intended to support better transit oriented development (TOD) patterns for the region. There is no regional plan, only the amalgamation of local plans, however the following organisations are involved with planning:

- Regional transportation planning is overseen by Wash ington Council of Governments (WashCOG);
- The Transportation Planning Board (TPB) is the designated Metropolitan Planning Organisation (MPO) for the wider Washington DC metropolitan area and are responsible for approving locally-sponsored plans. TPB is the approving body for funding to becoming eligible for distribution.

TOD has generally been successful, in part because for TOD everyone's objectives are mostly aligned. For the public "*there's clearly a market to be near transit*" and denser development near stations allows local authorities to increase their tax base and reduce congestion.

WMATA Influencing for Better TOD

TOD is an area in which WMATA have significant control and demonstrate real proactivity and innovation; it is a key source of income for the company and so WMATA invest effort in protecting it. A key question is why WMATA are successful at promoting and managing TOD compared to their experiences in other areas. Firstly, the demographic composition surrounding WMATA's system lends itself well to a TOD model of development, with a relatively high proportion of working young professionals without children, leading to a city form centred on apartment living rather than single plot residences. Secondly, this provides an example of what WMATA are capable of when an element of its management is more firmly within their grasp, rather than vulnerable to its governance environment. WMATA take the following measures to promote TOD:

- Proactively making suggestions to improve transit access around stations and actively measure the quantity of growth planned around station areas.
- Identifying and analyse projects, conducting cost-benefit analysis, and submitting lists of potential projects to local government as suggestions for implementation.
- Participating in joint ventures with developers, lenders and other public entities mean that WMATA, in partnership with these other stakeholders, can secure development opportunities above and around stations through its dedicated real estate team;
- Supporting developers with an interest in sites that has not yet progressed formally, for example through studying access needs to guide private developers on good access points around stations to "*help developers create a workable station area*". Interviewees

suggested that TOD is ultimately facilitated and made successful by accessibility, and WMATA show understanding of customer travel patterns outside of their own system, for example, it is estimated that only $^1/_3$ of riders walk to rail transit. Creating development that is easily walkable to transit is therefore a paramount consideration: "*you can build all the density you want but if people can't walk it doesn't work*". The development of a Station Site & Access Planning Manual which sets out design criteria based on lessons learned[9] from station planning presents WMATA's formal guidance;

- Applying a classification system to potential TOD sites, with the greatest priority applied to sites with existing private-sector interest that require low public-sector intervention or subsidy, in other words, sites that minimise intervention from stakeholders outside the development process;
- Capturing long-term value on railway land through remaining as the property holder (freehold) and providing ground leases, which allow them to "*participate in increasing value over time*". They have 35 ground leases in operation, having started with the easiest and highest value sites;

Extract from Metrorail Walkshed Atlas 2015[1]

WMATA has created innovative station growth and accessibility KPIs, and is included annually in their 'vital signs' report. The aim is to tell the local authorities how accessible the stations are and encourage them to improve. This is a world-leading best practice to promote last mile accessibility by increasing the planning authority's awareness of how good the last mile access is and what can be done to improve it.

The KPI, 'Rail Station Walk Score' shows the % of the ½ mile radius circle around the station that is actually accessible by a ½ mile walk on foot (e.g. not cut off by having to go around a busy road). The target is 63.7%, which is the maximum area within a circular radius that a rectilinear street grid can cover. The "Metro Station Walk Shed Atlas" plots out stations' walkability zone and this is used to estimate ridership potential and investment needs, particularly those that might be low-cost "quick-win" investments. Each station is given a walk score and are categorised as to whether they are car-dependent, somewhat walkable, very walkable, or "walker's paradise".

WMATA also have a KPI for growth near transit, towards the target levels of density shown below. These are the levels of density that planning office research shows are sufficient to support new rail extensions in Washington. The KPI shows the percentage of stations in each jurisdiction that meet the threshold for either households or jobs.

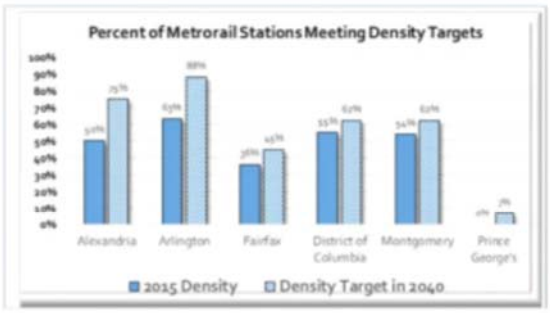
	Urban (per acre)	**Suburban** (per acre)
Households	≥15	≥12
Jobs	≥75	≥19

Development density targets around metro stations

[9] https://www.wmata.com/pdfs/planning/Station%20Access/SSAPM.pdf (accessed 1/8/16)

Growth Near Transit

- Local jurisdictions routinely forecast the number of households and jobs planned for their jurisdictions over the next 25 years. This growth can occur anywhere within the jurisdictional boundaries. However, more growth/density at Metro stations or proximate to bus routes means there is a better chance jobs, housing and retail will be better connected by transit on either end of a trip.
- This indicator seeks to measure how well our local partners are planning for future growth to be served by transit, both by proposing new development and by estimating growth to take place in existing transit-served areas. It also is a leading indicator of the extent to which market forces value transit-proximity – if private developers believe that transit proximity is valuable, they will propose more transit-oriented development.
- The measure focuses on growth in rail station areas, evaluating households and jobs growth projections within a ½ mile of stations as a share of the jurisdictions' overall growth projections.



Extract from Vital Signs Report 2015[10]

WMATA are clear that the purpose of encouraging development near stations is to support ridership. Thus if jurisdictions help bring development that supports ridership, fares income will increase and the jurisdictions' subsidy commitments will reduce.

Conclusions

WMATA's system itself was generally designed and planned well from the start. This shows through many of its characteristics: it was planned and continues to develop alongside TOD, the tunnels and platforms are designed for wide, long trains; the stations have exits in convenient places, often at both ends of the platform. Its fare system is ideal, using distance based peak and off-peak fares, with a history of regular inflation-based increases.

There are some design decisions were not ideal for an optimised system, particularly with respect to maintainability. Examples of this include installing too few crossovers or installing an outdated ATO system on the newer parts of the system, even on the recent and still-expanding Silver Line. As the system has aged, problems have developed. A long-term deficit of preventative maintenance, a lack of organisation-wide safety culture and demotivated staff has resulted in poor reliability and safety lapses, including a number of tragic incidents.

A new General Manager is in place and taking steps to turn the organisation around. Good progress is being made in customer service areas, but whilst more maintenance is being done there still appear to be opportunities to improve maintenance and the train service provided. Interviewees suggest that an operational culture has not yet become embedded at WMATA at an institutional level. Although currently many individual staff have operational experience and have worked in other metros or related industries, this emphasises the benefit to new metros of bringing in outside operational expertise during the very early years of operation, to establish the operating culture along best practice lines from the outset.

Insular thinking appears to be a constraint in Washington, based on interviews. It is difficult for WMATA staff to travel overseas and learn from metros in the rest of the world, and there are examples of why this is problematic, such as the company perceiving themselves as a comparatively new system when they were approaching middle-age in maintenance terms.

[10] https://www.wmata.com/about_metro/docs/VitalSignsReport2015FINAL.pdf (accessed 1/8/16)

A key issue is that WMATA have outgrown the governance structure set out for them. It was set up for building the 103 mile initial system, but does not function effectively for maintaining and operating that system. The governance and funding structure, even down to WMATA's Board, is set up to favour localism and disincentivises the regional thinking that is fundamental to a metro that seamlessly serves multiple governmental jurisdictions. The Board's composition and interests does not seem able to provide the strategic thinking and direction that the metro organisation needs for long-term sustainable operations.

Consequences of WMATA's Institutional Environment

Based on interviews, it is clear that it would be very difficult for a metro operator to succeed in this institutional environment to which issues with maintenance, safety and reliability can be traced. The environment has impacts on staff motivation, renders WMATA relatively impotent in guiding its own future, and prevents WMATA from adopting a forward-thinking, world-class view while it continues to focus on reacting and recovering from issues caused by its environment. Key consequences that WMATA are experiencing as a result of its institutional environment include:

- There is no single oversight authority responsible for the metro;
- There is no dedicated, reliable or predictable funding source;
- Funding is negotiated annually between the three jurisdictions (and in some cases the Federal government), with the result that:
    - Funding tends to meet the lowest common denominator of whichever jurisdiction is willing to contribute the least;
    - The jurisdictions tend to require that funding they contribute is spent in their own jurisdiction, so even maintenance projects are chosen based on political preference rather than the needs of the whole system;
    - Decisions are generally made on a short-term basis reflecting the political cycle rather than with the longer-term interest of the system in mind;
    - The General Manager's appointment appears politicised rather than based exclusively and objectively on who is the best candidate.
- WMATA has no effective oversight from technical experts. The Federal Transit Administration has financial and safety oversight, but is not an expert in metro systems. The failure to do preventative maintenance is a consequence of both the lack of technical leadership and the organisation's focus on construction rather than operations.

WMATA has a fundamentally good metro design and a critical role in the ensuring the social, economic, and environmental health of the National Capital Region. Its continuing immediate objectives will be to address its major institutional and governance challenges to be able to manage upwards and influence its environment, while continuing to build a strong operations, maintenance and safety culture.

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