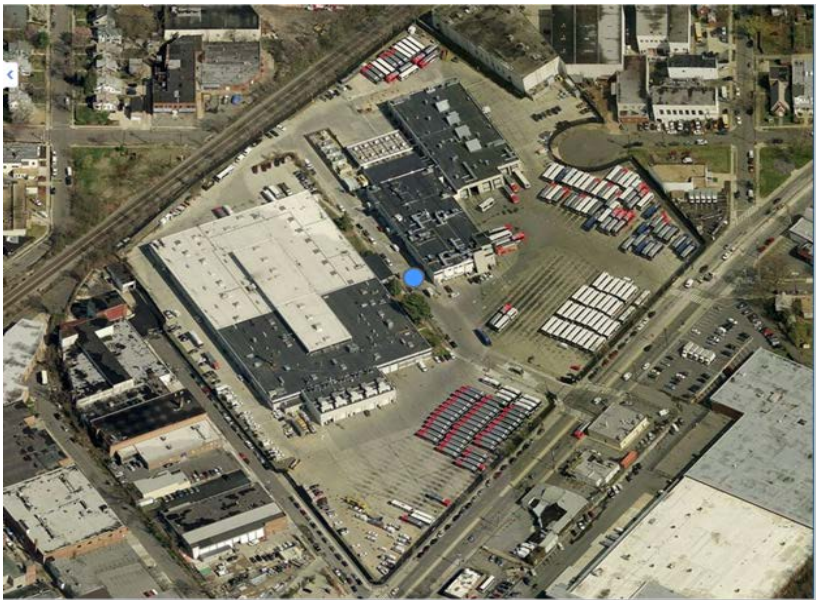
2017 METROBUS FLEET MANAGEMENT PLAN



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CONTENTS

REVISION HISTORY II

SIGNATURE PAGE III

SECTION ONE: INTRODUCTION 1

1.1. CURRENT METROBUS FLEET 4
1.2. ORGANIZATION OF REPORT 5
1.3. DEFINITION OF TERMS 7

SECTION TWO: RIDERSHIP DEMAND GROWTH 8

2.1. RECENT RIDERSHIP GROWTH 8
2.2. CURRENT RIDERSHIP CHARACTERISTICS 11
2.3. RIDERSHIP GROWTH PROJECTION 19
2.4. RIDERSHIP DEMAND FOR FLEET GROWTH 21

SECTION THREE: NETWORK DEMAND FOR FLEET GROWTH 23

3.1. NETWORK CHARACTERISTICS 23
3.2. PERFORMANCE AND FLEET REQUIREMENTS 25
3.3. SERVICE DESIGN MEASURES 28
3.4 SUMMARY OF NETWORK PERFORMANCE AND FLEET REQUIREMENTS 29
3.5. PRIORITY CORRIDOR NETWORK AND FLEET REQUIREMENTS 40
3.6 EMERGING CORRIDORS AND FLEET REQUIREMENTS 40
3.7 OTHER FLEET REQUIREMENTS 46
3.8. PROJECTION OF FLEET DEMAND 49

SECTION FOUR: METROBUS FLEET SUPPLY 51

4.1. CURRENT FLEET COMPOSITION 52
4.3. PLANNED FLEET PROCUREMENT 68
4.4. PROJECTION OF FLEET SUPPLY 72

SECTION FIVE: FLEET MAINTENANCE 75

5.1. Overview of Fleet Maintenance 76
5.2. Current Fleet Performance 78
5.3. Types of Maintenance 84
5.4. Maintenance Capacity for Fleet 89
5.5. Distribution of Maintenance Functions 90
5.6. Projection of Demand for Maintenance of Revenue Vehicles 91
SECTION SIX: CONCLUSIONS 93
6.1. Peak Vehicle Supply and Demand 93
6.2. Long Term Challenges 94
ADDENDUM 96
1.0. Safe Track 96
2.0. Ridership 96
APPENDICES 100

FIGURES

FIGURE 1-1: METROBUS SERVICE COVERAGE AREA 1
FIGURE 1-2: LOCATIONS OF METROBUS FACILITIES 3
FIGURE 2-1: AVERAGE WEEKDAY RIDERSHIP TREND (FY10 - FY15) 9
FIGURE 2-2: AVERAGE DAILY BUS RIDERSHIP BY YEAR AND DAY TYPE 10
FIGURE 2-3: WEEKDAY RIDERSHIP BY RESIDENCY 12
FIGURE 2-4: WEEKDAY TRIP PURPOSE 14
FIGURE 2-5: RIDERSHIP BY INCOME LEVEL 16
FIGURE 2-6: WEEKDAY RIDERSHIP BY VEHICLE OWNERSHIP 17
FIGURE 2-7: METROBUS ANNUAL RIDERSHIP TREND (FY09 – FY25) 20
FIGURE 4-1: METROBUS FLEET COMPOSITION (JUNE 2015) 52
FIGURE 4-2: CURRENT METROBUS REVENUE FLEET BY PROCUREMENT YEAR (JUNE 2015) 54
FIGURE 4-3: METROBUS COMPOSITION OF FLEET AGE (JUNE 2015) 55
FIGURE 4-4: AVERAGE AGE BY FLEET TYPE (JUNE 2015) 55
FIGURE 4-5: METROBUS FLEET BY FUEL TYPE (JUNE 2015) 56
FIGURE 4-6: METROBUS FLEET AVERAGE AGE BY FUEL TYPE (2009 – 2015) 56
FIGURE 4-7: METROBUS FLEET BY FUEL TYPE (2009 – 2015) 57
FIGURE 4-8: FLEET FUEL TECHNOLOGY CHANGES 64
FIGURE 4-9: AVERAGE AGE BY OPERATING DIVISION (JUNE 2015) 65
FIGURE 4-10: JURISDICTIONAL DISTRIBUTION AND AVERAGE AGE OF BUSES (JUNE, 2015) 67
FIGURE 4-11: PROJECTION OF AVERAGE FLEET AGE (FY16 - FY25) 74
FIGURE 5-1: AVERAGE IN-SERVICE FAILURES BY VEHICLE TECHNOLOGY 80
FIGURE 5-2: MEAN DISTANCE BETWEEN FAILURES VS AVERAGE FLEET AGE 81

FIGURE 5-3: TARGET AND ACTUAL MDBF 82

FIGURE 5-4: MEAN DISTANCE BETWEEN FAILURES BY VEHICLE TECHNOLOGY 83

FIGURE 6-1. PROJECTED FLEET DEMAND, FLEET SUPPLY, AND GARAGE CAPACITY* 93

TABLES

TABLE 1-1: METROBUS FLEET AND DIVISION ASSIGNMENT (JUNE 21, 2015) 4

TABLE 2-1: RIDERSHIP BY TIME OF DAY 13

TABLE 2-2: RIDERSHIP BY ETHNICITY 15

TABLE 2-3: MODE OF EGRESS 18

TABLE 2-4: BUS RIDERSHIP: ACTUAL AND FORECAST 19

TABLE 2-5: LOADING STANDARD BY LINE CLASSIFICATION AND TIME PERIOD 21

TABLE 3-1: METROBUS MINIMUM PRODUCTIVITY THRESHOLDS 26

TABLE 3-2: LATE NIGHT SERVICE PRODUCTIVITY THRESHOLDS 26

TABLE 3-3: FREQUENCY OF SERVICE THRESHOLD 28

TABLE 3-4: PEAK VEHICLE REQUIREMENT (PVR) BY DIVISION (JUNE 21, 2015) 29

TABLE 3-5: SCHEDULED PEAK VEHICLE REQUIREMENT BY LINE 31

TABLE 3-6: PRIORITY CORRIDOR NETWORK RIDERSHIP TREND 42

TABLE 3-7: PRIORITY CORRIDOR NETWORK PVR NEED AND IMPLEMENTATION SCHEDULE 43

TABLE 3-8: LIST OF EMERGING CORRIDORS RIDERSHIP TREND 44

TABLE 3-9: EMERGING CORRIDORS AVERAGE WEEKDAY RIDERSHIP, PVR NEED AND IMPLEMENTATION SCHEDULE 45

TABLE 3-10: SPARE FLEET REQUIREMENT 48

TABLE 3-11: NETWORK DRIVEN FLEET DEMAND PROJECTION 50

TABLE 4-1: COMPOSITION OF METROBUS FLEET (JUNE 2015) 53

TABLE 4-2: AVERAGE OPERATING COST PER MILE BY FUEL TECHNOLOGY 58

TABLE 4-3: COST ITEMS 58

TABLE 4-4: BUS LIFECYCLE COST ESTIMATE (IN '000, JUNE 2015) 59

TABLE 4-5: EXISTING FLEET LIFECYCLE COST ESTIMATE 60
TABLE 4-6: IMPLEMENTING 50% CNG AND 50% HYBRID POLICY 60
TABLE 4-7: CONVERTING HYBRIDS TO CLEAN DIESEL 61
TABLE 4-8: CONVERTING ALL BUSES TO CLEAN DIESEL 62
TABLE 4-9: COST COMPARISON 63
TABLE 4-10: FLEET FUEL TECHNOLOGY CHANGES 64
TABLE 4-11: BUS FLEET OPERATIONAL DISTRIBUTION BY GARAGE AND JURISDICTION (JUNE, 2015) 66
TABLE 4-12: METROBUS FLEET PROCUREMENT (2010 – 2015) 68
TABLE 4-13: METROBUS FLEET REPLACEMENT SCHEDULE (2016 – 2025) 69
TABLE 4-14: METROBUS FLEET EXPANSION SCHEDULE 70
TABLE 4-15: SUPPLY OF REVENUE VEHICLES 72
TABLE 5-1: CAUSES OF IN-SERVICE FAILURES (FY15) 79
TABLE 5-2: PREVENTIVE MAINTENANCE SCHEDULE 85
TABLE 5-3: MID-LIFE OVERHAUL SCHEDULE 88
TABLE 5-4: CURRENT MAINTENANCE CAPACITY 90
TABLE 5-5: LIST OF MAINTENANCE FACILITIES 90
TABLE 5-6: PROJECTION OF MAINTENANCE DEMAND FOR REVENUE VEHICLES (BASED ON GROWING DEMAND FOR BUS SERVICE) 92
TABLE 5-7: PROJECTION OF MAINTENANCE DEMAND FOR REVENUE VEHICLES (BASED ON PLANNED FLEET PROCUREMENT) 92
ADDENDUM 1: FLEET REQUIRED AND PLANNED FOR SHUTTLE SERVICES 96
ADDENDUM 2: BUS FLEET ASSIGNMENT 97
ADDENDUM 3: ROUTES WITH OVERCROWDING PROBLEMS 98

ADDENDUM 4: TRIPS WITH OVERCROWDING PROBLEMS 98

APPENDIX 1: METROBUS FLEET BY TYPE (21 JUNE, 2015) 101

APPENDIX 2: PEAK VEHICLE REQUIREMENT BY DIVISION AND BUS TYPE 102

APPENDIX 3: ALLOCATION OF ADDITIONAL BUSES FOR REVENUE SERVICE 103

APPENDIX 4: ALLOCATION OF EXPANSION BUSES FOR REVENUE SERVICE 104

APPENDIX 5: FLEET DEMAND AND SUPPLY BALANCE 105

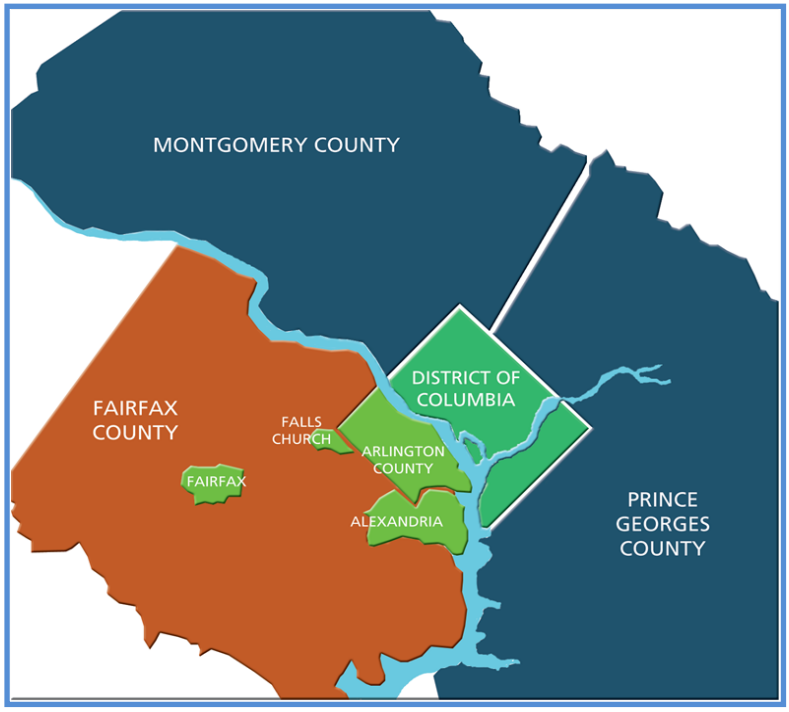
APPENDIX 6: MAXIMUM BUSES TO BE ASSIGNED AND SCHEDULED (21 JUNE 2015) 106

SECTION ONE: INTRODUCTION

The Metrobus system was created in 1973, when Metro consolidated service provided by four different private bus companies. Metrobus serves the District of Columbia, the suburban Maryland counties of Montgomery and Prince George's and the Northern Virginia counties of Arlington and Fairfax and the cities of Alexandria, Fairfax and Falls Church. Figure 1-1 shows the jurisdictions in which Metrobus operates.

The system currently operates 319 routes on 175 lines and serves a population of 3.9 million within the 1,500 square miles of Metrobus service area. At the end of FY2015, Metrobus had more than 1,500 buses and serve over 11,000 bus stops. In FY2015, Metrorail and Metrobus combined carried 339 million passenger trips, 133 million of which were on Metrobus. The average daily ridership reached 443,000 trips on weekdays, 231,000 trips on Saturdays and 161,000 trips on Sundays. All Metrobus vehicles are accessible to people with disabilities and provide bike racks.

Figure 1-1: Metrobus Service Coverage Area

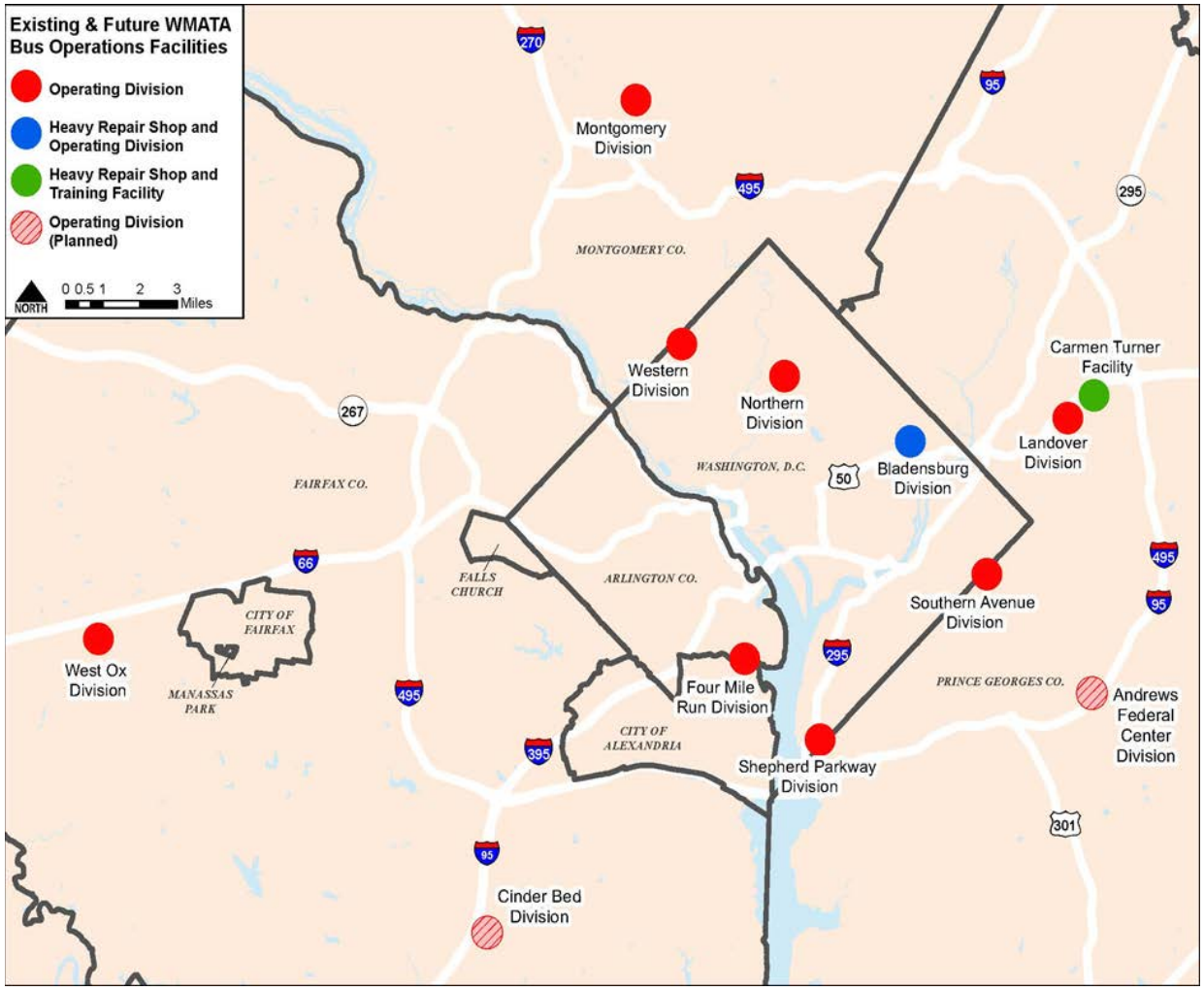


Metrobus is essential to the region's transportation system. The Metrobus network has a broad reach, serving regional activity centers as well as neighborhoods located in all parts of the region. Within the WMATA service area, more than 7 percent of residents ride a bus to work during the morning peak period, including Metrobus and local bus services. Not only does Metrobus provide a reasonably priced, flexible service, but it also transports large volume ridership in major urban corridors and complements the Metrorail system by connecting feeder bus service to stations.

Metrobus operates nine full-service operating divisions, as shown in Figure 1-2. At the end of June, 2015, there were four operating facilities located in the District of Columbia accommodating 49 percent of the total fleet, three in Maryland and two in Virginia accommodating 30 percent and 21 percent of the fleet respectively. In addition, the Carmen E. Turner facility at Landover performs major corrective maintenance and the Bladensburg Division serves as the home of the Metro Heavy Overhaul Program. The Heavy Overhaul program has been so successful at extending the useful life of a transit bus that the Metro Board of Directors raised the expected service life of a standard Metrobus from 12 years to 15 years and set the target average age of the Metrobus fleet at 7½ years.

The construction work for Cinder Bed Bus Garage in Northern Virginia and Andrews Federal Center Bus Garage in Prince Georges County has started and is scheduled for opening in FY18. A new Compressed Natural Gas (CNG) fueling facility is also anticipated to be constructed and opened at Shepherd Parkway Division in FY18. Bladensburg division is also scheduled for a major reconstruction work beginning FY18 and anticipated reopening in FY22.

Figure 1-2: Locations of Metrobus Facilities



1.1. Current Metrobus Fleet

As of June 2015, Metrobus active revenue fleet consisted of 1,571 vehicles, of which 67 are articulated buses, 93 small and the remaining 1,411 are standard size buses as shown in Table 1-1. The total fleet number includes 1,300 buses required for peak service, 243 buses under operating maintenance, 23 buses under heavy overhaul and 5 training buses.

Table 1-1: Metrobus Fleet and Division Assignment (June 21, 2015)

Division	Small (1)	Standard (2)	Articulated (3)	Total
Bladensburg	23	218	25	266
Four Mile Run	18	204	0	222
Landover	10	167	0	177
Montgomery	0	195	19	214
Northern	0	129	21	150
Shepherd Parkway	28	197	0	225
Southern Avenue	0	79	0	79
West Ox	0	96	0	96
Western	14	105	0	119
Undergoing Heavy Overhaul	0	21	2	23
System Total	93	1411	67	1571

Bus size definition:

Small buses (1): vehicles with a length of 30 feet - 35 feet

Standard buses (2): vehicles with a length of 35 feet - 42 feet

Articulated buses (3): vehicles with a length of 60 or more feet

1.2. Organization of Report

The 2017 Metrobus Fleet Management and Facilities Plan documents the process and practice by which Metro establishes its current and projected Metrobus revenue vehicle fleet and facilities requirements. This is a planning document that provides a system-wide analysis for fleet growth from FY16 through FY25, taking into consideration current and future ridership demand, proposed service enhancements, fleet supply, as well as capacities of the Metrobus maintenance programs and facilities.

This report is structured as follows:

Section 2 – Ridership Demand Growth: This section summarizes current ridership characteristics and projects ridership growth over the next ten years. It also analyzes Metrobus data using the 2014 Metrobus Passenger Survey and provides an overview of the Metrobus survey results, including ridership distribution, trip purpose, mode of egress, and socioeconomic characteristics of passengers.

Section 3 – Network Demand for Fleet Growth: This section provides an analysis of the demand for revenue vehicles and projects the fleet growth based on demand. The demand analysis is unconstrained and assesses the actual number of buses needed to provide a state of good operations (SOGO) to the current set of bus routes. This section also provides an overview of the performance and design measures Metro applies for network service evaluation and the current system performance and fleet requirements.

Section 4 – Metrobus Fleet Supply: This section addresses the supply of Metrobus revenue vehicles based on planned fleet procurements for the period FY16 – FY25. It accounts for total buses to be owned by fiscal year, anticipated procurement, and vehicles available for service. It also outlines the current fleet composition by size, age and fueling technology and summarizes the Metrobus replacement and expansion program.

Section 5 – Fleet Maintenance: This section identifies maintenance requirements to support the projected fleet growth based on previous sections. It provides an overview of the fleet maintenance program and assesses the performance of the current Metrobus fleet.

Section 6 – **Conclusion:** This section summarizes ridership growth and subsequent change in demand for bus transit as it translates into demand for increased fleet size. The chapter highlights the widening gap between the fleet demand and supply by comparing current and future supply and demand of buses, the development of new and replacement garage facilities.

Addendum – This section presents recent developments with regards to SafeTrack and ridership.

Appendices – This section presents the summary tables for the 2015 fleet plan.

1.3. Definition of Terms

The following terms are used within this document:

- Artic – Articulated bus, with length of 60 feet or longer.
- Artic conversion – Replacement of standard buses with articulated buses.
- Choice riders – Transit riders who have a vehicle available but "chose" to make the trip by bus instead.
- CNG – Compressed Natural Gas
- MDBF – Mean distance between failures
- Mid-life rehab – Comprehensive rehabilitation of a vehicle performed when it has reached half of its useful life.
- PCN – The Metrobus Priority Corridor Network is a system of the highest ridership Metrobus corridors.

SECTION TWO: RIDERSHIP DEMAND GROWTH

Metrobus has seen steady ridership growth in the past few years, largely driven by a strong recovery of the region's economy, a well-formed transit network inclusive of rail, bus and paratransit, and a solid base of transit riders across the service area. The present and anticipated ridership increases require Metro to provide a high quality and sufficient number of fleets to meet the passenger demand and to capture the growing transit market.

The 2013 Metrobus Fleet Management Plan Update used the results of the 2008 Regional Bus Survey. The 2017 Metrobus Fleet Management Plan will be based on the recently completed 2014 Metrobus Passenger Survey. The process Metro uses to develop a fleet plan starts with an evaluation of current passenger demand and anticipated growth in the transit market over the next ten years. This section provides an overview of current and projected ridership growth and its impact on the Metrobus fleet.

2.1. Recent Ridership Growth

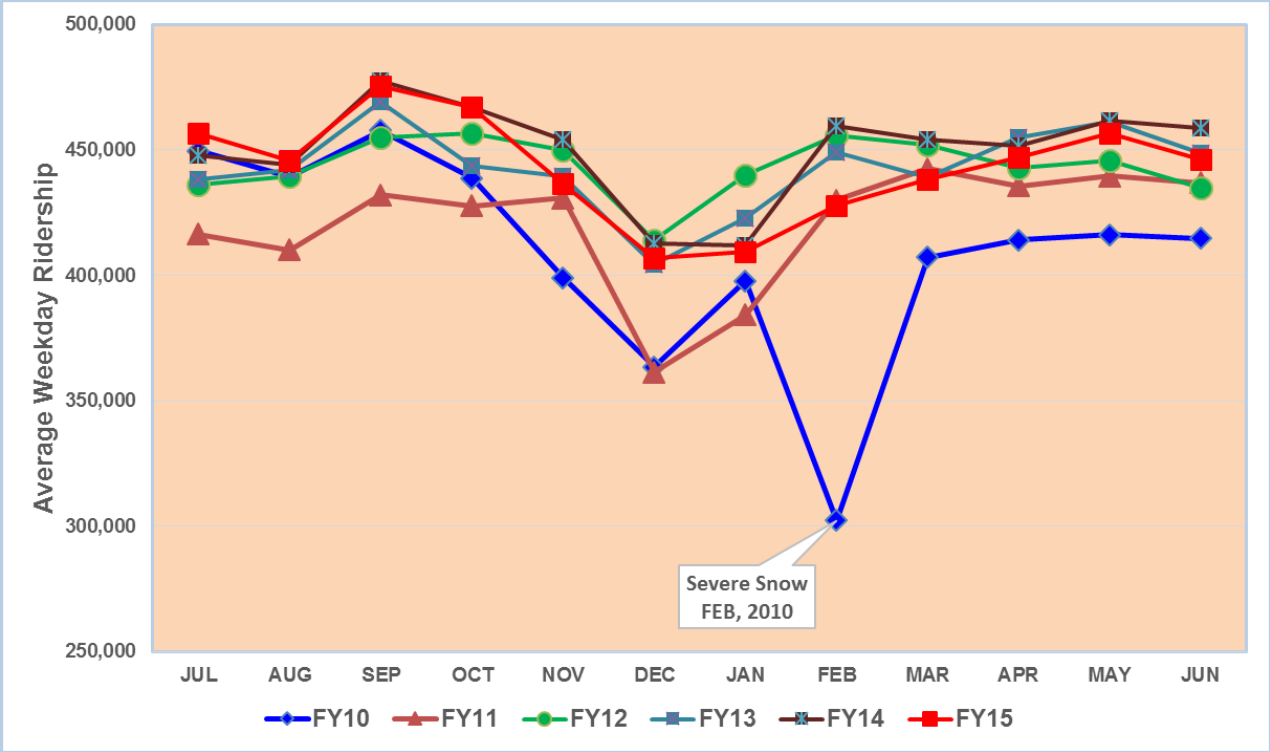
Metrobus ridership has shown steady increases since the economic downturn of FY09. Bus ridership has bounced back to the level of FY09 and continues to grow. Total bus ridership between FY10 and FY15 has grown 7.5 percent at an average of 1.5 percent per annum. During this period, the highest year on year growth of 5.7 percent was achieved in FY12.

Between FY10 and FY15 average daily ridership has increased as follows:

- Weekdays by 8 percent,
- Saturdays by 14 percent, and
- Sundays by 21 percent

Figure 2-1 illustrates Metrobus average weekday ridership trends by month from FY10 to FY15. The trend lines show the typical seasonal fluctuation of higher summer and lower winter ridership.

Figure 2-1: Average Weekday Ridership Trend (FY10 - FY15)



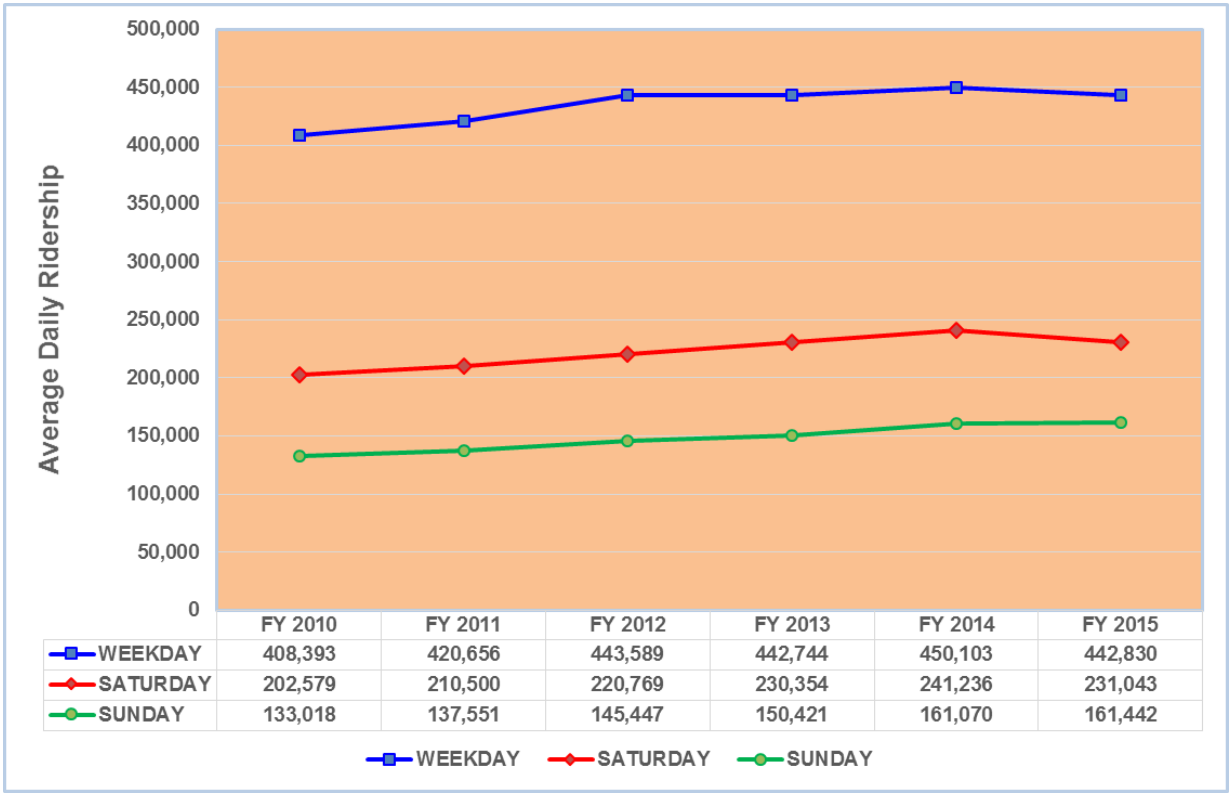
Note that the FY14 line (for most months) shows the highest ridership of the past six fiscal years. It is clear that Metrobus ridership has achieved a near-complete recovery from the economic downturn, and is back on the road to continued growth.

Monthly ridership trends were mostly consistent across the past six fiscal years. The one notable exception was the large drop in ridership in February 2010 (FY10), where two severe winter snow storms within one week shut down the federal government for four days and cut into bus service and ridership.

Weekdays have the highest ridership level, averaging above 478,000 in September 2014. Between FY10 and FY15, weekday ridership has grown by 8.4 percent with an average annual growth of 1.7 percent.

Figure 2-2 below present annual ridership growth trends for weekdays, Saturdays, and Sundays. The trend line indicates that Metrobus ridership has recovered from the economic downturn, and is back on the road to continued growth on all days of the week.

Figure 2-2: Average Daily Bus Ridership by Year and Day Type



	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
WEEKDAY	408,393	420,656	443,589	442,744	450,103	442,830
SATURDAY	202,579	210,500	220,769	230,354	241,236	231,043
SUNDAY	133,018	137,551	145,447	150,421	161,070	161,442

2.2. Current Ridership Characteristics

Within the WMATA service area, 7 percent of residents ride the bus to work during the morning peak period, according to the 2013 American Community Survey. This percentage includes both Metrobus and local bus service ridership. In areas of a quarter-mile walking distance to Metrobus lines, Metrobus commuting mode share reaches 9 percent. Since 2008, the mode share of commuters using bus transit has stayed constant at 7 percent, while the mode share of commuters using any mode of transit increased slightly from 18 percent to 19 percent.

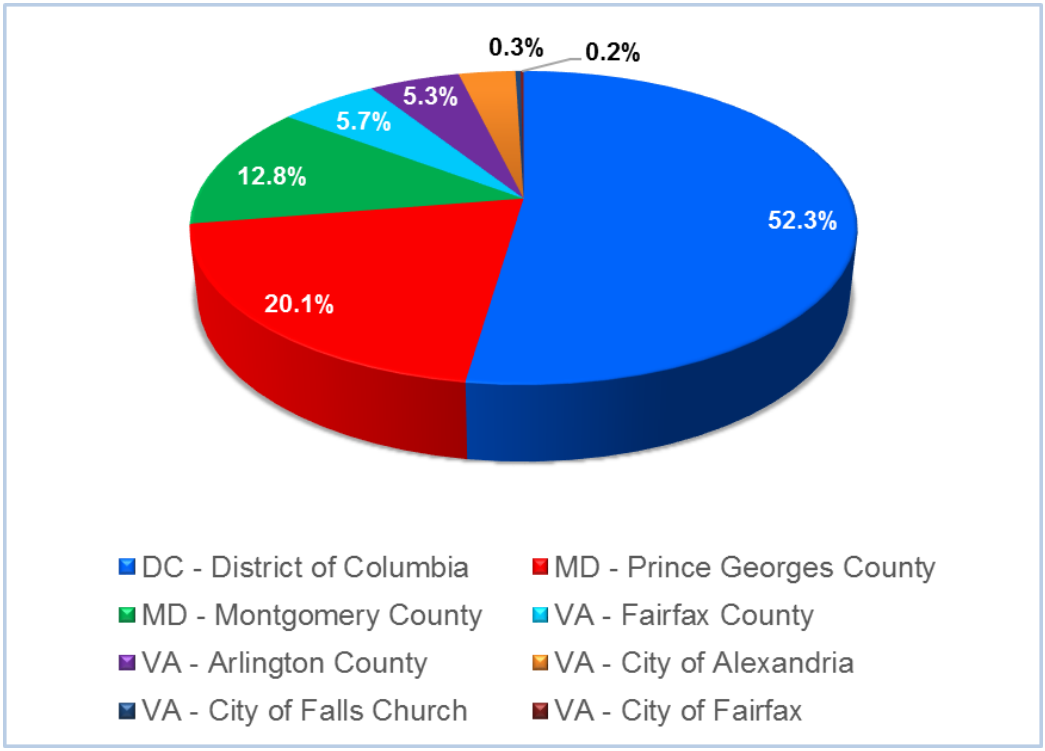
In 2014, the Metropolitan Washington Council of Governments (MWCOG) conducted the 2014 Metrobus Passenger Survey. The result of the survey, released in the spring of 2015, illuminated many characteristics of the current ridership.

In accordance with WMATA's survey standardization practice, methodological updates occurred between 2008 and 2014 data reporting to improve comparability of metrics with other Authority data. Included in this practice is the reporting of valid survey percent instead of percent of total surveys. This does not significantly alter estimates. Unless otherwise specified, average weekday results are reported.

2.2.1. Distribution of Ridership by Area and Time Period

Ridership by area was calculated using weekday jurisdictional boardings. Within the WMATA compact area, Metrobus boardings are highest in the District of Columbia accounting for 52.3 percent of system boardings. Maryland boardings account for 32.9 percent of the system total, and Virginia boardings account for the remaining 14.8 percent (Figure 2-3). Ridership by jurisdiction is very similar to the 2008 Regional Bus Survey results: as a percentage of the total, ridership increased slightly in Washington, D.C. at the expense of Fairfax County.

Figure 2-3: Weekday Ridership by Residency



Source: 2014 Metrobus Passenger Survey

Ridership by time of day was divided into four sections: AM peak, mid-day, PM peak, and evening. Morning and afternoon peak period ridership accounts for close to two-thirds of total weekday ridership (Table 2-1). While peak trends remain virtually identical to those reported in 2008, mid-day ridership as a percent of total ridership has decreased, whereas evening ridership has increased.

Table 2-1: Ridership by Time of Day

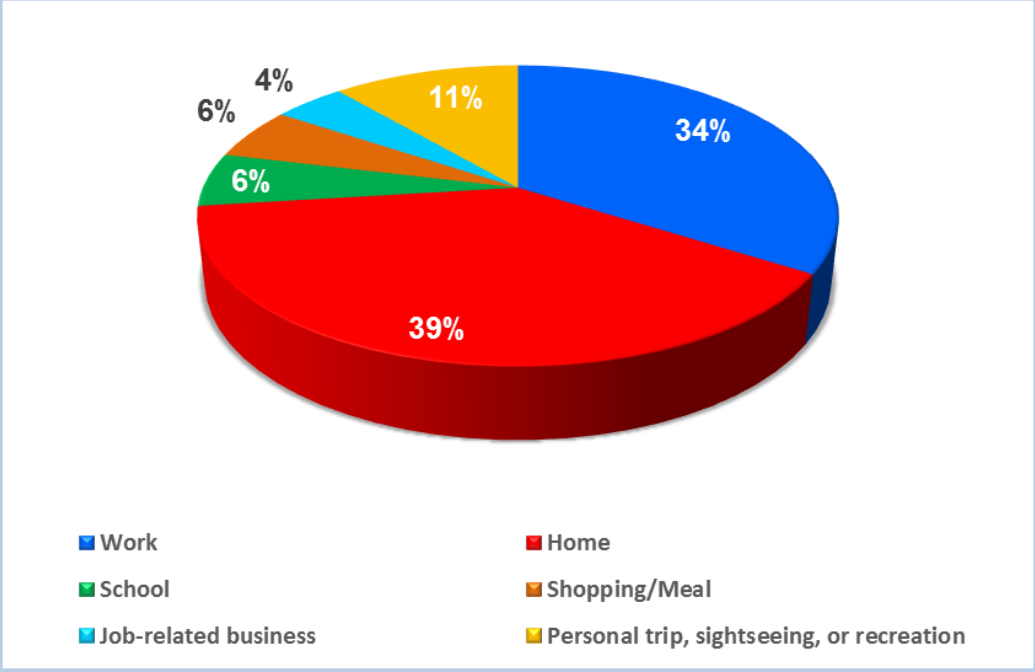
Time of Day	Ridership	Percent
AM Peak	143,804	32.0%
Midday	100,143	22.3%
PM Peak	147,920	32.9%
Evening	57,946	12.9%
Survey Total	449,813	100.0%

Source: 2014 Metrobus Passenger Survey.

2.2.2. Purpose of Metrobus Trips

Metrobus riders use the bus system for a variety of purposes. The 2014 Metrobus Passenger Survey determined trip purpose by stated destination, tabulated into the following categories: work, home, shopping or eating, school, job-related business, and personal trips/sightseeing/recreation. 73 percent of Metrobus riders use the bus to travel to work or to their home, with the remaining 27 percent divided between the other four trip purposes (Figure 2-4). Note that the 2014 Metrobus Passenger Survey aggregated some trip categories that were broken out in the previous survey. Overall there is no significant change in Metrobus trip purpose distribution from the 2008 survey.

Figure 2-4: Weekday Trip Purpose



Source: 2014 Metrobus Passenger Survey.

2.2.3. Socioeconomic Characteristics of Metrobus Passengers – Ethnicity

Ridership on the Metrobus system reflects the diversity of the region. Riders from all socioeconomic backgrounds and ethnicities use the system daily. 57.5 percent of riders identify as African American, 18.7 percent are white, 12.5 percent are Hispanic, 4.6 percent are Asian, 4.3 percent identify as two or more races, 1.2 percent are Native American, and 1.2 percent are another race (Table 2-2). Compared to 2008, African American ridership as a percent of the system total has declined by 5 percent and white ridership has declined by almost 1 percent. At the same time, Hispanic ridership has increased by slightly more than 2 percent, while Asian, Native American, and other-race ridership have increased by less than 1 percent each.

Table 2-2: Ridership by Ethnicity

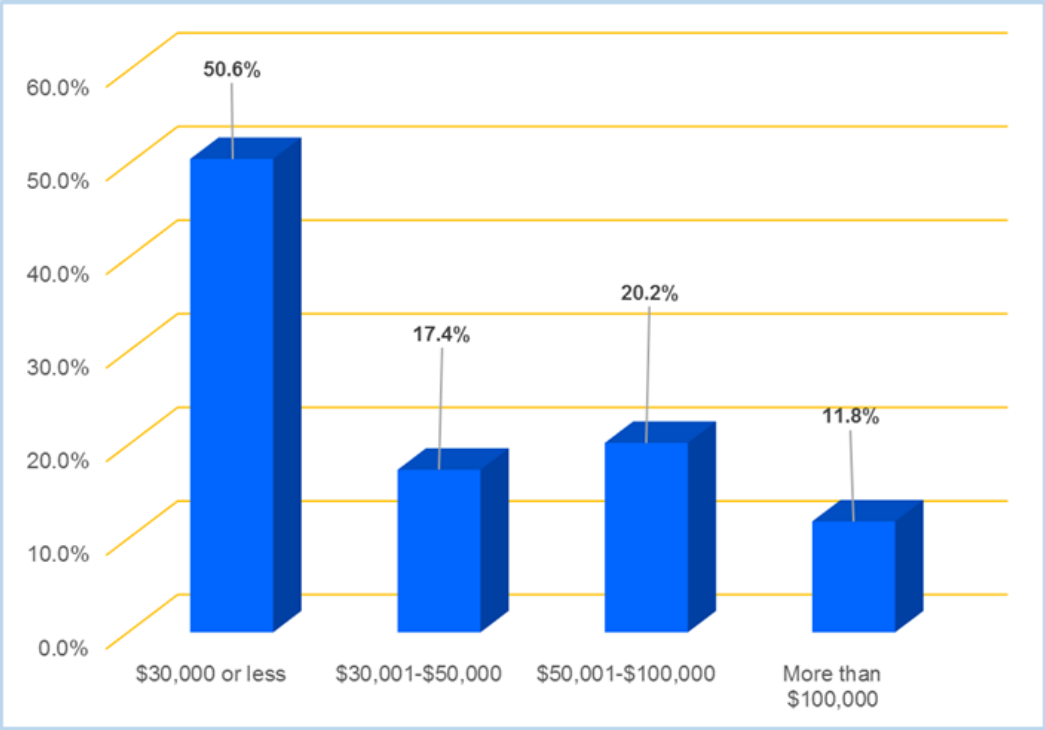
Ethnicity	Ridership	Percent
Black/African American	245,105	57.5%
White	79,609	18.7%
Hipanic	53,073	12.5%
Asian	19,535	4.6%
Two or More	18,417	4.3%
Native American	5,123	1.2%
Other Race	5,259	1.2%
Total	426,121	100.0%

Source: 2014 Metrobus Passenger Survey.

2.2.4. Socioeconomic Characteristics of Metrobus Passengers – Income Level

Metrobus serves a high proportion of low-income riders but the overall ridership spans a broad income spectrum. 50.6 percent of riders reported annual income of $30,000 or less. 17.4 percent reported income between $30,001 and $50,000 while 20.2 percent reported income between $50,001 and $100,000. 11.8 percent reported income greater than $100,000 per year (Figure 2-5). Compared to 2008, the income group earning $30,000 or less has increased by around 2.5 percent, and those earning over $100,000 has increased by slightly less than 2 percent. Income group earning between $30,001 and $50,000 has decreased by slightly less than 4 percent.

Figure 2-5: Ridership by Income Level

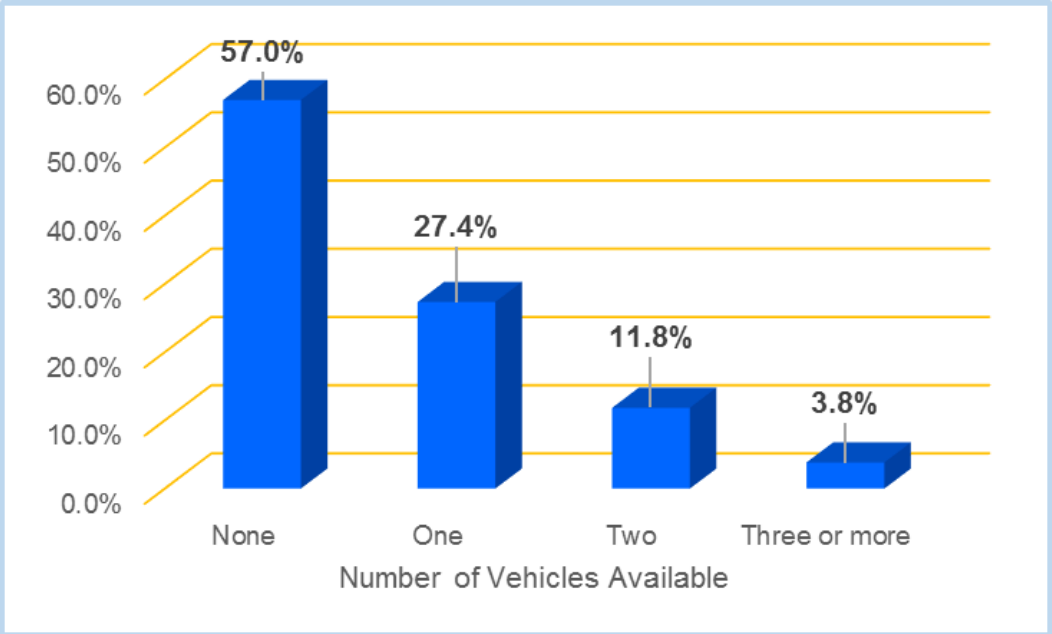


Source: 2014 Metrobus Passenger Survey.

2.2.5. Vehicle Ownership

According to the 2014 Metrobus Passenger Survey, 43 percent of Metrobus riders are choice riders. Choice riders are those people who have a vehicle available to them but choose to make a trip by bus instead of by car. Vehicle ownership for Metrobus riders is outlined in Figure 2-6.

Figure 2-6: Weekday Ridership by Vehicle Ownership



Source: 2014 Metrobus Passenger Survey.

2.2.6. Mode of Egress

The 2014 Metrobus Passenger Survey used mode of egress to evaluate mode of access. Mode of egress describes how people arrive at their final destination after alighting the bus and provides equivalent statistics as mode of access on a system level. 56.9 percent of riders walked to their destination, whereas 38.7 percent transferred to another Metro service (either Metrorail or Metrobus). The remaining 10.2 percent used other mode of egress to reach their destination, as shown in Table 2-3.

Table 2-3: Mode of Egress

Egress Mode	Percent
Walked only	56.9%
Metrobus	22.7%
Metrorail	16.0%
Other bus service	3.9%
Dropped off by someone	2.1%
Drove a car and parked	1.3%
Bicycle	0.7%
Taxi	0.7%
Rode with someone who parked	0.5%
Amtrak, MARC, or VRE	0.4%
Carpooled	0.4%
Wheelchair	0.3%

Source: 2014 Metrobus Passenger Survey.

2.3. Ridership Growth Projection

The approach used in previous fleet plans of matching service with projected demand continues in this fleet plan. This fleet plan have incorporated assumptions about ridership growth due to regional population and employment growth, with that growth matched by planned Metrobus service improvements on the Priority Corridor Network (PCN), Emerging Corridors as well as ongoing State of Good Operations (SOGO) investments.

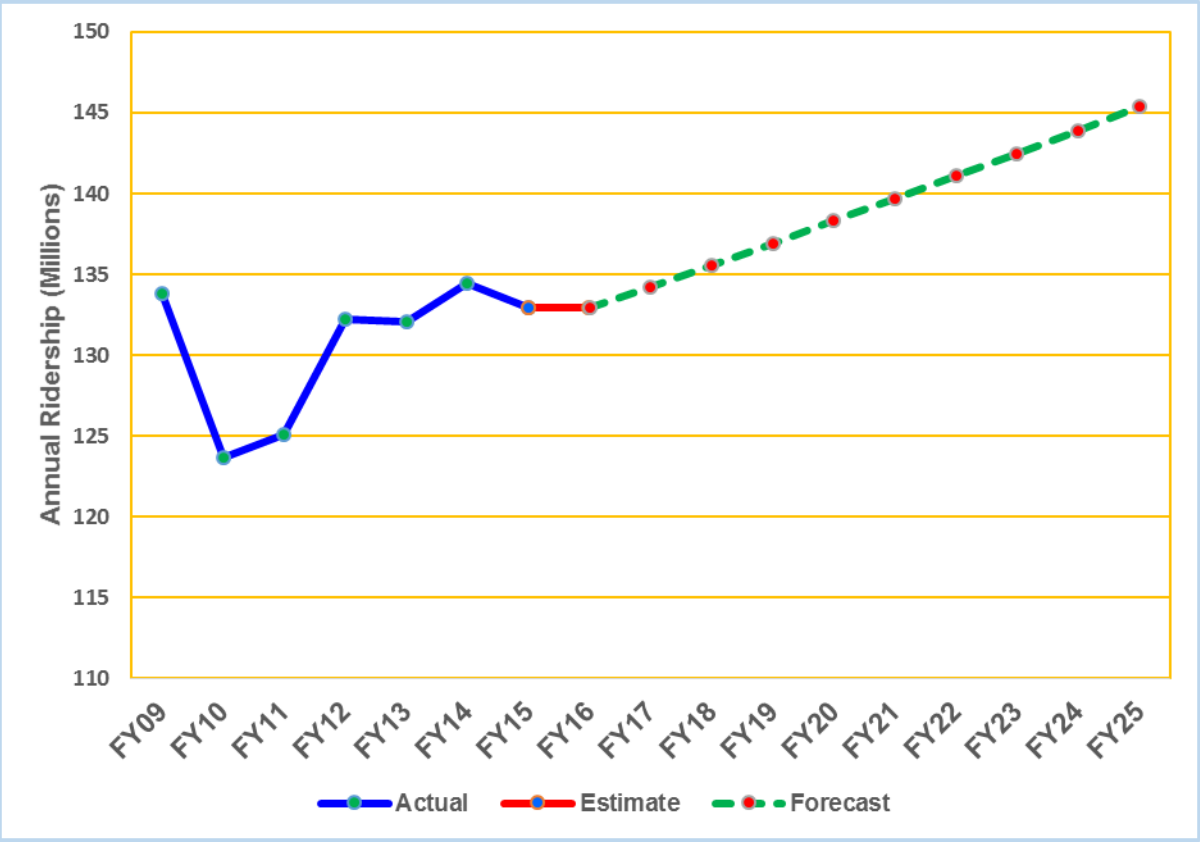
As of FY2014, Metrobus ridership has recovered to the level of FY2009, a benchmark year prior to the financial recession which greatly impacted ridership in FY2010 and FY2011. Ridership over the last one year has declined slightly and the first quarter of FY16 has not seen any improvements. As a result ridership for FY16 is projected to remain the same as FY15, with annual increases in ridership of approximately 1 percent in subsequent years (Table 2-4).

Table 2-4: Bus Ridership: Actual and Forecast

Fiscal Year	Status	Bus Ridership	% Change
2009	Actual	133,773,923	
2010	Actual	123,670,328	-8%
2011	Actual	125,089,241	1%
2012	Actual	132,220,196	6%
2013	Actual	132,064,874	0%
2014	Actual	134,407,528	2%
2015	Actual	132,901,867	-1%
2016	Estimate	132,901,867	0%
2017	Forecast	134,230,886	1%
2018	Forecast	135,573,195	1%
2019	Forecast	136,928,926	1%
2020	Forecast	138,298,216	1%
2021	Forecast	139,681,198	1%
2022	Forecast	141,078,010	1%
2023	Forecast	142,488,790	1%
2024	Forecast	143,913,678	1%
2025	Forecast	145,352,815	1%

Figure 2-7 shows Metrobus ridership past performance and projected future trend.

Figure 2-7: Metrobus Annual Ridership Trend (FY09 – FY25)



In conclusion, bus ridership has dipped and then recovered since the 2010 plan. With continued growth in regional population and employment, as well as continued PCN, Emerging Corridors and SOGO investments, a trend growth rate of 1 percent results in approximately 145 million annual trips by FY2025.

2.4. Ridership Demand for Fleet Growth

2.4.1. Quality of Service

Quality of service is what ultimately determines the success of any transit system. Metro is committed to quality of service and is taking steps to improve the system's performance.

Quality of service is key to retaining and increasing ridership, meeting customer demand and achieving Metro's vision of moving the region forward by connecting communities and improving mobility. Quality of service is a function of service characteristics, including safety, speed, cleanliness, courtesy, frequency, service reliability and comfort. The size and quality of the Metrobus fleet directly impact most service characteristics: cleanliness, comfort, safety, speed, and service reliability.

2.4.2. Passenger Load Standard

The Metrobus network is monitored regularly to balance passenger demand and fleet supply, make adjustments for traffic congestion, and ensure passenger comfort. Metro uses peak hour load factor to measure passenger demand and to determine when more buses are needed. The peak load is calculated using point-checks to determine the number of passengers at the maximum load point during the peak hour, divided by the seating capacity. For example: 200 passengers divided by 5 trips, divided by 39 seats, yields a load factor of 1.0. A load factor of 1.0 means all seats are occupied and no passenger is forced to stand. The load factor for service and vehicle adjustments adopted in the new Guideline (see section 3.1) varies by route classification and time period as shown below.

Table 2-5: Loading Standard by Line Classification and Time Period

	Load Factor	
Line Classification	**Peak**	**Off-Peak and Weekend**
Priority Corridor Network (PCN)	**1.2**	**1.0**
Framework	**1.2**	**1.0**
Local Area	**1.2**	**1.0**
Commuter/Express	**1.0**	**1.0**

Source: 2015 Metrobus Service Guidelines

2.4.3. Ridership Driven Fleet Projection

At the end of June, 2015, a total of 1,272 buses were put into service during the peak period. But this number was not a true reflection of the need for peak vehicles. Metro requires a number of additional buses, during the peak periods, to improve service reliability, reduce overcrowding and meet policy frequency standards. However, meeting this needs and requirements is constrained by lack of fleet. For FY2017 Metro service planners evaluated all the routes by looking at sufficiency of running time, reliability of service, frequency thresholds and crowding problems. Where problems were identified the need for additional peak vehicles was calculated. The result shows that, to keep up in proportion with ridership growth, improve the reliability of service and maintain the network in a State of Good Operation, Metro will need an additional 117 peak vehicles for FY2016 (Table 3-5). At the end of FY2016, a total of 1,389 buses will be needed for service during the peak period to satisfy the growth in demand. (See section 3.5, 3.7.1 and Table 3.10 for more details).

SECTION THREE: NETWORK DEMAND FOR FLEET GROWTH

Fleet growth over the next decade is driven by ridership growth, passenger demand for service quality, as well as continuous service improvements and network expansion to the existing Metrobus system. This section provides the fleet growth demand of the 2017 Metrobus Fleet Plan. An estimate of the fleet requirement is made based on the level of demand. There is a growing gap between supply and demand for the bus fleet that keeps widening over the timeframe of this plan. Metro fleet growth has not kept up with the demand for service provision and Metrobus has been coping with a shortage of expansion buses by delaying or limiting needed service improvements.

The primary conclusions of this chapter are as follows:

- Metro has a current need for 117 additional buses to serve weekday peak period service, resulting in a total peak PVR fleet size of 1,389 buses
- Several Metrobus routes have a demand for buses higher than those currently supplied/scheduled, resulting in an increase in the Schedule PVR by 117 buses
- The 15.6% spare bus ratio is unable to support the various needs for which the spare buses are intended
- This fleet plan recommends increasing the spare ratio to 18.5%
- The implementation of the Priority Corridor Network (PCN) will require an increase in the Schedule PVR by an additional 147 buses by 2025
- The implementation of the Emerging Corridors will require an increase in the Schedule PVR by an additional 87 buses by 2025
- Total PVR will increase from 1,500 in FY15 to 2,068 by the end of FY25 a net increase of 568

3.1. Network Characteristics

Traditionally, Metro classified lines and routes in the Metrobus network into five categories based on geographical characteristics of individual service areas: radial line haul, other urban, other suburban, express and small bus (30 foot or less).

More recently Metro has undertaken a Metrobus Service Guidelines (Guideline) study to provide a consistent technical guidance for service planners in evaluating and planning services. The Guideline classifies Metrobus services into four categories, listed below. Each category has different standards for peak and off-peak service.

3.1.1 Priority Corridor Network (PCN)

The Priority Corridor Network (PCN) is a WMATA Board-approved program that identifies specific Metrobus service with significant regional importance. There are 24 corridors included in the PCN category.

3.1.2 Framework Service

Framework services are defined as local bus lines that provide direct alignments following key arterial corridors. Framework services also include potential future limited stop Metrobus services. Radial, crosstown and emerging corridor services are included in this category.

3.1.3 Local Area Service

The services under this category operate within neighborhoods, connecting to a nearby major generator such as a Metrorail station. Circulating in local neighborhoods and connecting to nearby generators is the main focus of services under this category.

3.1.4 Commuter/Express Service

The services under this category are defined to operate between a residential area or park-and-ride and a business district or Metrorail station, or between a central business district and a peripheral employment area. These services have a limited number of stops in the catchment/distribution area before operating non-stop to/from the ridership generator. Peak direction services connecting park and rides or neighborhoods to major employment center, reverse commute services operating from central areas to suburban employment centers and airport services fall under this category.

The majority of Metrobus service is demand driven, which requires monitoring and matching of the fleet supply to the demand. During the peak periods, Metro maximizes fleet sizes and types to meet passenger demand and ensure passenger comfort. The rest of Metrobus service is policy driven, which is established by policy that a minimum level of service be provided even though the ridership does not justify the level of service provided. Policy driven services typically include night and weekend services with light ridership or new initiatives as demand develops.

The network today is facing both opportunities and challenges. Passenger demand has been increasing; however traffic congestion on urban arterials in the Washington DC region is also on the rise, directly impacting bus operations and passengers. The result has been increasing

crowding, bus bunching and degrading on-time performance. Metro planners adjust service and corresponding fleet on a routine basis to cope with today's operations environment. Metro has gradually introduced bus network enhancement initiatives by making fundamental changes to service structures through the Priority Corridor Network (PCN) and Emerging Corridors. The State of Good Operations (SOGO) is also used to maintain and improve service operations and reliability. The PCN, Emerging Corridors and SOGO's are described together with their associated fleet requirements in Section 3.5 – 3.7.

3.2. Performance and Fleet Requirements

For the existing network, Metro's service planners regularly monitor its performance and make service adjustments to address system deficiencies and enhance efficiency. To accommodate increasing traffic congestion without compromising quality of service, many service adjustment measures require increasing the number of buses for lines and routes.

The previous fleet plan update used slightly different performance and design measures to assess service performance and fleet needs. The 2015 fleet plan uses the new Service Guideline for evaluating services. The Guideline provided a revised performance measures and target values for reviewing operations and monitor service for the bus network as a whole. The Guideline has modified the thresholds for some of the key performance indicators used for reviewing operations and monitoring services.

Productivity, reliability and level of crowding are the three key performance measures used by Metro. **Productivity** measures how effectively the resources devoted to route operations are used, typically by calculating the number of boardings per hour, per mile, or per trip. Lines that have high productivity, carrying a relatively large amount of boardings per unit of service, are candidates for service expansion, which would increase the number of peak vehicles required. **Reliability** is a critical service quality measure for customers, reflecting customers' expectation for on-time bus arrival and on-time completion of a bus trip. Bus lines with poor travel time reliability, particularly ones whose travel time is longer than the scheduled travel time, may require additional vehicles in service to meet the schedule. **Level of crowding** is another service quality measure from a customer's perspective. Lines that experience regular overcrowding require additional capacity, resulting in more buses.

3.2.1. Productivity

Previously uniform productivity thresholds were applied across different class of services. The new Guideline applies different thresholds for different line classifications and for services that operate late in the night. Five different thresholds are used to measure service productivity: Cost Recovery Ratio, Subsidy Per Passenger, Passenger Per Hour (replaces the previous threshold of Average Daily Passenger), Passenger Per Revenue Mile, and Passenger Per Revenue Trip. Metrobus defines productivity failure as a line or route that fails one or more of the minimum thresholds. Performance is reviewed and updated every year by WMATA service planners as part of the regular service reviewing process. Table 3-1 and 3-2 below shows minimum productivity thresholds, developed as part of the Metrobus Service Guidelines.

Table 3-1: Metrobus Minimum Productivity Thresholds

Classification	Cost Recovery Ratio	Subsidy Per Passenger	Passenger Per Hour	Passenger Per Revenue Mile	Passenger Per Revenue Trip
PCN	30%	$2.5	35	4.0	35
Framework	25%	$3.0	30	3.0	25
Local Area	25%	$4.0	25	5.0	15
Commuter Express	25%	$5.0	20	1.5	19

Source: Metrobus Service Guidelines, June 2015

Table 3-2 shows the productivity thresholds for late night services (11PM - 4AM).

Table 3-2: Late Night Service Productivity Thresholds

Classification	Cost Recovery Ratio	Subsidy Per Passenger	Passenger Per Hour	Passenger Per Revenue Mile	Passenger Per Revenue Trip
PCN	20%	$5.0	20	2.00	15
Framework	20%	$6.0	15	1.50	10
Local Area	15%	$9.0	15	1.50	10
Commuter Express	25%	$8.0	12	0.33	10

Source: Metrobus Service Guidelines, June 2015

3.2.2. Reliability

Reliability of travel time is defined by the difference between actual travel time and scheduled travel time. The new Guideline hasn't changed the "on-time" performance threshold. Lines are considered to have poor reliability if they don't meet the on-time performance standards, departing from the time point more than two minutes early or seven minutes late from the scheduled departure time. The standard applies for all Metrobus Line Classifications.

The Guideline included a headway separation threshold to monitor service reliability for routes that are headway managed. Headway separation is measured by the deviation of the scheduled time between buses operating in the same direction on a route and the actual time between buses. The Guideline indicates that headway separation should not be greater than (or less than) 5 percent at a scheduled time point for all Metrobus Line Classifications. This will provide an indication of when "bus bunching" (i.e., trips operating too closely together) may be regularly recurring. For example, if a route is scheduled to have a 30 minute frequency (i.e., interval between buses), then two buses at a scheduled time point should depart the time point between 28.5 minutes and 31.5 minutes apart in order to satisfy the intent of this guideline.

Planners regularly assess if routes have adequate travel time. The criteria used to determine adequacy of travel time is based on the assumption that routes fail the reliability thresholds if, on average, 21 percent of the trips are late by more than seven minutes and headway separation is more than 5 percent of the scheduled time. To improve reliability Metro's service planners use a number of operational strategies such as, monitoring the service by Service Operation Managers, adding running time, reducing trip length and adding buses.

3.2.3. Level of Crowding

Vehicle load factor is a performance measure used to determine crowding on a particular bus line. The load factor is the number of people on the bus at the maximum load point divided by the number of seats. The load factor for service and vehicle adjustments adopted in the new Guideline varies by route classification and time periods. (See Section 2.4.2).

Passenger crowding is a component of service quality that receives much attention from Metro planners. They continuously monitor passenger feedback on this issue and regularly review data to determine the degree of crowding throughout the system. Lines that have a relatively large amount of boardings per unit of service, are candidates for service expansion. Lines that experience regular overcrowding require additional capacity, resulting in more buses. When

reductions are made to poorly performing routes, those resources can be reallocated to lines that are experiencing crowded conditions.

3.3. Service Design Measures

Service frequency is used as the primary service design measurer, together with span of service and duplication of service. Service frequency or headway, is the service interval between buses on a particular bus route. The previous fleet plan used two service classifications for recommending frequency thresholds. The new Guideline provides the threshold for all service classifications, by line and branch as well as by time of day and day type. The Guideline used the maximum service interval, or headway, as the measure of service frequency thresholds.

The Guideline states that in general Metrobus service intervals should not exceed 30 minutes during the peak period and 60 minutes during the off-peak periods. Other design measures, such as accessibility, number of stops, and location of stops along each route, are additional measures that have not been incorporated in this plan. Metro's recommended frequency thresholds are illustrated in Table 3-3.

Table 3-3: Frequency of Service Threshold

Day Type	Minimum Frequency (Minutes)			
	PCN	Framework	Local Area	Commuter Express
Weekday - Peak				
Line Level	10	20	15	20
Branch Level	15	30	30	30
Weekday - Off- Peak				
Line Level	15	30	60	60
Branch Level	30	60	60	60
Weekend				
Line Level	20	60	60	60
Branch Level	30	60	60	60
Late Night Service (11 PM - 4 AM)	60	60	60	60

Source: Metrobus Service Guidelines, June 2015

Service frequency determines the number of buses needed for operations, thus having a direct impact on fleet size particularly during peak periods. For the demand-driven routes carrying high ridership, frequency is determined by the number of vehicles required to accommodate the demand. For policy driven routes with lower ridership, frequency is based on corresponding service policies.

3.4 Summary of Network Performance and Fleet Requirements

As of June 21, 2015, Metrobus' Peak Vehicle Requirement (PVR) for weekday roll-out was 1,300 buses. With a spare ratio of 15.6 percent, this results in a total fleet size of 1,500 buses.

Table 3-4 presents the calculation of the current PVR by bus division as of June 21, 2015, and the system total. PVR is calculated on the division level because many routes require a different number of buses in the AM and PM peak period service. When different routes with different AM and PM bus requirements are housed in the same bus division, buses that serve one route in the AM peak can be repurposed to serve another route in the PM peak. Balancing the supply and demand of buses at the division level reduces the actual total number of buses required to maintain an adequate level of revenue service.

Table 3-4: Peak Vehicle Requirement (PVR) by Division (June 21, 2015)

Division	AM Peak	PM Peak	Schedule PVR	Strategic Fleet	Headway Mgmt.	Total PVR	Spares	Total Fleet
Bladensburg	214	213	214	3	1	218	34	252
Shepherd Pkwy [1]	182	183	183	2	1	186	27	214
Southern Ave	66	65	66	1	0	67	10	76
Landover [1]	130	143	143	3	0	146	23	169
Four Mile Run	184	183	184	3	2	189	29	218
West Ox	82	82	82	1	0	83	13	96
Montgomery	162	173	173	5	0	178	28	206
Northern	125	117	125	1	4	130	20	150
Western	102	95	102	1	0	103	16	119
System Total	1247	1254	1272 [2]	20	8	1300	200	1500

[1] 6 high back vehicles from Landover and 13 branded buses for Metroway from Shepherd Parkway are not included in the spare ratio.

[2] Total Schedule PVR is the sum of the individual division requirements, which are based on the maximum of the AM and PM peak requirements

The "Schedule PVR" column shows the peak vehicle requirement for scheduled buses per operating division, which is the greater of the AM or PM peak vehicle requirement. The "Total

PVR" column is the sum of the "Schedule PVR," "Strategic Fleet," and "Headway Management" columns (strategic fleet and headway management buses are defined in Section 3.7.2 below). Total PVR is the total number of buses necessary to operate service on a given day; this includes strategic fleet and headway management buses, which provide operational redundancy to assist in schedule/headway adherence. Finally, the "Total Fleet" column represents the required fleet size necessary to supply the service and is the sum of the scheduled buses, operationally required buses and spares.

Table 3-5 below presents a summary of how each Metrobus line fares with respect to the adequacy of vehicle requirements based on WMATA service evaluation measures. A "Yes" indicates that the line has sufficient fleet to provide the service that matches ridership demand. A "No" indicates that the line requires additional vehicles to be able to provide the service that matches ridership demand. If a "No" is shown, the table indicates the number of additional vehicles required to achieve adequate levels of service.

The assessment of fleet sufficiency is a function of evaluation measures: adequate travel time, frequency, and crowding. This fleet plan has used thresholds set out in the new Guidelines, assessments involving ridership and traffic checks, and professional judgment from service planners and corridor planners.

Table 3-5: Scheduled Peak Vehicle Requirement by Line

Line	Line Name	Classification	Adequacy of Fleet	Current Peak Buses (21 June 15)		Need for Additional Peak Vehicles		Total Fleet Demand	
				AM	PM	AM	PM	AM	PM
30N, 30S	Friendship Hghts - Southeast	PCN	Yes	7	8			7	8
31, 33	Wisconsin Ave	PCN	Yes	16	16			16	16
32, 34, 36	Pennsylvania Ave	PCN	Yes	22	20			22	20
37	Wisconsin Ave Limited	PCN	Yes	6	6			6	6
39	Pennsylvania Ave Limited	PCN	Yes	6	6			6	6
52, 53, 54	14th St	PCN	No	23	24	5	5	28	29
70	Georgia Ave - 7th St	PCN	No	11	13	1	1	12	14
74	Convention Ctr - SW Waterfront	PCN	Yes	4	4			4	4
79	Georgia Ave Limited	PCN	No	14	13	4	4	18	17
80	North Capitol St	PCN	Yes	17	15			17	15
81, 82, 83, 86	College Park	PCN	Yes	11	13			11	13
90, 92, 93	U St - Garfield	PCN	Yes	24	27			24	27
16A,B,E,J,P	Columbia Pike	PCN	No	11	11	1	1	12	12
16G,H,K	Columbia Heights W - Pentagon City	PCN	Yes	10	11			10	11
16L	Annandale - Skyline City - Pentagon	PCN	Yes	3	3			3	3
16X	Columbia Pike - Federal Triangle	PCN	No	6	7	0	1	6	8
16Y	Columbia Pike - Farragut Square	PCN	Yes	11	9			11	9
28A	Leesburg Pike	PCN	Yes	10	11			10	11
28X	Leesburg Pike Limited	PCN	Yes	8	9			8	9
29K,N	Alexandria - Fairfax	PCN	Yes	5	6			5	6

Table 3-5: Continued

Line	Line Name	Classification	Adequacy of Fleet	Current Peak Buses (21 June 15)		Need for Additional Peak Vehicles		Total Fleet Demand	
				AM	PM	AM	PM	AM	PM
9A	Huntington - Pentagon	PCN	Yes	3	3			3	3
A2,6,7,8,42-48	Anacostia - Congress Heights	PCN	Yes	17	22			17	22
A4, W5	Anacostia - Fort Drum	PCN	Yes	10	11			10	11
A9	M. L. King Jr. Ave Limited	PCN	Yes	6	5			6	5
C2,4	Greenbelt - Twinbrook	PCN	No	18	21	1	2	19	23
F4	New Carrollton - Silver Spring	PCN	No	11	13	1	1	12	14
F6	New Carrollton - Fort Totten	PCN	No	5	6	5	6	10	12
G8	Rhode Island Ave	PCN	No	12	10	2	2	14	12
J1,2,3	Bethesda - Silver Spring	PCN	No	14	19	1	1	15	20
J4	College Park - Bethesda Limited	PCN	Yes	6	7			6	7
K6	New Hampshire Ave - Maryland	PCN	No	9	10	1	1	10	11
K9	New Hampshire Ave - MD Limited	PCN	Yes	6	6			6	6
MW1	Metroway - Potomac Yard	PCN	Yes	7	7			7	7
NH1	National Harbor	PCN	No	3	3	3	3	6	6
P12	Eastover - Addison Rd	PCN	No	7	10	4	5	11	15
Q1,2,4,5,6	Veirs Mill Rd	PCN	Yes	15	16			15	16
REX (R99)	Richmond Hwy Express	PCN	No	11	13	1	1	12	14
S1	16th St - Potomac Park	PCN	Yes	15	5			15	5
S2,4	16th St	PCN	No	28	30	1	1	29	31
S9	16th St Limited	PCN	No	12	13	3	2	15	15

Table 3-5: Continued

Line	Line Name	Classification	Adequacy of Fleet	Current Peak Buses (21 June 15)		Need for Additional Peak Vehicles		Total Fleet Demand	
				AM	PM	AM	PM	AM	PM
T18	Annapolis Rd	PCN	No	8	7	2	2	10	9
X1,3	Benning Rd	PCN	Yes	9	8			9	8
X2	Benning Rd - H St	PCN	Yes	12	13			12	13
X9	Benning Rd - H St Limited	PCN	No	6	7	2	2	8	9
Y2,7,8	Georgia Ave - Maryland	PCN	No	14	16	2	3	16	19
Z2	Colesville - Ashton	PCN	Yes	2	6			2	6
Z6	Calverton - Westfarm	PCN	No	7	5	0	1	7	6
Z8	Fairland	PCN	No	8	9	1	1	9	10
42, 43	Mount Pleasant	Framework	No	17	16	1	1	18	17
60, 64	Fort Totten - Petworth	Framework	No	12	7	2	2	14	9
62, 63	Takoma - Petworth	Framework	No	10	13	1	0	11	13
89, 89M	Laurel	Framework	Yes	3	3			3	3
94	Stanton Rd	Framework	Yes	3	3			3	3
96, 97	East Capitol St - Cardozo	Framework	No	15	13	1	1	16	14
1A,B,E,Z	Wilson Blvd - Vienna	Framework	Yes	11	10			11	10
1C	Fair Oaks - Fairfax Blvd	Framework	No	8	8	2	2	10	10
10A,E,R,S	Hunting Point - Pentagon	Framework	Yes	10	4			10	4
10B	Hunting Point - Ballston	Framework	Yes	2	10			2	10
15K,L	Chain Bridge Rd	Framework	No	4	3	1	0	5	3
15M	George Mason Univ - Tysons Corner	Framework	Yes	4	4			4	4

Table 3-5: Continued

Line	Line Name	Classification	Adequacy of Fleet	Current Peak Buses (21 June 15)		Need for Additional Peak Vehicles		Total Fleet Demand	
				AM	PM	AM	PM	AM	PM
2A	Washington Blvd - Dunn Loring	Framework	Yes	7	8			7	8
2B	Fair Oaks - Jermantown Rd	Framework	No	5	6	1	1	6	7
2T	Tysons Corner - Dunn Loring	Framework	Yes	0	0			0	0
22A,B,C,F	Barcroft - South Fairlington	Framework	Yes	10	10			10	10
23A,B,T	McLean - Crystal City	Framework	No	11	12	1	1	12	13
25B	Landmark - Ballston	Framework	Yes	7	9			7	9
26A	Annandale - East Falls Church	Framework	No	2	3	2	2	4	5
3A	Lee Hwy - Falls Church	Framework	Yes	8	10			8	10
3T	Pimmit Hills - Falls Church	Framework	Yes	5	5			5	5
3Y	Lee Hwy - Farragut Square	Framework	No	3	3	1	1	4	4
38B	Ballston - Farragut Square	Framework	Yes	9	12			9	12
4A,B	Pershing Dr - Arlington Blvd	Framework	Yes	9	9			9	9
7A,F,Y	Lincolnia - North Fairlington	Framework	Yes	14	11			14	11
A12	Martin Luther King Jr Hwy	Framework	No	6	11	1	2	7	13
B2	Bladensburg Rd - Anacostia	Framework	No	18	15	2	2	20	17
B24,25	Bowie - Belair	Framework	Yes	3	2			3	2
C12,14	Hillcrest Heights	Framework	No	3	3	3	3	6	6
C21,22,26,29	Central Ave	Framework	No	7	6	2	2	9	8
C8	College Park - White Flint	Framework	Yes	6	6			6	6
D1	Glover Park - Federal Triangle	Framework	Yes	1	1			1	1

Table 3-5: Continued

Line	Line Name	Classification	Adequacy of Fleet	Current Peak Buses (21 June 15)		Need for Additional Peak Vehicles		Total Fleet Demand	
				AM	PM	AM	PM	AM	PM
D2	Glover Park - Dupont Circle	Framework	Yes	5	5			5	5
D3	Ivy City - Dupont Circle	Framework	Yes	7	5	(7)	(5)	0	0
D4	Ivy City - Franklin Square	Framework	No	4	4	2	2	6	6
D5	MacArthur Blvd - Georgetown	Framework	Yes	3	3			3	3
D6	Sibley Hospital - Stadium Armory	Framework	Yes	16	17			16	17
D8	Hospital Center	Framework	Yes	8	10			8	10
D12,13,14	Oxon Hill - Suitland	Framework	Yes	15	12			15	12
E2	Ivy City - Fort Totten	Framework	No	2	2	1	1	3	3
E4	Military Rd - Crosstown	Framework	No	13	10	2	2	15	12
F1,2	Chillum Rd	Framework	No	5	6	4	5	9	11
F8	Langley Park-Cheverly	Framework	No	5	5	5	5	10	10
F12	Ardwick Industrial Park Shuttle	Framework	No	5	4	5	4	10	8
F13	Cheverly - Washington Business Pk	Framework	No	2	2	2	2	4	4
F14	Sheriff Rd - Capitol Heights	Framework	No	6	6	6	6	12	12
G2	P St - Ledroit Park	Framework	Yes	7	6			7	6
G12,13,14,16	Greenbelt - New Carrollton	Framework	Yes	8	11			8	11
H1	Brookland - Potomac Park	Framework	No	5	3	1	1	6	4
H2,3,4	Crosstown	Framework	No	14	14	4	4	18	18
H8,9	Park Rd - Brookland	Framework	No	8	8	1	1	9	9
H11,12,13	Marlow Heights - Temple Hills	Framework	Yes	5	6			5	6

Table 3-5: Continued

Line	Line Name	Classification	Adequacy of Fleet	Current Peak Buses (21 June 15)		Need for Additional Peak Vehicles		Total Fleet Demand	
				AM	PM	AM	PM	AM	PM
J11,12,13	Marlboro Pike	Framework	No	3	4	3	4	6	8
K11,12,13	Forestville	Framework	No	5	5	2	2	7	7
L1,2	Connecticut Ave	Framework	Yes	15	15			15	15
L8	Connecticut Ave - Maryland	Framework	No	8	6	1	1	9	7
N2,3,4,6	Massachusetts Ave	Framework	Yes	14	14	(3)	(2)	11	12
P6	Anacostia - Eckington	Framework	Yes	10	9			10	9
R1,2	Riggs Road	Framework	No	5	9	1	1	6	10
R4	Queen Chapel Rd	Framework	No	3	4	1	1	4	5
R11,12	Kenilworth Ave	Framework	No	4	5	2	2	6	7
T2	River Rd	Framework	Yes	7	7			7	7
T14	R.I. Ave - New Carrollton	Framework	No	5	5	1	1	6	6
V2,4	Minnesota Ave - M St	Framework	Yes	14	14			14	14
V12	District Heights - Suitland	Framework	Yes	4	4			4	4
V14,15	District Heights - Seat Pleasant	Framework	No	6	5	2	2	8	7
W4	Deanwood - Alabama Ave	Framework	No	13	12	2	2	15	14
W9	South Capitol St Limited	Framework	Yes	2	2			2	2
X8	Maryland Ave	Framework	Yes	3	2			3	2
7M	Mark Center - Pentagon	Local	Yes	2	2			2	2
E6	Chevy Chase	Local	Yes	2	2			2	2
H6	Brookland - Ft Lincoln	Local	Yes	4	4			4	4

Table 3-5: Continued

Line	Line Name	Classification	Adequacy of Fleet	Current Peak Buses (21 June 15)		Need for Additional Peak Vehicles		Total Fleet Demand	
				AM	PM	AM	PM	AM	PM
K2	Takoma - Fort Totten	Local	No	2	2	1	0	3	2
M4	Nebraska Ave	Local	Yes	6	3			6	3
M6	Fairfax Village	Local	Yes	3	4			3	4
R3	Greenbelt - Prince George's Plaza	Local	Yes	2	2	(2)	(2)	0	0
U4	Sheriff Rd - River Terrace	Local	Yes	3	3			3	3
U5,6	Mayfair - Marshall Hts	Local	Yes	5	5			5	5
U7	Deanwood - Minnesota Ave	Local	Yes	2	2			2	2
U8	Benning Heights	Local	No	4	4	3	3	7	7
W1	Shipley Terrace - Fort Drum	Local	Yes	5	4			5	4
W2,3	United Medical Ctr - Anacostia	Local	Yes	9	10			9	10
W6,8	Garfield - Anacostia Loop	Local	Yes	8	6			8	6
Tags (S80,91)	Springfield Circulator	Local	Yes	4	4			4	4
87	Laurel Express	Comm./Express	No	4	4	1	1	5	5
11Y	Mount Vernon Express	Comm./Express	No	7	5	1	1	8	6
13Y	Arlington - Union Station	Comm./Express	Yes	0	0			0	0
17A,B,F,M	Kings Park	Comm./Express	No	4	8	1	1	5	9
17G,H,K,L	Kings Park Express	Comm./Express	No	14	15	1	1	15	16
18E,F	Springfield	Comm./Express	Yes	3	3			3	3
18G,H,J	Orange Hunt	Comm./Express	Yes	6	5			6	5
18P,R,S	Burke Centre	Comm./Express	No	8	12	1	1	9	13

Table 3-5: Continued

Line	Line Name	Classification	Adequacy of Fleet	Current Peak Buses (21 June 15)		Need for Additional Peak Vehicles		Total Fleet Demand	
				AM	PM	AM	PM	AM	PM
21A,D	Landmark - Pentagon	Comm./Express	Yes	3	3			3	3
28F,G	Skyline City	Comm./Express	Yes	3	3			3	3
29C,G	Annandale	Comm./Express	Yes	5	6			5	6
29W	Braeburn Dr - Pentagon Express	Comm./Express	Yes	3	3			3	3
5A	DC - Dulles	Comm./Express	Yes	5	5			5	5
7C,H,P,W,X	Lincolnia - Park Center - Pentagon	Comm./Express	Yes	12	10			12	10
8S,W,Z	Foxchase - Seminary Valley	Comm./Express	Yes	8	7			8	7
B21,22	Bowie State University	Comm./Express	Yes	2	3			2	3
B27	Bowie - New Carrollton	Comm./Express	Yes	2	2			2	2
B29,31	Crofton - New Carrollton	Comm./Express	No	2	2	2	2	4	4
B30	Greenbelt - BWI Airport Express	Comm./Express	Yes	3	3			3	3
C11,13	Clinton	Comm./Express	Yes	3	3			3	3
C28	Pointer Ridge	Comm./Express	Yes	3	2			3	2
J5	Twinbrook - Silver Spring	Comm./Express	Yes	3	3			3	3
J7,9	I-270 Express	Comm./Express	Yes	5	6			5	6
P17,18,19	Oxon Hill - Fort Washington	Comm./Express	Yes	12	13			12	13
V1	Benning Heights - M St	Comm./Express	Yes	4	4			4	4
V5	Fairfax Village - L'Enfant Plaza	Comm./Express	Yes	4	3			4	3
W13,14	Bock Rd	Comm./Express	Yes	7	7			7	7
W19	Indian Head Express	Comm./Express	Yes	6	5			6	5

Table 3-5: Continued

Line	Line Name	Classification	Adequacy of Fleet	Current Peak Buses (21 June 15)		Need for Additional Peak Vehicles		Total Fleet Demand	
				AM	PM	AM	PM	AM	PM
Z11,13	Greencastle - Briggs Chaney Exp	Comm./Express	Yes	11	6			11	6
Z9,29	Laurel - Burtonsville Express	Comm./Express	Yes	6	5			6	5
Strategic Buses				17	23			17	23
Headway Management				8	8			8	8
School Buses			No	15	2	1	1	16	3
Operator Shuttles				10	9			10	9
TOTAL				**1272**	**1285**	**110**	**117**	**1382**	**1402**

3.5. Priority Corridor Network and Fleet Requirements

Since the previous fleet plan update the study process for the PCN has been completed and implementation is still ongoing. As the timeframe for the first phase of PCN improvements nears an end (2016), Metro has started the study process for the enhancements for the next tier of bus services dubbed the Emerging Corridor Network. The PCN implementation and Emerging Corridors improvements are primary strategies for enhancing and improving the provision of bus services, reducing operating costs and increasing reliability.

3.5.1 PCN Routes and Implementation

All studies related to the Priority Corridor Network have been completed. Table 3-6 shows the list of PCN lines and ridership trends. Since FY11 ridership on the PCN corridors has increased by 8 percent, compared to an average system-wide increase of 6 percent. The previous fleet plan update estimated that the PCN requires an additional 134 peak vehicles and implementation will be completed by FY16. This fleet plan revised the PVR need from 134 to 147 and the timeframe of implementation is extended up to FY25. Table 3-7 shows the current PVR, additional PVR required and implementation schedule of the PCN.

3.6 Emerging Corridors and Fleet Requirements

With the completion of the PCN studies Metro has started putting together an investment plan for the Emerging Corridors. The Emerging Corridors are defined as the most productive Framework services which are not part of the PCN. Emerging Corridors are selected based on a number of factors such as frequency, span, farebox recovery, boardings per hour and service design. The Emerging Corridors are targeted to serve part of the region with high ridership growth potential, based on recent trends, and to serve the growing need of communities with transit friendly Life style.

Eighteen corridors are selected to be part of the Emerging Corridors. The Emerging Corridors incorporate 28 Metrobus Lines and account for 23 percent of the total Metrobus ridership. Between FY11 and FY15, ridership in these corridors have shown a 13 percent increase which is more than twice the rate of growth achieved by the Metrobus network.

The Emerging Corridors share many similar characteristics of the PCN. These corridors have significant ridership growth that is expected to continue and similar capacity and performance issues as the PCN network. The Emerging Corridors will require a comparable level of service, and facility improvements as well as investments as the PCN. In the previous fleet plan update

it was anticipated that during the timeframe of FY17 – FY27 a total of 105 peak buses would be required to address the fleet requirements of the Emerging Corridors. Due to the refinement of the corridors included in the Emerging Corridors, this fleet plan revised down the fleet requirement to 87 buses. Table 3-8 shows the list of the Emerging Corridors and the annual ridership trends and Table 3-9 shows the average weekday ridership, existing PVR, additional vehicle requirements and study schedules.

Table 3-6: Priority Corridor Network Ridership Trend

	Corridor	Routes	Annual Ridership (millions) FY11	FY12	FY13	FY14	FY15	FY10-15 Change
	District of Columbia							
1	Georgia Avenue / 7th Street	70, 74, 79	5.50	5.90	6.02	6.37	6.51	20.4%
2	Wisconsin Avenue / Pennsylvania Avenue	30N, 30S, 31, 32, 33, 34, 36	5.80	6.20	6.32	6.50	6.45	16.0%
3	16th Street	S1, S2, S4, S9	5.40	5.80	5.97	6.03	5.80	16.7%
4	H Street / Benning Road	X1, X2, X3, X9	4.10	4.70	4.61	4.78	4.92	25.9%
5	Anacostia / Congress Heights	A2, A6, A7, A8, A42, A46, A48; A4, A9, W5,	4.60	4.60	4.37	4.52	4.41	-0.5%
6	14th Street	52, 53, 54	4.30	4.60	4.76	4.88	4.69	15.8%
7	U Street / Garfield	90, 92, 93	3.90	3.80	3.83	3.88	3.80	-9.2%
8	North Capitol Street	80	2.10	2.20	2.17	2.17	2.04	-3.9%
9	Rhode Island Avenue (DC)	G8	1.00	1.10	1.17	1.18	1.16	18.4%
	Sub-Total		36.70	38.90	39.23	40.31	39.78	11.7%
	Maryland							
10	University Boulevard / East-West Highway	J1, J2, J3, J4	2.10	2.20	2.27	2.31	2.20	15.6%
11	Southern Avenue Metro / National Harbor	NH1,3	0.20	0.20	0.24	0.27	0.28	33.5%
12	New Hampshire Avenue	K6,9	1.90	1.90	2.04	2.25	2.31	25.6%
13	Georgia Avenue (MD)	Y2, Y7, Y8	2.30	2.40	2.52	2.62	2.68	21.1%
14	Veirs Mill Road	Q1, Q2, Q4, Q5, Q6	2.70	2.80	2.87	2.94	2.78	1.7%
15	East-West Highway (Prince Georges)	F4, F6	2.20	2.30	2.55	2.66	2.68	29.3%
16	Greenbelt / Twinbrook	C2, C4	3.40	3.60	3.71	3.74	3.62	4.1%
17	Rhode Island Avenue Metro	81, 82, 83, 83X, 86, T14, T18	1.60	1.80	1.78	1.72	1.72	4.4%
18	Eastover / Addison Road	P12	1.70	1.90	1.82	1.91	1.98	16.5%
19	Colesville Road / Columbia	Z2, Z6, Z8, Z9, Z29, Z11, Z13	2.40	2.60	2.53	2.53	2.43	-0.1%
	Sub-Total		20.50	21.70	22.34	22.95	22.67	12.1%
	Virginia							
20	Richmond Highway Express (REX)	REX	1.00	1.10	1.03	1.02	0.97	-2.6%
21	Columbia Pike (Pike Ride)	16A, 16B, 16E, 16J, 16P; 16G, 16H, 16K; 16L, 16X,16Y	3.60	3.70	3.53	3.73	3.74	3.9%
22	Crystal City / Potomac Yard	9A, MW1	0.90	0.90	0.79	0.77	0.79	-12.4%
23	Leesburg Pike	28A, 28X, 28F, 28G	2.00	2.10	2.03	2.17	2.06	3.1%
24	Little River Turnpike / Duke Street	29C, 29G; 29K, 29N	0.90	0.90	0.92	0.89	1.02	13.3%
	Sub-Total		8.40	8.70	8.29	8.58	8.59	2.2%
	Total		65.60	69.30	69.86	71.84	71.03	8.3%

Table 3-7: Priority Corridor Network PVR Need and Implementation Schedule

	Corridor	Metrobus Routes	Current PVR, (June 2015)	Additional PVR	Implement. Year
1	Greenbelt / Twinbrook	C2, C4	21	11	2017
2	Leesburg Pike	28A, 28X, 28F, 28G	23	1	2017
3	16th Street	S1, S2, S4, S9	55	8	2017-2018
4	H Street / Benning Road	X1, X2, X3, X9	28	6	2018
5	East-West Highway (Prince Georges)	F4, F6	19	1	2018
6	Little River Turnpike / Duke Street	29C, 29G; 29K, 29N	12	11	2018/2020
7	14th Street	52, 53, 54	24	11	2019
8	Richmond Highway Express (REX)	REX	13	3	2019
9	New Hampshire Avenue	K6,9	16	2	2020
10	University Blvd. / East-West Highway	J1, J2, J3, J4	26	5	2020
11	Veirs Mill Road	Q1, Q2, Q4, Q5, Q6	16	9	2021
12	Anacostia / Congress Heights	A2, A6, A7, A8, A42, A46, A48; A4, A9, W5, W9	40	8	2020-2021
13	Columbia Pike (Pike Ride)	16A, 16B, 16E, 16J, 16P; 16G, 16H, 16K; 16L, 16X, 16Y	41	3	2021
14	Wisconsin Ave./ Pennsylvania Ave.	30N, 30S, 31, 32, 33, 34, 36, 37, 39	57	12	2021-2022
15	Colesville Road / Columbia	Z2, Z6, Z8, Z9, Z29, Z11, Z13	34	11	2021-2022
16	Georgia Avenue (MD)	Y2, Y7, Y8	16	5	2022
17	U Street / Garfield	90, 92, 93	27	9	2023
18	Eastover / Addison Road	P12	10	6	2023
19	North Capitol Street	80	17	9	2024
20	Southern Ave. Metro / National Harbor	NH1,3	3	3	2024
21	Rhode Island Avenue (DC)	G8	12	5	2025
22	Rhode Island Avenue Metro	81, 82, 83, 86, T14, T18	25	8	2025
	Total		535	147	

Table 3-8: List of Emerging Corridors Ridership Trend

Corridor	Routes	Annual Ridership (millions)					FY11-15 Change
		FY11	FY12	FY13	FY14	FY15	
District of Columbia							
Takoma - Fort Totten-Petworth	62, 63; 60, 64	2.17	2.40	2.54	2.67	2.62	21%
Connecticut Avenue	L1, L2	1.03	1.09	1.35	1.49	1.53	48%
Mount Pleasant	42, 43	2.35	2.35	2.17	2.25	2.20	-7%
Crosstown/Brookland - Potomac Pk	H1, H2, H3, H4	2.02	2.30	2.25	2.23	2.15	6%
Bladensburg Road - Anacostia	B2	2.05	2.16	2.09	2.24	2.30	12%
East Capitol Street - Cardozo	96, 97	1.43	1.44	1.56	1.74	1.78	25%
Military Road - Crosstown	E4	1.82	2.01	1.97	1.98	2.00	10%
Benning Hgt. - Deanwood - Alabama Ave.	U8; W4	3.05	3.16	3.18	3.37	3.41	12%
Capitol Hgt. - Minnesota Ave - Benning Hgt. - M St.	V1; V2, V4	1.71	1.90	1.83	1.88	1.88	10%
Maryland							
Forestville	K11, K12, K13	0.55	0.61	0.61	0.58	0.59	6%
Laurel/Laurel Express	87, 89, 89M	0.37	0.40	0.39	0.38	0.41	10%
Riggs Road	R1, R2	0.85	0.96	1.01	1.04	1.04	23%
Greenbelt - New Carrollton	G12, G13, G14, G16	0.61	0.86	0.87	0.85	0.84	39%
Oxon Hill - Suitland	D12, D13, D14	1.31	1.42	1.44	1.43	1.41	8%
Virginia							
Wilson Boulevard - Fair Oaks	1A, 1B, 1E, 1Z; 1C	1.42	1.45	1.36	1.41	1.48	4%
Washington Boulevard - Fair Oaks	2A, 2B	0.95	1.00	0.99	0.99	1.03	9%
Tysons Corner - Shirlington - Crystal City	23A, 23B, 23T; 10B	1.81	1.87	1.88	1.97	1.82	1%
Lincolnia - Beauregard - Pentagon	7A, 7F, 7Y; 7C, 7H, 7P, 7W, 7X; 7M	1.15	1.66	1.74	1.68	1.69	47%
Total		26.64	29.04	29.22	30.15	30.19	13%

Table 3-9: Emerging Corridors Average Weekday Ridership, PVR Need and Implementation Schedule

No.	Line Name	Routes	Average Weekday Ridership (FY2015)	Peak Vehicle Requirement (Jun'15)		Additional PVR Required	Study Schedule
				AM	PM		
	District of Columbia						
1	Takoma - Fort Totten-Petworth	62, 63; 60, 64	8,992	22	20	15	Under Study
2	Connecticut Avenue	L1, L2	5,137	15	15	2	2017
3	Mount Pleasant	42, 43	7,296	17	16	3	2018
4	Crosstown/Brookland - Potomac Pk	H1; H2, H3, H4	7,141	19	17	6	2019
5	Bladensburg Road - Anacostia	B2	7,603	18	15	3	2020
6	East Capitol Street - Cardozo	96,97	5,909	15	13	4	2021
7	Military Road - Crosstown	E4	6,442	13	10	1	2021
8	Benning Hgt. - Deanwood - Alabama Ave.	U8; W4	10,788	17	16	10	2022
9	Capitol Hgt. - Minnesota Ave - Benning Hgt. - M St.	V1; V2, V4	6,374	18	18	6	2022
	Maryland						
10	Forestville	K11, K12, K13	1,986	5	5	2	2016
11	Laurel/Laurel Express	87; 89, 89M	1,627	7	7	4	2017
12	Riggs Road	R1, R2	3,619	5	9	4	2018
13	Greenbelt - New Carrollton	G12, G13, G14, G16	3,016	8	11	5	2019
14	Oxon Hill - Suitland	D12, D13, D14	4,588	15	12	5	2020
	Virginia						
15	Wilson Boulevard - Fair Oaks	1A, 1B, 1E, 1Z; 1C	4,715	19	18	4	2016
16	Washington Boulevard - Fair Oaks	2A; 2B	3,555	12	14	5	2017
17	Tysons Corner - Shirlington - Crystal City	23A, 23B, 23T; 10B	5,871	13	22	4	2018
18	Lincolnia - Beauregard - Pentagon	7A, 7F, 7Y; 7C, 7H, 7P, 7W, 7X; 7M	6,368	28	23	4	2019
	Total		101,027	266	261	87	

3.7 Other Fleet Requirements

3.7.1 State of Good Operations Service Adjustments

Every year Metro performs State of Good Operations (SOGO) planning by making a systematic analysis of all services to ascertain operational efficiency and improve service provision. This results in SOGO service adjustment buses used for minor service adjustments, changes to improve crowding, and service reliability. For FY16, as shown on Table 3-5, there is a need for 110 buses in the AM Peak and 117 buses in the PM Peak periods to improve service reliability, meet policy frequency and provide capacity for overcrowded lines. From FY17 to FY25 it is assumed that each year a 1% growth in the base fleet will be required to accommodate for SOGO service adjustments. During the timeframe of FY16 – FY27 a total of 240 peak buses would be required to address the service adjustment fleet needs for SOGO.

3.7.2 Conversion of Standard Buses to Articulated Buses

During the FY16 to FY25 period 114 articulated buses are planned to be purchased for replacing older vehicles and to expand articulated bus services. Out of the 114 articulated buses, 70 will be used for conversion of standard buses to articulated service on lines that operate in high ridership corridors. The remaining 44 articulated buses will be used to replace the 2003 Neoplan and 2008 NABI buses.

As indicated in previous fleet plans Metro had planned to convert routes that use standard buses to articulated buses on corridors with high ridership. Previous fleet plans also showed that conversion of standard bus to articulated buses will result in a reduction of the fleet size. This fleet plan assumes that conversion of standard bus to Artic buses will be on a one to one basis and will not result in a reduction of fleet size. The main reason for making a one to one conversion is to accommodate for future growth in ridership demand and maintain a similar level of service frequency provided by the standard buses.

To make the conversion cost effective, these additional Artic buses will have to be hosted by garage facilities located in the core transit market that need articulated buses, in particular the Northern and Western garages. While Western garage doesn't have the facility for Artic buses, Northern has only two designated maintenance bay for Artic buses. However, the Artic fleet required in the core service area exceed the number of buses that can be stored and maintained at Northern Division. As a result, services that should have been operated from Northern Division are now based in divisions that are further away, thereby increasing deadhead mileage.

Moreover, the Metrobus system is short of maintenance capacity for articulated buses, particularly in the core service operation areas. The 12 designated maintenance bays are spread across four divisions: Bladensburg, Montgomery, Northern and Shepherd Parkway. The new facility at Shepherd Parkway while designed to accommodate articulated buses, there are currently no articulated buses based at this division. This is mainly due to the location being farther away from the core transit market where the need for articulated buses exists. Operating articulated buses from these facilities would incur significant deadheading cost.

Therefore expanding the garage facilities to accommodate and maintain Artic buses in the core service areas will be crucial for the provision of an expanded Artic bus service. The deployment of articulated buses also would have to be timed with the rehabilitation and/or replacement of garages in the core transit market to allow them to store, maintain and operate articulated buses in a cost effective manner. Metro has been exploring opportunities for the replacement, rehabilitation and expansion of the Northern and Western garages. In the coming years it is anticipated that Northern will be replaced with a new facility and Western is being considered for redevelopment. Bladensburg division is also planned for a major redevelopment and expansion work. Metro will conduct a detailed analysis to identify the core routes to be converted from standard buses to articulated buses. In consideration of the circumstances aforementioned, this fleet plan assumes that the expansion of articulated bus services would occur after additional capacities for Artic bus storage and maintenance are created.

3.7.3 Strategic and Headway Management Buses

Strategic and headway management buses play similar but distinct roles in maintaining schedule/headway adherence. Strategic buses are strategically placed to be available to support a variety of routes in the event of unforeseen delays or disruptions in the provision of service. Headway management buses fill in for late buses on specific headway-managed routes. WMATA has continued its headway management strategy that was reported in the last fleet plan update. This strategy has improved service reliability and has led to a reduction in the number of strategic buses. As of June 2015, Metro uses 20 strategic and 8 headway management buses. But in the coming year's Metro plans to expand headway managed services significantly to include most of the high ridership corridors. This is mainly to mitigate service reliability problems that has continued to grow due to the ever growing traffic congestion problem in the region. It is assumed that a ratio of 10% headway management buses will be required for headway-managed routes.

3.7.4 Spare Buses

Metrobus previously used a spare ratio of 15.6% as established by board policy in 1997. The WMATA Board of Directors established the spare ratio to encourage a continued reduction in cost of providing existing service, and to acknowledge WMATA's excellent bus maintenance program. But over the years the Office of Bus Maintenance has documented that the 15.6% ratio was unable to support the various needs for which the spare buses are intended. Buses needed for driver training, and special projects were not factored into the 15.6%. The current fleet plan recommends increasing the spare ratio from the current 15.6% to 18.5% to include;

1. 14.7% to support routine day to day maintenance issues as well as longer term repair actions (Preventive and Corrective Maintenance's),
2. 1.5% to support midlife overhauls, and
3. 2.3% to support training, and special projects (fleet and sub-fleet improvement programs).

The proposed spare ratio is documented by extensive fleet operation experience and is deemed sufficient to support the various tasks spare buses are assigned for. Table 3-10 below shows the spare fleet requirements for 2015.

Table 3-10: Spare Fleet Requirement

Type	2015
1. Preventive Maintenance	144
2. Corrective Maintenance	47
3. Midlife Overhaul	20
4. Others*	30
Total Spare Bus	241
Peak Vehicle Requirement (Dec. 2015)	1,301
Fleet Spare Ratio (%)	18.5%

Note:
* - Other spare buses supporting training, fleet campaigns and special projects for improving fleet and sub-fleet electronic equipment's.

3.8. Projection of Fleet Demand

As indicated in previous sections, this fleet plan projected the demand up to 2025. Table 3-11 shows a summary of the fleet demand projection between 2016 and 2025. Overall it is projected that the total Peak Vehicle Requirement (PVR) will increase by 437 vehicles, from 1,272 at the beginning of 2016 to 1,564 by the end of 2025. The total scheduled buses will also increase by 595 vehicles, from 1,645 at the beginning of 2016 to 2,240 by the end of 2025. This projection would add buses for the purpose of fleet expansion on top of the ongoing procurement for bus replacement. The expansion buses will support the implementation of the PCN and Emerging Corridors from 2016 to 2025, provide capacity by adding buses for service adjustments to relieve crowding and running time adjustments, add buses for elevator and emergency shuttle bus services and increase spare buses in proportion to the fleet growth and other requirements.

Table 3-11: Network Driven Fleet Demand Projection

Fiscal Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Changes Over Period
Peak Vehicle Requirements												
Scheduled PVR (Beginning of Year)	1,261	1,272	1,277	1,302	1,329	1,354	1,396	1,432	1,475	1,503	1,530	269
Change in PVR	11	5	25	27	25	42	36	43	28	27	34	292
Priority Corridor Network	0	0	12	15	14	18	20	28	15	12	13	147
PCN Articulated Buses	0	0	0	0	0	12	12	12	12	10	12	70
Emerging Corridors	0	0	8	7	6	11	11	10	8	10	16	87
State of Good Operations (SOGO) (1)	11	5	5	5	5	5	5	5	5	5	5	50
New Service (2)	0	0	0	0	0	8	0	0	0	0	0	8
Scheduled PVR (End of Year)	1,272	1,277	1,302	1,329	1,354	1,396	1,432	1,475	1,503	1,530	1,564	292
Strategic Buses	20	20	20	20	20	20	20	20	20	20	20	0
Headway Management	8	8	8	8	8	8	8	8	8	8	8	0
Elevator and Emergency Shuttle Buse	0	11	11	11	11	11	11	11	11	11	11	11
Spare Buses Required (3)	200	218	269	276	282	292	301	311	318	325	334	134
Total Scheduled Buses	1500	1534	1610	1644	1675	1727	1772	1825	1860	1894	1937	437
Other Buses	145	139	97	97	97	97	97	97	97	97	97	(48)
Contingency Buses	43	50	32	32	32	32	32	32	32	32	32	(11)
Training Buses	5	5	5	5	5	5	5	5	5	5	5	0
Ready Reserve	52	69	50	50	50	50	50	50	50	50	50	(2)
Buses For Metro Transit Police K9	5	5	5	5	5	5	5	5	5	5	5	0
Historical Buses	5	5	5	5	5	5	5	5	5	5	5	0
Others (4)	35	5	0	0	0	0	0	0	0	0	0	(35)
Total Fleet (End of Year)	1,645	1,673	1,707	1,741	1,772	1,824	1,869	1,922	1,957	1,991	2,034	389
Unmet Fleet Demand (5)	-	112	9	9	10	10	10	11	11	12	12	207
Total Fleet Demand (End of Year)	1,645	1,785	1,828	1,871	1,912	1,974	2,029	2,093	2,139	2,185	2,240	595

Notes:

SOGO (1): SOGO for FY2015 is covered by using existing old vehicles and FY2016 reflects the unmet fleet demand. From FY2017 onwards SOGO is 1% of the total PVR + Unmet Demand.

New Service (2): To be used for the proposed new service from Alexandria to Pentagon Transit Center.

Spare Buses Required (3):

- For 2015 and 2016 Spares = 15.6% * (End of Year Scheduled PVR + Strategic Buses + Headway Management + Elevator Shuttles - 19). 19 buses (6 high-back for BWI Airport and 13 branded Metroway) are not included in the 15.6% system spare ratio.
- From 2017 to 2025 Spares = 18.5% (End of Year Scheduled PVR + Strategic Buses + Headway Management + Elevator Shuttles - 6). 6 high-back for BWI Airport are not included in the 18.5% system spare ratio.

Others (4): Include bues being prepared for scrap and incactive buses for maintenance reason.

Unmet Demand (5): For FY16 it is based on current fleet need to allievate overcrowding and improve reliablity. From FY17 onward it is the difference between 1% of the Scheduled PVR (Begining of Year) and SOGO.

SECTION FOUR: METROBUS FLEET SUPPLY

Rehabilitation, replacement and expansion of Metro's existing vehicle fleet are essential to delivering safe, reliable, and comfortable service to our customers. The Metrobus fleet has been modernized through a program of replacement and expansion. "Replacement" buses refer to newly-procured buses that replace older buses without increasing the size of the bus fleet. "Expansion" buses refer to buses that do increase the total size of the bus fleet. Increasing passenger and network demand on the system require continuing investments in bus replacement and expansion.

This chapter provides information on the fleet supply under the following categories:

- Current Fleet Composition
- Recent Fleet Procurement
- Planned Fleet Procurement
- Projection of Fleet Supply

The key findings of this section are the following (as of June 2015):

- Current average fleet age has increased to 7.6 years from the 6.4 years reported in the previous fleet plan update, slightly higher than the target of 7.5 years
- Metro's target for fuel technology mix is 50% CNG and 50% diesel/hybrid. As of June, 2015, the fleet was 30% CNG and 52% hybrid
- 91% of the bus fleet is powered by clean fuel technologies including CNG, hybrid and clean diesel, up from 80% in 2012 and 45% in 2010
- The lifecycle cost of operating Hybrid and CNG fleets are more expensive than Clean Diesel. A review of the policy towards future fuel technologies and type of garage facilities that need to be built is needed
- This fleet plan recommends changing the 50% CNG and 50% Hybrid fuel mix policy to a combination of CNG and Clean Diesel only vehicles policy
- The average fleet age is expected to stay below the planning target age of 7.5 years for the duration of the next 10 year
- Between FY16 – FY25 195 expansion buses will be added to the fleet, of which 70 will be expanding the Artic bus fleet

4.1. Current Fleet Composition

As of June 21, 2015, Metrobus had a total of 1,548 buses in service with 23 undergoing heavy overhaul, resulting in a total fleet of 1,571 buses. The current bus fleet size shows an increase of 65 buses as compared to the previous fleet plan update. Metro complies with the provisions of the Americans with Disabilities Act of 1990 and other regulatory requirements for providing an accessible public transit service. All of Metro buses are accessible. Metro has also developed a policy of making all of its fleet low floor buses. To meet this policy target Metro has been replacing old high floor buses with new low floor accessible buses. As of June, 2015 there are 143 (9.1%) buses in the revenue service with high floors. 70 other buses in non-revenue services have also high floors. In FY16 all of Metro's revenue bus fleet is projected to be provided with low floor buses, when it completes the replacement of the old high floor Orion V and articulated bus fleets. The fleet make-up is shown in Figure 4-1, with a complete listing of fleet vehicle types shown in Table 4-1.

Figure 4-1: Metrobus Fleet Composition (June 2015)

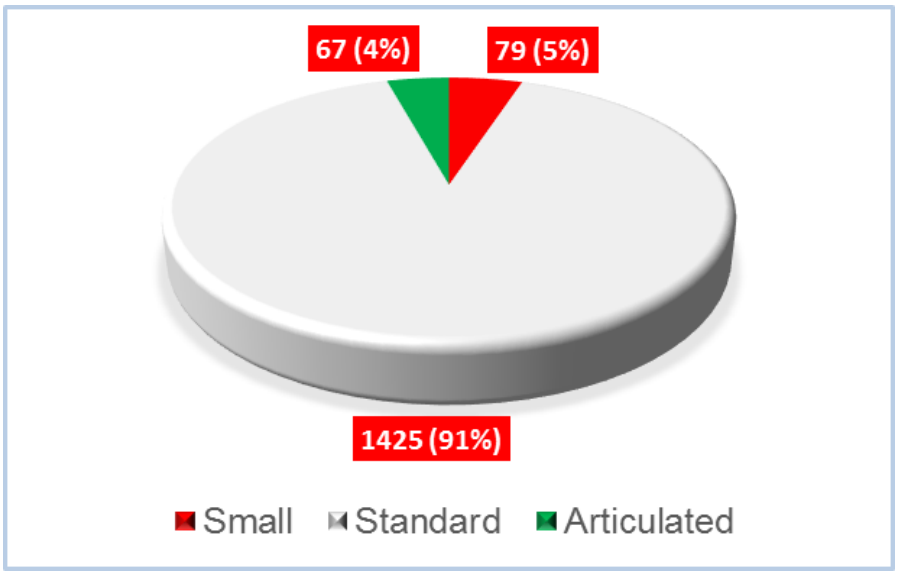


Table 4-1: Composition of Metrobus Fleet (June 2015)

Make	Model	Model Year	Age	Fuel Type	Length	Seats	Access	Count	Under Maint.
Orion	O5.501	1997	18	Standard Diesel	40	42	Lift	25	0
Orion	O5.501	2000	15	Standard Diesel	40	43	Lift	97	0
New Flyer	C40LF	2001	14	CNG	40	40	Ramp	98	0
New Flyer	C40LF	2002	13	CNG	40	40	Ramp	62	0
Neoplan	AN460	2003	12	Standard Diesel	60	66	Lift	21	0
Orion	O7.501	2005	10	CNG	40	41	Ramp	215	0
Orion	O7.505	2005	10	CNG	30	29	Ramp	35	0
New Flyer	DE40LF	2006	9	Hybrid	40	39	Ramp	1	13
New Flyer	DE40LFR	2006	9	Hybrid	40	39	Ramp	49	0
New Flyer	D40LFR	2006	9	Clean Diesel	41	39	Ramp	6	5
New Flyer	D40LFR	2006	9	Clean Diesel	41	38	Ramp	110	0
New Flyer	C40LFR	2007	8	CNG	41	40	Ramp	25	3
NABI	60BRT-08	2008	7	CNG	62	61	Ramp	22	2
New Flyer	DE42LFA	2008	7	Hybrid	42	39	Ramp	101	0
New Flyer	DE37LFA	2009	6	Hybrid	37	29	Ramp	19	0
New Flyer	DE62LFA	2009	6	Hybrid	62	62	Ramp	22	0
New Flyer	DE42LFA	2009	6	Hybrid	42	39	Ramp	58	0
New Flyer	DE42LFA	2010	5	Hybrid	42	39	Ramp	148	0
New Flyer	XDE40	2011	4	Hybrid	40	40	Ramp	15	0
New Flyer	XDE40	2011	4	Hybrid	42	40	Ramp	85	0
New Flyer	XDE40	2012	3	Hybrid	40	40	Ramp	67	0
Orion	O7.503	2012	3	Hybrid	30	27	Ramp	25	0
Orion	O7.503	2012	3	Clean Diesel	30	27	Ramp	27	0
Ford	F550	2013	2	Clean Diesel	26	40	Ramp	6	0
New Flyer	XDE40	2013	2	Hybrid	40	40	Ramp	104	0
NABI	BRT	2014	1	Hybrid	42	42	Ramp	105	0
		Average	7.6				Total	1548	23

4.1.1. Fleet Age

Metrobus retires buses after approximately 15 years of service. The exact time of retirement is based on the model year and depend on a variety of factors including condition and reliability. This results in an average age goal of 7.5 years.

As of June 21, 2015, the average Metrobus fleet age was 7.6 years old, increased from an average fleet age of 6.4 years in the 2013 Plan but still lower than the 8.7 years reported in the 2010 Plan. The recent increase in the fleet age is due to the continuous operation of older fleets as they are not replaced as scheduled. The oldest buses in the fleet are the Orion 5 buses, kept in service to replace the Orion 6 bus fleet which was withdrawn from service due to reliability problems. The previous fleet plan update stated that the Orion 5 bus fleet were scheduled to be retired by 2014. The current plan is to replace all of these buses in FY16. Previously it was also reported that there are no buses older than 15 years in the Metrobus fleet. As of June 21, there are 122 buses (8%) that are more than 15 years older in the Metrobus fleet. Figure 4-2 shows the breakdown of the fleet size by procurement years.

Figure 4-2: Current Metrobus Revenue Fleet by Procurement Year (June 2015)

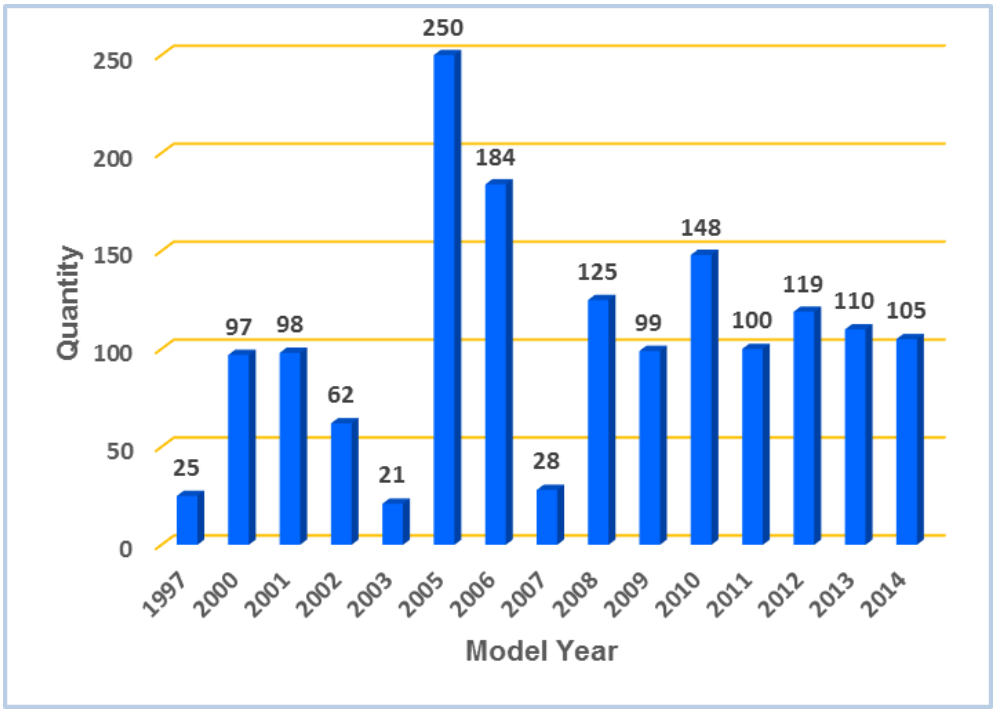


Figure 4-3 and 4-4 show the fleet composition by age and fleet type.

Figure 4-3: Metrobus Composition of Fleet Age (June 2015)

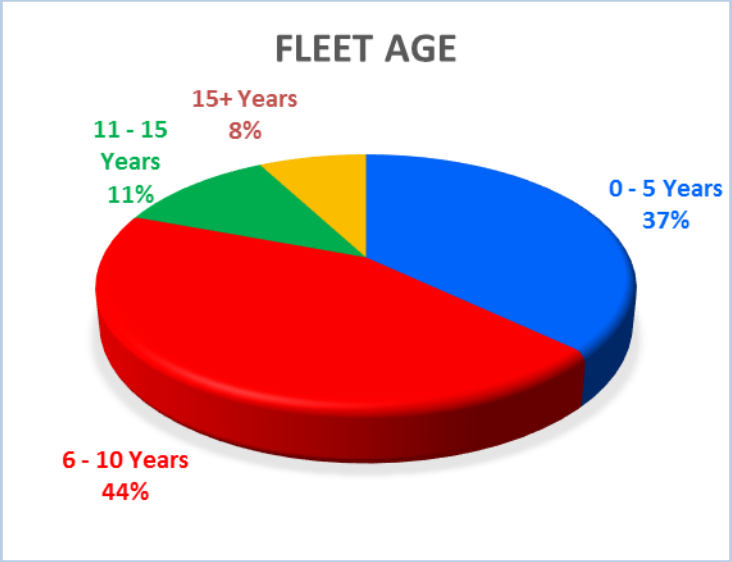
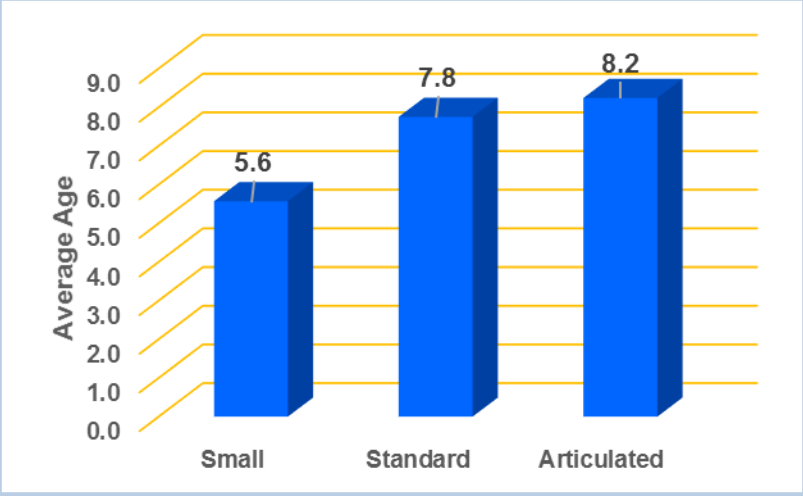


Figure 4-4: Average Age by Fleet Type (June 2015)



4.1.2. Fleet Fuel Technology

Over the past five years, WMATA has continued its programmatic goals to increase fuel efficiency and reduce greenhouse gas emissions. Of Metrobuses fleet 462 (29%) are fueled by compressed natural gas (CNG), 812 (52%) are hybrid diesel electric, 154 (10%) are fueled by clean diesel and 143 (9%) are fueled by standard diesel. Figure 4-5 presents the breakdown of the fleet by fuel type and Figure 4-6 shows average age by fleet type.

Figure 4-5: Metrobus Fleet by Fuel Type (June 2015)

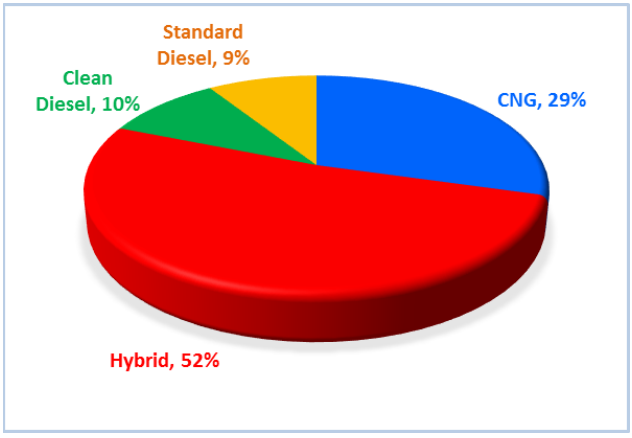
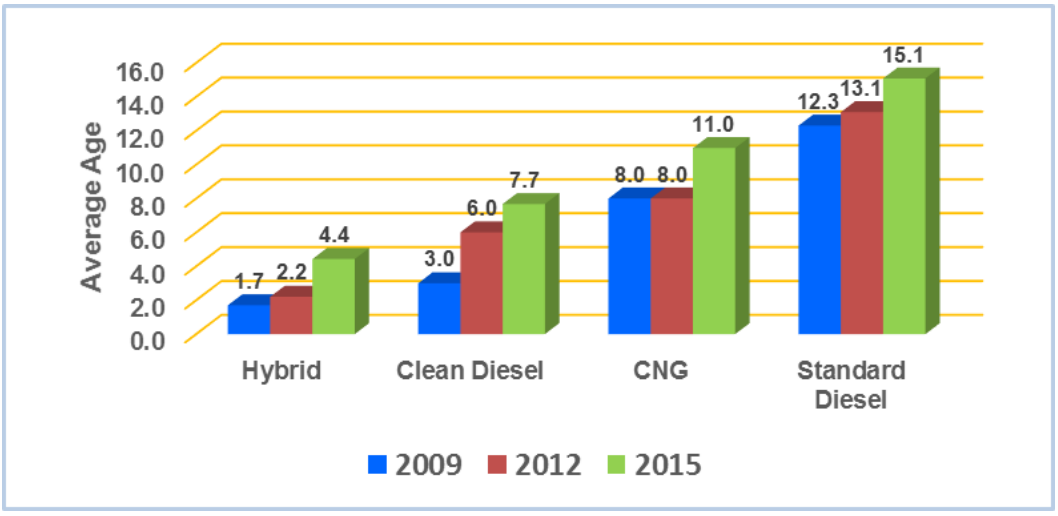


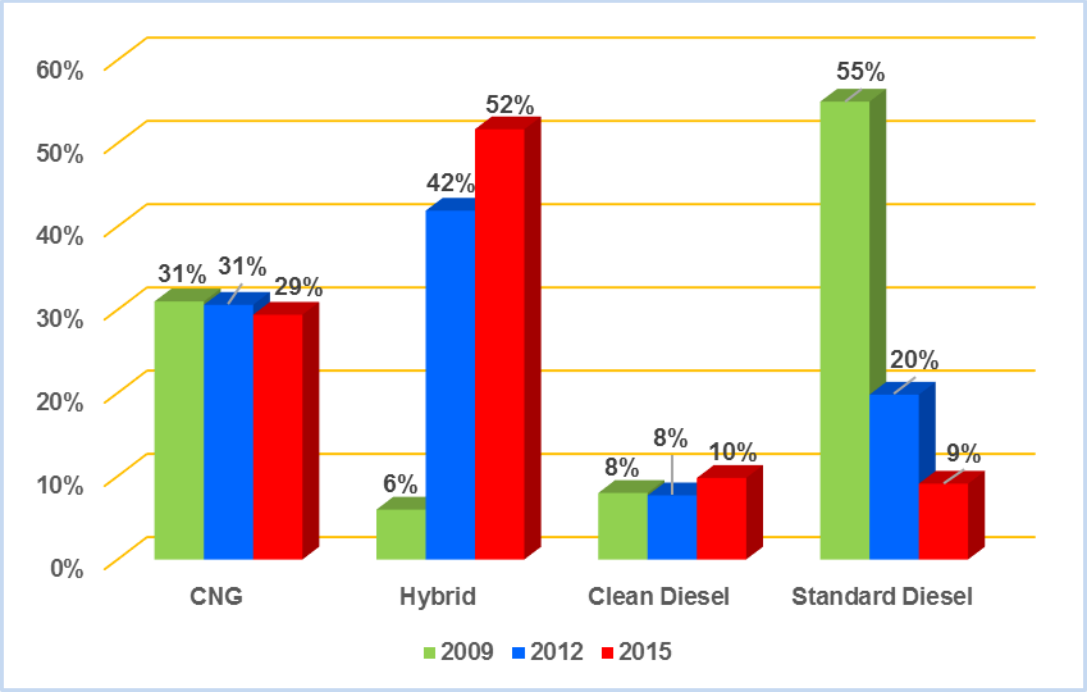
Figure 4-6: Metrobus Fleet Average Age by Fuel Type (2009 – 2015)



As illustrated in Figure 4-5, the share of the bus fleet using clean fuel technologies is 91 percent. This is an 11 percent increase over the previous fleet plan update and has more than doubled since the 2010 Plan that showed only 45% of the fleet was using clean fuels.

The standard diesel fleet has continued to decline from 55% of the Metrobus fleet in 2009 to 20% in 2012 and to 9% at the end of June, 2015. Correspondingly the Hybrid diesel electric buses have increased from 6% of the Metrobus fleet in 2009 to 42% in 2012 and 52% at the end of June, 2015. The share of CNG-fueled buses showed a slight decline from 31% of the fleet in 2009 and 2012 to 29% at the end of June, 2015. The clean diesel fleet has also shown a slight increment from 8% in 2012 to 10% by the end of June, 2015. Figure 4-7 shows the change in the fleet fuel composition since 2009.

Figure 4-7: Metrobus Fleet by Fuel Type (2009 – 2015)



While the average age is up in each fuel type category, the large decrease in standard diesel buses reduces the contribution of those buses to the fleet-wide average age. The purchase of nearly 500 hybrid diesel electric buses over the past 3 years has also greatly increased the contribution of those new buses to the overall average.

4.1.3 Fleet Operating Cost by Fuel Type

Since 2012 the cost of operating different fuel types has increased across the board with an overall increase in the average cost per mile of 14 percent. Substantial increases in the cost of services, as shown in Table 4-3, and Hybrid cost per mile have contributed to the upward trend. Table 4-2 and 4-3 present the cost per mile and items used for the cost calculation.

Table 4-2: Average Operating Cost per Mile by Fuel Technology

Year	CNG	Hybrid	Clean Diesel	Standard Diesel	Average Cost Per Mile
2012	$1.18	$0.99	$1.28	$2.32	$1.44
2015	$1.46	$1.62	$1.69	$2.86	$1.64
% Change	24%	64%	32%	23%	14%

Table 4-3: Cost Items

Items	2012	2015	% Change
Diesel/gallon	$2.50	$2.71	8%
CNG/gallon	$1.56	$0.82	-47%
Oil/quart	$2.15	$2.51	17%
Coolant/quart	$1.34	$1.34	0%
ATF/quart (1)	$6.34	$7.11	12%
Low floor tire/mile	$0.01	$0.01	0%
High floor tire/mile	$0.01	$0.01	0%
Services (2)	$202.59	$468.99	131%
Brake Shoe Reline	-	$74.60	-
Bus Cleaning	-	$72.03	-
Bus Seat Repair	-	$43.00	-
Camera Maintenance	-	$72.84	-
Destination Signs	-	$33.61	-
Fire Suppression	-	$30.89	-
Fluid Analysis	-	$11.37	-
Drive Cam	-	$47.72	-
Clever Devices	-	$82.93	-
Additional Labor (2)	-	$256.80	-
In house Bus Cleaning	-	$59.76	-
Service/Fuel Bus	-	$197.04	-
Average Cost Per Mile	$1.44	$1.64	14%

Note:

(1) - ATF - Automatic Transmission Fluid

(2) - Services and Additional Labor costs are per month and per bus.

Current WMATA policy is to work towards a 50/50 fleet mix of CNG and Hybrids. Since the last fleet plan update, WMATA has succeeded in transforming around half of its bus fleet to Hybrid buses, but the relative percentage of CNG buses has declined. The growth of CNG fleet has been hindered by the lack of adequate CNG fueling facilities. But with the anticipated opening of a CNG facility at Shepherd Parkway and a rebuilt Bladensburg there will be room for increasing the CNG fleet size in the coming years.

4.1.4 Bus Lifecycle Cost

The Office of Bus Maintenance have been tracking bus lifecycle cost for the different fuel technologies since the introduction of CNG and hybrid buses. The data indicated that, over a 15 year lifecycle, the costs of buying and operating CNG and hybrid buses are consistently more expensive than Clean Diesel buses. Table 4-4 below shows the estimated lifecycle costs of a bus for the different fuel technologies based on low, medium and high fuel cost estimates. The cost includes both capital and operating costs. The operating cost includes, fuel and tire, labor and material used for preventive and corrective maintenance, fuel compression and maintenance costs associated with CNG fueling stations. The capital cost includes the initial purchase, midlife overhaul costs and construction of CNG fueling facilities amortized over 20 years period. It should be noted that the driving factor for total lifecycle cost is the cost of fuel.

Table 4-4: Bus Lifecycle Cost Estimate (In '000, June 2015)

	Low Fuel Cost Estimate ($1.55/gal, $0.75/DGE)			Medium Fuel Cost Estimate ($2.87/gal, $0.82/DGE)			High Fuel Cost Estimate ($3.85/gal, $1.00/DGE)		
Fuel Technology	**Diesel**	**Hybrid**	**CNG**	**Diesel**	**Hybrid**	**CNG**	**Diesel**	**Hybrid**	**CNG**
Capital Cost	$678.9	$883.4	$734.3	$678.9	$883.4	$734.3	$678.9	$883.4	$734.3
Operating Cost	$580.3	$539.5	$817.5	$715.4	$662.3	$829.0	$815.8	$753.4	$993.5
Total Lifecycle Cost	$1,259.2	$1,423.0	$1,551.8	$1,394.4	$1,545.7	$1,563.3	$1,494.7	$1,636.8	$1,727.8

Using the existing fleet, the lifecycle cost is calculated for the low, medium and high fuel cost estimates. The lifecycle cost estimate ranges from $2.2 – $2.6 billion. See Table 4-5 below.

Table 4-5: Existing Fleet Lifecycle Cost Estimate

Total Life Cycle Cost Estimate				
Type	**No. Buses**	**Low Fuel Cost**	**Medium Fuel Cost**	**High Fuel Cost**
Diesel	**297**	**$373,991,607**	**$414,134,424**	**$443,937,186**
CNG	**462**	**$716,935,758**	**$722,255,688**	**$798,253,302**
Hybrid	**812**	**$1,155,452,452**	**$1,255,108,400**	**$1,329,095,404**
Total	**1,571**	**$2,246,379,817**	**$2,391,498,512**	**$2,571,285,892**

Using the lifecycle cost estimate the following three scenarios were used to assess the implications of the existing 50/50 fleet mix policy on the overall cost efficiency of Metrobus services. June 2015 fleet size is used for calculating the cost estimate.

Scenario 1 – Implementing 50% CNG and 50% Hybrid Policy

Fulfilling the 50/50 policy would require the conversion of more buses to CNG and the expansion of CNG facilities. Assuming an equal split of the fleet into the two fuel mixes the total life cycle cost estimate ranges from $2.3 - $2.6 billion (Table 4-6). Compared to the existing fleet lifecycle cost estimate, implementing the 50/50 policy will increase the overall lifecycle cost by $50 - $90 million.

Table 4-6: Implementing 50% CNG and 50% Hybrid Policy

Total Life Cycle Cost Estimate				
Type	**No. Buses**	**Low Fuel Cost**	**Medium Fuel Cost**	**High Fuel Cost**
Clean Diesel	**0**	**$0**	**$0**	**$0**
CNG	**785**	**$1,218,170,065**	**$1,227,209,340**	**$1,356,339,485**
Hybrid	**786**	**$1,118,455,206**	**$1,214,920,200**	**$1,286,538,162**
Total	**1,571**	**$2,336,625,271**	**$2,442,129,540**	**$2,642,877,647**

Full implementation of this scenario is a function of the diesel fleet age and CNG fueling stations availability in Metrobus facilities. New CNG fueling facility is under construction at Shepherd Parkway Division. Bladensburg facility will be demolished by 2019 for reconstruction and reopens by 2023. The combination of Bladensburg, Four Mile Run and Shepherd Parkway will provide a total CNG capacity of 725 by 2023, slightly less than the 50% share of the fleet. In order to implement this scenario, hybrid fleets purchased during 2008 and 2009 should be targeted for conversion to CNG when programming their replacement.

Scenario 2 – Converting Hybrids to Clean Diesel

This option takes into consideration the new CNG facility that is being built at Shepherd Parkway, continued use of the CNG facilities at Four Mile Run, and Bladensburg will continue to have CNG capacity after rebuilding. In addition it assumes utilization of the current CNG fleet and those that are in the process of procurement to the end of their lifecycle. All the remaining fleet will be converted to Clean Diesel. Based on this scenario, the total lifecycle cost ranges from $2.1 - $2.5 billion (Table 4-7). Compared to the lifecycle cost estimate of the existing fleet mix this option will reduce the total lifecycle cost by $92 - $104 million. When compared to the target 50/50 policy lifecycle cost estimate, this option will reduce the total lifecycle cost by $157 - $194 million. See Table 4-9 for details.

Full implementation of this scenario is a function of the hybrid fleet age and planned future replacement schedules. New hybrid vehicles were bought in 2015 and more will be added in 2016. Assuming that no new hybrid buses will be procured after 2016, phasing out all the hybrid fleet, under this scenario, will take place by 2030 and 2031.

Table 4-7: Converting Hybrids to Clean Diesel

Total Life Cycle Cost Estimate				
Type	**No. Buses**	**Low Fuel Cost**	**Medium Fuel Cost**	**High Fuel Cost**
Clean Diesel	**1,009**	**$1,270,564,079**	**$1,406,941,528**	**$1,508,190,642**
CNG	**562**	**$872,116,658**	**$878,588,088**	**$971,035,402**
Hybrid	**0**	**$0**	**$0**	**$0**
Total	**1,571**	**$2,142,680,737**	**$2,285,529,616**	**$2,479,226,044**

Scenario 3 – Converting All Buses to Clean Diesel

This option calculates the lifecycle cost estimate of the Metrobus fleet by assuming all buses will be converted to clean diesel. Based on this scenario, the total lifecycle cost ranges from $2.0 - $2.3 billion (Table 4-8). Compared to the lifecycle cost estimate of the existing fleet mix this option will reduce the total cost by $201 - $268 million. Similarly when compared to the target 50/50 policy, this option will reduce the total lifecycle cost by $295 - $358 million. See Table 4-9 for details.

Full implementation of this scenario is a function of the hybrid and CNG fleet age and planned future procurement schedules. Procurement of new CNG fleet for replacing old vehicles are in the pipeline for 2018 and 2019. Assuming that no new hybrid and CNG buses will be procured after 2019, phasing out all the CNG and hybrid fleets, under this scenario, will take place by 2034. This doesn't take into consideration the full lifecycle of the new CNG facility at Shepherd Parkway and Bladensburg.

Table 4-8: Converting All Buses to Clean Diesel

Total Life Cycle Cost Estimate				
Type	**No. Buses**	**Low Fuel Cost**	**Medium Fuel Cost**	**High Fuel Cost**
Clean Diesel	**1,571**	**$1,978,251,901**	**$2,190,589,832**	**$2,348,233,398**
CNG	**0**	**$0**	**$0**	**$0**
Hybrid	**0**	**$0**	**$0**	**$0**
Total	**1,571**	**$1,978,251,901**	**$2,190,589,832**	**$2,348,233,398**

Table 4-9: Cost Comparison

Compare Current (Table 4-5) to:	Low Fuel Cost	Medium Fuel Cost	High Fuel Cost
Scenario (1)	$90,245,454	$50,631,028	$71,591,755
Scenario (2)	($103,699,080)	($105,968,896)	($92,059,848)
Scenario (3)	($268,127,916)	($200,908,680)	($223,052,494)
Compare Scenario 1 to:			
BASE	$90,245,454	$50,631,028	$71,591,755
Scenario (2)	$193,944,534	$156,599,924	$163,651,603
Scenario (3)	$358,373,370	$251,539,708	$294,644,249

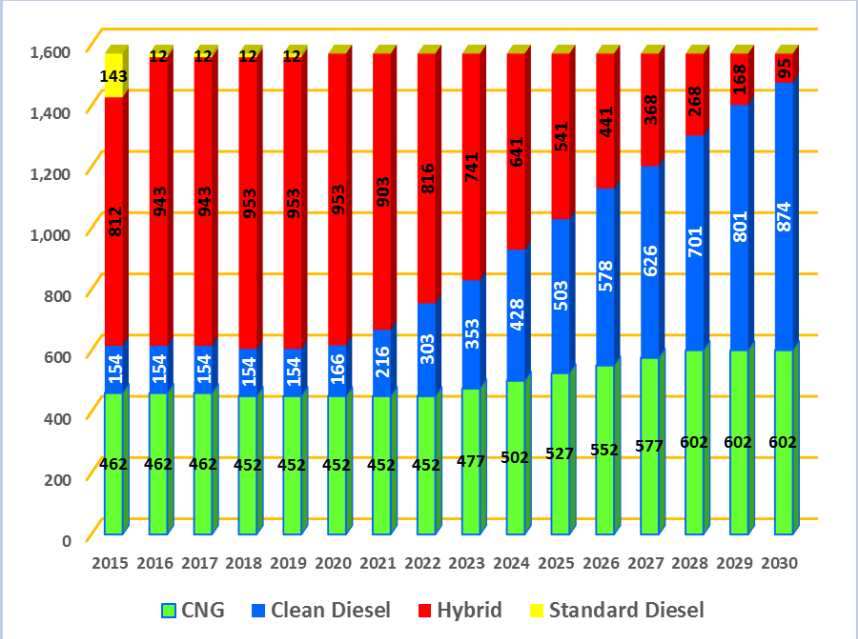
At the turn of the 21st Century diesel buses had a disadvantage compared to CNG and hybrid buses in terms of total emissions. Since then, significant progress have been made and all engine technologies emit nearly identical levels of regulated emissions (PM, NOx, HC, CO), while hybrids and CNG have an approximately 15% advantage over diesel in terms of GHG emissions. All buses, including CNG, diesel, and hybrids fully comply with the emission standards of the US Environmental Protection Agency (EPA).

WMATA has begun a new Capital Improvement Plan to be followed by bus fleet procurement program for the coming years. Given the significant cost saving which could be generated from changing the fuel technology, it is imperative to review the policy towards future fuel technologies and the type of garage facility that would be planned to be built. This fleet plan recommends changing the previous fuel mix policy (50% CNG and 50% hybrid) to a combination of Diesel and CNG vehicles policy. This is based on substantial lifecycle cost savings, and diesel's compliance to EPA's emission standards. Keeping the CNG fleet will also minimize exposure to risk of fuel price spikes, reduce the reliance on single fuel source, and allow the full lifecycle utilization of the existing CNG fleet and facilities. Based on this the changes in the fleet fuel technologies is shown on Table 4-10 and Figure 4-8.

Table 4-10: Fleet Fuel Technology Changes

Year	CNG	Clean Diesel	Hybrid	Standard Diesel	Total
2015	462	154	812	143	1,571
2016	462	154	943	12	1,571
2017	462	154	943	12	1,571
2018	452	154	953	12	1,571
2019	452	154	953	12	1,571
2020	452	166	953	0	1,571
2021	452	216	903	0	1,571
2022	452	303	816	0	1,571
2023	477	353	741	0	1,571
2024	502	428	641	0	1,571
2025	527	503	541	0	1,571
2026	552	578	441	0	1,571
2027	577	626	368	0	1,571
2028	602	701	268	0	1,571
2029	602	801	168	0	1,571
2030	602	874	95	0	1,571

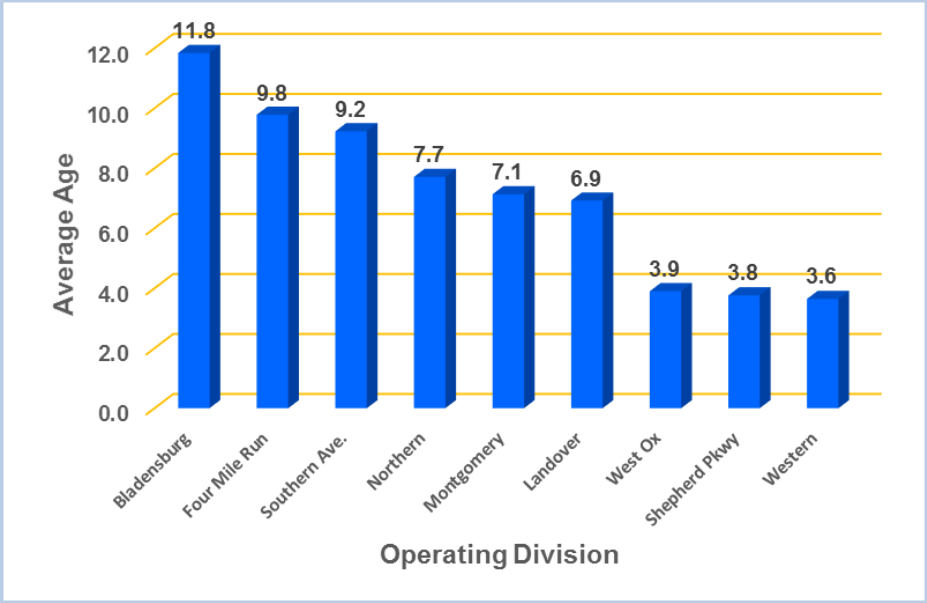
Figure 4-8: Fleet Fuel Technology Changes



4.1.5. Fleet Operating Division

Currently, four garages host vehicles with an average age greater than 7.5 years. In 2010, eight garages had average ages exceeding 7.5 years while in 2012 there were only three garages. Bladensburg division hosts vehicles with an average age of 12 years while West Ox, Shepherd Parkway and Western divisions provide service for newer fleets that have less than four years of average age. Figure 4-9 illustrates average age by operating division.

Figure 4-9: Average Age by Operating Division (June 2015)



4.1.6. Fleet Distribution by Jurisdiction

Metro has a policy objective of providing equitable service across all jurisdictions it serves. When new buses are procured they are distributed to the operating divisions by taking account of the age of buses in each division. As a result there is a comparable average age of buses in each jurisdiction.

There are nine operating divisions in the District of Columbia, Maryland and Virginia. The four bus facilities located in the District have 760 buses of which 724 are used for routes operating in the District. The average age of buses providing service in the District is 7.9 years. In Maryland 443 buses are used for services of which 394 are operated from the three garages located

within Maryland. The remaining 50 buses operate out of garages that are located in the District. With an average fleet age of 7.0 years Maryland has the youngest fleet in service. For services operated in Virginia 403 buses are used, 341 originate from the two operating divisions located in Virginia and the remaining 63 buses from Shepherd Parkway located in the District. The average age of buses providing service in Virginia is 7.1 years. Table 4-11 and Figure 4-10 provide more details.

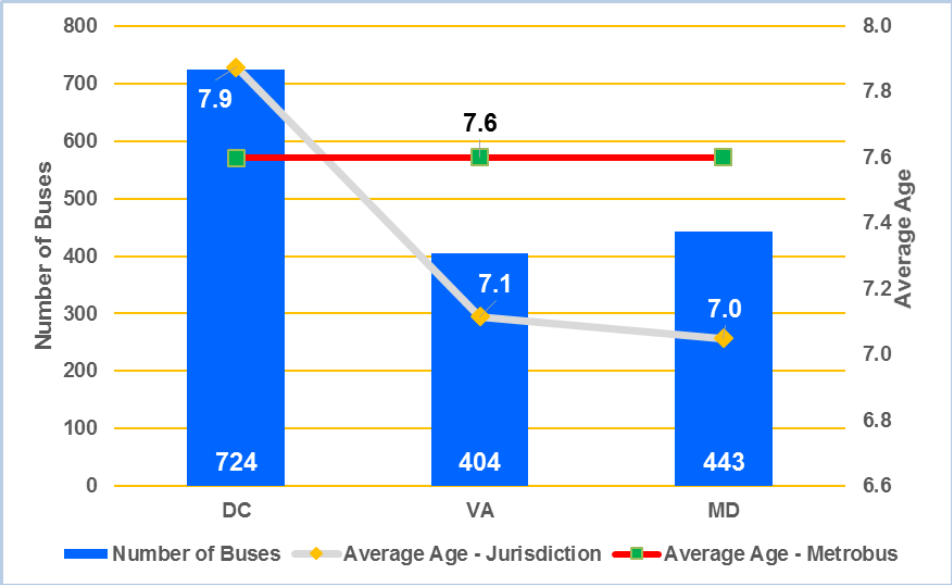
Table 4-11: Bus Fleet Operational Distribution by Garage and Jurisdiction (June, 2015)

DISTRICT of COLUMBIA		
Division	No. Of Buses	Average Age
Bladensburg	254	11.8
Northern	144	7.7
Shepherd Parkway	130	3.8
Western	119	3.6
From Southern	54	9.2
From Montgomery	22	7.1
Sub Total	724	7.9

MARYLAND		
Division	No. Of Buses	Average Age
Montgomery	192	7.1
Landover	177	6.9
Southern Avenue	25	9.2
From Bladensburg	12	11.8
From Northern	6	7.7
From Shepherd Parkway	32	3.8
Sub Total	443	7.0

VIRGINIA		
Division	No. Of Buses	Average Age
Four Mile Run	222	9.8
West Ox	119	3.9
From Shepherd Parkway	63	3.8
Sub Total	404	7.1

Figure 4-10: Jurisdictional Distribution and Average Age of Buses (June, 2015)



4.2. Recent Fleet Procurement

Between 2010 and 2015 Metro has purchased 662 buses, of which 599 are Hybrids, 30 CNG and the remaining 33 are Clean Diesels. The majority of the buses purchased over the past few years have been replacement buses with only 20 buses purchased for service expansion. Table 4-12 shows the fleet procurement by model year.

Table 4-12: Metrobus Fleet Procurement (2010 – 2015)

Model Year	Bus Size	Fuel Type	Quantity	Type
2010	40'	Hybrid	148	Replacement
2011	40'	Hybrid	100	Replacement
2012	40'	Hybrid	67	Replacement
2012	30'	Clean Diesel	27	Replacement
2012	25'	Hybrid	25	Replacement
2013	40'	Hybrid	104	Replacement
2013	26'	Clean Diesel	6	Replacement
2014	40'	Hybrid	85	Replacement
2014	40'	Hybrid	20	Expansion
2015	60'	Hybrid	21	Replacement
2015	40'	CNG	30	Replacement
2015	40'	Hybrid	29	Replacement
		Total	662	

4.3. Planned Fleet Procurement

Metro has plans to procure 995 replacement and 180 expansion buses between FY16 and FY25. Between FY17 to FY25 a total of 20 expansion buses per year is planned for procurement.

As shown on Table 4-12 above, the majority of buses purchased since the last fleet plan were hybrid with the exception of the 30 CNG and 33 Clean Diesel buses procured for replacement. The lack of CNG fueling capacity at bus garages has constrained the purchase of CNG buses for expansion. Shepherd Parkway is planned to have a CNG fueling facility by 2018. In the short run all CNG bus purchases will be for replacements of existing CNG buses. Expansion of CNG buses will start after Metro develops additional CNG fueling capacity.

4.3.1. Replacement of Buses

Overall Metro plans to procure 1,013 buses for replacement in the coming 10 years. Between FY16 and FY21 Metro has a firm plan to replace 616 buses of which 364 are CNG, 67 Clean Diesel and the remaining 185 are Hybrids. A further 200 buses are in the schedule of replacement for FY22 and FY23 of which 175 are Hybrids and 25 CNG. 200 more buses are also being planned for procurement to replace older buses in FY24 and FY25 with their fuel technology yet to be determined. See Table 4-13 for additional information.

Table 4-13: Metrobus Fleet Replacement Schedule (2016 – 2025)

Replacement Year	Size	Fuel Type	Quantity
2016	40'	CNG	134
2016	40'	Hybrid	81
2018	40'	CNG	80
2018	60'	Hybrid	10
2019	40'	CNG	100
2020	40'	CNG	15
2020	40'	Hybrid	50
2020	30'	CNG	35
2020	60'	Hybrid	22
2021	40'	Clean Diesel	67
2021	60'	Hybrid	22
2022	40'	Hybrid	75
2022	60'	Hybrid	25
2023	40'	Hybrid	75
2023	40'	CNG	25
2024	40'	Hybrid	75
2024	40'	CNG	25
2025	40'	Hybrid	75
2025	40'	CNG	25
	Total		1,016

Bus replacements are designed to relieve buses that exceed 15 years of service. Articulated buses are retired at 12 years, as they take more wear and tear than standard buses and are not cost effective to maintain beyond their minimum useful lifespan. The CNG replacements will be to relieve Metro's oldest CNG fleet, which have CNG tank certifications expiring after 15 years.

The replacement of old diesel buses with new fuel technology buses will continue in the coming years. As of the end of FY15 there are only 143 standard diesel buses in total accounting for 9 percent of the total fleet. The diesel fleet is planned to be reduced to 39 buses at the beginning of FY16 and Metro plans to replace all of its diesel buses by the end of FY21.

4.3.2. Bus Fleet Expansion

Weekday bus ridership averaged 443,000 daily trips in FY15 and total annual ridership for FY15 has reached 132.9 million. Based on Metro's in house prediction the total annual ridership could grow to 145.4 million by FY25, an increase of 9.4 percent (see Section 2.3). This projection results from growth on the existing network, and service improvements to be added in the PCN and Emerging Corridor networks. Metro plans to procure 180 new buses for fleet expansion. Table 4-14 shows the bus fleet expansion schedule.

Table 4-14: Metrobus Fleet Expansion Schedule

Expansion Year	Size	Fuel Type	Quantity
2017	40'	Hybrid	20
2018	40'	Hybrid	20
2019	40'	Hybrid	20
2020	40'	Hybrid	8
2020	60'	Hybrid	12
2021	40'	Hybrid	8
2021	60'	Hybrid	12
2022	40'	Hybrid	8
2022	60'	TBD	12
2023	40'	TBD	8
2023	60'	TBD	12
2024	40'	TBD	10
2024	60'	TBD	10
2025	40'	TBD	8
2025	60'	TBD	12
Total			180

4.3.3. Rehabilitation of Buses

During the first 7 ½ years of life a Metrobus will accumulate approximately 248,000 miles averaging around 33,000 miles per year. To maintain the fleet in a good state of repair, Metro performs a comprehensive overhaul as buses reach their midlife at 7½ years of age. The mid-life overhaul program rebuilds the bus engine, transmission and electronics, replaces chassis parts and seats and repaints the body, restoring the bus to an "as new" condition. On average, WMATA targets to rehabilitate 100 buses per year and the cost of the mid-life overhaul is approximately $210,000 per hybrid bus, and $160,000 for CNG/Diesel buses.

All major transit agencies operate a mid-life rehabilitation program which reduces maintenance and operating costs and results in fewer breakdowns and major repairs. Metro's mid-life rehabilitation program is a commitment to good maintenance and an effort to maximize capital investments.

Metro's current maintenance capacity at its garages allows for the rehabilitation of 20 buses at any given time, which totals 100 buses per year. Metro's maintenance capacity is anticipated to increase with the opening of Andrews Federal Center, Cinder Bed Road and rebuilding of Bladensburg facility. The heavy overhaul functions currently located at the Bladensburg division is planned to be transferred permanently to Andrews Federal Center. Currently there are 36 working bays at Bladensburg and this will increase to 46 working bays when Andrews Federal Center opens. This will increase the maintenance capacity by 10 additional buses and support the increased maintenance needs associated with a growing fleet size. The rebuilding of Bladensburg division is anticipated to start in FY19, when the new Cinder Bed and Andrews Federal Center garages opens, and completion expected in FY22. For detailed information refer to the 2017 Metrobus Facilities Plan.

4.3.4. Ready Reserve Fleet

Metro maintains a Ready Reserve Fleet of overage buses. The Ready Reserve Fleet is composed of older vehicles, past their scheduled replacement, that nevertheless would be suitable for passenger service to support regular revenue operations or special events. The primary purpose of the Ready Reserve Fleet is to replace buses that are not economically feasible to repair, accommodate approved increases in service, replace buses that are removed from service for fleet failures and provide buses for emergency situations. These vehicles are preserved in stored condition and are ready for service. Metro is authorized to keep and maintain 50 Ready Reserve buses. But the number of vehicles in the Ready Reserve Fleet

varies from year to year depending on the number of accidents, number of vehicles scheduled for peak service, necessary safety campaign and other emergencies.

4.4. Projection of Fleet Supply

4.4.1. Summary

In the FY15 and FY16 no money is budgeted for funding the expansion of the bus program. From FY17 to FY25 Metro plans to buy a total of 180 buses for fleet expansion of which 70 will be Articulated and the remaining 110 standard buses. Table 4-15 illustrates the current plan for bus procurement, with replacement buses being augmented by 20 expansion buses per year beginning in FY17. Overall the total fleet supply will increase by 195 buses from FY16 to FY25. The 195 bus includes the addition of 15 old buses that will be kept in the operating fleet. Because Metro does not have the capital budget to meet the demand for new buses, it is possible that buses targeted for retirement through the bus replacement program may be kept in the operating fleet. These buses would be used to help attain a state of good operations on existing bus routes.

Table 4-15: Supply of Revenue Vehicles

	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	Changes Over Period
Beginning of Year Total	1,560	1,645	1,660	1,680	1,700	1,720	1,740	1,760	1,780	1,800	1,820	260
New Buses For Replacement	80	215	0	110	132	105	97	100	100	100	100	1,059
Standard	*59*	*215*	*0*	*100*	*108*	*64*	*97*	*78*	*100*	*100*	*100*	962
Artics	*21*	*0*	*0*	*10*	*24*	*0*	*0*	*22*	*0*	*0*	*0*	56
Small	*0*	*0*	*0*	*0*	*0*	*41*	*0*	*0*	*0*	*0*	*0*	41
New Buses For Expansion	*0*	*0*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	180
Standard	*0*	*0*	*20*	*20*	*20*	*8*	*8*	*8*	*8*	*10*	*8*	110
Artics	*0*	*0*	*0*	*0*	*0*	*12*	*12*	*12*	*12*	*10*	*12*	70
Total New Buses Added	*80*	*215*	*20*	*130*	*152*	*125*	*117*	*120*	*120*	*120*	*120*	1,239
Old Buses Added to Service	85	15	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	15
Retired Buses	(80)	(215)	0	(110)	(132)	(105)	(97)	(100)	(100)	(100)	(100)	(1,059)
Net Change	85	15	20	20	20	20	20	20	20	20	20	195
Supply of Scheduled Buses End of Year	1,500	1,515	1,535	1,555	1,575	1,595	1,615	1,635	1,655	1,675	1,695	180
Other Buses	145	124	124	124	124	124	124	124	124	124	124	(21)
End of Year Total	1,645	1,660	1,680	1,700	1,720	1,740	1,760	1,780	1,800	1,820	1,840	195

4.4.2. Strategies for Fleet Mix

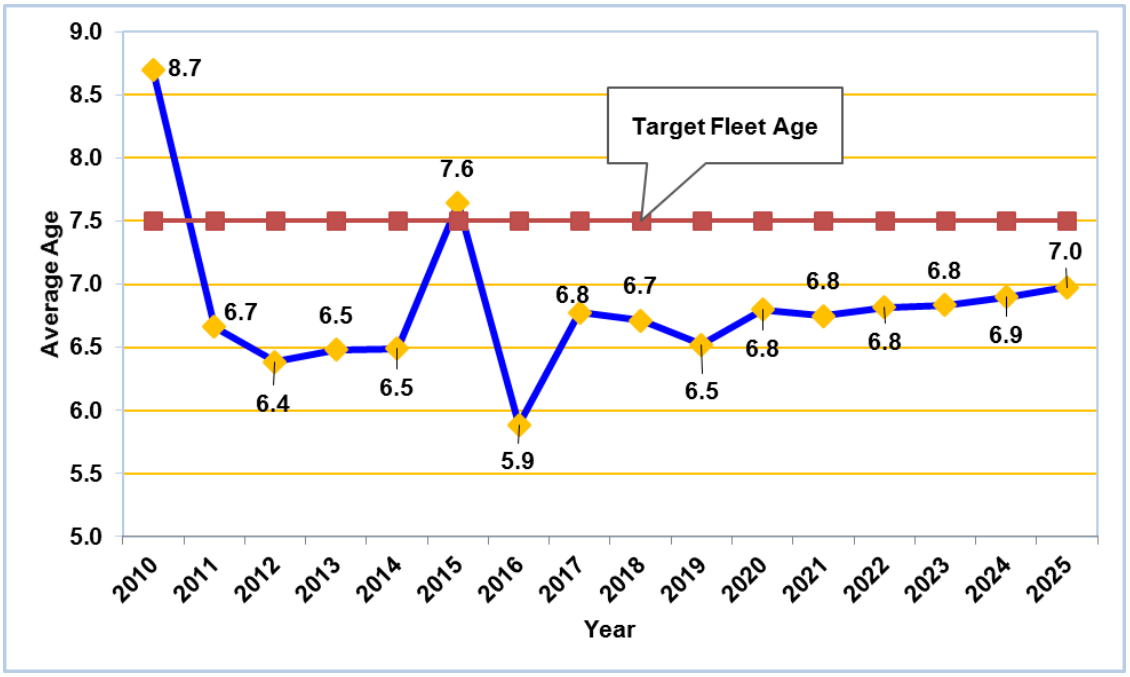
As noted previously Metro targets for a fleet mix of 50% CNG and 50% Hybrid buses. The share of Hybrid buses have reached the planned target but the share of the CNG bus fleet hasn't changed, due to fueling capacity constraints. Since the last fleet plan the focus has been on purchasing diesel-electric hybrid vehicles until additional CNG fueling capacity comes online. With the planned addition of CNG fueling facility at Shepherd Parkway Division, full reconstruction and possible expansion of Bladensburg, it is possible to plan for expansion of the CNG fleet.

However, as indicated in Section 4.1.4, the high lifecycle cost of both CNG and Hybrid buses makes them very inefficient for continued use in the future. Improvements in emission levels together with a significant cost savings associated with Clean Diesel buses makes them the ideal candidate for the future. This fleet plan recommends the change in the fleet mix policy and strategy in favor of CNG and Clean Diesel buses only.

4.4.3. Projection of Fleet Age

Metro has been successful at reducing the average fleet age. As noted above, the fleet age at the end of FY15 is 7.6 years, slightly higher than the last fleet plan update but down from 8.7 years registered for the 2010 fleet plan. But with the planned replacement of 295 older fleets in the coming year the average fleet age is projected to be reduced to 5.9 years by 2016. The fleet age, based on Metro's fleet replacement and expansion schedule, will continue to remain below the target age of 7.5 years for the fleet planning period. Figure 4-11 illustrates the change in average fleet age over a 15 year timeline. The bus replacement and expansion schedule, as shown in Table 4-13 and Table 4-14, above illustrates a smoother and more consistent procurement, resulting in an average age approaching 7.5 years, which is half the Metrobus retirement age.

Figure 4-11: Projection of Average Fleet Age (FY16 - FY25)



SECTION FIVE: FLEET MAINTENANCE

Each Metrobus vehicle is a major capital investment that needs proper maintenance in order to maximize its service life and reduce capital and operating expenditures. Proper maintenance of the fleet is also essential to providing safe, reliable and attractive service.

However, a portion of the fleet will be out of service due to unexpected failures as buses occasionally fail in service regardless of how well they are maintained. The ripple effect of a bus breakdown could cause passenger delay, increase travel time and overcrowd buses. In the past Metrobus had a large portion of older buses in active service which increased the possibility of breakdown even under a rigorous maintenance program. But more recently the consistent replacement of older buses with new ones and the reduction of the average fleet age has led to improvements in the reliability of the fleet.

Metro's maintenance needs and requirements will increase over the next decade, due to fleet growth and the mix of different vehicle technologies. A larger fleet requires more resources – equipment, facilities and personnel – to be devoted to maintenance. Additionally, new technologies continue to evolve over time, demanding new equipment's and practices.

This chapter provides information on the Metrobus fleet maintenance plan under the following categories:

- Overview of Fleet Maintenance
- Current Fleet Performance
- Types of Maintenance
- Maintenance Capacity for Fleet
- Distribution of Maintenance Functions
- Projection of Demand for Maintenance of Revenue Vehicles

The key findings of this section are the following:

- Operating policies and conditions have not changed significantly since the previous plan
- Mean distance between failures has improved
- Increase in projected maintenance demand due to increase in fleet size and spare ratio
- Due to lack of capacity, begining 2019 a significant part of the midlife overhaul maintenance work will be done more than a year later than the standard 7.5 years

5.1. Overview of Fleet Maintenance

Metro's in-house maintenance functions include the full scope of normal running maintenance, complete paint and body work, and full component overhaul. The stated mission of Metro's Bus Maintenance (BMNT) is "to provide safe, clean, reliable buses, service vehicles and support equipment to customers in an equitable and efficient manner." Maintenance procedures and practices are continuously reviewed and adjusted to stay ahead of impending issues that could affect future performances. In addition to controllable factors, risks that impact performance outside of BMNT's domain are also evaluated. BMNT uses a Risk Categorization table which enumerates all issues that may potentially reduce the fleet's performance during the year and possible situations that will be faced the following year.

Metro's BMNT has undertaken several initiatives that improved the reliability and efficiencies of vehicles. Some of the initiatives include, the CoABE(Consolidation of On-Board Ancillary Bus Equipment) on-board electronic installation program, (which ensured all on-board electronic equipment are in a state of good repair), introduction of EMP electric Fans into the fleet (to help reduce fuel use on Hybrid Fleet and reduces probability of bus fires) and opening of a new paint and body center at CTF, to provide additional capability to ensure the overall fleet appearance is maintained at a high level.

As a result of these initiatives and other improvements Metro's fleet reliability has improved significantly. Metro completed CY2014 with the highest Mean Distance Between Failures (MDBF) in Metrobus history at 8,309 miles.

Metro's maintenance functions follow procedures set forth by manufacturers' maintenance manuals and Metrobus standard practice. Completed maintenance activities are documented on the pertinent reporting forms, reviewed and certified by a supervisor, and entered into the specified reporting system. Metro established an extensive support infrastructure and quality control process for the program, allowing crews to exercise control over the process which translates into better body work, mechanical component overhaul and bus rehabilitation.

Metro uses an automated record keeping system, Maximo, for tracking bus maintenance functions, parts inventory, and record keeping. Metro developed both automated and manual systems for record keeping. The automated system is an on-line Maximo system, which provides a complete maintenance history on each vehicle and makes it possible to perform a thorough equipment reliability analysis. Using Maximo, maintenance crews are able to track all preventive and corrective maintenance actions. Metro also uses a manual record-keeping

system. The combination of automated and manual systems assures the best possible vehicle maintenance at the lowest cost.

Metro follows its Standard Operating Procedure (SOP) for Inventory Management to set up and/or modify an item in a storeroom within Maximo. The SOP specifies:

- The responsible section that ensures the sufficiency of stock levels to meet the operating needs of the divisions.
- Stock out rate shall be less than 5% at all locations.
- Preventive maintenance (PMI), ADA, bike rack, and fare box parts shall be maintained at 98% item availability.
- Storeroom locations shall not have more than 75 line items of No Demand Material with stock on hand.
- Slow moving items shall be reviewed monthly and adjust Reorder Points / Economic Reorder Quantity's as appropriate.

Metro uses industry standard "reorder point calculation" in order to optimize the reordering process for inventory items. This method captures the last three year average of vendor lead times plus the 45 days for internal administrative lead time as well as the demand (average daily usage) of the item. Reorder Point (ROP) = Lead Time * Demand

Metro also sets the economic order quantity (EOQ) to a six month usage at the main distribution center. This is due to the administrative time and cost to complete more than two procurement actions each year. To maintain an acceptable level of inventory Metro uses a Maximo report that reflects system-wide inventory usage to actual work orders. The Maximo report allows usage for a particular item across all departments. In addition, if a department is forecasting an increase in usage beyond past usage, the department is advised to notify their inventory planning team. In Bus Maintenance, the inventory planning team works closely with Bus engineering to determine service levels of the fleet to optimize the inventory, and attends lead-persons meeting to understand uptick in failures. In addition the Bus engineering and the inventory planning team collaborate to manage the bus fleet from warranty coverage from the manufacturers to operations and maintenance support.

Metro also stages tow trucks and service trucks throughout the system to respond quickly to vehicles that have failed while in service. Service trucks are equipped with fluids, air compressors, tool kits, jump start equipment and spare parts. If service truck personnel are unable to return a disabled bus to service, it is towed to its home division for more extensive repair, and a replacement bus is put into service.

Overall, Metro's fleet maintenance systems and policies have not changed significantly since the release of the previous fleet plan. But the maintenance systems, policies and procedures has been undergoing further developments and refinements over time. Metro also follows guidelines set forth in manufacturers' manuals merged with standard practice.

5.2. Current Fleet Performance

Overall Metrobus fleet performance has made steady progress over the years. The performance improvement is attributed to the implementation of procedures and policies such as, stringent specifications of buses, constant interface with vendors and manufacturers for improvement, the continuing replacement of old buses with new buses, a preventative maintenance program that is consistently reviewed and updated, a robust mid-life rehabilitation program averaging 100 buses per annum, and the collation and assessment of data that helps to curtail performance failures. Review and update of the maintenance program is done every two years but this subject to change with delivery of new buses and when a notice of change received from the manufacturer. Metro also applies its Standard Operating Procedures (SOP) that establishes the requirements for the development and performance of the preventive and corrective maintenance procedures.

5.2.1. In-Service Failures

Metro tracks bus failures daily, weekly, and monthly, and categorizes incidents into four categories which are:

- **Change-Off With Passenger Impact:** Any bus replacement for an incident between layover points that causes passengers to transfer from the defective bus to a replacement bus with or without deviation from schedule.
- **Change-Off Without Passenger Impact:** Any bus replacement at layover points or while deadheading where there are no passengers transfers or delays.
- **Road-Call With Passenger Impact:** Any incident while in revenue service that requires the bus to be removed from service or responded to by an emergency vehicle with deviation from schedule.
- **Road-Call Without Passenger Impact:** Any breakdown during deadheading, or at layover points that requires the bus to be removed from service or responded to by a service truck with no deviation from schedule.

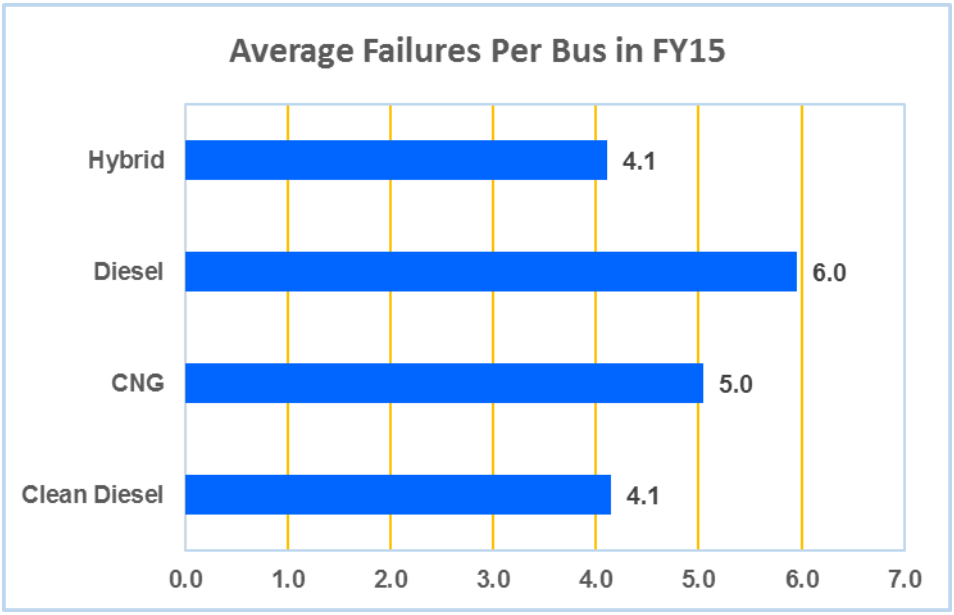
The 2010 fleet plan reported a total of 15,792 in-service failures for FY09, averaging 44 change-offs and road-calls per day. In FY15, Metrobus experienced a total of 7,154 bus failures, averaging 20 change-offs and road-calls per day. The in-service failures have been reduced by 55 percent since the 2010 plan. The main factors for this significant improvement in performance is the replacement of older vehicles with new ones resulting in a lower average fleet age together with a robust preventative overhaul program and other initiatives outlined above.

The in-service failures displayed in Table 5-1 vary among buses using different technologies, though primarily caused by the age of the fleet. As illustrated in Figure 5-1, diesel buses made up the oldest fleet (averaging 15 years of age) followed by CNG fleet (averaging 11 years of age). These fleets experienced the most failures (6 per bus for diesel and 5 per bus for CNG) in FY15; newer hybrid and clean diesel buses had lower failure rates.

Table 5-1: Causes of In-Service Failures (FY15)

Cause	Counts	Percent
Air	739	10%
Alarms/Buzzers/Indicatiors	1,160	16%
Body	1,115	16%
Brakes	389	5%
Electrical	247	3%
Engine/Transmission	2,653	37%
Fluid	380	5%
Wheelchair Lift	176	2%
Others	295	4%
Total	7,154	100%

Figure 5-1: Average In-Service Failures by Vehicle Technology



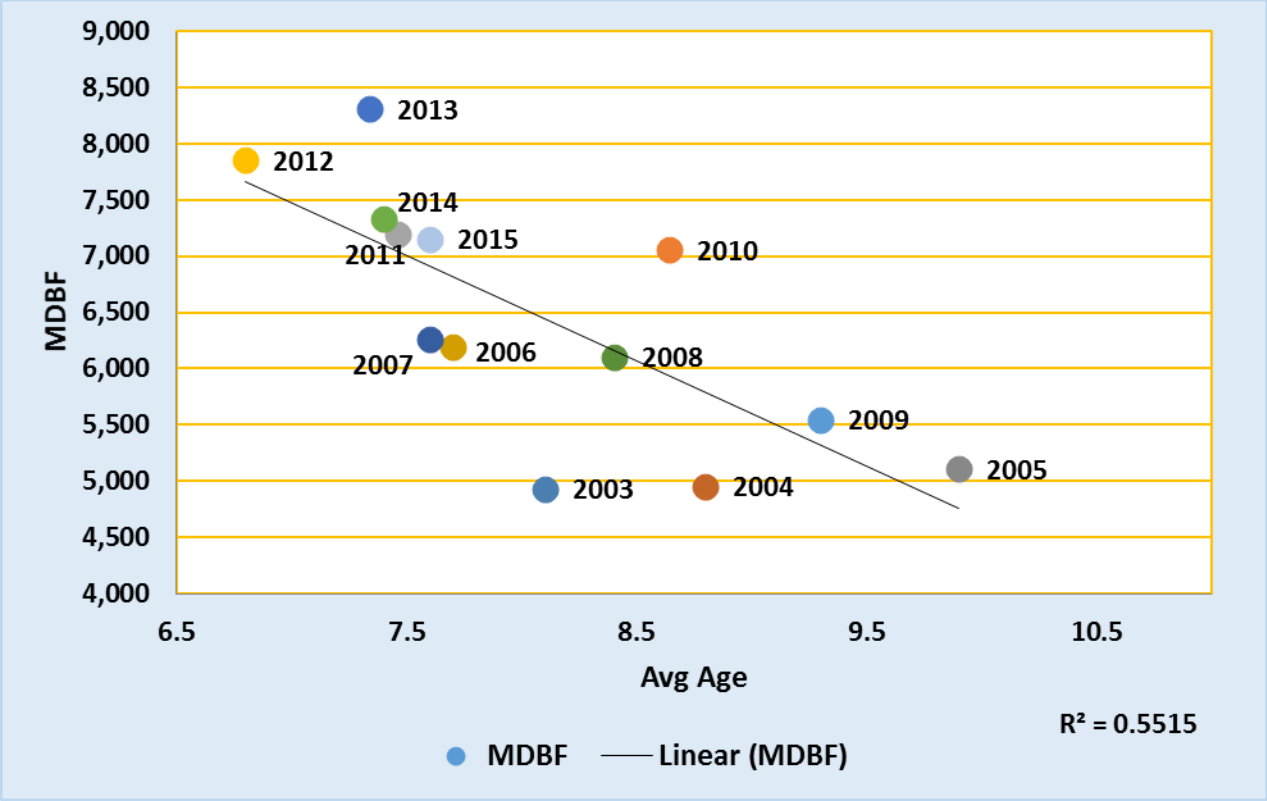
5.2.2. Mean Distance Between Failures

Mean Distance Between Failures (MDBF) is defined as the number of chargeable service interruptions during revenue service divided into actual miles. Metro has been able to limit the number of Metrobus failures by applying operating and maintenance strategies. The replacement of older vehicles and gradual decline of the average fleet age together with a strong maintenance regime continues to improve the MDBF.

As noted earlier, Metro completed CY2014 with the highest MDBF in Metrobus history at 8,309 miles. For FY15, the MDBF is 7,181 miles, reduced from the 7, 537 miles reported in the 2013 update. As reported in previous plans there is a heavy correlation between MDBF and fleet age. The average fleet age reported in the previous plan was 6.4 years, whereas this fleet plans reported fleet age is 7.6 years (Table-4.1), and explains partly the slight decline in the MDBF.

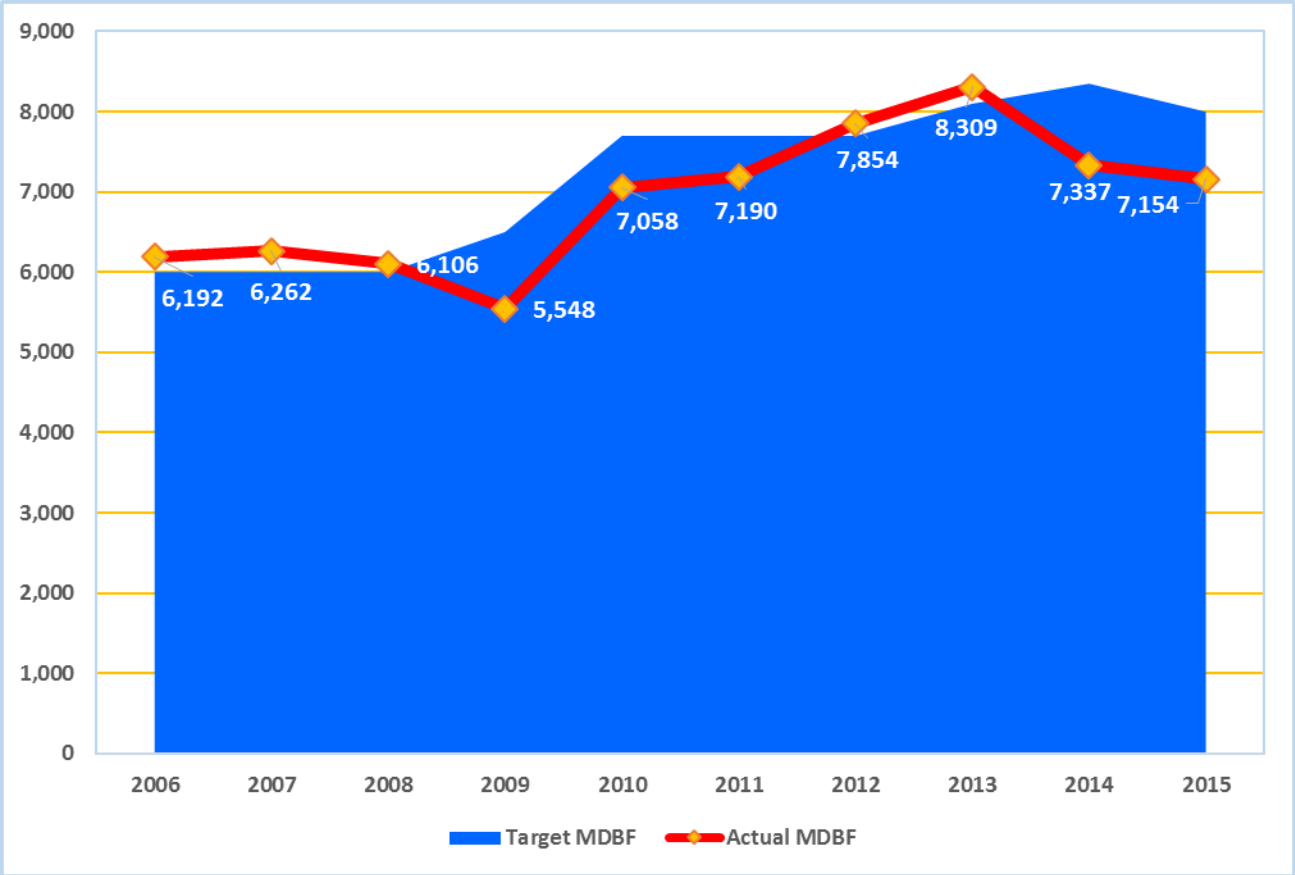
With the replacement of older fleets, Metro has been able to reduce the average age of the fleet and thereby increasing their performance and reliability. Figure 5-2 illustrates the correlation between average age and MDBF, with average age explaining about 55% of the variation in MDBF over time.

Figure 5-2: Mean Distance Between Failures vs Average Fleet Age



Over the last ten years Metro was able to meet or exceed half of its targeted MDBF, set by the maintenance program. Figure 5.3 shows the target and actual MDBF from 2006 to 2015. Over the years Metro has made significant progress in improving the fleet service reliability by increasing the mean distance between failures. The mean distance in 2006 of 6,192 miles dipped to 5,548 in 2009 and improved to 7,154 miles in 2015. Overall, as depicted in the chart below, the MDBF has shown an average increase of close to 2 percent per year over the last ten years.

Figure 5-3: Target and Actual MDBF

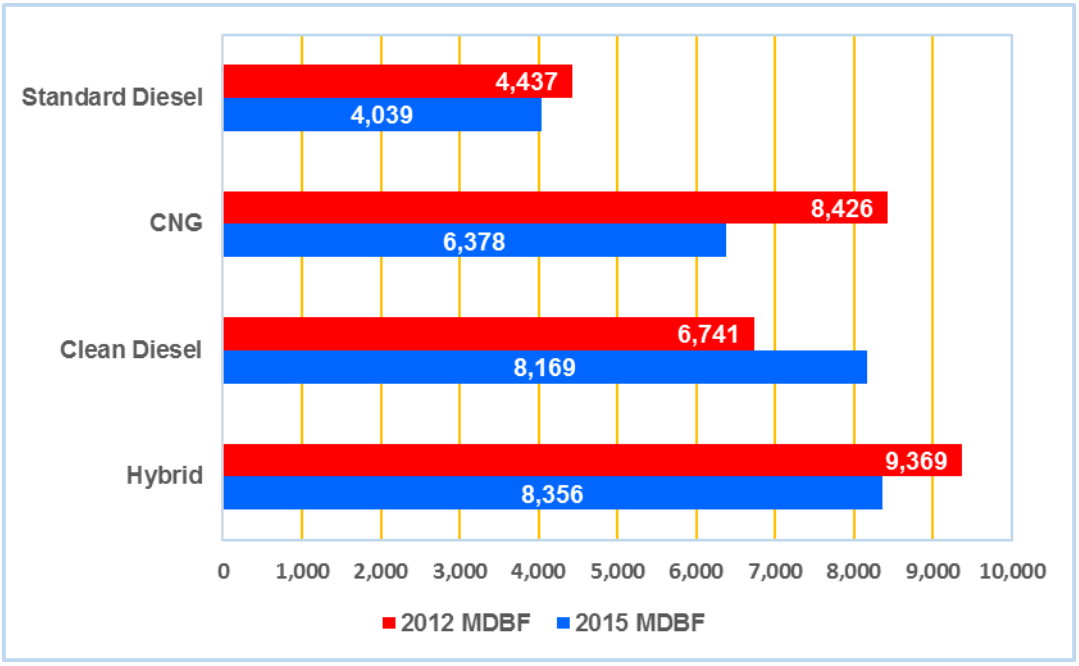


The correlation between MDBF and average vehicle age explains about 55 percent of the cause. It is also determined that the oldest buses, those that are most likely to fail, were the diesel fleets. Since the last fleet plan update, due to the replacement of these old buses with new fuel technology vehicles, the size of the standard diesel fleet has decreased drastically thereby limiting the failure rate.

While Figure 5-2 above shows correlation between average fleet age and MDBF over time, there is some variation in MDBF not explained by fleet average age. This leaves some opportunity for other factors such as fuel type or usage rate to play a role.

Figure 5-4 below compares the MDBF for 2012 and 2015. Note the significant decline in reliability of the CNG and improvement in reliability of Clean Diesel fleet. The lack of CNG fueling facility has hampered the expansion of the fleet and the majority of the CNG fleets are bought between 2001 and 2005. The average age of the CNG fleet is 11 years while the Clean Diesel fleet average age is 7.7 years.

Figure 5-4: Mean Distance Between Failures by Vehicle Technology



5.3. Types of Maintenance

Two types of maintenance are performed on the Metrobus fleet: Preventative and Corrective maintenance.

- **Preventative Maintenance (PM):** is a scheduled maintenance program to keep equipment in good working order, prevent in-service failures, and meet certain vehicle regulatory requirements. The **Mid-life bus overhaul**, part of the PM, is critical for maintaining the safety, performance, and reliability of the bus fleet throughout its life. The mid-life overhaul, developed in the early 90's, was designed to maintain buses in a state of good repair, reduce in-service breakdowns, improve safety and reliability, and introduce standardization across the fleet as possible.
- **Corrective Maintenance (CM):** is an un-scheduled maintenance to respond to unexpected vehicle breakdowns, malfunctions and accidents.

Over the past few years, significant improvements in fleet reliability has been made through a combination of bus replacements and a robust maintenance program. The average fleet age has also been reduced to 7.6 years from the 8.7 years reported in the 2010 plan. As a result the failure rate of buses has been reduced significantly thereby improving the reliability of service. Metro has been meeting its goal of 7.5 average fleet age since 2012, with a minor discrepancy in 2015, and this fleet plan projects that it will continue to meet this goal in the coming ten years (see Section 4.4.3).

In the previous fleet plan update it was stated that, in early 2013 Metro would begin a "mini-overhaul" at approximately three years of age. But following a review of the scope and cost, it wasn't found to be cost effective and as a result not implemented. The scope will be further reviewed in the coming years.

5.3.1. Preventive Maintenance (PM)

The Metrobus scheduled PM program sustains bus reliability by detecting and correcting potential defects. Buses are withdrawn from service at regular mileage-based intervals for preventive maintenance actions including inspecting equipment and conducting routine service. The schedule is developed based on manufacturer recommendations and WMATA experience. Measures include lubrication, replacing filters, replenishing fluids and making adjustments, cleaning of exterior and interior surfaces, and scheduled replacement of electrical and mechanical equipment. Table 5-2 shows schedules for the preventive maintenance program.

Table 5-2: Preventive Maintenance Schedule

Inspection Type	Inspection Interval	Labor Hours	Buses/Day
ADA Equipment Maintenance	90 Days & Annual	3.21	44
A-Inspection	6,000 Miles	8.00	36
B-Inspection	Bi-Weekly	1.00	107
Bus Interior Cleaning	Daily / Weekly	4.00	1501
Bus Steam Cleaning	6,000 Miles	2.95	36
Camera Maintenance	Bi-Annual	4.00	12
Clever Devices	Annual	2.00	6
Coolant and System Care	On-going	0.32	12
Engine Tune Up	36,000 Miles	5.10	6
Fire Suppression	Bi-Annual	5.00	12
Fluid Analysis - Various	Varies	0.52	36
GFI Farebox Maintenance	Varies	1.10	7
Heavy Maintenance Overhaul	7½ Years	-	20
HVAC Inspection	90 Days/Monthly	4.32	24
Interior Cleaning	Monthly	2.00	69
Service Lane Activity	Daily	0.32	1501

A-inspection provides the primary Metrobus vehicle inspection and service, completed every 6,000 miles. It covers the entire vehicle including driver's equipment and controls, passenger interior, vehicle exterior, engine and engine compartment, transmission, battery, chassis, lubrication, and articulation equipment (if pertinent) and culminates with a complete road test.

Each bus goes through daily and bi-weekly regular inspections to ensure day-to-day operations. Service lane activity is a daily cursory inspection concurrent with the routine refueling and service of the vehicle. It includes checking the farebox, fluid levels, lights, doors and interlocks. The interior is also swept, and the exterior is washed.

B-Inspection is done bi-weekly and follows a checklist of bus equipment condition and operation inspection which includes safety and weather-related equipment, passenger seats, stop chimes, doors, floors, windows, wheelchair equipment, brakes, axles, tires, battery, fluid levels, wires and hoses.

5.3.1.1 Mid-Life Overhaul

Mid-life overhaul, an integral part of the PM program, is another component of the fleet management plan. After 7.5 years of service, a Metrobus will have traveled about 248,000 miles. Many critical parts will wear out and basic overhauls will not be enough to maintain the expected performance.

Initiated in 1994, the Heavy Maintenance Overhaul Program provides for the rehabilitation of bus mechanical and electrical systems, including overhaul of the engine, transmission, pneumatic equipment, doors, wheelchair lifts, destination signs, suspension, and other structural components. In addition, the interior and exterior of the bus are repainted and all upholstery is replaced.

Heavy overhaul incorporates new technology and safety enhancements, keeps the fleet in compliance with air quality requirements, and permits standardization of configuration across bus fleets of varying ages. Buses undergoing Mid Life overhauls is a function of the number of new buses purchased in a given year, available funding and manpower as well as the fleet spare ratio.

On average, each year Metro plans to replace approximately 100 of its old fleet with new buses, in addition to any expansion buses bought. Over the years Metro's procurement of buses has varied in numbers. Between 2005 and 2015 the total number of buses bought for replacement and expansion were 1,327 averaging over 120 buses per year. This has led to a demand for Mid-Life overhauls exceeding the typical 100 buses per year capacity. With no major changes

to the maintenance capacity it will potentially lead to a situation where the overhaul program happening later than the ideal scheduled time. Previous plan to increase capacity from 100 to 116 overhauls per year has not materialized. Currently, 20 buses are in overhaul process at any given time, and each week, the program accepts two in-service buses and releases two buses completing rehabilitation.

Table 5-3 presents the mid-life overhaul projection. The overhaul projection shows that beginning in 2019 a significant part of the fleet overhaul maintenance work will be done more than a year later than the standard 7.5 years. As indicated above, the main reason for this is the procurement of a higher number of new buses over the past years without the corresponding increase in the maintenacne capacity of the heavy overhaul functions. Based on the current projection, from 2022 until 2025 less than 10 percent and in some years less than 5 percent of the mid-life overhaul will be done on time. This indicates that the capacity of the mid-life overhaul functions isn't keeping up with the fleet growth. With the planned transfer of the heavy maintenance overhaul to Andrews Federal Center and proposed changes to increase the spare ratio, it is anticipated that more capacity will be available to address the need for mid-life overhaul (See section 3.7.3 and 5.5). Figure 5.5 illustrates the heavy overhaul production flow and basic scope of work.

5.3.2. Corrective Maintenance (CM)

With a substantial preventive maintenance program, Metro is able to optimize the corrective maintenance requirement and minimize the accompanying service quality degradation. However, unexpected breakdowns will occur even on new systems and components, and all corrective maintenance is required to be complete within 48 hours unless awaiting shop repair or deferred for parts.

Table 5-3: Mid-Life Overhaul Schedule

Rehab Year		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Maintenance Capacity		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Year in Service	Quantity																		
2001	99	51	49																
2002	64	32	28	4															
2003	21			3	2														
2005	250		6	104	97	43	0												
2006	165					45	78	42											
2007	25						1	20	4										
2008	125					1	4	29	85	6									
2009	100								2	83	8	7							
2010	148									5	83	60							
2011	100										1	26	73						
2012	119												27	92					
2013	110													8	97				
2014	105														3	96	6		
2015	80															3	77		
2016	215																15	100	100
Yearly Total		83	83	111	99	89	83	91	91	94	92	93	100	100	100	99	98	100	100

Key	Early	On-Time	Late

5.4. Maintenance Capacity for Fleet

There are four categories of maintenance at Metro as outlined below: warranty, shop, garage and retrofit. The capacity of Metro's operating maintenance is a function of the capacity of the divisions. The following summarizes each of the scheduled maintenance activities.

1. **Warranty Maintenance:** Service and repair of systems and equipment that are still under the manufacturer's warranty. This work is specified by the equipment manufacturer and is required to be accomplished in order to preserve the warranty on the product.

2. **Shop Maintenance:** Heavy repair shop work involving activities such as accident repair, scheduled equipment overhaul and unscheduled corrective maintenance (e.g. engine or transmission replacement).

3. **Garage Maintenance:** The bulk of Metrobus preventive and corrective maintenance is accomplished at the individual garage level.

4. **Retrofit Maintenance:** Activities at this level include manufacturer's recall repairs, and special item retrofits.

In 2015, on an average weekday, a total of 211 buses (Table 3.10) have undergone different categories of maintenance including heavy overhaul. This indicates that 14.1 percent of the total scheduled fleet is tied up with maintenance activity each day.

In the previous fleet plan update, with the opening of Shepherd Parkway, the total garage storage capacity has increased from 1,524 to 1,740 buses and the maintenance capacity has also increased proportionally. Since then, the closure of Royal Street Division has reduced the garage storage capacity by 83 and with an additional 34 storage capacity created at Western, the current total storage capacity is 1,691. As a result the maintenance capacity has been reduced proportionally to 216, as shown in Table 5-4. The planned opening of Cinder Bed Road Division in FY2019 (December 2018), is intended to replace Royal Street Division and to provide an expansion of service capacity in Virginia.

Table 5-4: Current Maintenance Capacity

	2015		2012	
Garage Capacity	**1,691**		**1,740**	
Maintenance Type	**Maintenance Capacity**	**% of Storage Capacity**	**Maintenance Capacity**	**% of Storage Capacity**
Warranty	**17**	**1.00%**	**17**	**1.00%**
Shop	**47**	**2.80%**	**49**	**2.80%**
Garage	**144**	**8.50%**	**148**	**8.50%**
Retrofit	**8**	**0.50%**	**9**	**0.50%**
Total	**216**	**12.80%**	**223**	**12.80%**

5.5. Distribution of Maintenance Functions

Since the previous fleet plan update, there was one major change to the distribution of fleet maintenance functions and that is the closure of the Royal Street operating division.

Table 5-5 shows a summary of existing Metro maintenance facilities.

Table 5-5: List of Maintenance Facilities

Facility	Location	Facility Type
Bladensburg	District of Columbia	Operating Division
Northern	District of Columbia	Operating Division
Shepherd Parkway	District of Columbia	Operating Division
Western	District of Columbia	Operating Division
Montgomery	Montgomery County, MD	Operating Division
Landover	Prince George's County, MD	Operating Division
Southern Avenue	Prince George's County, MD	Operating Division
Four Mile Run	Arlington County, VA	Operating Division
West Ox	Fairfax County, VA	Operating Division
Bladensburg	District of Columbia	Heavy Repair
Carmen Turner	Prince George's County, MD	Heavy Repair

As noted above, by the end of FY15 the demand for vehicle storage and running maintenance is 1,571 spaces. Currently there are 1,691 storage spaces in the nine operating divisions, which is above the fleet requirements. The capacity of Metrobus facilities to store and maintain the fleet, planned and proposed changes to these facilities, including Cinder Bed and Andrews Federal Center will be presented on a separate document titled “2017 Metrobus Facilities Plan”.

The 2013 fleet plan update stated that Metro's capacity for operating maintenance will allow a maximum of approximately 223 buses undergoing maintenance at any one time. As indicated in Section 5.4, the current operating maintenance capacity is 216 buses. The previous plan also indicated that there will be an increase in heavy overhaul capabilities from 100 to 116 per year in early 2013. It was stated, this increase in capacity will allow up to 23 buses to be undergoing heavy overhaul at any given time. However, the planned increase in the heavy overhaul capabilities has not been implemented.

Andrews Federal Center is planned to open in FY18. With the transfer of mid-life overhaul functions to Andrews, it is anticipated that the total number of maintenance bays will increase from the current 36 to 46. The rebuilding of Bladensburg Division is also anticipated to increase overall capacity. These planned development changes are anticipated to address the shortcomings identified in the mid-life overhaul capacity and cater for future fleet growth.

5.6. Projection of Demand for Maintenance of Revenue Vehicles

The demand for maintenance facilities is a function of fleet size and age. Table 5-6 below shows the projection of fleet maintenance demand up to FY25, based on the growing demand for additional bus service in the Metrobus service area. Table 5-7 illustrates the growth in demand for maintenance capped by the planned fleet expansion, with only 180 expansion buses delivered between FY17 and FY25.

It should be noted that the current plans for expansion of only 180 buses results in a daily maintenance total of 273 by FY25, whereas a fleet expansion that would cover the region’s growing demand would result in a daily maintenance total of 334.

Table 5-6: Projection of Maintenance Demand for Revenue Vehicles (based on growing demand for bus service)

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Operating Fleet	1,300	1,428	1,462	1,498	1,533	1,585	1,631	1,685	1,724	1,763	1,809
Net Increase	0	128	34	36	35	52	46	54	39	39	46
Maintenance Total	200	218	269	276	282	292	301	311	318	325	334
Operating Maintenance	180	198	249	256	262	272	281	291	298	305	314
Mid-Life Overhauls (concurrent)	20	20	20	20	20	20	20	20	20	20	20
Operating Fleet Total	1,500	1,646	1,731	1,774	1,815	1,877	1,932	1,996	2,042	2,088	2,143

Table 5-7: Projection of Maintenance Demand for Revenue Vehicles (based on planned fleet procurement)

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Operating Fleet	1,300	1,315	1,335	1,355	1,375	1,395	1,415	1,435	1,455	1,475	1,495
Net Increase	0	15	20	20	20	20	20	20	20	20	20
Maintenance Total	200	200	243	247	250	254	258	262	265	269	273
Operating Maintenance	180	180	223	227	230	234	238	242	245	249	253
Mid-Life Overhauls (concurrent)	20	20	20	20	20	20	20	20	20	20	20
Operating Fleet Total	1,500	1,515	1,578	1,602	1,625	1,649	1,673	1,697	1,720	1,744	1,768
Actual Fleet	1,645	1,660	1,680	1,700	1,720	1,740	1,760	1,780	1,800	1,820	1,840

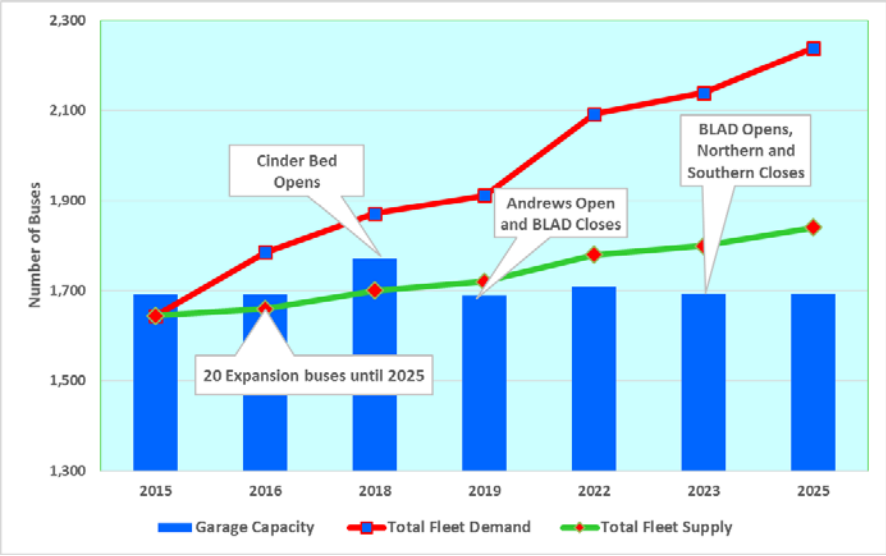
SECTION SIX: CONCLUSIONS

6.1. Peak Vehicle Supply and Demand

As illustrated in Section 3 and 4 above, Metrobus has more demand for bus transit than can currently be provided by Metro. Metrobus lacks the number of vehicles to provide a state of good service, i.e., to ensure that the criteria of productivity, reliability, capacity, and adequate frequency are met. Section 3 highlighted Metrobus entered FY16 with 117 fewer buses than required to meet a state of good operation. Table 3-11 illustrates that Metro will need 595 additional buses to satisfy demand that meets the need for state of good operations, Priority Corridor Network and Emerging Corridors implementation, and other fleet needs for new service. Section 3.7.3 addresses the current need to increase the fleet Spare Ratio from 15.6% to 18.5% which will help reduce the gap between fleet demand and supply. Metrobus will continue to uses older bus fleets and have devised a set of strategies (see Section 6.2) to overcome the gap in fleet demand and supply.

Section 4 described the current Metrobus fleet procurement plan, which supplies 20 expansion buses per year beginning FY17. To satisfy some of the fleet needs of FY16, 15 older buses have been added to the revenue fleet. Overall the gap between the fleet demand and supply is 448 buses as illustrated in Figure 6-1.

Figure 6-1. Projected Fleet Demand, Fleet Supply, and Garage Capacity*



Note * - Garage capacity will be discussed in detail on a separate document "2017 Metrobus Facilities Plan"

Figure 6-1 also illustrates that, if the growing need for buses were to be met through new funding streams, the ability for Metro to provide adequate maintenance and storage for the fleet will be exceeded. Additional storage and maintenance facilities are needed in the core operation areas if the fleet is to expand to meet the growing demand. This will be presented in detail on a separate document that covers Metrobus garage facilities.

6.2. Long Term Challenges

There is much uncertainty in finding funding streams that will support the fleet needs of Metrobus services. Finding convenient locations to build garage facilities that will support the core service area has also been a major challenge. The challenges faced by Metrobus were described throughout the report and are summarized below:

1) The demand for Metrobus is currently greater than the supply and this mismatch will continue to grow throughout the ten year period of this plan.
2) Metro's Priority Corridor Network program requires 147 additional buses on top of those needed for state of good operations, Emerging Corridors, Spare Ratio and other fleet needs.
3) Funding for fleet expansion is currently limited to 180 new buses to be procured between 2017 and 2025.
4) Metrobus management may decide to maintain older buses in the revenue fleet to provide state of good operations, prioritizing scheduled service over lowered maintenance costs and increased reliability.

To overcome the long term challenges WMATA:

1. Continues to implement the strategic plans outlined in Momentum (http://wmata.com/momentum.)
2. Developed a 10-Year Capital Needs Inventory (CNI) to quantify existing and anticipated capital needs to advance or maintain State of Good Repair (SGR) of assets, meet regulatory compliance, and invest in necessary enhancements to ensure a safe and modern system that continues to support the region’s economic competitiveness.
3. Approved a new six year Capital Improvement Plan (CIP) FY2018-FY2023 that provides continued investment for bus replacement and mid-life overhaul service. The CIP, by making available funds to replace older buses with new ones, plays a key role in the provision of a reliable and consistent bus service and maintaining a younger average age for buses.

4. Plans to implement a new fleet fuel mix technology that favors clean diesel. The implementation of this strategy will help to reduce the burden of capital investment and ongoing maintenance costs.
5. Initiates a State of Good Operations (SOGO) process annually to make targeted improvements to deliver and maintain quality of service. This is accomplished by reducing overcrowding, improving on-time performance, and re-structuring or eliminating routes or portions of routes to provide more productive service.
6. Has been advocating for a stable, dedicated funding stream. Working with the regional stakeholders and decision makers, WMATA is developing a more predictable and dedicated funding source to ensure that the resources required for procuring the fleet need and their maintenance are met.

ADDENDUM

1.0. Safe Track

In June 2016, Metro started SafeTrack, an accelerated track work plan to address safety recommendations and rehabilitate the Metrorail system to improve safety and reliability. The plan significantly expands maintenance time on weeknights, weekends and midday hours and includes 16 "Safety Surges" - long duration track outages for major projects in key parts of the system.

During the duration of the SafeTrack period, Metrobus provided shuttle bus service to transport customers between sections of the Metrorail System that were closed for maintenance work. The need for additional peak period bus capacity was accommodated from the Ready Reserve Fleet (detailed in Section 4.3.4). In FY2018 three major closures of parts of the Green, Red and Yellow Metrorail lines are planned that will require bus shuttle services.

The table below shows a sample of the fleet requirements for three completed SafeTrack surges and three more round-the-clock station closures planned for FY2018. As shown on the table, 56 buses are the highest peak buses needed and Metro was able to accommodate this demand from the Ready Reserve Fleet.

Addendum 1: Fleet Required and Planned For Shuttle Services

			Number of Metrobuses			
Surge #	Decription	Date	Weekday		Saturday	Sunday
			AM	PM		
3 & 4	National Airport - Braddock Road	07/05/16 - 07/18/16	54	56	40	40
15	Stadium Armory - New Carrollton	05/16/17 - 06/15/17	45	27	44	44
16	Shady Grove - Twinbrook	06/17/17 - 06/25/17	45	45	30	30
FY2018	Naylor Road - Branch Avenue	08/05/17 - 08/20/17	15	15	15	15
FY2018	Fort Totten - Silver Spring	11/23/17 - 12/10/17	25	25	20	15
FY2018	Huntington - King Street	05/12/18 - 27/12/18	25	25	20	15

2.0. Ridership

Ridership on both Metrorail and Metrobus has shown a sustained decline in FY16 and FY17. The decline in Metrobus ridership is related to rail ridership decline. The bus lines heavily impacted are those that provide feeder services to rail stations closed for SafeTrack maintenance work. In addition to safety and reliability problems on Metrorail, other external

factors contributed to the ridership decline on both Metrorail and Metrobus, including - sustained reduced fuel prices, telecommuting, alternate work schedules, availability of transport alternatives such as Uber and Lyft, are among the factors cited for the steady decline in Metro's ridership over the last couple of years.

Since the preparation of this Fleet Plan, Metrobus ridership declined by 4.1% in FY2016. In FY2017, ridership is estimated to decline by an additional 3.9%[*]. At the time Section Two: Ridership Demand Growth was written, it was anticipated that ridership would grow by 1 percent over this Fleet Plan's planning period.

An analysis of bus ridership divided into two groups, trips that involved a transfer to and from rail, and those that did not, revealed that rail related bus ridership is falling four times faster than those that are not related to rail. The analysis also indicated that more than half of bus ridership loss over the past three years is directly related to rail ridership loses.

However, the decline in bus ridership did not have a significant effect on the total Metrobus fleet requirements and was not accompanied with a reduction in the bus fleet. The total fleet requirement from FY2015 – FY2017 is presented below.

Addendum 2: Bus Fleet Assignment

Fleet Assignment	Jun-15	Jun-16	Jun-17
Peak Vehicle Requirement	1300	1281	1260
Spare Buses	200	201	201
Rehab. & Special Projects Contingency	43	40	62
Rail Shuttle Contingency	0	61	60
Other	5	5	0
Total Buses Assigned	1548	1588	1583

Source: Metrobus Fleet Assignment

[*] Note that the FY16 and FY17 ridership data are from the farebox, and count paying passengers only. There may be a significant number of passengers who are not counted in the data.

As shown in the table above the total buses assigned for scheduled and unscheduled services have increased over the most recent two year period, except for a minor decrease in the peak vehicle requirement. This drop is due to service reductions.

The reason for maintaining the peak fleet requirement is mainly due to the fact that existing service provision was constrained by lack of fleet. The Fleet Management Plan Section 2.4.3 and Section 3 highlighted that the number of buses put in service was far below the fleet requirement and as a result service demand was constrained. To improve service reliability, reduce overcrowding and meet policy frequency standards in FY16, Metro needed an additional 117 buses during the peak period, but this couldn't be achieved for lack of fleet.

The inability to put the required number of buses in service led to an increase in overcrowding, and reliability of service suffered. It should be noted that the effect of the decline in bus ridership over the last couple of years is reflected more in the reduction of bus overcrowding instead of the fleet requirement. A Ridecheck data analysis (see Addendum 3 & 4 below) shows that the level of bus overcrowding has eased significantly since FY15 – the start of ridership decline. The tables below present the number of Metrobus routes and trips that are overcrowded and the decline in overcrowding over the same time period.

Addendum 3: Routes with Overcrowding Problems

Signup	>120% AVG MAX Load Routes		Total Routes		% Routes Overcrowded	
	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
Aug, 2015	62	51	267	273	23.2%	18.7%
Aug, 2016	51	35	249	253	20.5%	13.8%
Mar, 2017	33	25	249	253	13.3%	9.9%

Source: Metrobus Ridecheck Data Analysis

Addendum 4: Trips with Overcrowding Problems

Signup	>120% AVG MAX Load Trips		Total Trips		% Trips Overcrowded	
	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
Aug, 2015	254	231	3,615	4,518	7.0%	5.1%
Aug, 2016	151	126	3,557	4,462	4.2%	2.8%
Mar, 2017	77	75	3,605	4,498	2.1%	1.7%

Source: Metrobus Ridecheck Data Analysis

As can be seen from the above tables, the most recent data shows that after sustained ridership decline Metro still requires additional buses to overcome crowding problems and provide a reliable service. The fleet requirement for rail shuttle services, arising from SafeTrack and successor programs, has contributed to the slight increase in the total assignment of the fleet over the most recent two year period.

APPENDICES

Appendix 1: Metrobus Fleet by Type (21 June, 2015)

Division	Small			Standard				Artic			System Total
	CNG	Hybrid	Clean Diesel	Clean Diesel	CNG	Hybrid	Diesel	CNG	Hybrid	Diesel	
District of Columbia	23	25	17	0	196	387	66	22	3	21	760
Bladensburg	23	0	0	0	196	0	22	22	3	0	266
Northern	0	0	0	0	0	101	28	0	0	21	150
Shepherd Parkway	0	11	17	0	0	181	16	0	0	0	225
Western	0	14	0	0	0	105	0	0	0	0	119
Maryland	0	0	10	121	3	282	56	2	19	0	493
Landover	0	0	10	40	0	105	22	0	0	0	177
Montgomery	0	0	0	0	0	164	31	0	19	0	214
Southern Avenue	0	0	0	76	0	0	3	0	0	0	79
Carmen Turner	0	0	0	5	3	13	0	2	0	0	23
Virginia	12	0	6	0	204	96	0	0	0	0	318
Four-Mile Run	12	0	6	0	204	0	0	0	0	0	222
West Ox Road	0	0	0	0	0	96	0	0	0	0	96
System Total	35	25	33	121	403	765	122	24	22	21	1571

APPENDIX 2: Peak Vehicle Requirement by Division and Bus Type

	Small		Standard		Articulated		Scheduled PVR	Strategic and Headway	Total PVR	Total Fleet Assigned
	AM	PM	AM	PM	AM	PM				
District of Columbia	65	60	512	502	46	46	624	14	638	760
Bladensburg	23	22	166	166	25	25	214	4	218	266
Northern	0	0	104	96	21	21	125	5	130	150
Shepherd Parkway	28	28	154	155	0	0	183	4	187	225
Western	14	10	88	85	0	0	102	1	103	119
Maryland	10	10	328	352	19	19	381	9	390	470
Landover	10	10	120	133	0	0	143	3	146	177
Montgomery	0	0	143	154	19	19	173	5	178	214
Southern Ave	0	0	65	65	0	0	65	1	66	79
Virginia	18	18	248	247	0	0	266	6	272	318
Four Mile	18	18	166	165	0	0	184	5	189	222
West Ox	0	0	82	82	0	0	82	1	83	96
Total	93	88	1088	1101	65	65	1271	29	1300	1548

Appendix 3: Allocation of Additional Buses for Revenue Service

(Net Change from Existing to 2025)

	PCN	Emerging Corridors	Service Adjustment	New Service	Elevator and Emergency Shuttle	Spares	Total Additional Fleet Required
District of Columbia	76	50	102	0	4	62	293
Maryland	53	20	113	0	4	46	236
Virginia	18	17	43	8	3	26	115
System Total	147	87	257	8	11	134	644

Appendix 4: Allocation of Expansion Buses for Revenue Service

(Net Change from Existing to 2025)

	Small Buses	Standard Buses	Articulated Buses	Total New Buses	Share
District of Columbia	0	251	44	295	45.9%
Maryland	0	209	26	235	36.4%
Virginia	0	114	0	114	17.7%
System Total	0	574	70	644	100.0%

Appendix 5: Fleet Demand and Supply Balance

Fiscal Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Total Fleet Requirements											
Scheduled PVR (Beginning of Year)	1261	1272	1277	1302	1329	1354	1396	1432	1475	1503	1530
Change in PVR	39	156	185	196	204	231	235	253	249	260	279
Spare Buses Required	200	218	269	276	282	292	301	311	318	325	334
Other Buses	145	139	97	97	97	97	97	97	97	97	97
Total Fleet (End of Year)	**1645**	**1785**	**1828**	**1871**	**1912**	**1974**	**2029**	**2093**	**2139**	**2185**	**2240**
Total Fleet Supply											
New Buses	80	215	20	130	152	125	117	120	120	120	120
Old Buses Added to Service	85	15	0	0	0	0	0	0	0	0	0
Retired Buses	(80)	(215)	0	(110)	(132)	(105)	(97)	(100)	(100)	(100)	(100)
Net Change	85	15	20	20	20	20	20	20	20	20	20
End of Year Total	**1645**	**1660**	**1680**	**1700**	**1720**	**1740**	**1760**	**1780**	**1800**	**1820**	**1840**
Supply / Demand Balance											
Supply vs. Demand at End of Year	**0**	**(125)**	**(148)**	**(171)**	**(192)**	**(234)**	**(269)**	**(313)**	**(339)**	**(365)**	**(400)**
Percent Difference	**0%**	**-8%**	**-9%**	**-10%**	**-11%**	**-13%**	**-15%**	**-18%**	**-19%**	**-20%**	**-22%**
Garage Capacity											
Garage Capacity at End of Year	**1,691**	**1,691**	**1,691**	**1,771**	**1,689**	**1,709**	**1,709**	**1,709**	**1,694**	**1,694**	**1,694**

Appendix 6: Maximum Buses to be Assigned and Scheduled (21 June 2015)

DIVISIONS	SUN PVR	SAT PVR	BASE PVR	A M PVR	P M PVR	MAX SCHED PVR	STRA - TEGIC FLEET	HEAD - WAY MGMT	MAX STRA HDWY	15.6% SPARES RATIO	ACTUAL BUS NEED	GARAGE CAPACITY
BLADENSBURG	95	100	104	214	213	214	3	1	218	34	252	257
SHEPHERD PKWY	71	89	73	182	183	183	3	1	187	27	214	250
SOUTHERN AVE	0	0	34	66	65	65	1	0	66	10	76	103
LANDOVER	44	64	76	130	143	143	3	0	146	23	169	210
FOUR MILE RUN	68	95	66	184	183	184	3	2	189	29	218	218
WEST OX	0	0	31	82	82	82	1	0	83	13	96	100
MONTGOMERY	51	60	82	162	173	173	5	0	178	28	206	240
NORTHERN	43	59	50	125	117	125	1	4	130	20	150	175
WESTERN	40	45	44	102	95	102	1	0	103	16	119	138
SYSTEM TOTAL	412	512	560	1247	1254	1272	21	8	1300	200	1500	1691

Updated: 06/25/2015

Note: Landover Fleet includes 6 high-back with luggage racks dedicated to BWI service which are not included in the 15.6% system spare ratio. Shepherd Parkway Fleet includes 13 Branded Buses for Metroway Services that are not included in the 15.6% system spare ratio.