Assessment of Various APM Technologies
For Airsides 2 and 4 Replacement Project

September 30, 2016
Purpose

• Identify List of All Available Transit Technologies.
• Review the Advantages and Disadvantages for the Various Technologies.
• Identify the Most Appropriate Candidate Technology for Airsides 2 and 4 (A2-B4) Replacement.
OIA General Layout (Airsides and Guideways Designations)
Evaluation Criteria

The following criteria were used:

• Ability for Technology to Match Existing Structural Infrastructure
  • Minimizes Passenger Impacts
  • Reduces Impacts to Airport Operations
  • Manage Known Costs and Minimize Hidden Costs

• Evaluation of Vehicle Capacities Based on Existing Operational Demands.
Evaluated Technologies

Personal Rapid Transit (PRT)
- Requires Station Modifications
- Cannot Meet Line Capacity Demands

Monorails
- Requires specific guidance structure, not compatible with existing guideway and emergency egress requirements
- Requires major reconstruction

Automated Light Rail Transit System (ALRT)
- Typically longer systems
- Difficult to match existing infrastructure requirements.
- Requires major reconstruction
Evaluated Technologies

Cable-Propelled APMs
- Presently upgrading & operating MIA system
- High interest from Vendors for Procurement

Self-Propelled Rubber Tired APMs
- Current System
- Replacement Technology for Airsides 1&3 (A1-B3)
- High interest from Vendors for Procurement
Site Specific Assessment

Evaluation based on technical database of technology and application in recent projects; A1–B3 replacement, and similar projects in Miami International Airport. The following Technologies are considered and evaluated in detail:

**Self Propelled (SP) Technology:**
- Technology A: Innovia by Bombardier (modern version of existing CX-100)
- Technology B: Crystal Mover by MHI (being adopted for A1-B3)
- Other Similar Technologies: Siemens, IHI and Woojin

**Cable Propelled (CP) Technology:**
- Technology C: Mini Metro by Leitner Poma (being implemented at MIA)
- Doppelmayr is a similar cable propelled system
System Capacity

- A2-B4 Systems are **Must Ride** Systems
- Single Shuttle Capability (especially during construction).
- The B4 System has 40% reduced capacity during International Mode.
- Cable Propelled Capacity 72% of that of Self Propelled, based on MIA application.
- Dual Lane Shuttles adequate for all Technologies.
- Single Lane Shuttle: Self-Propelled adequate most times
- Cable-Propelled multiple occurrences where passengers are remaining on platform for extended time periods.
Passenger Demand A2
- Dual Lanes: Adequate All Technologies.
- Self Propelled: Single Lane, capacity issues 4 times/day.
- Cable Propelled: Single Lane, capacity issues numerous times/day.

Passenger Demand B4
- Dual Lanes: Adequate All Technologies, except in IM mode, Cable Propelled issues 6 times/day.
- Self Propelled: Single Lane, capacity issues during IM Mode.
- Cable Propelled: Single Lane, significant capacity issues during IM Mode (significant rolling effect of passengers left on platform.)
# System Capacity Summary

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Self Propelled</th>
<th>Cable Propelled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car Capacity</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Normal Operations /Dual Lane</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Adequacy of Single Lane</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>Vehicle Size</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
</tbody>
</table>
Vehicle Compatibility

Existing A1-B3 Vehicle Schematic

Existing A2-B4 Vehicle Schematic
Vehicle Compatibility

Technology A (SP)
- Innovia by Bombardier
- Contemporary Version of Existing System
- Car doors match 16' alignment of existing
- Car nose is slightly longer and will require modifications to meet all Platform Station Doors
- Centerline of wheels match exactly to the running pad
- Vehicle height is exact match
- Vehicle width is exact match
Vehicle Compatibility

Technology B (SP)

- Crystal Mover by MHI (center guidance)
- Adopted for Airside A1 and B3
- Car doors match 16’ alignment of existing
- Car nose is slightly longer and will require modifications to meet all Platform Station Doors
- Centerline of wheels are ± 2.5” from running pad
- Vehicle height is taller (though no issues with A1-B3)
- Vehicle width is slightly narrower
Vehicle Compatibility

Technology C (CP)
- Mini Metro by Leitner Poma
- Being implemented in MIA Concourse E
- Car doors match 16’ alignment of existing
- Coupled cars are shorter and will require coupling extension to meet all Platform Station Doors
- Centerline of wheels are ± 8” from running pad
- Vehicle height is slightly taller
- Vehicle width is slightly narrower
Guideway Interface Self Propelled

Guideway
• Exact or near match to guideway running pad
• No structural issues
• No enhancements required to running surface
• Tech A “Good” Rating
• Tech B “Neutral” Rating since not an exact match

Emergency Walkway
• Vehicle door height meets the existing emergency walkway height of 3’ – 7”
• No modifications required.
• Tech. A & B receive “Good” Ratings

INNOVIA APM 100
Proposed for A1/B3

MHI Proposed for A1/B3
Guideway Interface Cable Propelled

Leitner Poma MIA - Satellite E

Guideway
- ± 8” Variance to Guideway Running Pad, possible structural modifications required to compensate.
- Guideway modifications required to accommodate cable system.
- Tech C ranges from “Neutral” to “Less Compatible”.

Emergency Walkway
- Vehicle door height does NOT meet the existing emergency walkway height. Exact height differential depends on guideway modifications.
- Due to Passenger Demographics; technology is “Less Compatible”.

CENTER LINE OF WHEEL 8 (+/-) INCHES OFF FROM GUIDEWAY RUNNING PAD CENTER LINE
Guideway Interface Cable Propelled

Aesthetics

• Cable Propelled system requires 2 Deviation Bull Wheels along the Guideway

• Requires dedicated additional space for Gear Room for these wheels

• Tech. C has a significant impact.

Deviation Bull Wheels at MIA Concourse E
# Guideway Interface Summary

<table>
<thead>
<tr>
<th>Guideway Structure Needs / Compatibility</th>
<th>Self Propelled</th>
<th>Cable Propelled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheel Base</td>
<td>Good</td>
<td>Neutral</td>
</tr>
<tr>
<td>General Structural Compatibility</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Walkway Elevation</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>

- **Wheel Base**: Good (Tech. A), Neutral (Tech. B), Neutral (Other S.P. Tech.), Less Compatible (Tech. C)
- **General Structural Compatibility**: Good (Tech. A), Good (Tech. B), Good (Other S.P. Tech.), Neutral (Tech. C)
- **Aesthetics**: Good (Tech. A), Good (Tech. B), Good (Other S.P. Tech.), Intrusive (Tech. C)
- **Walkway Elevation**: Good (Tech. A), Good (Tech. B), Good (Other S.P. Tech.), Less Compatible (not acceptable) (Tech. C)
Station Layout and Interface

Technologies A & B (SP)
- Similar to existing system, fits into existing infrastructure
- No additional equipment required.
- Minor modifications required to car nose to match existing Station Doors

Technology C (CP)
- Similar to existing system, fits into existing infrastructure
- Additional equipment required at Station (Return and Tension Wheel)
- Impacts FIS under B4
- Minor modifications required to vehicle coupling to match existing Station Doors
Station Layout and Interface

Technology C (CP)
• Return Bull Wheel Impacts

Airside 4 Level 1 (under Station)
Station Layout and Interface

Airside 2 Level 1

Technology C (CP) Return Bull Wheel Airside 2
# Station Layout and Interface

<table>
<thead>
<tr>
<th></th>
<th>Self Propelled</th>
<th></th>
<th>Cable Propelled</th>
</tr>
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<tbody>
<tr>
<td><strong>Landside Station:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Configuration</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Additional Equipment Required</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Station Doors</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
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Impact of New Installation

- Additional equipment
- Additional space

Impact of Phased Commissioning

- Sequencing of Construction
- Additional O&M Personnel
- Overlap with Existing O&M Personnel
Maintenance Facility O&M Contract

Timeline:

• Design Life gap for B4 after A2 (possibly 6-7 years)

• 2 possible Contractors/Systems simultaneously operating in confined space
## Flexibility of Airport’s Future Growth and Expansion

**Ground Level Improvements:**
- Space Constraints
- Impact on Operations
- Limiting Growth

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<th>Maintenance Space</th>
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<th>Cable Propelled</th>
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<tr>
<td>Impact of New Installation</td>
<td>Minimal</td>
<td>Minimal</td>
</tr>
<tr>
<td>Impact of Phased Commissioning</td>
<td>Neutral</td>
<td>Significant</td>
</tr>
<tr>
<td>O&amp;M Contract &amp; System Replacement Timeline</td>
<td>Minimal</td>
<td>Neutral</td>
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<table>
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<tr>
<th>Flexibility for Growth of Airport Operations</th>
<th>Self Propelled</th>
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<tbody>
<tr>
<td>Ground Level Improvement</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Suitability for Expansion of B4 IM (capacity)</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
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| **Guideway Structure Needs / Compatibility** |         |         |           |         |
| Wheel Base       | Good    | Neutral | Neutral  | Less Compatible |
| Gen. Str. Compatibility | Good | Good | Good | Neutral |
| Aesthetics       | Good    | Good    | Good     | Intrusive |
| Walkway Elevation | Good | Good | Good | Less Compatible (not acceptable) |

| **Landside Station** |         |         |           |         |
| General Config.     | Good    | Good    | Good      | Good    |
| Added Equip.        | Good    | Good    | Good      | Good    |
| Station Doors       | Good    | Good    | Good      | Good    |
| **Airside Station** |         |         |           |         |
| General Config.     | Good    | Good    | Good      | Good    |
| Added Equip.        | Good    | Good    | Good      | Significant (not acceptable) |
| Station Doors       | Good    | Good    | Good      | Good    |

| **Maintenance Space** |         |         |           |         |
| Impact of New Installation | Good | Good | Good | Significant |
| Impact of Phased Commissioning | Neutral | Less Compatible | Less Compatible | Less Compatible |
| O&M Contract & System Repl. Timeline | Good | Neutral | Neutral | Neutral |

| **Flexibility for Growth of Airport Ops.** |         |         |           |         |
| Gr. Level Improvement | Good    | Good    | Good      | Significant |
| Suitability for Expansion of B4 IM (capacity) | Neutral | Neutral | Neutral | Reduced |

| **Total (rated)** | Acceptable | Acceptable | Acceptable | **Includes Two Not Acceptable** |

Discussion