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

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Location</th>
<th>Status</th>
<th>Capacity*</th>
<th>Number of cars in service in North America</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMU Single-Level (SL DMU)</td>
<td>None</td>
<td>In Production at Colorado Railcar, Target early 2008 Delivery of 3 DMUs to Portland</td>
<td>74 seats, Crush load: 235</td>
<td>0</td>
<td>Colorado Railcar, Potential: Rotem, Siemens, Bombardier, Nippon Sharyo</td>
</tr>
<tr>
<td>DMU Double-Deck (DD DMU)</td>
<td>Miami</td>
<td>One In Demonstration Service, Target Delivery of 4 DMUs to Miami</td>
<td>165 seats, Crush load: 206</td>
<td>1</td>
<td>Colorado Railcar</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>Corridor</th>
<th>EMU</th>
<th>DMU</th>
<th>DMU dd</th>
<th>Original FasTracks Budget*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>East Corridor</strong></td>
<td>$76 M</td>
<td>$106 M</td>
<td>$72 M</td>
<td>$96 M</td>
</tr>
<tr>
<td><strong>Gold Line</strong></td>
<td>$63 M</td>
<td>$73 M</td>
<td>$48 M</td>
<td>$69 M</td>
</tr>
<tr>
<td><strong>North Metro</strong></td>
<td>$57 M</td>
<td>$66 M</td>
<td>$57 M</td>
<td>$56 M</td>
</tr>
<tr>
<td><strong>Northwest Rail</strong></td>
<td>$38 M**</td>
<td>$44 M**</td>
<td>$57 M**</td>
<td>$40 M</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Vehicles</th>
<th>Electrification Costs</th>
<th>DUS: Cost to accommodate technology</th>
<th>Maintenance Facility****</th>
<th>Total</th>
<th>Original FasTracks Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMU</td>
<td>$76 M</td>
<td>$76 M</td>
<td>$0**</td>
<td>$20 M</td>
<td>$172 M</td>
<td>$172 M</td>
</tr>
<tr>
<td>DMU</td>
<td>$106 M</td>
<td>$0</td>
<td>$3 M</td>
<td>$0</td>
<td>$109 M</td>
<td>$109 M</td>
</tr>
<tr>
<td>DMU dd</td>
<td>$72 M</td>
<td>$0</td>
<td>$25 M***</td>
<td>$0</td>
<td>$97 M</td>
<td>$97 M</td>
</tr>
</tbody>
</table>

*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.
Stand Alone Analysis

Summary of Differential Costs* Compared to Original FasTracks Budget

Gold Line

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Vehicles</th>
<th>Electrification Costs**</th>
<th>DUS: Cost to accommodate technology</th>
<th>Maintenance Facility*****</th>
<th>Total</th>
<th>Original FasTracks Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMU</td>
<td>$63 M</td>
<td>$0</td>
<td>$0***</td>
<td>$20 M</td>
<td>$83 M</td>
<td>$83 M</td>
</tr>
<tr>
<td>DMU</td>
<td>$73 M</td>
<td>$0</td>
<td>$3 M</td>
<td>$0</td>
<td>$76 M</td>
<td>$76 M</td>
</tr>
<tr>
<td>DMU dd</td>
<td>$48 M</td>
<td>$0</td>
<td>$25 M****</td>
<td>$0</td>
<td>$73 M</td>
<td>$73 M</td>
</tr>
</tbody>
</table>

*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**

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Vehicles</th>
<th>Electrification Costs**</th>
<th>DUS: Cost to accommodate technology</th>
<th>Maintenance Facility****</th>
<th>Total</th>
<th>Original FasTracks Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMU</td>
<td>$57 M</td>
<td>$63 M</td>
<td>$0**</td>
<td>$20 M</td>
<td>$140 M</td>
<td></td>
</tr>
<tr>
<td>DMU</td>
<td>$66 M</td>
<td>$0</td>
<td>$3 M</td>
<td>$0</td>
<td>$69 M</td>
<td>$56 M</td>
</tr>
<tr>
<td>DMU dd</td>
<td>$57 M</td>
<td>$0</td>
<td>$25 M***</td>
<td>$0</td>
<td>$82 M</td>
<td></td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Vehicles</th>
<th>Electrification Costs**</th>
<th>DUS: Cost to accommodate technology</th>
<th>Maintenance Facility****</th>
<th>Total</th>
<th>Original FasTracks Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMU</td>
<td>$38 M</td>
<td>$118 M</td>
<td>$0**</td>
<td>$20 M</td>
<td>$176 M</td>
<td>$176 M</td>
</tr>
<tr>
<td>DMU</td>
<td>$44 M</td>
<td>$0</td>
<td>$3 M</td>
<td>$0</td>
<td>$47 M</td>
<td>$40 M</td>
</tr>
<tr>
<td>DMU dd</td>
<td>$57 M</td>
<td>$0</td>
<td>$25 M***</td>
<td>$0</td>
<td>$82 M</td>
<td>$82 M</td>
</tr>
</tbody>
</table>

* 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 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

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

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<th>DMU</th>
<th>DMU dd</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Corridor</td>
<td>$23 M</td>
<td>$32 M</td>
<td>$27 M</td>
</tr>
<tr>
<td>Gold Line</td>
<td>$16 M</td>
<td>$18 M</td>
<td>$19 M</td>
</tr>
<tr>
<td>North Metro</td>
<td>$17 M</td>
<td>$19 M</td>
<td>$17 M</td>
</tr>
<tr>
<td>Northwest Rail</td>
<td>$19 M</td>
<td>$21 M</td>
<td>$21 M</td>
</tr>
</tbody>
</table>

*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)
Stand Alone Analysis

Corridor Break Even Results
Least Expensive Technology by Year*

- **East**: DMU dd, EMU
- **Gold Line**: DMU dd, DMU, EMU
- **North Metro**: DMU, DMU dd
- **Northwest Rail**: DMU, DMU dd

*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
**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
**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