



Commuter Rail Vehicle Technology Analysis

May, 2007

Purpose:




To present the results of the EMU, DMU and DMU double deck (DMU dd) analysis

Including:

- **Description of the Vehicles**
- **Life Cycle Cost Analysis**
- **Pros & Cons**
- **Alternatives Under Consideration**
- **Need for a Timely Decision**

Description of the Vehicles

Description of the Vehicles

Vehicle	Location	Status	Capacity*	Number of cars in service in North America	Manufacturer	
EMU Single-Level	Long Island & Southern Connecticut, Chicago & Northern Indiana, New Jersey, Philadelphia, Montreal	Well Established, Daily Operations in Metro Areas	88 to 110 seats Crush load: 225 to 265 (seated + standees)	2,231	Bombardier, ALSTOM, Rotem, Kawasaki, Nippon Sharyo	
DMU Single-Level (SL DMU)	None	In Production at Colorado Railcar, Target early 2008 Delivery of 3 DMUs to Portland	74 seats Crush load: 235	0	Colorado Railcar Potential: Rotem, Siemens, Bombardier, Nippon Sharyo	
DMU Double-Deck (DD DMU)	Miami	One In Demonstration Service, Target Delivery of 4 DMUs to Miami	165 seats Crush load: 206	1	Colorado Railcar	

* Additional luggage storage would reduce capacities

Life Cycle Cost Analysis

Life Cycle Cost Analysis

Inputs to the Analysis Include:

- **“Differential” Capital Costs**
 - Vehicles
 - Construction capital costs for infrastructure (electrification, maintenance facility)
- **Operating and Maintenance Costs**
 - Fuel type
 - Consumption
 - Maintenance costs

What are “Differential” Costs?

The difference between what you need to make a specific technology work (vehicles & support) assuming the alignment and stations are already in place.



Vehicles



**Support for
Vehicles**



**= Differential
Cost**



Life Cycle Cost Analysis Results by Corridor (Stand Alone) then by System

- **First:** Each corridor was evaluated as a “**Stand Alone**”* for that technology
 - Costs will be higher in a stand alone analysis because each corridor will take on all of the costs of that technology
- **Then:** Technologies were evaluated from a “**System Perspective**”
 - This perspective will show how cost sharing impacts the total cost because corridors can share infrastructure (substations etc).
- **Therefore:** Costs from the individual corridor analysis cannot be added together to get the systems results

*Assumption in a “stand alone” analysis is that only one corridor is that particular technology

Stand Alone Analysis

Vehicle Costs* Compared to Original FasTracks Budget

Corridor	EMU	DMU	DMU dd	Original FasTracks Budget*
<i>East Corridor</i>	\$76 M	\$106 M	\$72 M	\$96 M
<i>Gold Line</i>	\$63 M	\$73 M	\$48 M	\$69 M
<i>North Metro</i>	\$57 M	\$66 M	\$57 M	\$56 M
<i>Northwest Rail</i>	\$38 M**	\$44 M**	\$57 M**	\$40 M

*Vehicle costs and FT vehicle budget are both in 2006 dollars

**If 12 axle vehicles are required by BNSF this cost could go up significantly for both single and double deck DMU's (50% to 100%)

Stand Alone Analysis
Summary of Differential Costs*
Compared to Original FasTracks Budget
East Corridor

Vehicle Type	Vehicles	Electrification Costs	DUS: Cost to accommodate technology	Maintenance Facility****	Total	Original FasTracks Budget
EMU	\$76 M	\$76 M	\$0**	\$20 M	\$172 M	\$96 M
DMU	\$106 M	\$0	\$3 M	\$0	\$109 M	
DMU dd	\$72 M	\$0	\$25 M***	\$0	\$97 M	

*Differential costs are vehicles and support for those vehicles (maintenance facility & electrification (if needed)). Costs in 2006 dollars

**Electrification for DUS is included in corridor cost estimates

***This assumes not having to relocate 20th St. structure.

****Maintenance Facility costs were not part of the individual corridor budgets but were a separate budget line item in original FasTracks budget. \$20 M assumes that each corridor takes on the total cost. As a system, this cost would be shared

Summary of Differential Costs*

Compared to Original FasTracks Budget

Gold Line

Vehicle Type	Vehicles	Electrification Costs**	DUS: Cost to accommodate technology	Maintenance Facility*****	Total	Original FasTracks Budget
EMU	\$63 M	\$0	\$0***	\$20 M	\$83 M	\$ 69 M
DMU	\$73 M	\$0	\$3 M	\$0	\$76 M	
DMU dd	\$48 M	\$0	\$25 M****	\$0	\$73 M	

*Differential costs are vehicles and support for those vehicles (maintenance facility & electrification (if needed)) Costs in 2006 dollars

**For the Gold Line this included electrification since FasTracks assumption was Light Rail

***Electrification for DUS is included in corridor cost estimates

****This assumes not having to replace 20th St. structure

*****Maintenance Facility costs were not part of the individual corridor budgets but were a separate budget line item in FasTracks. \$20 M assumes that each corridor takes on the total cost. As a system, this cost would be shared

Stand Alone Analysis
Summary of Differential Costs*
Compared to Original FasTracks Budget
North Metro

Vehicle Type	Vehicles	Electrification Costs**	DUS: Cost to accommodate technology	Maintenance Facility****	Total	Original FasTracks Budget
EMU	\$57 M	\$63 M	\$0**	\$20 M	\$140 M	\$56 M
DMU	\$66 M	\$0	\$3 M	\$0	\$69 M	
DMU dd	\$57 M	\$0	\$25 M***	\$0	\$82 M	

*Differential costs are vehicles and support for those vehicles (maintenance facility & electrification (if needed)) Costs in 2006 dollars

**Electrification for DUS is included in corridor cost estimates

***This assumes not having to replace 20th St. structure

****Maintenance facility costs were not a part of the individual corridor budgets but were a separate budget line item in original FasTracks budget. \$20 M assumes that each corridor takes on the total cost. As a system, this cost would be shared

Stand Alone Analysis

Summary of Differential Costs*

Compared to Original FasTracks Budget

Northwest Rail

Vehicle Type	Vehicles	Electrification Costs**	DUS: Cost to accommodate technology	Maintenance Facility****	Total	Original FasTracks Budget
EMU	\$38 M	\$118 M	\$0**	\$20 M	\$176 M	\$40 M
DMU	\$44 M	\$0	\$3 M	\$0	\$47 M	
DMU dd	\$57 M	\$0	\$25 M***	\$0	\$82 M	

*Differential costs are vehicles and support for those vehicles (maintenance facility & electrification (if needed)) Costs in 2006 dollars

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Stand Alone Analysis

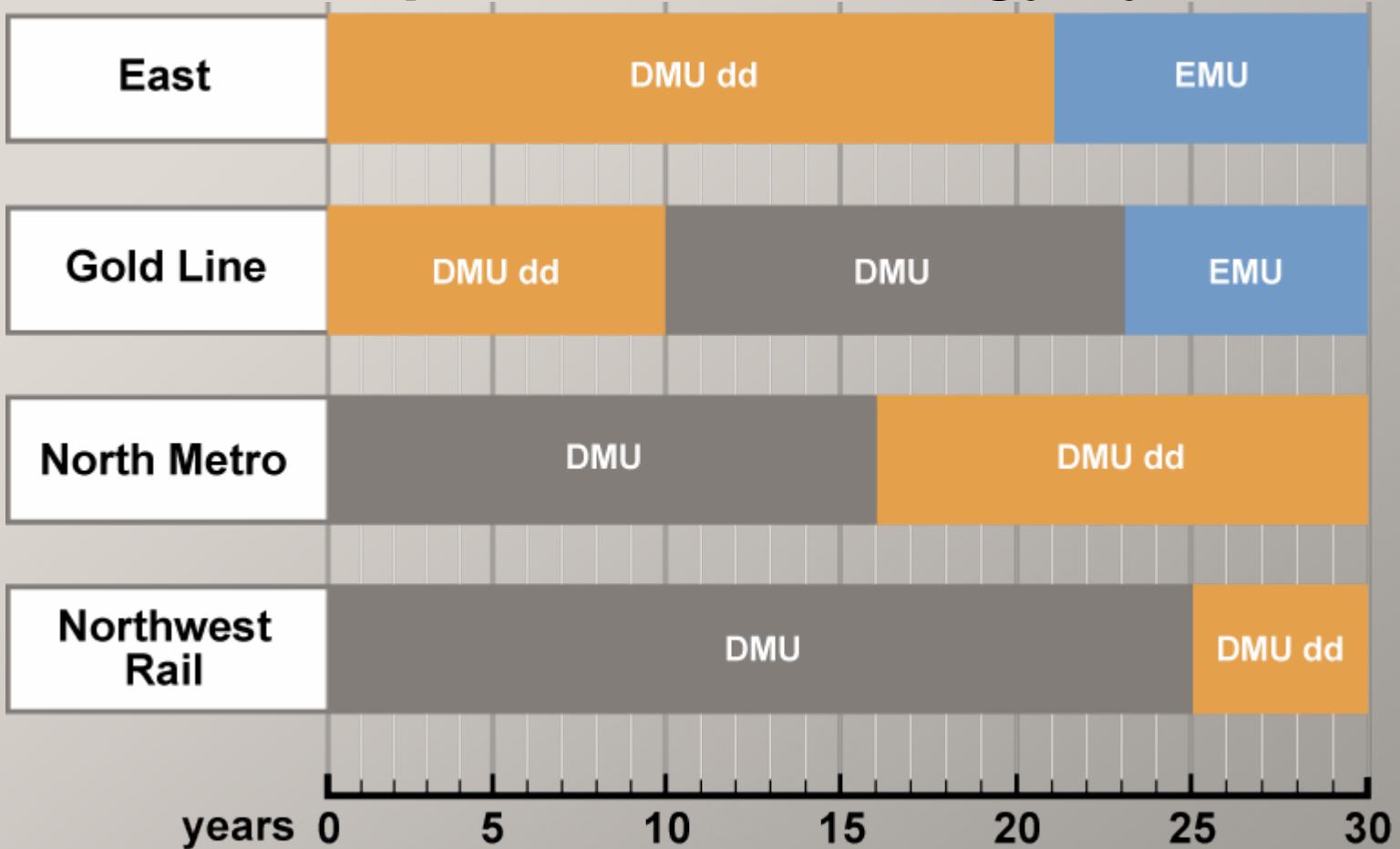
Average Annual (Over 30 years) O&M Costs by Corridor*

Corridor	EMU	DMU	DMU dd
<i>East Corridor</i>	\$23 M	\$32 M	\$27 M
<i>Gold Line</i>	\$16 M	\$18 M	\$19 M
<i>North Metro</i>	\$17 M	\$19 M	\$17 M
<i>Northwest Rail</i>	\$19 M	\$21 M	\$21 M

***Assumptions**

- Annual inflation rate is 3.4% (applied to fuel and electric over 30 years)
- Fuel price \$2.52 gal (current cost)
- Cost of electricity \$.085 per kilowatt hour (current cost)

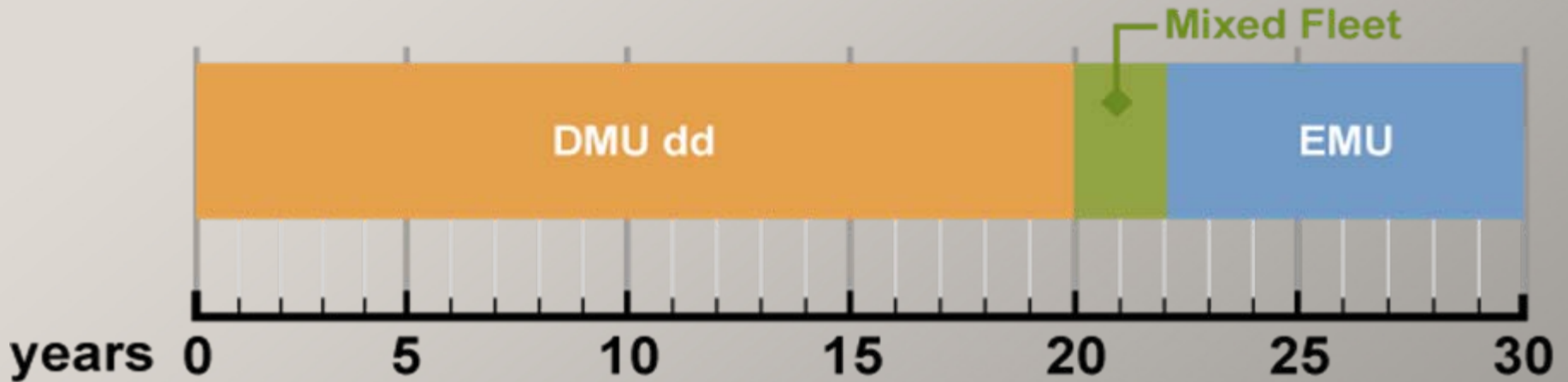
Corridor Break Even Results Least Expensive Technology by Year*



*Cumulative Capital and O&M Costs

System-wide Break Even Results Least Expensive Technology by Year*

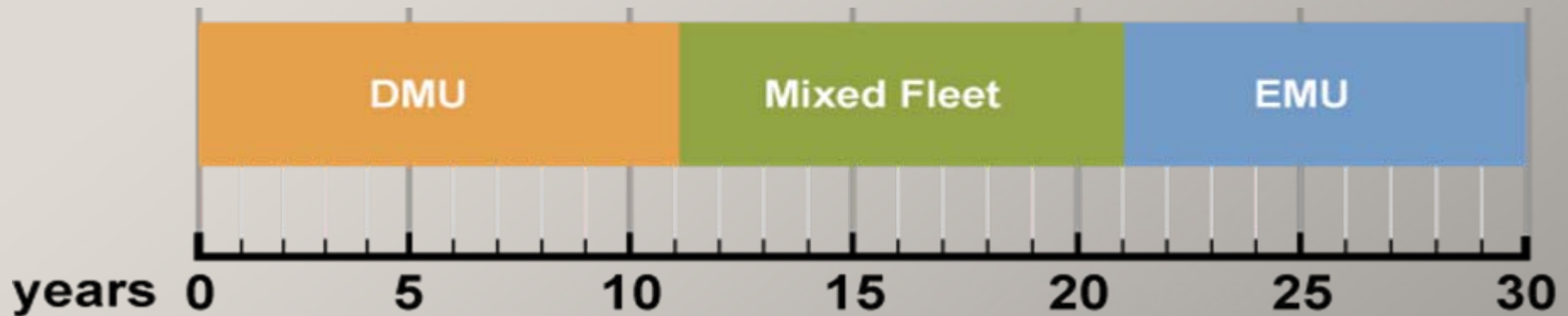
DMU, DMU dd, Mixed Fleet and EMU Compared:



*Cumulative Capital and O&M Costs ** Mixed Fleet is 2 EMU and 2 DMU

System-wide Break Even Results Least Expensive Technology by Year*

DMU, Mixed Fleet and EMU Compared:



*Cumulative Capital and O&M Costs ** Mixed Fleet is 2 EMU and 2 DMU

Pros & Cons of the Alternatives Under Consideration

All EMU

Pros

- Quieter (FTA rule)
- Air quality cleaner in the corridor
- Simplification of maintenance and operations due to single technology
- Lower O&M cost in long term
- Proven in operations in multiple transit agencies
- Numerous manufacturers
- Meets stakeholder expectations in East and Gold Line corridors
 - Will allow environmental and design to proceed on schedule

Cons

- Higher initial capital investment
- Higher costs to expand beyond FasTracks Plan
- May not meet stakeholder expectations in North Metro and Northwest Rail Corridors
 - Considered a visual impact by some

All DMU

Pros

- Lower initial investment than EMU
- Simplification of maintenance and operations due to single technology

Cons

- Higher O&M costs over time
- Not proven in revenue service (demonstration only)
- One manufacturer currently
 - Risk for large vehicle order (74+ cars)
- Gold Line: expected Light Rail. Change to DMU is inconsistent with FasTracks technology assumptions
- East Corridor: need to weigh the strong support of citizens and DIA for EMU against the cost impacts of selecting EMU technology
- Need to consider the likelihood of being able to implement the project without community or agency support in the East and Gold Line Corridors
- Need to reopen EIS decisions which will delay the project

All DMU dd

Pros

- Opening day cost savings
- Simplification of maintenance and operations due to single technology
- More seated capacity/car than single level DMU
- Could use shorter platforms (less cost)

Cons

- Would require design changes to DUS with a cost of \$25 to \$100 M*
- One manufacturer with uncertain production or financial capacity
- Patented design
- 60% of seated passengers must climb stairs
- Less standee capacity than single level DMU
- Limited capacity for luggage & standees due to vehicle stability issues
- Requires more loading & unloading time
- During emergencies top floor evacuation difficult
- Will require high surety guarantee for delivery
- At present does not meet ADA level boarding requirements
- Need to reopen EIS decisions which will delay the project

*This analysis assumed \$25 M

Mixed Fleet

(2 DMU, 2 EMU)

Pros

- Meets stakeholder expectations in East and Gold Line Corridors
- No schedule delays for environmental rework or design
- Matches vehicle technology to individual corridor characteristics and needs
- Better performance over mid and long term operations
- Mixed fleet is least expensive from year 11 to 21 (after that all EMU is least expensive)

Cons

- More complex operating and maintenance requirements than a single fleet technology
- Some higher initial construction costs

Summary of Alternatives Under Consideration

Alternative One: All EMU

- **Initial capital investment significantly over FasTracks budget**
- **Return of capital investment due to operational savings does not occur until after 21 years**

Alternative Two: All DMU

- **Less initial capital cost than EMU**
- **Operational cost increases outweigh initial capital savings before 30 years**
- **Risk in being able to procure vehicles on time**
- **No guarantee of adequate production capacity**
- **No significant history in operations**
- **Does not meet strong stakeholder expectations for Gold Line or East Corridor**

Alternative Three: All DMU dd

- **Initial capital savings**
- **Current manufacturer has a patent**
- **Risk of procurement**
- **No guarantee of adequate production capacity**
- **Only one current manufacturer**
- **Very limited history in revenue operations**
- **Does not meet strong stakeholder expectations for Gold Line or East Corridor**
- **May not work for Northwest Rail because 3 car consists may be required to comply with BN signal requirements**
- **For Northwest Rail, the potential need for RTD to purchase extra vehicles to comply with BN signal requirements would mean purchasing vehicles not required to meet ridership demand**

Alternative Four: Mixed Fleet (2 EMU, 2 DMU) Staff Recommendation

- **Cost differences are equalized over time compared to all DMU or all EMU**
- **EMU on East Corridor and Gold Line pays back at 15 years and is cost effective over time**
- **DMU on North Metro and Northwest Rail is least expensive initially and over time**
- **Will meet strong community and agency expectations for East & Gold Line Corridors**
- **Will not require additional environmental and design studies and costs**
- **To pick this consensus position is consistent with Federally mandated NEPA process**
- **Will keep East & Gold Line Corridors, DUS & Commuter Rail Maintenance Facility on schedule**
- **Creates better potential for combined bid packages**

Need for a Timely Decision on Commuter Rail Vehicle Technology

FasTracks Program is on hold until we know what we are building.

A timely decision is required to:

- **Ensure compliance with FTA's requirements for participation in the Penta P program which requires the selection of a Locally Preferred Alternative**
- **Communicate information to stakeholders and address concerns**
- **Provide input to the updated FasTracks financial plan in July 2007 (necessary to meet federal funding deadlines)**
- **Plan, design, secure funding and construct commuter rail corridors and maintenance facility on schedule**
- **Design and construct DUS on schedule which requires a decision ASAP (design build contract scheduled for 2008)**
- **Initiate procurement process (regardless of delivery method)**
- **Attract vendors and ensure competitive bids**
- **Ensure vehicles are delivered by opening dates**