PRIIA SECTION 305 NEXT GENERATION EQUIPMENT COMMITTEE REPORT

Equipment Ownership, Maintenance, and Management

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1 INTRODUCTION .................................................................................................................. 4
  1.1 Overview of PRIIA Section 305 and the Committee .................................................. 4
  1.2 NGEC’s Overarching Objectives ................................................................................. 4
  1.3 Objectives of the Study ............................................................................................... 5
  1.4 Overview of the Intercity Passenger Rail Equipment Market in the United States ......... 6

2 TOPIC AREA 1: EQUIPMENT MANAGEMENT ................................................................. 7
  2.1 Overview .................................................................................................................... 7
  2.2 Discussion, Options, and Evaluation ........................................................................... 8
     2.2.1 Fleet Planning ...................................................................................................... 8
     2.2.2 Management of Specifications and Procedures .................................................... 9
     2.2.3 Purchasing and Procurement ............................................................................ 11
     2.2.4 Comparison between Intercity Passenger Rail and Other Markets .................. 12
     2.2.5 Identification and Evaluation of Procurement Options ...................................... 13
  2.3 Conclusions and Recommendations .......................................................................... 14

3 TOPIC AREA 2: EQUIPMENT MAINTENANCE ............................................................... 14
  3.1 Overview .................................................................................................................... 14
  3.2 Discussion, Options, and Evaluation ........................................................................... 15
     3.2.1 Maintenance Provider Options .......................................................................... 15
     3.2.2 Maintenance Philosophy ................................................................................... 20
     3.2.3 Maintenance Planning and Scheduling .............................................................. 31
     3.2.4 Maintenance Facilities ....................................................................................... 33
  3.3 Conclusions and Recommendations .......................................................................... 41

4 TOPIC AREA 3: EQUIPMENT DEPLOYMENT ................................................................. 42
  4.1 Overview .................................................................................................................... 42
  4.2 Discussion, Options, and Evaluation ........................................................................... 42
     4.2.1 Scenarios for Equipment Deployment ............................................................... 42
     4.2.2 Interoperability and Equipment Pooling ............................................................. 43
     4.2.3 Standards for Interoperability .......................................................................... 45
  4.3 Conclusions and Recommendations .......................................................................... 45

5 TOPIC AREA 4: EQUIPMENT ASSIGNMENT ................................................................. 46
  5.1 Overview .................................................................................................................... 46
  5.2 Discussion, Options, and Evaluation ........................................................................... 46
     5.2.1 Governance ......................................................................................................... 47
5.3 Conclusions and Recommendations ................................................................. 47

6 TOPIC AREA 5: FINANCIAL RELATED – FUNDING, PRICING, AND COST SHARING
.............................................................................................................................. 48
6.1 Overview ........................................................................................................... 48
6.2 Discussion, Options, and Evaluation ................................................................. 48
   6.2.1 Funding and Financing Considerations ...................................................... 48
   6.2.2 Pricing and Cost Allocation Structures ..................................................... 51
   6.2.3 Risk Allocation and Liability Insurance .................................................. 52
   6.2.4 Relationship to PRIIA Section 209 ............................................................ 53
6.3 Conclusions and Recommendations ................................................................. 54

7 TOPIC AREA 6: EQUIPMENT OWNERSHIP MODELS AND STRUCTURES ........ 54
7.1 Overview .......................................................................................................... 54
7.2 Discussion, Options, and Evaluation ................................................................. 55
   7.2.1 Equipment Ownership Options ............................................................... 55
   7.2.2 Leasing ..................................................................................................... 56
7.3 Conclusions and Recommendations ................................................................. 56

8 ILLUSTRATIVE SCENARIOS FOR CONSIDERATION ...................................... 56
8.1 Potential Scenario 1: “The Incrementalist” ....................................................... 57
   8.1.1 Scenario Description ................................................................................ 57
   8.1.2 Implementation Phasing Opportunities ................................................... 57
8.2 Potential Scenario 2: “The Regional Concessionaires” ..................................... 57
   8.2.1 Scenario Description ................................................................................ 57
   8.2.2 Implementation Phasing Opportunities ................................................... 58
8.3 Potential Scenario 3: “The Public Regionalist” ............................................... 58
   8.3.1 Scenario Description ................................................................................ 58
   8.3.2 Implementation Phasing Opportunities ................................................... 59
8.4 Potential Scenario 4: New National Non-profit .............................................. 59
   8.4.1 Scenario Description ................................................................................ 59
   8.4.2 Implementation Phasing Opportunities ................................................... 59
8.5 Comparison of Scenarios .................................................................................. 59

APPENDIX A: AMTRAK EQUIPMENT ACQUISITION PLAN .................................. 62
APPENDIX B: EQUIPMENT MANAGEMENT PRACTICES IN OTHER INDUSTRIES ... 64
   B.1 US Freight Rail .............................................................................................. 64
**B.2** Aviation .................................................................64
**B.3** Shipping .................................................................65
**B.4** The U.S. Passenger Rail Market Compared to Other Industries........66

**APPENDIX C: EQUIPMENT OWNERSHIP AND MANAGEMENT PRACTICES IN OTHER COUNTRIES** .................................................................68
**C.1** United Kingdom..........................................................68
**C.2** Spain ..............................................................................69
**C.3** Germany .........................................................................69
**C.4** Japan ...............................................................................70

**APPENDIX D: COMMUTER RAIL OPERATIONS IN THE U.S.** .................................................................71
1 INTRODUCTION

1.1 Overview of PRIIA Section 305 and the Committee

The Passenger Rail Investment and Improvement Act of 2008 (PRIIA), Section 305, requires Amtrak to “…establish a Next Generation Corridor Equipment Pool Committee (NGEC), comprised of representatives of Amtrak, the Federal Railroad Administration (FRA), host freight railroad companies, passenger railroad equipment manufacturers, interested States, and, as appropriate, other passenger railroad operators. The purpose of the Committee shall be to design, develop specifications for, and procure standardized next-generation corridor equipment.” At least 13 State Departments of Transportation are involved in the activities of the NGEC, 11 of which are Executive Board Members. FRA, Amtrak, and over 200 members of the manufacturing and supply industry are also participating in the NGEC efforts.

Amtrak established the NGEC, which has completed the development of technical specifications for single- and bi-level passenger rail cars, diesel-electric locomotives, and single level trainsets that will be used for future equipment procurements for state corridor services. The Committee has also developed a technical specification for Diesel Multiple Units (DMUs). However, the work of the committee is long-term and on-going, and will include the development of at least one more equipment specification for the Dual-Mode Locomotive as well as continuing to update and maintain the specifications through a well-defined and efficient document management control system that has been put in place by the NGEC Technical subcommittee.

1.2 NGEC’s Overarching Objectives

The NGEC and FRA identified several key priorities related to the ownership, maintenance, and management of rail equipment:

- Efficient and cost-effective utilization of equipment, both in-state and multi-state corridors
- Deployment of equipment that allows for adjustments due to demand changes including seasonal adjustments
- Standardization of intercity rail passenger equipment, its management, maintenance, and related documentation
- Minimization of commercial life-cycle costs (LCC) over the equipment’s expected lifetime
- Adequate Funding for operations, maintenance, and overhauls (including facilities and tooling) over the equipment’s lifecycle
- Equitable allocation of costs
- Adequate ownership models and structure
Another key goal of the NGEC is to further establish the intercity passenger rail equipment manufacturing and supply industry in the US. The on-going Midwest and California procurement of bi-level cars demonstrates the feasibility of cost effective production, while meeting stringent Buy America provisions that are required when utilizing federal funds.

1.3 Objectives of the Study

The NGEC is leading coordination efforts among the states that have been awarded High Speed Intercity Passenger Rail (HSIPR) grants for the procurement of new intercity passenger rail equipment to support growing intercity rail efforts in the Midwest and California. Through a cooperative grant agreement, California, Washington, and the Midwest states (Illinois, Michigan, Missouri, and Iowa) are jointly procuring new rail cars and locomotives. Through two separate procurements, the Midwest states and California are seeking bi-level rail cars, and the Midwest states, California, and Washington are seeking diesel-electric locomotives.

One of the requirements of the cooperative grant agreement is to define and implement a coordinated approach to the ownership, maintenance, and management of the new rail cars and locomotives. This study examines best practices in the ownership, maintenance, and management of intercity passenger rail equipment. Based on these best practices, recommendations are offered that can be applied to the Midwest procurement as well as other possible future procurements in other regions.

Specifically, the purpose of this study is as follows:

**Task 1.** Identify good and best practices in six topic areas, including

- a. Equipment Management;
- b. Equipment Maintenance;
- c. Equipment Deployment;
- d. Equipment Assignment;
- e. Financial Related- Funding, Pricing, and Cost Sharing; and

Assess these practices and make recommendations for implementation by equipment owners.

**Task 2.** Apply the best practice recommendations to the specific Midwest situation.

**Task 3.** Develop a handbook that can be applied elsewhere for similar joint procurements.

This report documents the results of Task 1, the identification, assessment, and recommendation of good and best practices for managing passenger rail rolling stock for state corridor services.

The remainder of this report focuses on the following areas:

- An overview of the passenger rail equipment market in the United States, to provide a perspective on the nature and magnitude of future potential procurements;
- Identification of a range of options for addressing a series of key equipment-related issues, including pros and cons; and
A description of several scenarios that present combinations of the options for addressing the key issues, to provide a range of examples on the roles, responsibilities, and approaches for the ownership, maintenance, and management of rail equipment.

For each of the six topic areas, it should be noted that there may be many significant legal, contractual and tax implications associated with decisions regarding pooling of equipment, joint procurements, and operation of state owned assets in other states. While this document does not attempt to address these issues, they may play an important role in final decision making and should be an important part of any future discussions and analyses.

1.4 Overview of the Intercity Passenger Rail Equipment Market in the United States

The intercity passenger rail equipment market in the United States has largely been tied to the existence and purchasing trends of Amtrak. In addition to Amtrak, California, New York, North Carolina, Oregon, Washington and Wisconsin have also purchased intercity passenger rail equipment, with California purchasing the most. Amtrak has not purchased new equipment since 2002, but currently has an active procurement for 70 new electric locomotives and 130 new single level cars. In addition, Amtrak has developed a plan to replace its aging fleet and also allow for moderate ridership growth (2% per year). The average age of Amtrak's fleet as of 2012 was 28 years. In addition to the active single level long distance and electric locomotive procurements mentioned above, Amtrak's fleet plan anticipates the purchase of new high speed trainsets to replace the Acela fleet, 695 single level cars, 508 bi-level cars, 280 diesel locomotives and 42 switchers by 2022. It is important to note that the majority of these purchases remain unfunded. However, Amtrak has identified a number of potential funding sources.

Amtrak's planned equipment procurement is significant and would represent approximately 100 single level cars per year between 2016 and 2022, and 100 bi-level cars per year between 2018 and 2022.

Even with the recent and planned purchases by Amtrak and state-supported service partners in the Midwest and California, the overall scale of equipment purchases remains small by international standards. As such, it is difficult for equipment manufacturers to reliably predict new orders and dedicate sufficient resources to establish an on-going assembly line that is needed to reduce overall unit costs. States and Amtrak must continue to work together through the PRIIA Section 305 process to pool equipment purchases in such a manner as to reduce unit costs as much as possible.
2 TOPIC AREA 1: EQUIPMENT MANAGEMENT

2.1 Overview

Equipment management is comprised of a number of functions, all of which must be addressed to successfully sustain and develop a successful intercity passenger rail operation. These functions include the development and management of equipment specifications, fleet planning, equipment procurement, ownership, operating and capital maintenance, equipment assignment and deployment, and funding and finance. The Task 1 report addresses each of these functions.

Perhaps the most critical planning process is establishing a clear definition of the service requirements for the corridor(s) to be served and the identification of equipment needs to support the current and planned level of service. When considering equipment design and engineering, national goals for standardization must be accommodated. Standardization provides the potential optimization and cost savings sought by the NGEC. Standardization is also a prerequisite for effective equipment pooling, shared equipment procurements, and interoperability (to enable flexibility so that equipment use is not constrained to a single or limited number of corridors). Without standardization and sharing of maintenance facilities and inventory, it is difficult to realize cost savings from economies of scale. As described in the Introduction, the NGEC has made great progress in the area of standardization and in fact has developed equipment specifications for many equipment types.

The illustration provided below was created by the NGEC, and provides an excellent overview of equipment management function and related tasks.

---

**Generic Equipment Lifecycle**

- **Market Research and National Fleet Planning**
  - Planning
  - Forecasting
  - Market Analysis
  - Requirements Analysis
  - Deployment

- **Vehicle Engineering**
  - Specifications
  - Processes and Standards
  - Configuration Management
  - Systems and Tools
  - R&D
  - Maintenance Strategies and Standards
  - Maintenance Procedures

- **Acquisition**
  - Procurement regulations and procedures
  - Buying
  - Testing
  - Delivery
  - Disposition

- **Asset Management and Maintenance**
  - Inventory (asset register)
  - Maintenance execution
  - Life Cycle Cost model
  - Rehabs/overhauls/modifications
  - Operations
  - Disposal at end of life

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2.2 Discussion, Options, and Evaluation

2.2.1 Fleet Planning

A robust planning process forms the centerpiece of equipment management. The first step in this process is the development of a corridor or regional service plan. This effort may be a part of a State Rail Plan or corridor Service Development Plan. If a regional approach is taken, the region must develop an integrated Service Development Plan that defines services to be offered, ridership projections, frequencies, and other elements from which a regional fleet plan can be developed.

The service plan will establish the vision for the service that is to be provided. It is a long range planning document but contains more concrete elements in the short to medium term. The service plan define the corridor(s) be served, how they will be served, required funding, and projected ridership. Rail ridership can be very concentrated at certain times of day so average ridership is not a useful planning tool. Instead, it is important to know how demand is spread across weeks and seasons in order to allocate sufficient resources to avoid deterring ridership through lack of capacity.

With the service vision established, a fleet plan is then required. The fleet plan contains several elements, such as the following:

- Equipment requirements;
- Equipment management/sustainment; and
- Maintenance facilities.

The fleet plan should build upon the goals from the service vision and translate those goals into equipment requirements. The fleet plan should not have to determine the service needs, but rather should reflect the needs that have been identified previously. This element will result in a projection of new equipment, overhauls, modifications and facility upgrades and the funding requirements for these will contribute to the larger investment plans that occur in the service vision. As an example, Amtrak’s most recent equipment acquisition plan, which is a component of its fleet plan) is included as Appendix A. Additional information regarding the structure and contents of a fleet management plan will be developed as part of Task 2 of this study.

Given the long timescales associated with the life of intercity passenger rail equipment, along with the development and acquisition process, the fleet plan must have a long time horizon - at least 20 years and potentially further. The further into the future, the less precise the assumptions about service will be. However, developing the long term outlook allows conceptual budgeting to occur. As time passes, the requirements at a given point will become more clearly focused and the fleet plan will be updated, providing a comprehensive view on investment needs in the short to medium term.

A key part of long-term equipment planning is establishing policies for the life of equipment. The exact nature of these equipment life policies will be determined based on the type of equipment, the usage it experiences, the cost of sustaining it, the rate of change of the industry standard for that type of equipment and the customer expectations of it. Having those policies in place means that planning for equipment needs is not just a function of service development but also the need to recapitalize the existing fleet periodically. Since rail equipment has a long life, it can be wrongly assumed to be usable indefinitely. Such an assumption effectively would be transferring a capital investment burden to an operating budget burden as the cost of
sustaining aging equipment rises and ridership potentially suffers due to the image of the equipment being outdated in the eyes of the customer.

While planning for long-term equipment needs is certainly an important part of the fleet plan, the sustainment of the existing equipment is equally vital. Therefore, a section of the fleet plan should be devoted to establishing current equipment condition and needs, required investment related to that equipment, and its remaining service life.

Planning aspects must include overhaul cycles, refurbishment of the cars to enhance the customer experience, systems additions or replacement (either to enhance the customer experience or to provide commonality with other equipment types), and modification programs related to performance improvements, reliability growth and obsolescence issues. A thoughtful capital plan is required to program these expenses and associated capital needs in future years.

Fleet investment priorities must also be established. Modification programs should have a clearly defined financial benefit that justifies the necessary investment. Having all modifications and other investments analyzed in the same manner allows for comparisons of value across different equipment types and, therefore, a prioritization of the modifications based on the returns they provide. It should be noted that some modifications will be required for safety or rule change based reasons, and these will be considered mandatory and prioritized over optional modifications.

The creation and sustainment of suitable maintenance facilities is also a critical element of the planning process. Without adequate maintenance facilities, the ability of the equipment to deliver service will degrade. This issue can be a particular problem as service patterns and fleet sizes grow. A maintenance facility that is initially suitable may not necessarily have capacity to cope with growth and so must receive investment in parallel with equipment acquisition. Also, as services develop, the suitability of a location may come into question. While facility placement decisions may be made appropriately for the initial operations, future lengthening of routes or the addition of new routes may result in a facility that at some point in the future is no longer in the best place to serve the network as a whole. It is crucial, therefore, to include the maintenance facilities in the fleet planning process.

### 2.2.2 Management of Specifications and Procedures

A series of specifications have already been completed for the core equipment types that have been identified as a requirement for the states and Amtrak. These specifications were created in a partnership between Amtrak staff, FRA staff, state staff and representatives of the manufacturer and consultant industries. Since all specifications require an owner, and the NGEC currently does not exist as a legal entity, Amtrak has taken the responsibility of owning the specifications until an alternative is established.

The creation of that entity and who has a stake in it are important to consider. Ownership of the specifications and the update of those specifications are important since a legal entity is required. What that entity is, who takes what role in it, and who provides the necessary staff to fulfill its obligations must be assessed. From this determination comes the process by which the specifications are updated. With acquisition programs occurring with use of the specifications, there is a high likelihood that changes to the specifications may be required or requested by the states undertaking the procurement. Ensuring the entity is positioned to respond to those requirements in a timely fashion is important.

There are several options for management of the equipment specifications in the future:
1. Continue with Amtrak managing as is the current situation;
2. Choose an alternative entity already in existence to manage the specifications in future; and
3. Create a new entity to own and manage specifications.

The first option is the simplest to implement. Amtrak currently owns the specifications on behalf of the NGEC. Going forward, a documented agreement between Amtrak and the NGEC could be used as the basis for Amtrak continuing to own the specifications. This agreement might state the reasons for Amtrak having ownership, define the stakes of the various parties to the specifications, and establish the process for updating the specifications and the rights to reallocate ownership to an alternative party should the NGEC decide to do so at a later date.

Alternatively, a new specification management entity could be selected, such as the NGEC if it became a legal entity, or an entity such as AASHTO. If this were the case, the requirements described previously for defining the relationship with Amtrak could be replicated with the new entity. Additionally, a funding mechanism might be necessary for that entity to undertake the work, which could replace some of the current funding provided by the NGEC to Amtrak for its services. Finally, it would be prudent to clearly define the technical responsibilities of the new entity in specification management, ensure that the entity is suitably staffed, and create an audit process to ensure that the transition is smoothly undertaken and all requirements were achieved.

Creating a new entity would add complexity combining the above elements with some further needs. The formation of such an entity may require ownership to be established, a legal status in a state or states to be created, and staff to be provided. The level of staff required must be determined but should include the core officers of the company at a minimum. Their roles and responsibilities as well as the method for funding them should be defined. In addition, the obligation of ownership of the specifications would have to be discharged using technical capabilities either in house or contracted. Either approach likely would require funding to sustain. All of these requirements could be quite expensive and, given the relatively low throughput in specifications and changes, might be an unnecessary burden financially for the benefit it would offer relative to the status quo, unless a new entity were created for other reasons.

In addition to the considerations regarding the management of specifications, another focus area is advancing the specifications themselves. One possible area for development would be an approach to the commonality of maintenance procedures and processes. With common equipment across multiple operations, having a common approach to the maintenance would seem preferable. However, the differences in operations in different locations and the environments in which they operate can result in differing approaches to maintenance practice. Moreover, if the suppliers of maintenance are commercial providers, they may consider some of their processes to be commercially sensitive.

Instead, it would be appropriate to establish working groups for the various types of equipment. In the same way that transit agencies that use the Bombardier bi-level equipment have a working group where they discuss the maintenance and operation of their equipment, working groups could meet periodically to discuss and share experiences and best practices. This process would allow the knowledge to be shared without forcing operators to adopt approaches that they do not consider appropriate to their situation, and would allow maintenance providers to share only what they are comfortable with.
This concept could be similarly adopted by the states’ rail departments. They could meet periodically to discuss how effective the equipment is in operation, what modifications and enhancements they are making or considering, what changes might be adopted that could be fed back into the specification management process, and any other knowledge that would be beneficial to other states with less experience or that are just becoming involved in operations. Joining such a working group would be advantageous to a state just starting service in order that they may learn from the experiences of the states that are further developed with their operations.

2.2.3 Purchasing and Procurement

The procurement of intercity rail passenger rolling stock follows a traditional project management process, consisting of the following activities:

- Initiating
- Planning
- Executing
- Monitoring and Controlling
- Closing

The specific application of these processes is determined by the project manager, project team, and other requirements, such as those imposed by federal and state agencies. In the recent past, for example, Amtrak would initiate and plan rolling stock procurement, develop detailed specifications in-house, and then invite bids from various manufacturers. Amtrak would closely monitor the production process and ultimately accept the equipment and close out the project.

However, the procurement process now has many more nuances that involve third parties and contractors in a variety of roles. The key issue becomes the identification of the project initiator for the procurement. As mentioned above, Amtrak was the initiator for many procurements; however as mentioned elsewhere in this report, several states have also initiated rolling stock procurements, and the ongoing PRIIA bi-level procurement is an indication that multiple states can work effectively to initiate a joint procurement.

With regard to joint procurements, the benefit of combined acquisitions across multiple states or other entities is that there is greater scale to make the programs attractive to prospective bidders. The demand for intercity passenger equipment has not been large when compared to other elements of the U.S. passenger rail market and certainly not when compared to the U.S. freight market or the international passenger market. The volumes in recent years in the U.S. have been focused on commuter rail, light rail and heavy rail sectors with relatively few intercity acquisition programs. Three recent acquisition programs have demonstrated how scale can improve pricing. The bi-level acquisition program for Caltrans and the Midwest states received competitive bids and pricing better than expectations. The long distance single-level program for Amtrak had very aggressive pricing. The new electric locomotives for Amtrak received competitive pricing from two bidders once the number of locomotives was increased from 20 to 70. Economies of scale with regard to vehicle purchases could be achieved through a variety of means, including the use of a facilitator (e.g. AASHTO or Amtrak) or other entity that could pool resources and assist with the procurement process.

The individual equipment needs of the states in the short term are not going to be sufficiently large to provide a competitive environment. However, aggregating them will improve this situation and allow for a more aggressive bidding process. With the current car acquisition
program awarded to Sumitomo, they may have an advantage when it comes to bidding for additional equipment. This effect boosts the goals of standardization but it may have a negative impact on pricing. Having a competitive environment will be dependent in part on the need to acquire a sufficient number of cars to make other bidders consider it worthwhile to bid and have sufficient pricing flexibility to potentially overcome the learning curve advantage that Sumitomo has gained.

2.2.4 Comparison between Intercity Passenger Rail and Other Markets

Appendices B & C provide some descriptions of how other markets approach equipment ownership and how other countries deal with the equipment for intercity passenger rail services. These appendices explain the benefits that come from each of the approaches and how they relate to the operator. It is important to first understand how these other markets relate to intercity passenger rail service in the United States.

With states providing the services within their borders, the controlling interest is not a commercial entity. Consequently, there is no profit motive nor issues with what assets are held on a balance sheet in the way that a commercial operator would have to consider. This advantage also applies to debt issues. States can raise funds as permissible and available but their form of debt is considerably cheaper than commercial debt for a private operator. Moreover, if federal grant funds are available, these monies provide a source of capital with no long term cost obligation. In this manner, a state does not consider capital investment in the same way a commercial operator would, whether the market is rail, aviation or shipping.

Thus, the concept of offloading capital sourcing to a third party may not be beneficial. Indeed, such a benefit would only exist if the traditional sources of capital were constrained and no funds were available in the timescales required to meet project goals. Then, the use of commercial funding might be attractive.

Risk transfer is highlighted as a benefit in a couple of situations in the appendices. First, if there is the steady evolution of a technological standard, the ability to return equipment for technologic advancement is appealing. Such an approach does require a secondary market for the equipment in order for a lessor to willingly take on ownership risk. Given the desire for commonality in equipment across the nation, this would seem to be counterproductive. Of course, a cascading of equipment is feasible. Whether having a commercial body take on that risk rather than having it managed nationally is worthy of further debate. Having the residual value risk would involve a pricing premium for taking that risk which might reduce the overall value to the states of offloading the risk.

Second is the benefit of having long term assets in the hands of those who can make use of them for the full life if the operator cannot guarantee to do so. In the European passenger rail sector, this approach has become common in some areas where operations are franchised out for fixed periods of time. In those cases, having ownership of an asset that might have considerable life left at the end of the franchise period with no guarantee of continued utilization makes an operating leasing model attractive. The lessor takes the ownership risk and can remarket the asset to other franchisees if it is returned.

At the moment, the US market does not operate in this fashion. The states generally control their services and are assumed to continue to do so indefinitely. Therefore, they do not have the same risk of ownership as a franchise operator. Owning equipment is something that is more acceptable and may even be a legal requirement if state funds have been invested.
Changes to service patterns and operational requirements over time might make having fleet flexibility more attractive. Allowing another entity to take the ownership risk or willingly selling equipment to other states in due course can be considered.

When trying to draw conclusions about what constitutes best practice in this area, there are not exact parallels with other operations to determine benchmarks. Nationalized passenger rail operators may make use of a variety of alternatives for some of their equipment but, predominantly, they continue to own their own fleets, particularly when looking at the equipment that is core to their business.

2.2.5 Identification and Evaluation of Procurement Options

The extent of the options available for procurement of new rail equipment and associated services, such as maintenance, will broadly equate to the identified governance, ownership and funding structure.

Some equipment procurement options include the following:

<table>
<thead>
<tr>
<th>Option</th>
<th>Agency</th>
<th>Resource Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amtrak</td>
<td>Amtrak, under contract to the NGEC, manages the procurement process</td>
<td>Limited DOT /Agency staff requirements. Amtrak brings equipment design and engineering experience, one stop shopping and ability to pool orders.</td>
</tr>
<tr>
<td>New, national entity</td>
<td>A new, not for profit, national entity, manages the procurement process</td>
<td>New entity would bring the ability to pool orders. Staff expertise must be developed.</td>
</tr>
<tr>
<td>New, regional entity</td>
<td>New, regional, not for profit entities, manage the procurement process</td>
<td>New entity would bring the ability to pool orders. Staff expertise must be developed.</td>
</tr>
<tr>
<td>States with Facilitator</td>
<td>States procure, AASHTO or NGEC or other entity assists with management of the purchasing process including maintenance of equipment specifications and standards</td>
<td>Requires significant state staff resources. Facilitator would pool orders and provide approved specifications.</td>
</tr>
<tr>
<td>Concessionaire</td>
<td>A concessionaire plans, procures or leases equipment in the instances where states adopt a concession approach for a corridor(s)</td>
<td>Concessionaire handles most if not all aspects of the procurement and accepts schedule and cost risks.</td>
</tr>
</tbody>
</table>

Aside from the procurement of the new rail equipment, consideration also should be given to the 'bundling' of other services into the procurement package:

- Maintenance services to be provided by the manufacturer across all or part of the life cycle of the rail equipment – further explained in section 3.2; and
- Consideration for the supply of the maintenance overhaul and repair facilities.

The decision-making basis for a preferred procurement option will be based on a number of criteria including the following:
• Selection of organization/entity that is best placed to conduct a certain function;
• Risk transfer, for example from a State ‘owner’ to a private maintainer;
• Pre-existing facilities that may be available for maintenance;
• Availability of and type of funding;
• Constraints of the involved states with regard to use of funds, split between capital and operating cost allocations and ownership requirements; and
• The entity’s ability and willingness to embrace change and risk with new processes.

2.3 Conclusions and Recommendations
A strategic rail plan, which may take the form of a State Rail Plan or corridor Service Development Plan, is necessary for a state or a regional entity that is planning intercity passenger rail service. This plan must establish the service plans for the coming decades, including anticipated frequencies, service profile, and demand. The plan should include data on peak demand as well as average ridership and revenue in order to facilitate planning of the investments necessary to deliver the service.

A fleet plan, based on the service plan, must also be created. This plan will assist in determining equipment requirements, and the plan should include three main elements:

• Equipment needs and acquisition requirements;
• Current equipment plans and investment needs to sustain equipment in service; and
• Maintenance facility requirements to support the fleet in service.

With regard to managing specifications and acquisition and ownership of equipment, there are a number of options that can be considered. It is important to consider these options in light of the strategic vision for service. The solutions for management and ownership of equipment are driven by the volume of equipment involved, the frequencies of new equipment orders, and the number of participants in the program.

3 TOPIC AREA 2: EQUIPMENT MAINTENANCE

3.1 Overview
The development of a core maintenance plan is a key decision facing any entity initiating a service, introducing new equipment and/or a maintenance program, or implementing significant service expansion. Assuming a clean slate – no facilities, maintenance workforce or vehicles that already exist – the following criteria are primary considerations driving the development of a fleet maintenance paradigm:
Similar considerations also apply to existing agencies that are reevaluating their maintenance strategies, but the options will be more limited due to the need to incorporate existing facilities, equipment, and/or workforce.

Each of these issues are interrelated and therefore must be considered in recognition of the effects that one element has on the others.

3.2 Discussion, Options, and Evaluation

Various strategies for passenger rail fleet management are employed throughout the world. Naturally, the selected approach must meet the needs, expectations and constraints of the entity responsible for maintenance and its operating environment. The selection of the appropriate maintenance philosophy must be based on a thorough consideration of the key decisions discussed in the following sections:

- Section 3.2.1: Maintenance Provider Options
- Section 3.2.2: Maintenance Philosophy
- Section 3.2.3: Maintenance Planning and Scheduling
- Section 3.2.4: Maintenance Facilities

3.2.1 Maintenance Provider Options

A key element in developing an overall maintenance strategy is the designation of the entity that will perform maintenance. Maintenance providers may include: in-house management and labor, bid procurement (short-term or long-term contracted) or single (sole) source to Amtrak. The provider decision affects the level of control the entity will have regarding maintenance decisions, costs, and workforce issues. Financial constraints are also a significant decision factor. Further, not all maintenance functions have to be performed by the same provider. An entity may choose to outsource turnaround servicing and periodic maintenance to Amtrak, while outsourcing heavy overhauls and rebuilds to another provider. In the case of North Carolina, the opposite is true. As described below, North Carolina outsources daily and periodic maintenance of the Piedmont service equipment to a private contractor and has outsourced heavy overhaul and rebuild work to Delaware Car Company and Amtrak.
Recognizing that the maintenance and management of a shared equipment fleet that is used in intercity service presents unique challenges, examples of several options currently in use are offered. Both North Carolina and Washington State currently use contract service providers to maintain rolling stock. In the case of North Carolina, Rail Plan maintains the state owned Piedmont equipment at the Capital Yard maintenance facility in Raleigh, NC. As described above, heavy maintenance and rebuilds are outsourced to off-site providers.

Washington State contracts maintenance of the Cascades equipment to Talgo, which provides management of Amtrak employees that perform maintenance services at Amtrak facilities in Seattle. In addition, Amtrak frequently outsources turnaround servicing at outlying locations.

The domestic commuter rail industry also provides useful examples regarding the choice of maintenance provider. Five out of six of the nation’s largest commuter rail operations perform maintenance of rolling stock in-house, although 17 of 21 operations identified also outsource at least some elements of the service, including services for rolling stock maintenance. It is important to consider that in-house maintenance of commuter equipment in most cases will require fewer facilities given the limited geographic area when compared to intercity services.

Additionally, it is important to consider who will operate the service, as coordinating two separate entities for operations and maintenance requires additional management oversight. One consideration is that splitting the operation between two separate entities for Operations and Maintenance services may increase costs as overhead expenses will likely increase.

3.2.1.1 Amtrak-Provided Maintenance

Amtrak was created in 1970 by the Federal Government to provide intercity passenger rail service and thus relieve private freight railroads of the obligation to continue operating these unprofitable services. The vast majority of states have used and still do use Amtrak to maintain equipment operated in state-supported service. All states currently utilize Amtrak to operate state-supported intercity service. For many states and agencies, using Amtrak has provided “one-stop shopping” and therefore been a simple way to provide service. Amtrak offers several key advantages as a service provider, including the aforementioned “one-stop shopping”, liability protection, and the right to access freight-owned rail lines at incremental cost. In addition to providing maintenance services, Amtrak can also provide equipment and access to existing maintenance facilities. Amtrak has also has extensive equipment design and engineering expertise and the ability to respond quickly in the event of an equipment shortage due to unforeseen events.
3.2.1.2 Short-Term Maintenance Contract

An entity may also choose to outsource its rolling stock maintenance functions. Contracting reduces reliance on in-house expertise, but does not entirely eliminate this need. Establishing an operation with a contracted maintenance provider, while less involved than creating an in-house maintenance staff, still requires a core group of experienced personnel to oversee maintenance activities and ensure quality and contract performance.

A contracted maintenance service necessitates an agreement that effectively communicates the expectations of the entity and holds the contractor to a high standard of performance. To reach an effective agreement, the entity must possess rail expertise within its staff to identify contract requirements, procurement selection criteria, and on-going contract oversight to ensure performance.

The process of developing a Request for Proposal, receiving and reviewing bidder proposals, and awarding the contract is time consuming and resource-intensive. This amount of effort must be considered when establishing the contract term. Short term contracts, typically 5 or 7 years or less, may be attractive from a flexibility standpoint but will require additional effort as opposed to the issuance of a long term contract. Once the contract is awarded, the selected contractor will need a period of time to mobilize and train its staff. Just as with in-house maintenance, there will be a learning curve for the contracting entity, but with contracted operations, a smaller learning curve and transition period will occur every time a new contract is awarded if a new maintainer is selected. With a short term contract, mobilization costs, which are passed on to the managing entity at some level, are spread over fewer years than with long term contracts.

3.2.1.3 Long-Term Maintenance Contract or Concession

A long term maintenance contract is generally defined as one having a term of more than 15 years, excluding options that are at the sole discretion of the owner agency. The long term contracting option may go beyond rolling stock maintenance and could include opportunities within other disciplines – operations, transportation, engineering, maintenance, information technology, and customer service. These opportunities can all influence the way in which a potential contractor approaches an operating contract with a longer term.

There are two main approaches to “Long Term Contracting”:

1. **Conventional Long Term** – This type of rolling stock maintenance contract typically has a 15-20 year term. A benefit of a conventional long term contract is the opportunity for the contractor to become fully vested in the service and benefit from any capital investments in the system’s assets, training, business systems and employee programs. With a long term contract, the contractor must develop a long range plan for maintenance, training and quality control. The focus will shift from a short term approach where the focus typically would be on a four year maintenance cycle with the likelihood that only one or two cycles would be included in the contract. Therefore the quality of materials, procedures, and training must be developed to ensure that when the 10-12 year heavy maintenance cycle occurs, it can be completed in an efficient and cost effective manner. Including rolling stock mid-life overhauls, rehabilitation programs and
facility improvements and upgrades in the contract can also lead to additional interest by potential contractors. The long term maintenance provider may contract certain overhaul and heavy maintenance functions, or the sponsoring DOT or agency may contract this work separately.

If FTA funding is to be used for intercity passenger rail services, there is a five year limitation on rolling stock and rolling stock replacement parts ref. 49 U.S.C. § 5325(e)(1). Therefore, if future rolling stock acquisitions are planned under a long term operating contract, FTA funding may not be available if the operating contract’s term is greater than five years. Although it is not likely that FTA funds would be received for intercity rail, an example of such a case is the Keystone Service between New York City and Harrisburg, PA. In 2006, a service improvement project that electrified and improved signals on the Pennsylvania portion of the route was completed, partially paid for with FTA funds.

It should be noted that while some states use FTA funding for their services, there are specific limitations concerning the use of these funds to support intercity services. In some cases, Congestion Mitigation Air Quality (CMAQ) funding that is jointly administered by the FTA and the FHWA can be used to fund operating expenses for new or expanded intercity passenger rail service, but time limitations and other restrictions apply.

2. **Public-Private Partnership (PPP)** – This type of agreement between a public entity and a private company or companies allows the private company to perform some of the functions of a public agency. Such contracts are long term and usually have terms of 20-30 years. Public-Private Partnerships may include a variety of arrangements, including Design-Build-Operate-Maintain (DBOM), Design-Build-Finance-Operate (DBFO), Build-Operate-Transfer (BOT) and Build-Own-Operate (BOO). Given the complexity of the PPP arrangement, it is unlikely that services that are to be provided would be limited to equipment maintenance functions. Infrastructure maintenance, operations, construction and other services would likely be included.

Generally speaking, a PPP is best suited for a new service, for which construction on at least some of the infrastructure or facilities has not yet commenced. The arrangement usually includes a set payment to the contractor over the contract term, with the contractor being responsible for meeting performance specifications while constructing and operating the service. Variations exist on who assumes the financial risk and possible financial benefits for the service and who owns the assets in the short and long term. Under many of these arrangements, the private partner assumes the financial risks during the contract term, but also receives the financial benefits resulting from efficient and intelligent implementation of the service. It is therefore in the private entity’s best interest to construct, operate and maintain the service in a way that reduces costs and maximizes customer satisfaction, ridership, safety, and service reliability for the long term. However, these opportunities are often tied to revenue. In the case of existing state-supported intercity services, operating subsidies are required. Therefore, it may be difficult to transfer significant demand / revenue risk under this type of contract structure as state payments will still be required to compensate for operating losses. Additionally, a 30-year time
horizon is generally too long a period over which potential bidders can make accurate ridership and revenue forecasts.

A recent example of a PPP is the Denver Eagle. This project to extend the Gold and Blue light rail lines in Denver includes Design, Build, Operate, Maintain and Finance functions. In this case, the equipment maintenance function is only a small piece of the overall PPP arrangement. With this project, the contractor has assumed all risk associated with the assets that it has designed, constructed and commissioned. For rail services that are already well established with complete infrastructure and workforce, it is more difficult to initiate a PPP since there are more limited options for modifying the arrangement of the service, facilities or workforce. However, given particular circumstances, it may be possible to include elements of a PPP arrangement in the operation and maintenance of a new or improved service with some complete infrastructure or equipment in exchange for a longer term contract. Local, State and Federal procurement guidelines and regulations should be reviewed.

As with a conventional long term contract, the FTA rules regarding funding of rolling stock procurements under an operating/maintenance agreement exceeding five years would apply.

3.2.1.4 In-House Maintenance
For an entity that is new to intercity passenger rail, creating a new division or entity to maintain a rail fleet in-house has both benefits and challenges. With the “In-House” option, the sponsoring agency or DOT does not have to pay for the contractor’s profit or management expenses. It may also be possible to realize further cost savings by consolidating oversight roles and eliminating redundancy between the contractor and the contracting entity. Overhead costs may also decrease from those charged by the private contractor by integrating the management and use of existing facilities of the newly created division within the existing agency.

Challenges to in-house maintenance also exist. Before considering in-house maintenance, DOT’s or other sponsoring agencies must gain a full understanding of the potential impacts related to Federal Railroad Worker’s Unemployment Insurance, the Railroad Retirement Act, the Railway Labor Act and the Federal Employers Liability Act. Currently, most State and DOT employees are not covered by these Acts, so when creating a “Railroad Operations” division within a DOT, legislation is often required to provide clear separation between the DOT and the Railroad. At New Jersey Transit, the commuter rail service is operated under a subsidiary, NJ TRANSIT Rail Operations, Inc. Similar approaches are used at SEPTA and Long Island Rail Road. In large part due to these challenges, no state currently provides in-house maintenance for its intercity passenger rail operations.

In addition to policy and potential regulatory issues, the in-house approach requires a significant level of effort and planning. Experienced managers must be hired to lead and oversee the maintenance operation and determine how to best organize staff, determine staffing needs and required skills, identify necessary facilities and equipment, budget, hire workers and perform all other components of a maintenance operation. This process is intensive and can require several years to complete.
Once staff has been hired, they must also be trained. For new equipment, training is often included in the services provided by the vehicle manufacturer, and can thus be required as part of the vehicle procurement contract. The level of staff training must contain the appropriate level of detail, especially considering the potential “skills gap” of a staff inexperienced with railcar maintenance. For existing vehicles, agencies will likely need to contract training to raise the skills of the new staff to acceptable levels. In addition to training, there will be an initial learning curve where the skills obtained in training are put to use and potential additional training needs could be identified. The same transition period is true for management and supervision. There will be a period in which management methods are fine-tuned to obtain the desired results of the maintenance activities. In essence, there is a learning curve and it is imperative to hire at least a core set of professionals with significant passenger rail maintenance experience.

There is no specific fleet size threshold to determine whether to perform maintenance in-house or to contract out, but generally the larger the fleet, the more appropriate in-house maintenance may be. As noted earlier, no state-supported intercity services currently are maintained by DOT or agency in-house personnel. The commuter experience is different, based on a review of commuter rail agencies in the United States (see Appendix D). With a few exceptions, most agencies with over 1,000 vehicles in peak service perform their maintenance in-house, per the 2011 National Transit Database. In addition, three organizations with less than 1,000 vehicles also perform maintenance in-house, being:

- Southeastern Pennsylvania Transportation Authority (SEPTA) – 327 vehicles
- Northern Indiana Commuter Transportation District (NICTD) – 66 vehicles
- Utah Transit Authority (UTA) – 34 vehicles

While the fleet size is one factor that is related to the decision of whether to perform in-house maintenance or contract out, there are several other factors that must also be considered. In particular, whether an entity operates as a host railroad or tenant railroad can often make the decision easier. Many tenant agencies rely on an outside entity (their host railroad) for dispatching and maintenance of way service. This is the case for almost all of the existing state-supported intercity passenger rail services in the US. In this case, since many services are already provided by Amtrak and the applicable host railroad, it may not make sense to create an in-house department or management structure for the equipment maintenance function alone, or even O&M functions alone. Contracting out their operations and maintenance is the simplest strategy. Another issue is the potential regulatory issues. The operating entity must carefully consider local, state and federal laws and regulatory issues associated with the In-House vs. Outsourced approach.

3.2.2 Maintenance Philosophy
A DOT or agency’s chosen maintenance philosophy must support the development of preventive maintenance activities, programs, and overhauls to optimize vehicle reliability and available resources while minimizing total life cycle costs. At the same time, the approach to maintenance must comply with all applicable regulations including those promulgated by the Federal Railroad Administration (FRA), Environmental Protection Agency (EPA) and Federal Transit Administration (FTA) (if FTA funds are used). Amtrak or other operating entity’s recommendations, standards and best practices (where applicable), and Original Equipment
Manufacturers (OEM) recommendations for the service and environmental characteristics, life expectancy and maintenance needs (example: diesel electric locomotives vs. coaches) all influence the railroad’s selection of a maintenance philosophy. The selection of a maintenance philosophy is closely connected to the arrangements/contract(s) defining the maintenance provider.

The specifications for bi-level passenger coaches and diesel-electric passenger locomotives provide a consistent requirement of 4 to 10 coaches capable of operating 18 hours and up to 1,200 miles per day with a minimum design service life of 25 years for locomotives and 40 years for coaches. These vehicle specifications also provide reliability objectives that include Mean Distance Between Train Delays (MDBTD) and individual system and sub-system reliability goals for the vehicle. Along with these reliability objectives, the vehicle manufacturer is required to provide a vehicle in compliance with the minimum Mean Time To Repair (MTTR) requirements in order to maximize coach and locomotive availability, minimize costs and time in shop, and with the exception of consumables, the locomotive maintenance intervals shall not be less than 92 days.

To establish a successful asset management plan for rolling stock, a computerized maintenance management system (CMMS) or related system must be implemented. During the reliability demonstration phase of the vehicle procurement process, the contractor(s) will be required to provide the actual in-service reliability as well as the maintenance plan outlining all the required maintenance to achieve these goals. Data entries in a CMMS system that is owned by the agency or DOT during the reliability demonstration phase of the vehicle procurement will provide a database of past maintenance activities and can be populated with current and future maintenance needs for the rolling stock (and any other asset). As the vehicle warranty expires, more involved vehicle maintenance activities are required with the increases in mileage. Performance goals such as MTTR and MDBDT can be easily monitored, corrective action taken as needed and long-term capital planning and maintenance can be forecasted. This data is a valuable resource, and if maintained and updated, can support an agency in moving towards the cycle-based maintenance philosophies discussed later in this section.

Common maintenance philosophies are summarized in the following graphic and in Sections 3.2.2.1 through 3.2.2.5.
3.2.2.1 Scheduled Inspection and Preventive Maintenance

The most commonly used maintenance philosophy in the US transit industry is scheduled inspection and preventative maintenance. This approach includes all mandated inspections and maintenance, plus some level of additional inspections and preventive maintenance at regular intervals, based on OEM recommendations and best practices. This maintenance is complemented by a mid-life overhaul, and for locomotives, two top-deck overhauls. The maintenance and inspection program is usually based on OEM recommendations, along with any regulatory requirements. In addition, this type of maintenance incorporates preventive maintenance and inspections for all vehicle parts with a goal of keeping all vehicle parts in working condition through proactive inspections and maintenance.

Although this maintenance philosophy can effectively maintain a vehicle in the long term, many items are not replaced or repaired until they fail. Therefore, failures are expected and they often occur in-service, particularly as the vehicles age. As the vehicles approach their mid-life overhaul, many components are near, or have already passed their useful life. Those components do undergo regular preventive maintenance, but unless they fail, they are usually not replaced until the mid-life overhaul. The effect of such failures on passenger experience varies based on the function of the failed part; some may cause only minor disruptions while others may cause significant passenger delays and trip cancellations.

While this philosophy historically has worked reasonably well, there are some drawbacks that are leading many agencies to consider other philosophies. One of the biggest drawbacks is the reliance on a mid-life overhaul. The various systems, components and sub-systems in a vehicle all have different useful lives. Any attempt to select a single overhaul service interval will result in running some of the vehicle’s components past their designated useful life. This, in turn, results in an increase of in-service failures and unscheduled repairs of these “overused” components. Likewise, some components may be replaced earlier than necessary due to the overhaul cycle.

Obtaining the large influx of one-time funding required for a mid-life overhaul has been problematic for many DOT’s or agencies. While the need for a mid-life overhaul is obvious to those maintaining the vehicles, in difficult financial times, an agency may find that it has more pressing items to fund, and since the vehicles still function, their overhaul is delayed. This can lead to an even greater number of subsequent equipment failures.

Furthermore, a full mid-life overhaul is vehicle and labor intensive over a short time (several years). Most small agencies outsource the overhauls, thus reducing the labor burden, but any agency is affected by the need to remove vehicles from service for many months to be overhauled. The number of vehicles varies based on the fleet size and the availability of the overhauler, but for small fleets, even a few vehicles can significantly reduce their spare ratio to a point where additional failures will cause service cancellations.

To eliminate these drawbacks, many agencies have already or are considering moving to a Life Cycle (LCM) or Reliability Centered Maintenance (RCM) philosophy. Those philosophies, which are particularly well suited to new rail vehicle fleets, are discussed in Sections 3.2.2.2 and 3.2.2.3.
The Scheduled Inspection and Preventive Maintenance approach is a reasonable maintenance strategy, particularly for rail vehicles that are well into their service lives, but not yet nearing retirement. However, for a new equipment fleet in an agency that is willing to make the financial and intellectual investment, LCM and RCM are the state-of-the-art maintenance philosophies, with the experience of several rail operators and operators in other industries showing significant benefits in lower costs and higher reliability.

3.2.2.2 Life Cycle Maintenance Program
To ensure the long term viability and reliability of new cars and locomotives, some entities are adopting a LCM-based maintenance philosophy. LCM is based on the goal of each component being changed out at the end if its “life cycle” but before it fails, rather than at one single time, as in a mid-life overhaul. This approach minimizes in-service failures and unscheduled repairs and optimizes the use of components and resources. The result of an LCM approach would ideally be a predictable, consistent maintenance budget, smoothing out the one-time spikes in expenditures resulting from traditional mid-life overhauls and from unplanned maintenance. Furthermore, an LCM philosophy should result in a significant decrease of in-service component failures, as compared to other maintenance philosophies. It is important to note that if scheduled properly, the frequency of preventative maintenance activities may not increase dramatically, but a relatively high number of maintenance activities can be assumed with this approach.

The LCM program evaluates each component’s estimated life span and schedules rebuild or replacement sometime prior to that component’s statistically expected failure. To determine the statistically expected failure timeframe, LCM maintenance relies on extensive tracking of maintenance and failure data in addition to OEM recommendations and industry experience.

Under this philosophy, parts and components are usually replaced / repaired / overhauled while still functioning, rather than once they have failed. This is done because the failure calculations estimate that otherwise, they are likely to fail in-service, causing greater inconvenience to passengers, less predictable maintenance costs and greater cost to remedy (e.g. unscheduled transportation to maintenance facility, possible overtime labor, possible alternate transportation for stranded passengers, possible damage to other components caused by the failure etc.). The goal of this philosophy is to fine tune the replacement interval so that the unused life of the replaced parts is minimized.

Within the constraints of this philosophy, maintenance intervals are increased or decreased until component failure rates reach an acceptable level. When no failures occur, the interval can be increased, and when many failures occur, the interval is decreased. It is an iterative process, and takes time to implement – partially because of the labor involved, and partially because the maintenance data can only be analyzed as the vehicles and components age enough to provide sufficient in-service reliability data to make accurate failure estimates.

Generally, at least one dedicated employee would be required to manage and analyze the data and determine what work should occur when a vehicle is pulled out of service. Although unscheduled maintenance can never be eliminated, its frequency and duration can be reduced, and when an unscheduled repair occurs, additional cycle
maintenance work might be able to be completed during this time, reducing the requirements during the vehicle’s next scheduled maintenance interval.

In its purest form, LCM maintenance would address every part of a vehicle, with work ranging from full overhaul of major systems down to items as small as light bulbs or door latches, for example. In practice, the data collection, analysis and the labor required for LCM on every part or component of a vehicle at the ideal time for each item would be overwhelming and not cost effective. Therefore, in practice, agencies have found ways to make the philosophy more manageable and cost effective.

The two most common methods of making this philosophy effective are:

- Reduce the list of items for which data is tracked and analyzed to the most relevant. The list of items addressed through an agency’s LCM program depends on the specifics of each vehicle class, the identification of the lowest replaceable unit (LRU) and the priorities and funding of the agency; however, the most common method is to limit it to items that would disrupt passenger service or impact the safe operation of the vehicle.

- Group LCM activities by cycle length and set time or mileage milestones at which each group of LCM activities will be performed. For the most efficiency, this can be done when equipment is projected to be out of service for other required maintenance, such as FRA-mandated inspections, thus minimizing the effect of the LCM work on vehicle availability. This approach requires a rather extensive tracking system, but ideally can take better advantage of any planned “down time” between scheduled runs.

In general, an LCM-type approach is the direction in which the rail industry is going, particularly for new equipment fleets. It is logical to maintain each component and part with the frequency best suited to it, rather than find one timeframe (e.g. mid-life overhaul) that moderately fits all components on a vehicle. However, a full-scale, pure LCM approach is unlikely to be the most cost effective or efficient method. Instead, it is recommended that a new agency pursue a version of this philosophy such as RCM (described below) or some combination of LCM-style maintenance that fits the specific needs, resources and budget of an agency.

3.2.2.2.1 LCM Example – Metropolitan Transit Authority New York City Transit

Metropolitan Transportation Authority (MTA)-New York City Transit (NYCT) began implementing a version of LCM they call the Selective Maintenance System (SMS) Program in the early 1980s. The program was started as a way to maintain the newly improved performance of older cars that had just emerged from a complete overhaul in their General Overhaul (GOH) program. With the success of the program, it was continued on new vehicles purchased in later procurements. MTA states that the development and implementation of its SMS philosophy has resulted in an increase of mean miles between failures (MMBF) from 9,000 to 160,000 miles, between the years 1984 and 2013.

Under the SMS program, MTA inspects, overhauls and replaces major system components (e.g., trucks, traction motors, HVAC equipment) with new or rebuilt components before they become prone to failures while in revenue service. This
philosophy extends to all work from regular preventive maintenance through heavier work that would normally be completed at a mid-life overhaul. Through the implementation of this program, MTA has eliminated the need for a classic mid-life overhaul, as all major components are repaired when most suitable for the specific component, not at the midpoint of the vehicle’s life.

A part of the program not standard to LCM maintenance is that MTA has permanently coupled vehicle sets (“married pairs”) and then removed redundant parts to reduce the number of items to maintain without compromising function. This allows more time and budget to be spent where it is needed. While this strategy has been successful for MTA, it may not be suitable for all agencies, depending on the type of vehicles used and how much flexibility is needed in the fleet.

Although used by MTA and other heavy rail agencies, permanently coupling vehicle sets not a common construction method for intercity rolling stock in the US. However, a related practice that can be used with intercity rail cars is creating dedicated sets that always contain the same vehicles, and maintaining them in-consist. There are a variety of considerations to weigh when determining whether this is a suitable practice for a specific agency. In-consist maintenance is further discussed in Section 3.2.4.2.

MTA has utilized four distinct SMS cycles performed at 4, 6, 7 and 12-year intervals. The larger-scale SMS work scheduled at 6 and 12-year cycles has been assigned to NYCT’s overhaul shops. Six-year SMS work includes change out of air brake valves, the electrical portion of the couplers, the undercar HVAC system, and the car’s trucks. SMS work at the 12-year cycle includes all 6-year work as well as car body work and the replacement of additional components such as the mechanical portion of the couplers, door sensors and the propulsion system. Four-year and 7-year SMS work (primarily involving the replacement of brake valves, air compressors and batteries) are performed at other NYCT maintenance shops.

While MTA has the facilities and experienced workforce to complete all work in-house, an LCM-type program such as MTA’s SMS Program could also be implemented at an agency with fewer resources. By stocking adequate spare components, a similar program can be initiated using unit exchange with overhaul of those units performed off-site.

3.2.2.3 Reliability Centered Maintenance Program (RCMP)
Reliability Centered Maintenance (RCM) is a focused version of LCM; it prioritizes the identified LCM maintenance tasks based on their effect on functionality. It targets specific rolling stock components for which an unexpected failure would affect reliability of the service for customers.

As with LCM, these components are programmed for overhaul/repair/replacement prior to the end of their designed service life. Components and systems typically not included in a RCM are systems considered non-“mission critical” with low risk to safety and mean miles between failures (MMBF). These systems undergo scheduled preventive maintenance per OEM recommendations and best practices, and are repaired as required. Major corrective maintenance and programs are established as a need arises and funding becomes available. Typical examples include interior lights/ballasts, passenger seats, windows, and paint.
RCM is ideal for maintenance of a new rail passenger fleet. By implementing RCM with the acceptance of new vehicles, the traditional “repair on failure” type maintenance can be prevented. Otherwise, once “repair on failure” maintenance has begun, it becomes increasingly difficult to initiate an RCM type program concurrently with a repair type maintenance program, since a significant increase in cost is required during the transition period until the benefits of the program work becomes evident.

3.2.2.3.1 RCM Example – Long Island Rail Road (LIRR)

Since the early 2000s, LIRR has been implementing an LCM/RCM philosophy, partially coinciding with the addition of new vehicles to its fleet. Starting in 1997 and 1998, new C3 coaches and DE30AC/DM30AC locomotives were added to replace LIRR’s existing fleet of coaches, locomotives and Electric Multiple Units (EMUs) – the M1s and M3s. Between 2002 and 2006, over 800 new M7 EMUs began service while the older M1 EMUs were retired.

As stated in MTA’s 2004 Annual Report, the new M7 EMUs were very reliable from the start, often reaching near 250,000 miles between failures. However, the coaches and locomotives proved to be more problematic, as were the older M1 EMUs, due to their age.

As the older M1 cars were replaced with new M7s and the problems were worked out of the coach and locomotive fleets, the benefits of LIRR’s RCM philosophy became evident (see following chart). The agency’s MMBF for the entire fleet has risen dramatically, from under 30,000 in the year 2000 to almost 200,000 in the year 2012. Despite the difficulties presented by the coaches, locomotives and older EMUs, the MMBF began to steadily increase almost immediately, even prior to the arrival of the M7 fleet in 2002. Once the retirement of the M1 EMUs was complete, in 2006, the fleet-wide MMBF increased at an even greater rate and is almost approaching the initial reliability numbers of the M7 fleet, with the average age of the fleet greater than 10 years.

**Long Island Railroad Fleetwide MMBF**

![Graph of Long Island Railroad Fleetwide MMBF](image)

Experience from LIRR has indicated that great success can be achieved through this type of maintenance philosophy, but it is only possible with agency-wide support, particularly at the top levels. It also requires much more planning and analysis than
reactive maintenance to ensure that shop space can be properly allocated to complete all tasks in a timely manner, and ensure that parts and labor are available when needed to avoid delays. Planning for maintenance activities to be performed on a specific day is done several months ahead of time at LIRR to ensure that everything is in place at the appropriate time.

3.2.2.3.2 RCM Example – Amtrak

In order to support Amtrak's passenger service fleet of approximately 1,500 coaches and 400 locomotives with an average age of 29 plus years, Amtrak has developed and implemented a Condition Based Maintenance (CBM) program that is based on the RCM philosophy. CBM incorporates monitoring equipment into the RCM philosophy. This monitoring equipment reports the real-time health status of the rail vehicle and its components; the data is used to feed the analysis that determines maintenance cycles for major components in any RCM program. CBM relies not only on time intervals to predict equipment failures, but also on physical indicators.

Amtrak’s Maintenance Methodology

Included in Amtrak’s CBM plan for FY13 are 448 Life Cycle Planned Maintenance activities that include paint every ten years, engine work every 6-7 years, truck overhauls every 5-10 years, HVAC systems every 5 years and air compressors every 8 years. Unlike most commuter rail networks, Amtrak has a network of overhaul and heavy maintenance facilities across the United States available to support these initiatives.

Using CBM based on the principals of RCM, less than three percent of Amtrak departures were delayed due to a mechanical failure in FY2009. RCM also increased the availability of Acela trainsets and dramatically reduced annulments due to mechanical reasons. According to a report by the Amtrak Inspector General, the improved reliability of the Acela service allowed two additional trainsets to be placed into service – resulting in over $50 Million in incremental revenue.
3.2.2.4 Selective System Replacement Programs

Unlike a LCM approach, a selective system replacement program is typically applied to supplement an existing maintenance program or philosophy that has not achieved the desired MMBF or service commitment levels. This type of approach targets reliability and safety initiatives and is typically applied to maintain reliability, vehicle availability and return vehicles and/or sub systems to a state of good repair. In some cases, this approach can be a part of a service life extension program for vehicles awaiting replacement. Systems or subsystems are identified for replacement and/or overhauls and individual program initiatives are established. As vehicles are removed from service for scheduled or unscheduled reasons these programs are completed on the vehicles as required.

3.2.2.4.1 Selective Systems Replacement Programs Example – MBTA

The Massachusetts Bay Transportation Authority (MBTA) recently implemented the Coach Reliability and Safety Program (CRASP). The CRASP program is designed to target the replacement and/or overhaul of selected components to increase safety and reliability of a fleet of coaches approaching 25 years in age without having the benefit of a mid-life overhaul. This program was later expanded to include locomotives and bi-level coaches to focus on key items essential to maintain reliability until the rolling stock can be replaced or programmed for overhaul. The scope of this program included truck, coupler and HVAC overhauls, HVAC control system upgrades as well as floor and window replacements. The HVAC overhaul and temperature control upgrades along with detailed inspection, training and repair procedures improved the reliability of the HVAC system from having an HVAC defect in one (1) of every (10) ten coaches in service during the summer of 2006 to having 99.9% of coaches functioning properly during the 2012 cooling season.

3.2.2.5 Run to Failure (FRA Requirements + Overhauls)

The “run to failure” approach simply means that beyond the federally-required inspections and maintenance activities, little to no preventive maintenance or inspections are performed on the vehicle or its sub-systems, and repairs are made when the component fails. This approach is usually supplemented by an overhaul program, where a majority of the vehicle systems and sub-systems are replaced or overhauled at one designated time, usually at half of the vehicle’s useful life (around 15 years) in an attempt to return the vehicle to a “like new” condition.

As previously stated, the timing of a single mid-life overhaul will never overlap with the midlife or end of life of all parts and components on a vehicle. This can lead to failures of parts that are in need of more intensive maintenance than preventive maintenance provides prior to the vehicle’s midlife overhaul.

From the view of a maintenance department, in-service failures result in unpredictable labor and material costs and, in some cases, longer and more expensive repairs as a result of defective equipment having to be removed from service. Furthermore, having an unreasonably high number of unscheduled failures can disrupt an agency’s ability to perform scheduled inspections and maintenance, since they use valuable shop capacity, labor and materials unexpectedly.

Failure to implement preventive maintenance on some critical components can lead to more catastrophic failures when they do occur or long lead times for replacements.
Since most vehicle fleets include large groups of vehicles from the same procurement with similar construction timeframes, without preventive maintenance or planning to spread out the ages of specific pieces of equipment, most fleets will tend to have failures of the same equipment on multiple vehicles in a short timeframe, further increasing the effects of the run-to-fail maintenance philosophy.

Due to passenger inconvenience, increased costs and less availability, the Run-to-Failure philosophy is inherently flawed as an ongoing maintenance strategy, and may only have a place as a very short term strategy at the end of a vehicle’s useful life. In practice, it is often the result of underfunding, poor planning, or a fleet imminently awaiting replacement, but is never a recommended philosophy.

3.2.2.6 Maintenance Program Conclusions
The primary maintenance philosophies are:

- Scheduled Inspection and Preventive Maintenance;
- Life Cycle Maintenance (LCM); and
- Reliability Centered Maintenance (RCM).

While these three philosophies are viable, recent industry best practices recommend LCM and RCM. All three maintenance philosophies provide ongoing preventive maintenance to retain the fleet in a state of good repair, yet LCM and RCM practices maximize equipment availability and minimize overall life cycle costs.

LCM and RCM focus on increased vehicle availability and reduced in-service failures. When successfully implemented, they can effectively eliminate the need for a separate mid-life overhaul, and can even out labor needs and expenditures. Both rely heavily on predictions of component and part service lives and thereby, extensive data collection and analysis. These types of philosophies are commonplace in other industries, particularly aeronautics, and are becoming more common in the rail industry. Agencies that have switched from standard inspection and preventive maintenance approaches have shown considerable success, with increased Mean Miles between Failures (MMBF).

Despite the benefits of an LCM or RCM-type maintenance philosophy, some new agencies may still choose to implement a Scheduled Inspection and Preventive Maintenance philosophy. This is a reasonable philosophy; particularly for smaller operations or operations with significant spare equipment, or an agency with facilities that are not large enough or well enough equipped to handle the additional demands of converting a mid-life overhaul into ongoing maintenance. This is also a wise philosophy to follow if the agency does not have, and does not wish to take on the expense to obtain the appropriate technology and staffing to track and analyze maintenance data and maintenance cycles to verify their effectiveness or modify them.

Additionally, the maintenance provider arrangement may significantly affect the ability of an agency to implement a specific maintenance philosophy. Generally speaking, a new agency should be able to create a workforce, or a contract with an outside workforce, that allows any type of reasonable maintenance philosophy; but there may
be regional or agency specifics that limit the choice of philosophy. Maintenance provider options are further discussed in Section 3.2.1.

Although ideally an LCM-type approach would have consistent annual expenditures, in reality there would still be increases in spending when a majority of the most expensive large systems require overhaul. One benefit of an RCM or LCM-type approach is that it provides the opportunity to smooth out costs even further by staggering almost all work on vehicles, including some items generally included in a mid-life overhaul. In contrast, a standard mid-life overhaul is harder to stagger since it addresses such a wide variety of components; it becomes even more difficult to stagger it if the overhaul is outsourced. A more detailed discussion of cost and maintenance staggering is provided in Section 3.2.3.

A sample of possible annual expenditures for each of the three maintenance philosophies is shown below. The true expenditures would depend on the fleet composition, fleet usage, and how specific components are handled at a specific agency, as each agency has its own preferences.

**Sample Order of Magnitude Expenditures for Coach Maintenance**

![Graph showing annual expenditures over the life of a vehicle](image)

Each of the described maintenance paradigms has a unique makeup of requirements that are necessary to succeed. For example, LCM and RCM require a significant effort to continually evaluate fleet maintenance and failure history. This effort is required to interactively balance maximizing fleet reliability while minimizing both material and labor costs. In other words, replace components before they fail, but not unnecessarily soon. Scheduled Inspection and Preventive Maintenance requires a large enough spare pool of vehicles to support a mid-life overhaul. It also potentially requires...
contingencies for dealing with more in-service failures than with an LCM or RCM philosophy and a more flexible funding arrangement that can handle large swings in funding needs.

In addition to these full maintenance strategies, it may be appropriate for some agencies to augment with some partial maintenance plans, such as:

- Selective Systems Replacement; and
- Run-to-Failure.

For an agency with some or all older vehicles in their fleets, the use of Selective Systems Replacement may facilitate bringing the vehicles into a more reliable state. But this strategy must be coupled with a full maintenance strategy (Scheduled Inspection and Preventive Maintenance, LCM, RCM, etc.) to maintain the improved state of repair subsequent to the program. Similarly, an agency with a fleet of vehicles awaiting imminent replacement may find that the Run-to-Failure philosophy is appropriate for the short term until new vehicles are delivered. In such an instance, the agency must plan for a full maintenance strategy to be implemented with the arrival of the new vehicles.

3.2.3 Maintenance Planning and Scheduling
A successful maintenance practice involves proper planning to proactively schedule maintenance activities that will prevent major failures while ensuring availability of labor and necessary parts. The following strategies may assist agencies in ensuring that they are able to perform the maintenance required for a reliable fleet.

3.2.3.1 Staggered Maintenance
A first step that any agency can do to make maintenance more manageable is to stagger the maintenance dates throughout the fleet. Unless carefully managed, a fleet of new vehicles will require most maintenance activities at approximately the same time for all vehicles. If the fleet is small, vehicles may have manufacture/delivery dates that all fall within a single year, or less.

Some of the more labor and cost-intensive activities only occur at intervals of several years. If these activities are completed in that timeline based on delivery/manufacture dates, there will be a long period of inactivity, followed by a peak of labor, parts and out of service time for vehicles, which puts a strain on the entity’s maintenance and operations. To effectively level out those maintenance efforts, an entity would plan to start some of the activities earlier than required. For example, an activity that is required every four years might be performed for the first time on some vehicles after two or three years, before reverting back to the four-year interval.

The goal is to spread out these activities so that they are regularly performed on one vehicle and rarely on more than one (for a larger entity it might be regularly performed on two or three). This requires an initial investment to perform the first round of early maintenance, but afterwards everything continues following the regularly scheduled interval, with staggered start dates for each vehicle.

Such an exercise may seem counterintuitive, since initially parts are being replaced that still have useful life. However the benefits become evident as the vehicles age.
and significant expense for overtime work is not required to complete major work on the entire fleet in a short timeframe. Such an approach allows for more consistent budgeting of labor expenses, stocking of parts and when performed properly, ensures that those parts are not falling in large quantity.

This approach can be extended to all parts of the vehicle and all types of repairs, including overhauls, in a Lifecycle or Reliability-Centered Maintenance philosophy. Instead of scheduling mid-life overhauls, the work included in an overhaul can be split up into discrete activities and addressed at the proper time for each component or part and staggered through the fleet so that they are just a part of scheduled maintenance.

3.2.3.2 Labor and Expense Planning

The intent of labor and expense planning for vehicle maintenance is to fully account for the parts, consumables and labor expenditures required to maintain reliable and safe vehicles. Once all items are accounted for, planning extends into determining when and where to complete all work required. This includes adequate staffing, efficient utilization of shop space and equipment and, where possible, coordination of all work required on a vehicle to minimize the number of times it is removed from service.

It is also important to ensure that all parts required for planned work are available, plus a contingency for unplanned work. When parts are not available at the proper times, there is a tendency to “cannibalize” other cars, removing the needed parts from vehicles that may be out of service for other reasons. This practice is inefficient and increases labor hours and can significantly delay the time it takes to get that vehicle back in service, reducing vehicle availability.

Wherever possible, labor and expenditures should be balanced over time in a manner that meets the maintenance needs of the fleet, so that there are no periods of particularly high or low demand. This is an integral part of a Lifecycle or Reliability Centered Maintenance (LCM or RCM) philosophy, and should also be a component of a Scheduled Inspection and Preventive Maintenance Philosophy. As previously discussed, staggering maintenance intervals is a first step in achieving this. If labor requirements vary widely from day to day and week to week, the agency needs to employ enough skilled labor to meet the high demand periods, yet much of the workforce is not utilized during low demand periods. Therefore, leveling out labor requirements aids an agency in properly sizing the workforce, thus lowering labor-related expenses.

When possible, keeping labor and expenditures relatively consistent has an additional benefit related to funding. When all maintenance required on a vehicle (including overhauls) is staggered and viewed as routine preventive maintenance – as with LCM or RCM – there is no need to seek funding above normal levels to complete major activities like an overhaul. This effort is important particularly since in periods of scarce resources, many budgets are trimmed and significant capital outlays, such as mid-life overhauls, are often delayed. The resulting deferred maintenance results in reduced reliability.

3.2.3.3 Extended Parts Agreements

Some agencies, including LIRR, have made extended parts agreements with OEM suppliers. Under these agreements, the suppliers typically maintain parts warehouses
near the agency that are stocked with the most common parts and components used for maintenance of the fleet. Those parts are owned by the supplier until used by the agency, thus reducing the upfront financial commitment related to the purchase and storage of parts/material. Other less frequently used parts and components are written into the agreement with the supplier to be available within a guaranteed lead time. Prices are included in the contract, and can either be valid for the duration of the contract, or include an escalation factor to account for inflation.

Such agreements may benefit the agency by ensuring parts availability, guaranteed pricing, and reduced warehouse space and expense. It benefits the supplier by providing a steady revenue stream. Additionally, this approach may lead to a more responsive supplier and guaranteed support for parts that may otherwise become obsolete before a vehicle is retired.

However, since there is a significant inventory expense that will fall to the supplier, this cost will ultimately be passed to the contracting entity. The benefits and costs must be carefully evaluated for each agency, with the specifics of their fleet and agency.

3.2.4 Maintenance Facilities
The determination of both maintenance scope and required maintenance facilities is sufficiently intertwined that discussing them together is appropriate. As with the maintenance paradigm discussion, there are a variety of significant variables to be considered. For example, what maintenance will be performed by the entity and what will be contracted and performed off-site. Another factor is whether consist-based or vehicle-based maintenance will be employed. Finally, site availability is an important factor and can weigh heavily on the decision-making process.

Regardless of the level of repair work that will be completed in either on-site or off-site repair facilities, some mechanical functions will take place at outlying layover sites. This work includes daily inspections, fueling, toilet servicing, cleaning (interior and exterior), watering and light repairs.

In many cases, OEM’s can provide maintenance services for their equipment. When the Washington State Department of Transportation (WSDOT) and Amtrak purchased Talgo rail passenger equipment in the mid-1990s, an option to perform maintenance activities for 20 years was included in the RFP. Both Amtrak and WSDOT signed virtually identical long term maintenance agreements with Talgo to perform maintenance on the equipment. Talgo and Amtrak signed a separate agreement in which Amtrak provides maintenance personnel to Talgo to perform the work, under Talgo supervision.

The agreement with Talgo has reliability performance metrics for the Talgo equipment. When failures occur, their severity is registered and they are recorded. Likewise, if Talgo is able to complete all maintenance activities in a shorter than required timeframe (if a train is late to the maintenance facility due to operational issues), then they receive a credit they can use against a failure. This system of “carrots and sticks” encourages Talgo to work off the failures, and get late trains out on-time, even when they are not the cause of the delay to the maintenance facility. At the end of each calendar year, failures and credits are reconciled and liquidated damages are assessed to Talgo if failures exceed credits.

The agreement for maintenance personnel between Talgo and Amtrak has some unique provisions. Amtrak employees who ‘bid’ into a Talgo job are required to stay in the position for a
lock-in period of approximately 18 months. This is due to the unique training requirements needed to maintain the Talgo equipment. This enables Talgo to train the employees and retain them on the job for a period of time, rather than the employee going through intensive training, and then bidding off a Talgo position.

### 3.2.4.1 Types of Maintenance Facilities

Although there are variations across agencies on how maintenance activities and facilities are divided, generally most facilities and related activities can be described as the following, or a combination thereof:

**Layover Facilities**

Layover facilities are typically located at the end of a line, or another convenient location near the initial terminal for the beginning of the daily schedule. The presence of a layover facility eliminates the need for dead-head or switching moves to locate equipment for daily peak service. As trains arrive for layover at each facility at the end of revenue service or the PM rush, locomotives can be shut down and plugged in to wayside power stations preventing possible cold weather damage and eliminating unnecessary idling.

Once trains have been shut down and placed on layover, staff at these facilities can clean and inspect each train for defects. Light bulbs, brake shoes, filters, other consumables and minor repairs can be completed. Consists can be cleaned, interior floors swept and mopped, seats and windows wiped down, toilets serviced, and windshields made clean and ready for the next day’s service.

If a defect is identified and corrective action taken, the repair should be logged in the maintenance management system. If the maintainer is unable to repair the defect, the management team should be notified and a timely determination can be made on status of the equipment to avoid an adverse impact on the operation.

Each scheduled revenue service train must have its safety devices inspected and tested daily and must be in functioning condition in accordance with FRA regulations. These tests verify that the brake systems, cab signal equipment, alerter, bells, horns, radios, etc. function properly on locomotives. In addition, each passenger coach must also be inspected and tested to ensure conformity with FRA regulations (e.g. Class 1 Brake Test); this includes the interior and the exterior of the coach. All tests must be performed when the equipment is unplugged from the layover power and with the locomotive running. These activities are usually performed at a layover facility.

Typical layover facilities are multi-track facilities that can accommodate 7-10 car train sets with a wayside power station, compressed air, and a building with bathroom / locker room facilities for transportation and mechanical crews. Parts storage and paved space between stored trains and running water for interior cleaning should also be included.

**Service and Inspection (S&I) Facility**

An S&I facility is generally situated in a location accessible to all consists. This can be accomplished by using a location that all routes pass in normal operation, or by cycling consists through different routes so that each is able to stop at the facility regularly — usually every 3-5 days.
Inspections, tests and maintenance that can be completed quickly, in-consist, between scheduled runs would be completed in this facility; for example: fueling locomotives, sanding, exterior cleaning, and some preventive maintenance. Making efficient use of layover facilities can significantly reduce the amount of work to be done in the S&I facility, which can reduce the need for a large S&I facility and related staffing.

This type of facility would include one or two tracks, each capable of containing up to a 10-coach consist, with pits for undercar access (required for the FRA 5-day disk brake inspection requirement). A vestibule-floor height island platform should be provided between the tracks, and roof-top access should be available for locomotive inspection. The facility can be equipped with two full-servicing stations for locomotive fueling, sanding, replenishment of vital fluids and general servicing. Provision can be made for overhead crane(s) and a train washer at the end of each track.

Any maintenance or repairs that cannot be completed in a few hours, or requires a car to be cut from a consist would not be done in an S&I facility; rather, they would be sent to the main maintenance facility.

**Main Maintenance Facility**
The main maintenance facility is where all repairs and other maintenance are performed that cannot be accommodated in the S&I or layover facilities. The main maintenance facility can be attached to the S&I facility, nearby, or in a different location, depending on a variety of agency and location specifics (existing facilities, operational specifics, land availability, maintenance philosophy, staffing plan, etc.)

This facility would generally have all equipment and provisions required for regular maintenance and required inspections. At a minimum the main maintenance facility should be a multi-track facility with dedicated areas for locomotive and coach inspection and repair. Each area should have high and low platforms with undercarriage access, a 15-ton overhead crane for coaches and a 25-ton overhead crane for locomotives. Fall protection should be provided for roof access to coaches and locomotives. A dedicated truck shop, drop pit and wheel machine should be available. This facility would also house an inventory storeroom and support shops. Administrative offices, restroom facilities, locker rooms and lunchrooms can also be located at this type of facility and an adjacent yard should be located within the facility for storage of equipment.

A typical main maintenance facility would not be able to handle major programs, like a mid-life overhaul or major repairs; such work would be either contracted out or performed in a back shop.

**Back Shop**
Some older, well-established railroads have facilities for all types of inspection, preventive maintenance, repairs, heavy repairs and “back shop” capabilities that result in a self-sufficient operation. Locomotive and coach systems and sub-systems are troubleshooting, repaired and overhauled within the agency’s network of facilities. In order to support this type of operation the “back shop” requires specialized shop test equipment and training for the employees that staff this type of repair facility.

To allow the proper testing, troubleshooting, calibration, repair and overhaul of locomotive and coach components, specialized shop test equipment and functional
test stations are required for a variety of equipment; for example: microprocessor and electronic printed circuit boards, electronic devices, modules, and assemblies; high power equipment, rotating electrical, mechanical and pneumatic and the skilled staff to operate this equipment is required. This type of facility is larger and better equipped than a basic main maintenance facility; it can handle almost any repair or maintenance required on the agency’s fleet, including complete overhauls.

### 3.2.4.2 Level of Repairs to be Performed On-Site and Off-Site

Regardless of the maintenance program that is selected, an entity must determine the level of repairs that will be performed at its facilities. Some older commuter rail operations have facilities for repair of major components and dedicated staff to perform those repairs. Much of the reasoning for that decision is historical and based on self-sufficiency. While it is possible to set up such facilities for any entity, for most new rail operations, particularly for those with only small equipment fleets, it is typically more efficient to limit on-site work to troubleshooting, inspection, minor repairs and component change out.

Generally, types of equipment maintenance include:

- Daily inspection and maintenance of locomotives and coaches;
- Periodic inspections and maintenance;
- Heavy repair/unscheduled maintenance;
- Seasonal maintenance; and
- Cleaning (pre-service, midday, heavy, periodic and exterior)

Daily rolling stock maintenance and cleaning can be accomplished in-line during mid-day and nightly layovers. Preventive maintenance, some unscheduled repairs, service and inspection and some OEM- and FRA-required maintenance can be completed within facilities that can accommodate entire train sets when a consist is available for 5-8 hours. Heavy maintenance, unscheduled major repairs and some FRA mandated inspections that require the vehicle to be removed from the consist typically require a corrective action at the coach/locomotive main repair facility.

Shop space and manpower requirements can be estimated based on the following, and can be adjusted by increasing or decreasing activities during the off shifts and weekends:

- Mean Time to Repair goals (in PRIIA specification)
- Daily maintenance requirements
- Maintenance intervals required by the FRA, EPA or other regulatory agency
- OEM requirements

The capital investment required to build, equip, and staff facilities that support major component repair and replacement can be very large. Given this impact, in most cases the investment cannot be justified for operations with small equipment fleets. However, one must also consider fleet expansion plans when conducting this analysis. If the fleet is expected to expand significantly in the near future (5 to 10 years), then the investment in plant and equipment may be justified. If not, then additional spare
equipment may be required to substitute for equipment sent off-site for maintenance and repairs.

In many cases, it is more cost effective to send major components out to a larger facility that performs repairs and rebuilds for many different customers. In addition to cost savings, the larger facilities are able to accommodate a larger number of repairs simultaneously. Repairs from an outside repair shop also generally come with some length of warranty, which is typically not the case for in-house repairs.

When planning for the maintenance of a new fleet of vehicles, an entity must assess the various vehicle components, the likely failure types, the associated repair times and facilities that are required. Based on these considerations, the managing entity should determine the level of and types of repairs that will be performed on-site and which will be sent out. These considerations apply whether maintenance is performed by an in-house staff or by a contracted equipment maintainer. However, if a contracted maintainer is selected, depending on their abilities and their own facilities, it may be appropriate to allow the contractor to perform some of the off-site repairs at their own facility rather than sending to a third party.

After identification of maintenance facilities and the scope of services to be performed at each facility, the development of the appropriate resources can be initiated. Based on the depth of maintenance and the OEM requirements, as well as industry practice, facility layout and plant equipment can be developed. Similarly, the maintenance scope and OEM recommendations will together define the capacity of material warehouse and shipping and receiving requirements (note previous discussion of outsourcing the inventory function in Section 3.2.3.3).

3.2.4.3 In-Line or Single-Car Maintenance

Another consideration is whether vehicles will be maintained in-line, meaning still part of a train consist, or whether they will be uncoupled from the train for single car maintenance. A combination of in-line and single car maintenance activities need to be considered when planning for the construction of facilities along with the availability of sites with rail access, cost of real-estate and skilled workforce as well as any environmental constraints (noise, emissions etc.). It is important to design a maintenance facility(s) to minimize unnecessary switching moves for adding and subtracting coaches or locomotives from a consist and minimize dead head moves reducing fuel and crew costs.

In-Line Maintenance

In-line maintenance means that trainsets are created and a policy is made to permanently keep the same vehicles in each consist. Maintenance is performed on entire trainsets, without uncoupling, except in the case of heavy maintenance or unplanned maintenance requiring extensive work, such as resulting from a wreck.

There are several benefits to choosing in-line maintenance:

- **Minimizes coupling errors** — keeping trainsets together reduces the possibility of errors and oversight related to cabling equipment, coupling and any other inter-car connections that may affect train performance.
• **Reduces maintenance delays due to car cuts and adds** – Since most maintenance can be completed with a car still in-consist, there are fewer delays waiting for a crew to remove a car from its consist and bring it to the maintenance facility. Similar delays are also avoided in reinserting a car into a consist after maintenance is complete. Associated labor needs and costs for yard crews needed to perform the uncoupling and recoupling activities are also reduced.

• **Maintenance economies of scale** – This method allows all vehicles in a single set to always be scheduled for maintenance at the same time. When vehicles are added and cut from trains on a regular basis, the vehicles in a trainset at any one time will likely be at different points in their maintenance cycles and therefore require different maintenance and component change outs. Keeping vehicles in-line allows for certain economies of scale in performing maintenance. For example, a maintainer could change out all air filters on an entire train during one stop in the shop, thus consolidating the time required to get the new filters and dispose of the old, and making more efficient his actual change outs since the same procedure will be performed many times in sequence.

• **Consistent Trainset Composition** - From an operational perspective, in-line maintenance means that train consists are always the same. For an entity with trainsets of different lengths or composed of various vehicle types this can be particularly important in ensuring that suitable trainset compositions are available for the scheduled passenger services. However, since trainsets are always the same size, the ability to tailor capacity to meet demand is lost.

In-line maintenance can only be performed if there is a maintenance location large enough to accommodate a full train that has all the necessary equipment and design elements (for example, pits). It also depends heavily on the spare ratio of the fleet and the operational needs of the service. With inline maintenance, in some cases, such as with semi-permanently coupled Acela and Talgo equipment that is difficult to uncouple, a single vehicle failure can remove an entire trainset from service. Thus, the operation of revenue service must be able to recover from such a loss. Where cars can efficiently be removed, the problem is not as significant as bad order equipment can be cut from the train consist. This approach may still create capacity issues, but allows for continued service at some level.

Although in-line maintenance assumes that vehicles are kept in consist, there will still be occasions when it does become necessary to remove a vehicle. This situation might occur for repairs after an accident, or when other major repairs are necessary. Generally, any work that can be completed in a Service and Inspection (S&I) timeframe (e.g. 2 hours) at the S&I facility would be performed in-line. These activities would include locomotive fueling, sanding and fluids top off as well as toilet dumping. Repairs and FRA inspections (45, 180 day) that can be completed in a day, or similar short timeframe set by the agency, might be completed with the vehicle cut from its consist, but with the consist nearby awaiting reinsertion of the vehicle. Depending on the service needs, that consists could be put back into service, swapped out with a “protect” set, or handled in any other manner suitable to the agency while awaiting the addition of its missing vehicle.
Longer repairs might see a permanent replacement of the vehicle, or a spare vehicle might be inserted into the set to allow the trainset back in service while the vehicle is repaired. When possible, the vehicle being repaired would be swapped back into its original consist once it is ready for service to retain the benefits of in-line maintenance.

There are many variations of how to handle repairs beyond the limits of S&I repairs. Each agency has to determine what their operations, facilities and staffing can handle, but generally speaking, in the long term the initial composition of each trainset needs to be consistent if the benefits of in-line maintenance are to be realized.

To minimize the frequency of entire trainsets going out of service, in-line maintenance works best when combined with either a lifecycle or reliability centered maintenance philosophy, since both attempt to prevent equipment failures and make those that do occur more predictable.

**Single Car Maintenance**
If an entity is unable to perform in-line maintenance, or chooses not to, the goal is to make single car maintenance as efficient as possible.

With this strategy comes a further consideration of whether to permanently assign each vehicle to a specific trainset, or whether they will be shifted around as necessary to complete properly sized sets. Some of the benefits of in-line maintenance can still be realized through single car maintenance if trainsets consistently contain the same vehicles. Again, the example of replacing air filters – if a trainset always contains the same vehicles, the entire set will require new filters at the same time, but if trainsets are constantly reconfigured, a trainset could require new filters on a different day for each vehicle.

If not determined and formalized as a policy, the decision to maintain consistent trainsets will likely be left to the needs of the operational side of the organization. If a trainset of a particular size is needed for passenger service, those who prepare the trains for service will pull together whatever required vehicles are available to create the appropriately sized train. This will make it difficult to return to the predetermined vehicle consists if it is not corrected immediately and routinely.

### 3.2.4.4 Maintenance Facility Site Availability

The identification of maintenance facility infrastructure will be a significant criterion in the development of an overall maintenance plan. For a start-up entity, the identification of maintenance facility sites will be driven by factors including the following:

- **Quantity and Type of Facilities** – As previously discussed, the agency will need to decide which and how many of each type of facility (layover, S&I, main maintenance facility, back shop) is required, based on their agency, fleet and operational requirements.

- **System Layout** – The location of each maintenance facility should be considered relative to the concentration of routes forming a given network. A location which leads to deadhead requirements or dependency on carriers outside those traditionally involved in the network (as host railroads) should be avoided. For example, all routes in the Midwest intercity route network, with one exception,
operate into and out of Chicago. As such, easy access to Chicago is an important location factor.

- **Operational Characteristics** – Some routes will include significant branch lengths with extended overnight layovers. These operations may lend themselves to several smaller maintenance facilities to take advantage of that overnight contact time. Other intercity trains with shorter runs and more streamlined mid-day logistics may benefit from a larger, centralized maintenance facility. Operating scenarios requiring the entire equipment fleet to cycle through a centralized terminal make the selection of a central maintenance complex fairly straightforward.

For the new Midwest bi-level fleet, the cycling of train equipment should be carefully evaluated to determine whether an additional facility would need to be provided for the St. Louis – Kansas City route that does not serve Chicago. Alternately, it may be possible to rotate the fleet such that all vehicles can pass through a central maintenance facility as frequently as necessary to meet all required and recommended maintenance.

- **Property availability** – The availability and price of property for maintenance facilities are important considerations in the identification of maintenance infrastructure. For example, while it may be desirable to implement an in-line maintenance program, an entity may determine that a site for a thousand foot long building is simply not feasible, either because the land is not available, or because the cost of the land is too high. Not only the availability of the property itself, but the zoning of the area surrounding the potential sites needs to be considered. Due to the environmental impacts of a maintenance facility, any new facility or increased usage of an existing facility would require an environmental review.

- **Existing Facilities** - If existing maintenance facilities are available, the agency will have to review their condition, location, layout and obligations to determine whether they can or need to incorporate those facilities into their maintenance plan. If existing facilities are used, the agency should still evaluate the needs of the system and see if those can be accommodated at the facility, rather than simply deciding to use it as it had been used in the past. Although the end use of the facility may still rely heavily on the design of the facility, it may make sense to make some modifications to accommodate maintenance practices or tasks for which the facility was not initially envisioned.

- **Workforce Availability** – An agency should also consider the availability of skilled labor near any major maintenance facilities, and accessibility of the site to that workforce. Locating a facility in an area where it would be difficult to hire sufficient qualified workers could affect the ability to adequately or efficiently maintain the fleet. A separate, but related problem arises when it is located near other facilities that would compete for the same labor pool, thus increasing wages to retain employees.

- **Training** - Identifying, hiring and maintaining a trained, qualified and stable workforce capable of performing all levels of maintenance required to maintain the fleet of rolling stock is the backbone of the maintenance program. The process begins with establishing the required skill sets to establish the initial workforce and
the ongoing technical training program. The initial hiring requirements should include a written examination covering the equipment and tasks for which they will be responsible for and demonstrate the “hands-on” capability to successfully perform these tasks. Once the workforce has been identified, a complete Technical Training Program needs to be established that at a minimum complies with 49 CFR 238.109 and OEM requirements. This training should be required for all managers, clerical and maintenance craft staff and include periodic refresher training, at an interval not to exceed three years, that includes classroom and “hands-on” training and safety training. The safety training included in the curriculum should include the following topics at a minimum:

- Blue Flag Protection;
- Safe work practices on and around railroad equipment;
- High Voltage Electricity on Applicable Railway Equipment;
- Drug and Alcohol awareness (Supervisors-Managers only);
- Roadway Worker Protection;
- Right to Know; and
- Fall Arrest.

**Future Expansion** – Any maintenance facility plan should also consider anticipated system expansions or service increases that would need to be accommodated by the maintenance facilities. Depending on the imminence of those expansions, facilities could be built to accommodate them, or include space for facility expansion. Alternately, depending on the types and locations of anticipated expansions, it could be decided that an additional maintenance facility would be built as part of the expansion.

As stated above, the identification of the facilities and maintenance scopes will drive the layout and resources necessary for each facility. Furthermore, plans/models for maintenance facility siting should consider regional implications, such as the potential utility of sites across corridors/regions, i.e. what types of maintenance can and should be accommodated at facilities that are not “on corridor”. The maintenance approaches that are ultimately selected also impact these considerations.

### 3.2.4.5 Ownership of Maintenance Facility

It is unlikely under the contracted maintenance scenario that a contractor would have a facility or facilities of these types to include in their proposal unless the contact was structured as a PPP in which a long term contract was awarded that required the construction of such facilities. The advantages and disadvantages of such a model are discussed earlier in this narrative, and it is unlikely to be a good fit for the Midwest model. Therefore it is most likely that if an existing railroad facility does not exist, the State will be responsible for the funding, design and ultimate construction of the required facility. This approach will allow the State(s) to have some significant capital assets to offer as part of a contracted option or the necessary infrastructure for an in-house option.

### 3.3 Conclusions and Recommendations

The final determination of a fleet maintenance plan and maintenance philosophy requires investigation and evaluation of a variety of interrelated criteria and agreement by all members of the pooling entity on the type and approach of maintenance
required. A new entity must analyze its operating charter, both long and short term, its funding, staffing preferences, and maintenance facility options to develop the most desirable maintenance approach. As described in Section 3.2.2.6 of this report, maintenance programs based on LCM/RCM maintenance philosophies represent the best practice, and will result in increased equipment availability, lower overall life cycle cost and increase revenue potential.

4 TOPIC AREA 3: EQUIPMENT DEPLOYMENT

4.1 Overview

This topic area refers to the day-to-day or periodic deployment of equipment to specific routes and trains based on various considerations that include both availability and demand. In cases of dedicated corridors, equipment deployment decisions may be straightforward. However, many intercity passenger rail services operate as part of a larger network of interconnected or closely related corridors. In these cases, ensuring interoperability and therefore allowing the use of pooled equipment that may be moved between corridors to protect service and/or meet demand, can bring many benefits by reducing the overall fleet needs and therefore improving utilization.

4.2 Discussion, Options, and Evaluation

4.2.1 Scenarios for Equipment Deployment

Deployment of equipment under a shared ownership or management structure must be aligned with the managing entity’s overriding goals and objectives. Dependent upon these goals, deployment decisions, as discussed below, may be based on financial, equity, performance, or political factors. The deployment decision model must also be flexible and able to respond to unforeseen events or changes in demand.

Key factors providing input into the deployment decision process include:

1) Maintaining an established minimum level of service on each route
2) Maintenance and station facility constraints
3) Legal and or policy related constraints
4) Ridership & revenue
5) Flexibility (ability to move equipment as needed due to unforeseen events)
6) Reliability (spare count)
7) Political (not included in the decision model, but may influence the process)
8) Utilization (how many miles per hour of service per day per unit) – net impact of deployment decisions

Depending upon the managing entity’s goals, and assuming that there is an overall shortage of equipment, deployment decisions may be based purely on performance factors such as ridership and revenue. In this scenario, equipment would be deployed to routes with the highest demand and that can pay any net increase in costs associated
with the operation of additional equipment. However, this option may fail to protect
current services on other routes throughout the network and therefore may not gain
sufficient political acceptance for implementation, and may not deploy resources in a
manner that is consistent with long term growth potential. Therefore, it is unlikely that a
group of states would choose to establish a deployment model strictly on this basis.

In many cases, maximizing ridership and revenue may present a tradeoff. For example,
as illustrated in the simplified example provided below, if equipment is deployed to Route
A to serve a group of 120 making a trip of 50 miles as opposed to Route B to serve 90
riders making a longer trip of 250 miles, revenue and utilization would both be
compromised.

<table>
<thead>
<tr>
<th>Incremental Values</th>
<th>Route A</th>
<th>Route B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car Miles</td>
<td>700</td>
<td>700</td>
</tr>
<tr>
<td>Riderhip</td>
<td>120</td>
<td>90</td>
</tr>
<tr>
<td>Passenger Miles</td>
<td>6,000</td>
<td>22,500</td>
</tr>
<tr>
<td>Revenue</td>
<td>$1,200</td>
<td>$4,500</td>
</tr>
<tr>
<td>Seat Miles</td>
<td>49,000</td>
<td>49,000</td>
</tr>
<tr>
<td>Average Load Factor (PM/SM)</td>
<td>12%</td>
<td>46%</td>
</tr>
</tbody>
</table>

Clearly defined goals must be established and agreed to in order to provide guidance in
trade off scenarios such as this.

Variations in demand based the
direction of travel must also be
considered. While it may be
tempting to deploy equipment
to serve demand on an outbound trip during a peak period, the impact of returning the
equipment empty the next morning must be calculated.

A more likely deployment model will first establish a baseline service level for each
member route. Under this scenario the baseline, which would represent the minimum
level of capacity for each route, would form the basis of the initial equipment assignment.
The baseline will be maintained by the managing entity at all times. The managing entity
may seek to identify and secure protect equipment that will be maintained and ready to
deploy given unforeseen events. The protect equipment may be secured through
agreement or actual ownership.

4.2.2 Interoperability and Equipment Pooling

Most equipment pooling benefits are realized when equipment is pooled at the regional
(multi-state) network level. The key benefits of regional equipment pooling are as
follows:

- Economies of scale can be realized (i.e. larger equipment orders can be placed
to receive better unit cost bids);
- Maintenance facilities can be shared and common training programs can be
  used; and
- Equipment utilization can be optimized, reducing the need for spare equipment
  beyond that which is necessary in revenue service.

In addition to the pooling of equipment, benefits can also be realized through the ability
to deploy spare parts and warranty parts as a result of buying cooperatively and
managing equipment that is standardized and interoperable. Necessary parts could be
deployed throughout the network as needed, and the parts inventory could be managed
more efficiently than through individual equipment orders. Inventory management may
also be performed by the equipment supplier or another entity, which would assume
logistics responsibility.
Under PRIIA Section 209, states must pay Amtrak an Equipment Capital Charge. This charge is to be based on a five-year equipment capital plan that will be developed with input from the states. The charge will be used to fund equipment overhauls and rebuilds of Amtrak-owned equipment that is used in state-supported service. Amtrak’s ability to pool equipment at the regional, and even national for some equipment types, helps to minimize equipment capital payments. By pooling, Amtrak also has the ability to act quickly in the event of an emergency or other service interruption leading to an equipment shortage.

Benefits from equipment pooling at a national level are harder to achieve due to the costs of moving equipment over longer distances. However, under certain circumstances, benefits from sharing equipment across regions can be realized. For example, during seasonal variations when one region peaks while another is in a trough, if sufficient spare equipment is available and interoperable, the benefits of avoiding the need to purchase additional equipment may exceed the costs of moving it among regions. Sharing across regions can be accomplished either by having a national equipment pool or through identifying opportunities for regional equipment pools to share with each other. In many cases, Amtrak has moved equipment great distances in order to protect service levels due to unforeseen events.

It may also be possible to reallocate equipment between different common networks, provided that there is compatibility between the equipment to be transferred and the infrastructure and systems characteristics of the destination network. As the common networks may not be adjacent, the transfer charges to realize the reallocation may be considerable, so the duration of the transfer is likely to need to be lengthy in order to be cost effective. Such a transfer could be a practical solution if a previously non-electrified common network is electrified, releasing now surplus to requirement diesel equipment.

One difficulty in transferring equipment between networks is that certain travel demand sectors affect all networks at similar times. For example, college- and university-related traffic flows are similar from one line to the next, with similar schedules for the beginning of the term, various holidays/periodic breaks, and the conclusion of the term. This pattern means that peak traffic flows tend to occur on all networks at similar times. However, this is not always true when comparing commuter and intercity demand. While commuter networks tend to have less traffic during holiday periods, intercity networks peak. Amtrak has successfully demonstrated the use of commuter equipment in the NEC during peak periods. However, commuter equipment is only suitable for short distance trips and customer expectations must be carefully managed.

Another difficulty is that the distribution of peak traffic days tends to occur throughout the year, thwarting the objective of longer-term transfers of equipment from one network to

\[\text{Acela train in New Haven, CT}\]
the next. In addition, even within a single network there will be conflicting priorities between one state and the next in terms of a willingness to transfer cars off of one line to meet demand on another. The potential transfer of equipment also raises branding issues. Many of Amtrak’s fastest growing and most successful services have specific product branding. These services include the Acela, Capitol Corridor, Cascades, Downeaster, Pacific Surfliner and Piedmont. While still viewed as Amtrak trains, these services have in large part created an identity of their own, generating increased awareness and product loyalty. The issue of branding across a shared fleet must be carefully planned as the equipment will support a number of routes throughout the region and perhaps the country in the event of demand or incident based repositioning. Regional branding efforts will be required and must be supported by unified marketing goals and objectives. Development of the brand will require jointly developed materials, graphics and other media. The commercial aviation industry, where multiple airlines have joined forces to form alliances, may provide some examples.

4.2.3 Standards for Interoperability

The NGEC has developed specifications to ensure interoperability within and among various equipment types. Amtrak has also developed standards to ensure interoperability. Critical interoperability conditions include coupler compatibility, electrical connectivity and braking systems, communication and signal (for locomotives) systems, voltage (if electric), end door sizing, and heights and vehicle clearance requirements. The NGEC specifications are prescriptive about the core systems that will ensure that equipment of a given type can operate together. States have optional areas that can be tailored to their service but these are more focused on customer-facing elements.

There is a requirement for subsystems standardization in the NGEC technical specifications, and this condition has been incorporated into the only acquisition contract to date. If interoperability is taken to the next level, the issue of maintainability of equipment that is moved between operating locations must be addressed. Maintenance costs will decrease if there are common spare parts requirements.

4.3 Conclusions and Recommendations

The concept of making equipment deployment decisions to deliver baseline service focuses on public mobility and benefits. Once baseline service is protected, additional/expansion equipment could be deployed based on “purely” financial considerations, such as cost-revenue, utilization, and revenue maximization etc. In reality, actual deployment decisions will involve balancing these considerations by conducting a trade-off analysis between protecting basic public mobility and financial considerations.

There are many benefits of interoperability and the resulting ability to pool equipment for operation on multiple corridors. The need for spare rolling stock is reduced, driving lower total fleet life cycle costs, and availability is maximized. Major maintenance
facilities can be shared, lowering both initial capital and operating costs. While pooling rolling stock is not an option for corridors that are isolated in relation to other services, opportunities to pool equipment at the regional, and to some extent national level should be fully investigated and where practical implemented. Because Amtrak utilizes a regional or national equipment pool for many passenger rail routes, they realize the benefits of pooling as described above. Pooling of state- or agency-owned equipment for operation on multiple corridors will require close cooperation and management, as well as cost sharing and liability sharing agreements.

The Amtrak Cascades service provides an excellent example of the benefits of equipment pooling. This service, which operates with Talgo trainsets, F40 Cab/baggage cars and EMD F59PHI locomotives, uses equipment owned by Washington State (3 Talgo trainsets), Amtrak (2 Talgo trainsets and 6 F59PHI locomotives) and Oregon (F40 cab/baggage units and 2 new Talgo trainsets w/integrated cab control car). Until the Summer 2013 delivery of the two ODOT-owned Talgo trainsets, this service operated with no spare trainsets (spare cab cars and locomotives were available).

5 TOPIC AREA 4: EQUIPMENT ASSIGNMENT

5.1 Overview

Decisions regarding the composition and assignment of the vehicle fleet will impact the near-term and long-term ability to provide effective and efficient service. A well mapped process must be in place to enable key stakeholders to make decisions regarding issues such as equipment assignment, in which equipment may be purchased by one entity but ownership / control is transferred to a different entity. Example situations in which equipment assignment decisions must be considered include the following:

- If a Midwest regional entity is created to manage the bi-level fleet of equipment and new locomotives that are currently on order, what are the legal and or implications of transferring ownership and control of equipment to such an entity?

- If equipment is retired prior to the end of its useful life due to the procurement of new equipment to supplement the fleet, how should the retired equipment be re-assigned to another state or group of states which might be in need of equipment?

The process must support the overall goals of the governing entity and be flexible enough to adapt to unforeseen events. Additionally, the decision process must protect the interests of all stakeholders while also advancing the position of passenger rail as a viable and growing mode of transportation.

5.2 Discussion, Options, and Evaluation

While the assignment decision process related to the purchase of new equipment, and the use of dedicated protect equipment is relatively straightforward, the decision model also must deal
with more complicated scenarios. For example, should a state elect to discontinue service due to a lack of funding or for other reasons, the model most provide a process through which assignment of the newly available equipment will be determined. The agreed decision model must include funding capacity (ability of a state or states to fund additional equipment, if the net financial impact is negative) and also be need based. In the event that multiple states are capable of funding all costs associated with assignment of additional equipment, the overall increase in demand (ridership) over the life of the equipment (except for possible seasonal adjustments) must be considered. Ridership and revenue studies will likely be required to determine growth longer term corridor growth potential. Potential legal issues and potential policy related constraints concerning the assignment of state owned equipment that will be operated in other state(s) must also be considered.

5.2.1 Governance

If multiple states share a pool of common equipment and/or a common maintenance facility, those states will need to establish a framework for promoting their common interest and addressing legal constraints as well as issues amongst competing state interests. While day-to-day decisions can and should generally be made by the management (professional staff) of the organization, broader issues will need to be addressed by a governing body.

In the context of a regional equipment pool, governance issues might be addressed through a board of directors or commissioners. Such a board could take multiple forms, such as for each state’s governor to appoint their share of members to the board. If federal involvement were desired, federal members might also be appointed, either in an ex-officio fashion or possibly as voting members (past precedent suggests the federal government may desire voting rights if it provides significant financial support). Other non-voting board members might also be appointed for other stakeholders who are important partners. These approaches are similar to what is used for multi-state entities such as the Northeast Corridor Infrastructure and Operations Advisory Commission (NEC Commission), the Washington Metropolitan Area Transit Authority (WMATA), and the Appalachian Regional Commission.

Multiple options exist for the governance of a new national non-profit organization. One approach would be for the entity to be organized as an Amtrak subsidiary company, while another would be for the sponsoring states to form a non-profit corporation (without federal involvement) and name their own board of directors. Another approach might be for the board of directors to be presidential appointments, such as is the case with the Tennessee Valley Authority’s nine-member board. In this approach, Congressional oversight would take on a larger role.

Voting rights are also a key issue in the context of multi-state governance. One option would be for each board member to have one vote, while another would be for each board member to vote with the number of “shares” they have in the regional equipment pool. Shares might be linked to the number of vehicles the state has contributed to the equipment pool or the amount of its financial contribution to the regional entity. Veto rights as well as the number of votes required to address issues would also need to be considered.

5.3 Conclusions and Recommendations

Equipment assignment decisions must consider a number of factors that include establishing a baseline level of service for each route, the duration of proposed reassignments, costs of reassignment, demand (ridership and revenue), utilization factors, and long term growth potential. Where excess equipment exists, equipment should be assigned to member corridors.
(assuming there is a desire for additional equipment and the requesting state(s) are willing to fund related expenses) based on the agreed-upon goals of the managing entity. In most cases, this will likely result in decisions based on the largest net gain in ridership and/or passenger miles resulting from reallocation. In some cases, ridership and revenue studies may be required to generate the necessary data to make informed decisions.

6 TOPIC AREA 5: FINANCIAL RELATED – FUNDING, PRICING, AND COST SHARING

6.1 Overview

Funding, financing, pricing, and risk management are also key issues that must be addressed when considering management of a shared equipment fleet. In addition to grant funding or direct state funding, financing approaches such as loans and leasing should also be considered. These tools can be useful for amortizing (spreading) equipment capital costs over time, which can facilitate the budgeting process and alleviate challenges associated with securing up-front capital, which can be difficult during challenging economic periods. How equipment is priced is also paramount, as it is important for new approaches to avoid the creation of incentives that indirectly encourage poor management practices (e.g., retaining old equipment such that it negatively affects reliability or retiring equipment before the end of its useful life). The effects of PRIIA Section 209 also need to be considered, as these changes will also have an impact on these issues if Amtrak owned equipment is involved.

6.2 Discussion, Options, and Evaluation

6.2.1 Funding and Financing Considerations

The key funding and financing issues can generally be categorized as follows: funding for equipment purchases, maintenance, and renewal; financing approaches to amortize equipment capital costs; and funding of the managing organization’s operating costs.

Regardless of which approach is taken, the presence of state funding and FRA grants will continue to be important pillars to support the expansion of intercity passenger rail services and acquisition of new and/or replacement equipment. These funding sources will be needed regardless of whether states directly purchase new equipment, lease equipment, or procure concessions and contracts for private partners to provide and/or maintain equipment.

Beyond funding sources, new financing approaches may be necessary in order to implement the NGEC’s vision for the next generation of intercity passenger rail equipment. The creation of a new entity must also be considered, but this would also require funding for its operations. Both of these issues are discussed further below.

6.2.1.1 Financing Approaches to Amortize Equipment Capital Costs

As mentioned above, securing adequate funding at the optimal time for equipment renewal or replacement is a challenge for many states (as well as Amtrak). If funding is not received on a timely basis, renewal or replacement can be deferred, resulting in an increase in maintenance costs and a negative impact on equipment reliability. The
end effect can be sub-optimal optimization of life-cycle costs and/or discouraging customers from rail service—both of which are counterproductive.

This issue can be mitigated by amortizing the capital costs of equipment over time. Although amortization generally results in adding financing costs to the equipment, the annual funding needs fluctuate far less when the funding needs are spread over the life of the equipment, which can alleviate budget pressures when public budgets are constrained. Three ways to achieve this are: (1) states or Amtrak can finance the capital costs of equipment purchases through loans, (2) states or Amtrak might lease equipment from a third-party (e.g., new national non-profit), and (3) states could use a long-term public-private partnership concession agreement where a private partner provides equipment to the state and recovers its capital investment over time through the annual payments in the concession contract.

The risk of not receiving payments on time is an important factor influencing the cost of borrowing from banks or private investors. Because the market for intercity passenger rail equipment in the United States is smaller and less mature than in other countries and other industries, providing the rail equipment as collateral for the loan has a limited impact in reducing the cost of borrowing. In other words, in today’s U.S. passenger rail market there are a relatively small number of other potential buyers in the event the borrower defaulted on the loan and the lender needed to claim and then sell the equipment. However, if the domestic passenger rail equipment market flourishes and does so with standardized/interoperable equipment, the size of the potential resale market would increase and the cost of borrowing from non-federal sources on a limited recourse basis could be reduced.

In order to receive more favorable lending terms, “backstopping” (which is the practice of providing an additional revenue source pledge to provide lenders greater confidence the loan will be repaid) or loan guarantees by a government entity could be used. For this approach, the creditworthiness of the borrowing organization and the security/risk of the revenue source to repay borrowed funds are important factors that influence the cost of borrowing from non-federal programs. In order for a new non-profit entity to borrow funding from commercial sources at reasonable interest rates, the non-profit would need some form of a backstop pledge or guarantee for the lenders.

FRA RRIF loans as well as USDOT TIFIA loans are two existing federal financing tools that could be used for a public agency to finance the cost of new equipment. TIFIA also offers loan guarantees. These programs can be beneficial in that they can provide loans at the federal government’s borrowing cost, which has been generally lower than the cost of borrowing from other sources (particularly since the 2008 financial crisis) and can be structured to defer initial payback of principal. Amtrak has recently used FRA RRIF loan financing to fund new equipment purchases.

Although none have been enacted to date, various legislative proposals would expand the list of financing tools available; chief among them are a national infrastructure bank and tax-credit bonds. PRIIA reauthorization could assist the financing of the next generation of intercity passenger rail equipment by including new or improved financing tools that lower the cost of financing rail equipment below the rates associated with RRIF and TIFIA (some of the tax-credit bond proposals have proposed lower effective borrowing rates). To provide a wide array of options, these programs would be most beneficial if states, Amtrak, private equipment concessionaires, and new rail non-profit organizations were all eligible. Finally, federal tax
policies as regards capital asset leasing merit re-examination if only to assist in achieving longer-term economic re-industrialization goals.

6.2.1.2 Funding for a New Organization’s Operating Costs

If a new national entity is created, or if the NGEC continues and becomes the organization that will provide equipment management services, annual funding will be needed to pay for the organization’s operating costs such as overhead (management, administrative, benefits, and facilities) and staffing costs.

Over the long term, one possibility is that a national non-profit equipment procurement entity might generate sufficient annual revenue from its professional services to cover its operating costs (although external funding would still be needed for the capital costs of equipment acquisitions).

One way in which these revenues might be realized would be for the organization (assuming the entity were to perform large joint procurements on behalf of states and Amtrak) to keep a portion of the savings realized by the additional economies of scale generated by its aggregated procurement. A per car fee could also be considered; however, unless there were to be a mandate that all equipment purchases must be through the entity, the fee should be less than the benefits of the savings to the states or else the fee might discourage use of the entity. A steady stream of equipment orders through the organization would be needed for either of these to be practical options as a primary funding source for the entity’s operating costs. Another potential source might be consulting services offered by the entity. If the entity leased equipment to others, then revenues from lease payments might also be a source of operating revenue.

To start up such an entity and until it became financially self-sufficient, funding from outside sources would be needed cover the entity’s operating costs. Some of the potential sources to consider further include the following:

- Direct grants from FRA’s HSIPR grant program;
- Funding through Amtrak appropriations at the direction of Congress (to the extent Amtrak is a member, or the new organization provides some level of services to Amtrak; this is similar to the approach used to provide funding for the NEC Commission);
- A small set-aside (e.g., 0.5%) from all FRA capital grants (both HSIPR and Amtrak);
- A new program (that doesn’t currently exist) that might be sought for implementation in a future multi-modal (highway, transit, and passenger rail) federal transportation bill;
- Dues from states that plan to use the new entity’s services; and
- Financial support from AASHTO.

Dedicated funding sources from the federal government, such as a set-aside from all FRA capital grants or a new program that might be created in a new federal transportation authorization bill, would be ideal for a new entity. Funding reliability is a common challenge for many public agencies, and dedicated sources help an entity plan for the future and focus on their core mission rather than assessing whether they
will receive funding next year and spending considerable energy on securing the next
twelve months of funds. While desirable, dedicated funding sources can be more
challenging to secure. Elected officials, particularly legislatures, often prefer to
maintain control in decision-making about year-to-year funding levels because this
provides them with additional opportunities for oversight and control of the entity.
Additionally, they may be hesitant to create a dedicated funding source if the
advocates suggest the entity could ultimately become financially self-sustaining in the
future. Therefore, one-off funding sources (e.g., funding from AASHTO, or a one-time
grant from FRA or Amtrak) may be the most practical and feasible in the early years
until the entity demonstrates its benefits to elected officials and stakeholders.

6.2.2 Pricing and Cost Allocation Structures

6.2.2.1 Pricing and Cost Allocation

For the equipment management entity, the method(s) of cost allocation must reflect
costs associated with both maintenance- and equipment-related operating costs.
Recapitalization costs could also be included. While the needs for equipment and
service may differ, the ability to accurately predict and capture maintenance costs will
be critical to creating maintenance cost formulas. Maintenance costs should reflect a
life cycle cost if the model/structure is to be sustainable. The approach needs to also
have controls that enable its implementation across different corridors, public and
private participation, and with different points of entry relative to both time factors and
levels of participation.

Potential cost allocation and/or pricing methods should consider both time and usage
in terms of mileage. Useful statistics may include units used, which is a statistic used
by Amtrak to allocate both operating and capital equipment-related costs to individual
routes. This statistic is a measure of units that are used in a particular service over an
established timeframe. Simple statistics such as car miles, or locomotives miles
should also be considered, and may be appropriate for allocation of costs among
multiple states that support a route(s). However, the use of car miles or locomotives
miles or even frequencies that are operated will not fully capture the amount of time
that equipment is dedicated to a specific corridor or sponsoring state. The allocation of
costs among states on that sponsor a single route(s) could include ridership or
passenger miles to represent usage, but this would create a perverse incentive
structure where states are awarded for contributing fewer passengers. Therefore, this
approach is not recommended. The use of difference allocation factors for operating
and capital expenses may also be appropriate.

The methodology used by TTX Corp. in its pooling agreement with member railroads
(10 Class 1 and Class 2 railroads) offers another example. TTX owns a pooled fleet of
mostly intermodal cars that are used by member railroads. Usage charges include
both a per diem (daily charge), and mileage charge (either empty or loaded). The per
diem is reduced by 50% for periods when cars are not in service.

Cost allocation and/or pricing may also vary by equipment type. For example, if
protect equipment is available, it would not be reasonable to price the equipment
solely on a per usage basis as all participating states benefit from its availability.
Therefore, the pricing in this scenario may be based on an annual charge that covers
base costs and usage charge that only covers direct costs associated with usage on a
particular corridor.
Finally, equipment pricing methodology must also consider unforeseen events and related expenses associated with equipment damage and liability protection. To address this issue, the costs related to equipment damage could be allocated solely to the state or state(s) sponsoring the service where the damage occurred. While this is perhaps the simplest method, it could have the effect of placing a large burden or a state or small group of states. Therefore, the pricing policy should consider methods through which liability related expenses are shared. To ensure fairness, risk factors may be applied to adjust prices and credits could be calculated for investments, such as grade crossing elimination or improvements that improve safety.

Task II of this report will recommend a specific pricing and cost allocation methodology for the Midwest intercity passenger rail network, where the new bi-level cars and high performance locomotives will operate.

6.2.2.2 Comparison between Rates of Old and New Equipment
One of the goals when creating a pricing model is to avoid encouraging actions that are counter to the larger goals that are being set. For those options that include a price for the capital asset, it is important to set up a pricing structure that does not make a life-expired asset too attractive from a price perspective. If the entity is being created only through new equipment, this issue is not one that will initially be relevant but it will have an impact in due course. (For a commercial entity, the ability to constrain the pricing models is limited since the businesses can choose to price as they see fit.)

Therefore, only if existing equipment is being added to the portfolio will the pricing immediately have an impact. The goal should be to have a distribution of equipment ages throughout the fleet and then replace the equipment when it reaches defined life thresholds. Older equipment should not be priced at too great a discount; otherwise, it becomes a disincentive to replace when a customer is going to have a significant increase in lease rental for the new equipment.

6.2.3 Risk Allocation and Liability Insurance
Establishment of a shared equipment fleet has the potential to create a number of liability issues related to third party maintenance. Amtrak currently indemnifies and defends state-supported service partners against claims that might arise as a result of their operation of the service. However, based on current practice, Amtrak will not indemnify states against claims that might arise due to equipment condition if the subject equipment is controlled and/or maintained by a third party. Currently, Amtrak requires that third party maintenance providers indemnify and defend Amtrak against such claims and to maintain significant levels of insurance. The cost to procure and maintain required insurance levels can be large.

The US commuter rail market provides a case study. Most commuter railroads do not enjoy the same liability protections that are afforded to Amtrak’s state-supported service partners. As such, they must secure sufficient liability protection. While PRIIA caps total liability resulting from passenger rail accidents at $200 million, some railroads require commuter operators to carry even greater coverage. In total, commuter railroads typically spend between 1% and 15% of their total operating budget on liability protection.¹ Regional or some other form of centralized

¹ United States GAO Report to Congressional Requesters, Gao-09-282, COMMUTER RAIL, February 2009
equipment ownership or management may generate benefits from economy of scale in the purchase of liability protection. The owning or managing entity, along with member states should evaluate opportunities to jointly procure both liability and property insurance. Potential legislation to reduce liability exposure at the national, regional or state level should also be considered.

The managing entity must also weigh the potential savings in this area that may result from using the same entity to provide both operations and maintenance, such as the service Amtrak provides to most states today. To a lesser extent, savings could be available from other operators that also manage equipment maintenance functions. It must also be noted that Amtrak provides turnaround servicing at many locations via a contractor that is under Amtrak management. Washington State is unique in the Amtrak employees perform maintenance services under Talgo management. In each of these cases, Amtrak is sufficiently involved in the maintenance process to not require indemnification for potential losses that result from equipment failures.

6.2.4 Relationship to PRIIA Section 209

Section 209 of the Passenger Rail Investment and Improvement Act of 2008 (PRIIA) significantly alters Amtrak’s relationship with its state-supported service funding partners. To the extent Amtrak-owned and controlled equipment is used under potential ownership/control structures, PRIIA Section 209 will bring three primary changes from current policy. First, under the proposed policy as developed by the States Working Group (SWG) and Amtrak, beginning in FFY2014, existing state-supported service partners will begin making equipment capital contributions. Second, existing system corridor trains will transition to become state-supported. Third, non-capital mechanical expenses will be determined based on the results of Amtrak’s Performance Tracking (APT) cost allocation system, with support costs calculated as an additive. These impacts are examined in greater detail below.

6.2.4.1 Equipment Capital Charge for Use of Amtrak Owned Equipment

Under the existing state-supported service pricing policy, states are responsible for funding non-capital maintenance including turnaround servicing, locomotive and car maintenance and maintenance of equipment support expenses.

Under the proposed methodology, states will be charged an equipment capital charge for use of Amtrak owned equipment based on the type and amount of equipment used in each service. For existing equipment, charges will be based on the capital maintenance expense associated with equipment rebuilds and overhauls. For new equipment, the charge will also include the purchase and associated finance charges resulting from equipment acquisition.

The equipment capital charge will be based on an approved five year equipment capital plan that is developed with input from impacted states. The capital charge will be based on the cost to perform overhauls and rebuilds for each equipment type. States will be charged for their use of each equipment type using the units used statistic, which calculates the level of usage by route and equipment type. Since states only pay for the equipment that is used in their service (by equipment type) and not by specific cars, reassignment and/or movement of specific cars and locomotives between routes is not an issue.
As stated previously, the equipment capital charge under PRIIA Section 209 only applies to the use of Amtrak-owned equipment.

6.2.4.2 Conversion of System Corridor Trains to State-Supported Status

Conversion of system corridor trains to state-supported status will impact a number of key intercity passenger rail corridors throughout the United States. These services include a number of major corridors such as the Empire Corridor, New Haven to Springfield, Pacific Surfliner (partially supported), Cascades (partially supported), Keystone Corridor (partially supported), Wolverine service and the Washington to Richmond/Newport News services (partially supported).

While states must pay for the operation of these routes, they will have input into operating and maintenance decisions.

6.3 Conclusions and Recommendations

Cost allocation among routes that use a shared equipment pool should reflect the relative usage of equipment for both operating and maintenance expenses and overhaul and rebuild expense. To reflect relative usage, the allocation methodology may vary between operating and capital. While a number of options exist, the cost sharing methodology must consider usage in terms of both mileage and time. Availability of data to support the selected allocation model is also a key factor. Even simple measures such as train miles and car miles require the maintenance of data related to actual (as opposed to scheduled) train operations. Usage on a single route that serves multiple states must also be measured.

7 TOPIC AREA 6: EQUIPMENT OWNERSHIP MODELS AND STRUCTURES

7.1 Overview

There are a number of viable options when considering ownership of passenger rail equipment. When selecting ownership form, assuming that equipment is owned and not leased, a number of key factors including the desired level of control, legal, policy and political issues and constraints, desired level of customization for the subject equipment, requirements of the operating entity, and importance of efficiency and cost effectiveness must be considered. For example, while each state owning its own equipment may make sense from a control and in some cases political, legal or regulatory standpoint, this option will likely result in significant duplication of effort when applied in the regional or perhaps even national context. Ownership by a new regional or national entity would result in less control and to some extent less opportunity for customization, but will would likely result in new efficiency and the potential for economy of scale. International case studies also provide insight into potential ownership structures. Some of these international examples are highlighted in Appendix C.

Equipment ownership should not be considered a goal unto itself. States should develop proposed approaches to their key issues first, and then decide which ownership model(s) are most appropriate to help accommodate or facilitate those approaches.
7.2 Discussion, Options, and Evaluation

7.2.1 Equipment Ownership Options

Five principal ownership options have been identified:

Existing Ownership Structures

1. **Individual states** can continue to own equipment required to provide service in their State or over their state-supported corridor(s). Currently, California (Pacific Surfliner, San Joaquin, and Capitol Corridor), North Carolina (Piedmont), Oregon and Washington State (Cascades) own rolling stock that is used in Amtrak state-supported services. As discussed in the governance section of this report, states may also maintain ownership and turn over some or all management functions to Amtrak, or a new regional or national entity.

2. **Amtrak** owns rolling stock that is currently operated in 24 of 27 state-supported and other short distance routes. This includes Amtrak owned equipment that operates interchangeably with state-owned equipment in the Cascades and Pacific Surfliner services. Amtrak provides equipment for use in state-supported services without charging for capital maintenance or other ownership related fees. States do pay for turnaround servicing, program maintenance and other routine servicing. PRIIA Section 209 will change this equation. Under the proposed pricing policy, Amtrak will begin charging an equipment capital fee for use of its equipment.

With regard to ownership, if Amtrak agreed, a state or group of states could purchase equipment through Amtrak, or transfer ownership of equipment to Amtrak after it is purchased. While Amtrak in many ways offers one stop shopping, this option provides the less control than individual state or regional ownership and would require significant oversight as the sponsoring entities would no longer own rolling stock used in their services and availability must be assured. Despite the loss of control, Amtrak offers a number of advantages including maintaining equipment availability through its extensive network during a crisis situation that may result in equipment being out of service for an extended period.

New Ownership Structures

1. **Regional not-for-profit entities** could be established to own and/or manage and maintain shared equipment fleets. Under this option the regional entity or authority would own state-supported equipment and likely perform many of the management functions. The new regional entity would likely serve under the direction of a board or directors or other oversight structure that includes representatives from states for which the equipment serves. While these entities might be created for just new equipment, context-specific factors (e.g., characteristics of existing maintenance facilities, commonality of existing equipment, willingness of states to cede some control, etc.) would influence whether it is appropriate for them to also include existing equipment.

2. **A national not-for-profit entity** could be established to own new rail equipment. This option is much like the regional not-for-profit scenario, but at a national level and presumably only for new state-supported equipment purchases. While this option may offer the greatest potential benefit from economy of scale, it may not be practical in the
near term given the limited fleet size that is currently envisioned and regional nature of corridor operations.

3. **Concessionaires**, if they run a contracted state-supported service, concessionaires could also own the equipment (although this is less likely if the concession contract life is considerably less than the life of rail equipment).

There are dozens of potential variations these options could entail, however, all three of the new ownership options would presumably have agreements between the state supporting the service and the new entity that would need to be negotiated. If Congress mandated some specific requirements of use, there might be fewer terms that need to be negotiated, which could also promote consistency in the agreements.

Additional benefits or adopting a new approach for ownership (aside from those described elsewhere in this section) include:

- Potential for demonstration and development of new equipment.
- Central ownership could ease logistics for testing on multiple corridors.
- Cost sharing for demonstration equipment would need to be developed.

7.2.2 **Leasing**

Two of the most important characteristics of leasing are that it can help finance equipment and it can help with the distribution of equipment from a larger pool owner. Leasing reduces the initial capital outlay by amortizing purchase costs over a longer term. If priced and structured appropriately, leasing can create incentives for replacing equipment at the end of its useful life (which can improve reliability to promote quality service). If the market conditions are sufficient to support a leasing business, this approach provides flexibility for lessees to scale their equipment needs up or down more quickly as their needs change. By reducing capital costs and supply timeframe, leasing also reduces barriers to entry.

7.3 **Conclusions and Recommendations**

In general, equipment ownership should not be considered a goal unto itself. Rather, equipment ownership might be thought of as a byproduct of decisions made on other factors such as the states’ desired approach for equipment management, the degree to which equipment should be shared across state lines in a multi-state regional network, or some states’ potential desire to lease equipment from a private contractor/concessionaire. It is recommended that states develop proposed approaches to the other key issues first, and then decide which ownership model(s) are most appropriate to help accommodate or facilitate those approaches.

It should be noted that the benefits of a new national not-for-profit entity are largely based on economies of scale. Therefore, if many states opt not to use a new national entity—instead preferring to have individual states, regional entities, or concessionaires own the equipment they use—then its attractiveness and viability could diminish.

8 **ILLUSTRATIVE SCENARIOS FOR CONSIDERATION**

While prior sections presented a range of options for addressing each key issue, in those sections each issue was considered and discussed in relative isolation. The ultimate approach to the next generation of rail equipment, however, will need to address all of the key issues cohesively. While the NGEC might “mix and match” among the menu of options presented in
Sections 2-7, some options pair together more naturally than others. This section presents multiple scenarios for ways in which some of the options on the key issues might be combined. These scenarios are by no means the only possible combinations—many exist—but they are intended to present a tangible set of potential approaches that could be a starting point for NGEC review and further refinement. Informal names (e.g., “the regional concessionaires”) are used to describe the scenarios purely for illustrative purposes.

Many of these scenarios represent radical changes from this country’s current approach to intercity passenger rail equipment. As such, this section will also identify some potential incremental actions that could be taken to work toward implementation of the scenarios. It should be noted that a “do nothing” or “status quo” scenario also exists in theory but is not described here because the spirit of the NGEC and the purpose of this report is to present a range of options for new approaches.

8.1 Potential Scenario 1: “The Incrementalist”

8.1.1 Scenario Description
In this scenario, NGEC would continue to update the specifications and standards although it would do so as an AASHTO committee. Equipment would be procured similar to how it is done today, but with assistance from AASHTO or Amtrak, who would manage a procurement clearinghouse that helps put purchasers in touch with others placing similar equipment orders. Equipment would be maintained by Amtrak or a private contractor procured by the sponsoring state(s) for each corridor. Equipment would be owned by either Amtrak or the states (if owned by the states, states might provide what they have to Amtrak or the contractor in exchange for lower contract costs). To the extent that equipment is owned by states and private contractors are used to maintain it, it is assumed the contracts would be relatively short-term (i.e., less than 15 years) and therefore the states would retain responsibility for the equipment life-cycle management decisions. Equipment would generally be used only in the corridor or state for which it was purchased (although Amtrak might redeploy equipment it owns/manages).

8.1.2 Implementation Phasing Opportunities
By its nature, this scenario could be considered an opportunity for incremental actions toward other scenarios. Therefore, there are few opportunities for phasing within this scenario. Two key opportunities for phasing in this scenario are as follows:

1. Establishing an AASHTO Committee to be responsible for updating the technical equipment specifications and standards; and
2. Creating a procurement clearinghouse through AASHTO or Amtrak.

8.2 Potential Scenario 2: “The Regional Concessionaires”

8.2.1 Scenario Description
This scenario is similar to the first in that NGEC would update the specifications and standards as an AASHTO committee. A major difference is that equipment would be pooled on a regional (multi-state) basis, and new regional non-profits (i.e., new multi-state regional authorities) would be created to facilitate these actions. In this scenario, the regional authority would rely extensively on contracts for the management, maintenance, and provision of vehicles. The regional authority would procure 15-30 year contracts for a concessionaire to provide equipment to the regional network and maintain it. The concessionaire would purchase and own its equipment, and equipment already owned by states might be offered up to the concessionaire...
(although it could be kept separate if desired). The concessionaire would be compensated on an “availability basis”, where it receives annual payments for delivering the equipment but is penalized for not delivering the specified number of vehicles to service each day or if the vehicles encounter issues during the day. Costs would be allocated among the states based on an agreed-upon formula. Day-to-day decisions on equipment maintenance would be made by the concessionaire but larger decisions would be made by the regional non-profit’s board, which might be comprised of members appointed by state governors and the federal government.

8.2.2 Implementation Phasing Opportunities

There are several potential opportunities for incremental actions toward this scenario. Opportunities include:

1. Implement Scenario 1;
2. Appoint a dedicated regional equipment manager within Amtrak;
3. Create an Amtrak equipment company;
4. Create an Amtrak subsidiary for state-supported services; and
5. Create a multi-state regional planning/policy entity.

In the second opportunity, a regional equipment manager would be appointed to coordinate and manage equipment services across Amtrak’s departments for state-supported corridors within a regional network. This individual could also serve as a single point of contact for states and help coordinate and share information between states that are in the regional network.

The third option would create a new company within Amtrak to manage all of Amtrak’s equipment. The scope could be national, including equipment for long-distance services. This company might not only take on responsibility for planning associated with Amtrak’s fleet, but also a leadership role in compiling and sharing information about equipment procurement plans of the states. A different type of Amtrak company would be created in the fourth option, where an Amtrak subsidiary would be created to provide and manage all aspects of Amtrak’s state-supported services.

The fifth opportunity would promote regional coordination among states within a regional intercity passenger rail network. By limiting the functions of the new multi-state entity to planning and policy, the entity could promote multi-state cooperation and coordination, as well as establish a framework to potentially take on a broader range of functions at some point in the future. Such an entity could take several forms: examples include the Northeast Corridor Infrastructure and Operations Advisory Commission (NEC Commission), which was created by Congress in PRIIA, or the I-95 Corridor Coalition, which is a non-profit organization with voluntary membership. This opportunity could be implemented in conjunction with any of the other opportunities identified in this section.

8.3 Potential Scenario 3: “The Public Regionalist”

8.3.1 Scenario Description

The third scenario is similar to the second, but equipment would be procured, owned, managed, insured, and maintained directly by the new regional non-profits. The regional non-profits would employ staff to perform these functions, where the staff might be designated as federal employees and/or employees of the regional authority. Some regional authorities might use consultants to act as an extension of staff. Day-to-day decisions on the equipment would be made by the professional staff while larger decisions would be made by a board of directors.
When new or additional equipment is needed the regional entity would procure an equipment order, and the state(s) that needs the equipment would be required to provide funding for the equipment purchase. Maintenance and insurance costs would be allocated among the states based on an agreed-upon formula.

8.3.2 Implementation Phasing Opportunities
There are several potential opportunities for incremental actions toward this scenario. Each of the potential phasing opportunities identified for Scenario 2 could also apply to this scenario. Further, Scenario 2 could also be considered for a potential phase of this scenario, as it may be easier to procure a regional concessionaire with a minimal number of public-sector employees than directly hiring all the staff needed to manage and maintain a multi-state equipment fleet.

8.4 Potential Scenario 4: New National Non-profit

8.4.1 Scenario Description
In this scenario, a new national non-profit would be created that owns and updates the specifications and standards, finances/procures/owns/insures all new equipment, leases equipment to states, performs heavy maintenance or procures heavy maintenance contracts, and makes deployment decisions among the states. Day-to-day decisions on equipment, as well as light maintenance, would be performed by states or regional non-profits.

8.4.2 Implementation Phasing Opportunities
Potential phasing opportunities also exist for incremental actions toward this scenario. Opportunities identified from the prior scenarios that could also apply here include:

1. Implement Scenario 1;
2. Create an Amtrak equipment company; and
3. Create an Amtrak subsidiary for state-supported services.

Although one avenue for creation of a non-profit corporation could be federal legislation, states could also create a non-profit corporation for equipment pooling and management without federal intervention. This non-profit might initially be formed by a relatively small number of states as an initial phase, and then grow to add other states over time.

FRA grants or cooperative agreements might be used for seed capital and funding in the early years, while special financing tools (e.g., loan guarantees, tax-credit bonds) and revenues from lease transactions might ultimately be used finance the non-profit.

8.5 Comparison of Scenarios
Although there are dozens of possible variations, the four scenarios presented in this section represent a wide range of different approaches to the next generation of intercity passenger rail equipment. The table below contrasts key elements of the four scenarios.
<table>
<thead>
<tr>
<th>Function</th>
<th>The Incrementalist</th>
<th>The Regional Concessionaires</th>
<th>The Public Regionalist</th>
<th>New National Non-Profit</th>
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<td>NGEC</td>
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<td>Regional concessionaires</td>
<td>New Regional non-profits</td>
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<td>Amtrak or AASHTO clearinghouse</td>
<td>Amtrak or AASHTO clearinghouse</td>
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<td>New regional non-profits (public sector employees)</td>
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<td>New regional non-profits</td>
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<td>New national non-profit board of directors</td>
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Relative to the other three scenarios, “The Incrementalist” is likely to be the easiest for implementation in the near term. Variations of this scenario could likely be implemented within existing law. It is based in large part on greater partnership and coordination among the states and Amtrak, relying on a facilitator (such as Amtrak or AASHTO) to promote information sharing and voluntary participation of the states. Although this approach may be effective at coordinating procurements and updating the equipment specifications, it generally leaves equipment management, maintenance, deployment, assignment, ownership, and financing issues as the status quo. Based on past precedents, most decisions and agreements would likely be “corridor based” rather than optimized from the perspective of a multi-state regional network; however, states would likely retain the most direct control over the equipment and associated decisions.

“The Regional Concessionaires” scenario would represent a significant transformation from today. Equipment would be approached on a regional network level (embracing economies of scale), promoting enhanced multi-state coordination and optimizing across the regional network rather than with respect to each state. Financial incentives included in the long-term public-private partnership (P3) contract that would be intended to promote efficiency in equipment procurement, management, maintenance, deployment, and assignment. States could be relieved of procuring vehicles and would instead have agreements with their respective regional authority(s), which would procure the P3 contract and provide oversight of the concessionaire. To implement this scenario, both state and federal legislation generally would be required in.
order to create the regional authorities. As outlined in this scenario, states effectively would cede some decision-making authority and powers to the new multi-state regional entity. As there are few examples of where this has occurred on such a scale in the past, strong support from the states would likely be required in order to gain Congressional approval. The role of the states and Amtrak could also evolve in this scenario, as the regional concessionaire would be responsible for most day-to-day equipment decisions.

“The Public Regionalist” scenario is similar to the former in many ways but includes some notable contrasts. In contrast to The Regional Concessionaires, public employees would be used in lieu of a concessionaire to procure, manage, maintain, deploy, and assign equipment. From a political acceptance perspective, there is a diverse range of views with respect to the issue of public versus private employees, with insufficient experience/data to conclude definitively whether public or private would be more cost effective. Public employees and a board of directors would provide oversight in either case, although this scenario may mitigate some stakeholders’ potential concerns of transferring significant responsibilities to for-profit entities. Other stakeholders, however, may be concerned about the creation of a large new multi-state public agency. As with the prior scenario, consensus among the states on the need for such an entity would likely be required in order to gain Congressional approval for this scenario.

The fourth scenario, which would create a new national non-profit, would have the most national centralization. By centralizing all new public agency equipment procurements and heavy maintenance, it could promote the greatest economies of scale in procurement, insurance and heavy maintenance activities. If federal legislation were sought to create a new stand-alone entity, consensus among the states and Amtrak would likely be required in order to gain Congressional support.
APPENDIX A: AMTRAK EQUIPMENT ACQUISITION PLAN
<table>
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<tr>
<th>Fiscal Year</th>
<th>New Single Level Car</th>
<th>Horizon</th>
<th>Superliner (40) + Dome Parlor Cars (12)</th>
<th>Auto Carrier</th>
<th>Work Cars</th>
<th>Electric Locomotives</th>
<th>Diesel Locomotives (incl. Switchers)</th>
<th>Amtrak Fleet Management</th>
<th>HighSpeed Trains</th>
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Source: Amtrak Fleet Strategy – Building a Sustainable Fleet for the Future of America’s Intercity and High-Speed Passenger Railroad (Attachment 2), March 2012
APPENDIX B: EQUIPMENT MANAGEMENT PRACTICES IN OTHER INDUSTRIES

B.1 US Freight Rail
Today, over 40% of the US’s freight (measured in ton-miles) is carried by rail. There are over 560 freight railroads in operation in the US, but there are only seven major (“Class I”) railroads.

It is common practice for Class I Railroads, which account of 70% of the industry’s total track mileage operated, to lease a substantial portion of their rail cars and locomotives. For example, Union Pacific, one of the two largest railroads, has maintained a balance of owned-to-leased rail cars of nearly one to one for over five years. Approximately one-third of their locomotives are leased. Lease agreements can range from just a few months to more than 30 years. With typical costs of cars ranging from $78,000 to $120,000 each, it is easy to see that purchasing enough cars for just a few new trainsets can be a substantial capital investment.

The lessor market is similar to the leaser market in that a few companies control the majority of the market. The lessor market is composed of independent leasing companies, financial institutions, private equity firms and brokers, and financial advisors. Some of the largest lessors include: CIT Rail, GATX, First Union (owned by Wells Fargo) and GE Capital Rail Services. The ten largest lessors and TTX account for 700,000 freight cars, or close to half of the North American fleet. Outside of this core group of lessors, smaller firms that specialize in a particular type of rail car are common.

The TTX Company is not a traditional lessor and is an example of a “leasing” company that was created to achieve multiple goals. The company is a consortium of railroads and pool cars that are dedicated to intermodal services. TTX was founded by three independent railroads in efforts to (1) standardize the rail equipment for piggybacking (the practice of carrying trailers, or semi-trailers in a train atop a flatcar), (2) foster the growth of piggybacking, provide its members with the best available equipment, and keep its members abreast of new developments, and (3) furnish equipment to its members at the lowest possible cost. TTX has managed to reach its three initial goals and has provided railroads with a pool of cars that they can use without returning to the origin site. Sharing amongst owners allows them to maximize car utilization by minimizing the number of miles a car travels empty. TTX has a fleet of over 200,000 cars and enables its owners to conserve capital for other critical infrastructure needs.

B.2 Aviation
Like the US freight industry, many aircraft operators lease assets to preserve capital and maintain fleet flexibility. Fuel efficiency and its impact on the useful economic life of an aircraft is one of the largest factors affecting aircraft leasing companies. The presence of leasing companies continues to grow in this industry, especially as operators are becoming more credit-squeezed. Operating leases account for almost 40% of all deals.

Since 2008, the lessor market has grown considerably, primarily as a function of tough credit markets and volatile fuel prices. Of the four largest aircraft owners, the top two are lessors. As of early 2012, GE Capital Aviation Services (GECAS) owned 1,732 planes while International Lease Finance Corporation (ILFC, owned by AIG) had 1,031 aircraft. These two lessors dwarf the largest operators Delta and American Airlines, which own 800 and 775 aircraft respectively. Worldwide, the total value of the lease jet fleet is approximately $220 billion, with $62 billion of
that controlled by GECAS and ILFC. Even though a large portion of the market is controlled by the two largest players, there are over 50 lessors with fleets valued over $120 million.

Allocating risk is one of the primary reasons that the aircraft lease market has been thriving. Even though operators can receive large tax breaks by leasing rather than owning, one of the major reasons for leasing has to do with the risk of purchasing. It is very difficult for airlines to forecast which aircraft will maintain their value and be economically viable for a minimum of 20 years. By leasing rather than purchasing, operators are able to defer most of that risk to the lessors. For example, operators that were leasing a substantial portion of their fleet before the rise in oil prices in 2007 and 2008 were able to mitigate the impact by changing their fleet to be more fuel-efficient. On the other hand, operators that owned most of their fleet have been forced to take large write-downs, as portions of their fleet have become prematurely obsolete because the aircraft cost too much to operate.

Recently, operators have preferred newer aircraft, which puts lessors in a difficult situation. The average age of retired aircraft has been decreasing over time because of increased competition, fuel prices, and operators’ inability to purchase aircraft due to poor credit ratings. An increasingly common practice is for operators to sell a portion of their fleet to lessors and then lease the planes back. This frees up capital for financing fleet renewal. This strategy, along with the ever-increasing fuel-efficiency of jets has resulted in much higher demand for new aircraft and a great reduction in demand for older aircraft. The average age of permanent aircraft retirement in 2008 was 31.5 years, whereas in 2012 it was 23.7 years. This is an important shift because a shorter economic life decreases the amount of time that lessors have to seek returns from that asset. This trend likely will result in increased lease rates enabling lessors to meet their hurdle rates.

### B.3 Shipping

The shipping industry features four primary types of vessels: containerships, tankers, dry bulk vessels and gas carriers. Containerships can carry everything from cars to clothes to oil. Of the approximately 6,000 active liner ships that compose the world fleet, nearly half of them are chartered from non-operating owners.

There are three types of charter agreements: (1) the voyage charter, where the vessel is rented for use between the loading port and the discharge port, (2) the time charter, where the vessel is hired for a set period of time, and (3) the bare boat charter, where the charterer acts as the ship’s operating manager and provides crew and maintenance.

Like the US freight rail market, there are many contenders, but only a few companies hold a substantial portion of the business. The top three companies by volume (APM-Maersk, Mediterranean Shipping Company, and CMA CGM Group) own/charter 37% of the world’s liner fleet. However there are hundreds of smaller companies that only have a handful of ships. The top three companies also charter 61%, 57%, and 78% of their fleets respectively. Of the top 20 companies’ 3,284 ships, 1,900 of the ships are chartered.

One of the main reasons that so many companies choose to charter their ships is because of the huge amount of capital required to purchase one. This amount is prohibitively large for many operators so they are forced into chartering the ships. Additionally, there is a substantial delay when purchasing a vessel. During times of high demand, it can take a shipyard two years to deliver a vessel. Leasing mitigates this risk and helps shippers respond quickly during times of increased demand.
There is a wide variety of ship lessors, ranging from private owners to internationally traded companies. Both the small and the large players are located all over the world and often have headquarters in countries with favorable laws. For example, Chinese lessors are becoming more prominent as laws in the country evolve and the nation continues to focus on exporting. Some private owners may just own one ship and have the ship managed through the use of a broker. On the other end of the spectrum, large corporations such as Global Ship Lease, simply own and charter vessels. This company has a fleet of 17 vessels, only eight full time employees, and engages in long-term (current lease range from 5 to 17 years), fixed-rate time charters to container shipping liner companies. One of Global Ship Lease's largest competitors, Danaos Corporation has a fleet of 64 vessels of which it owns and operates a portion and charters the rest.

The shipping market is intimately tied to international trade and ebbs and flows with global economic conditions. During the recession, many operators struggled to adjust to the great decrease in trade activity. Operators with primarily leased fleets even struggled because of the lease agreements. In this market, most liners charter ships for years at a time, making it difficult for them to respond quickly to dips in demand. The container shipping market is better at responding to increases in demand than decreases because of the duration of the lease agreements.

B.4 The U.S. Passenger Rail Market Compared to Other Industries

The figure below compares market attributes of domestic passenger rail to other related industries.

<table>
<thead>
<tr>
<th>Lease Market</th>
<th>Domestic Rail: Passenger</th>
<th>Domestic Rail: Freight</th>
<th>Aviation</th>
<th>Shipping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life of Asset</td>
<td>![Not Conducive]</td>
<td>![Moderately Conducive]</td>
<td>![Highly Conducive]</td>
<td>![Highly Conducive]</td>
</tr>
<tr>
<td>Cost of Asset</td>
<td>![Not Conducive]</td>
<td>![Moderately Conducive]</td>
<td>![Highly Conducive]</td>
<td>![Highly Conducive]</td>
</tr>
<tr>
<td>Barriers to Entry</td>
<td>![Not Conducive]</td>
<td>![Moderately Conducive]</td>
<td>![Highly Conducive]</td>
<td>![Highly Conducive]</td>
</tr>
<tr>
<td>Number of Lessees</td>
<td>![Not Conducive]</td>
<td>![Moderately Conducive]</td>
<td>![Highly Conducive]</td>
<td>![Highly Conducive]</td>
</tr>
<tr>
<td>Compatibility/Standardization</td>
<td>![Not Conducive]</td>
<td>![Moderately Conducive]</td>
<td>![Highly Conducive]</td>
<td>![Highly Conducive]</td>
</tr>
<tr>
<td>Route Flexibility</td>
<td>![Not Conducive]</td>
<td>![Moderately Conducive]</td>
<td>![Highly Conducive]</td>
<td>![Highly Conducive]</td>
</tr>
<tr>
<td>Asset Mobility</td>
<td>![Not Conducive]</td>
<td>![Moderately Conducive]</td>
<td>![Highly Conducive]</td>
<td>![Highly Conducive]</td>
</tr>
</tbody>
</table>

The following bullets discuss some of the reasons that other industries have mature lease markets.

- **Domestic Freight Rail**: The domestic freight rail lease market developed through both individual lessors and organization amongst freight rail companies. One of the primary reasons that domestic freight rail car leasing companies have been successful is that there is a lot of volatility with the location of demand. It is rare for demand to be evenly balanced
at both ends of a freight rail corridor, and returning empty freight railcars to make a return trip is a costly exercise. However, if there is operational flexibility, the freight railcars can move to a different location, loaded with a new commodity. Additionally, freight rail cars can operate on multiple corridors, enabling lessees to make one directional trips. These market attributes create a large space for leasing companies to occupy. Since passenger rail service rarely operates routes that are not bidirectional and since the interoperability of assets is limited, leasing may not be as beneficial in this market.

- **Aviation:** The highly competitive and flexible nature of the airline industry has resulted in the development of a robust aviation lease market. Most large airlines have similar service areas which make them highly substitutable. Since passenger rail service only operates in defined areas, there is not as much direct competition. Entering the aviation market is also relatively easy in comparison to the domestic passenger rail market because of right-of-way requirements. Airlines have minimal infrastructure requirements compared to passenger railways and can quickly move assets from one route to another, unlike the passenger rail market.

- **Shipping:** The shipping lease market has developed organically for a variety of reasons. Unlike domestic passenger rail, the capital costs in the containership market often prohibit operators from purchasing vessels. This makes leasing the only alternative. Additionally, there is a high degree of standardization across vessels. All containerships accept standard sized containers, making the market highly competitive and flexible. This is an especially important attribute of the market since many vessels do not travel on bidirectional routes. The domestic passenger rail market does not have the luxury of this level of standardization or route flexibility, thereby potentially making a market more difficult to develop.
APPENDIX C: EQUIPMENT OWNERSHIP AND MANAGEMENT PRACTICES IN OTHER COUNTRIES

C.1 United Kingdom
The United Kingdom, relative to the United States, has a compact and dense rail network. The system is dominated by four principal longer-distance inter-city corridors and regional networks centered on the main metropolitan areas. In addition, the ownership and governance structure of the network is complex with a not-for-profit entity managing infrastructure and privately owned enterprise running train operating franchises, utilizing train equipment from independent leasing companies.

With regard to interoperability, it is not uncommon for a leasing company to move equipment from corridor to corridor, and even network to network based on factors including train operating company needs and desires, changes in demand profile, and technical changes. Aiding this practice is the fact that much equipment is ‘route cleared’ to operate across much of the network, and that a gradual process of electrification has filled in the gaps in the network of electrified lines. Thus, electric equipment can be reallocated with greater ease and surplus diesel equipment can be reallocated –often replacing life expired equipment elsewhere on the network. This approach is frequently described as ‘cascading’.

The UK privatized its rail market in the mid-1990s. The passenger operations were franchised out on a regional or route basis and the infrastructure was sold to a single entity that, after a commercial failure, became a not-for-profit business with stakeholders across the industry. The franchise periods for the passenger operations were substantially less than the economic life of the equipment. Consequently, leasing companies were set up to own the equipment and lease it to the franchisees. These companies were known as Rolling Stock Companies or ROSCOs.

Three ROSCOs were created to ensure a competitive environment. They were each given a portion of the existing UK equipment fleet with the types of equipment distributed such that at least two ROSCOs had a substantial number of each type (e.g. DMUs, EMUs, intercity equipment). The leases on the equipment were of varying lengths. The franchisee was responsible for the ongoing maintenance of the equipment but the ROSCOs were responsible for the heavy overhauls of the equipment. This approach was designed to protect the long term value of the fleets.

An effort was made to create a pricing system for the leases that did not provide a significant differential between new and old equipment. The goal was to have a system that did not encourage the constant aging of the national fleet, but rather to not discourage reinvestment in new equipment and to undertake the necessary recapitalization. This approach resulted in a substantial program of new equipment acquisition and a steady growth in national capacity. With the ROSCOs having the releasing risk, it was incumbent on them to ensure the equipment was attractive to future operators and to address any reliability and performance problems that would hinder re-marketability.

There were limitations to the effectiveness of the market. Concerns were raised about whether the market was truly competitive or whether the ROSCOs were abusing their dominant position. A review ultimately concluded that the market was not fully effective but apportioned a level of blame on the way the franchising process was undertaken and the limitations that put on the ability of the franchisees to have the ROSCOs competing. This issue was relevant mostly to the
existing equipment; however, new equipment had a far more open and competitive environment.

Even so, the government was concerned that the ROSCOs were too powerful and has implemented new approaches to equipment acquisition that were designed to bypass the ROSCOs with new equipment being bought through turnkey programs involving financiers and car-builders. Additionally, for one fleet a new ROSCO was created, originally as a stop gap measure. However, the plan to buy out the equipment in due course has not been followed through in order to preserve the capital for other projects.

C.2 Spain
Renfe is the major owner and operator of rolling stock in Spain. Renfe is the rail operator for the Spanish railway system and is 100% wholly owned by the Spanish National Government. ADIF is the rail infrastructure owner and manager for the Spanish railway system and is 100% wholly owned by the Spanish National Government. In the fall of 2012, the Spanish Government passed a law to liberalize the National Railway system. Renfe will be divided into four wholly owned subsidiary units: Maintenance, Passenger Operations, Freight Operations, and Rolling Stock. These subsidiaries may be bid out in part or in whole to private investors in the future. The Rolling Stock subsidiary, which should be established by the end of 2013, will be given 26 high-speed rail trains to lease. Renfe and a maximum of two other competitors will be allowed to bid for the use and operation of these train sets.

C.3 Germany
- Deutsche Bahn (DB) AG is the state rail provider in Germany and it is wholly owned by the Federal Republic of Germany. DB AG is divided into five main operating companies: Arriva, DB Bahn, DV Fernverkehr, DB Regio, and DB Stadtverkehr. DB AG and the operating companies have more than 1,000 affiliates and subsidiary units across the globe. DB AG and its operating companies own and operate their own equipment. In addition, a number of private entities operate services under concessions from the states and major cities.
• Railpool was created in 2008 by two German Banks, KfW IPEX-Bank GmbH and HSH Nordbank AG. Each bank maintains a 50% ownership of Railpool. The company leases rolling stock throughout Europe, including locomotives and passenger cars. They have the ability to lease trains for the variety of power supply systems in Europe. They have at least 100 electric locomotives in their inventory and have recently ordered 42 more. They have not, thus far, standardized their inventory or made recommendations for specification standards. The Railpool agreements can include elements of preventive maintenance, corrective maintenance, documentation, replacement vehicles, availability of spare parts, insurance, finance, support by mobile teams, and vehicle management. Current Railpool activities include the following:
  
  o Will lease 15 electric locomotives to Silesian Railways (Poland) for €12.5 million per year with the winning bid. They may also have entered a bid for 40 or 46 passenger coaches.
  o Are leasing to DSB (Denmark) with a €75 million order of 45 Bombardier double deck coaches.
  o Are leasing to Przewozy Regionalne (Poland) 10 Bombardier TRAXX F140MS electric locomotives for the Poland-Germany cross border service.

• Alpha Trains is a private rail rolling stock leasing company which was renamed from the mainland European arm of Angel Trains in 2010. It is owned by Arcus European Infrastructure Fund, Public Sector Pension Investment Board (Canada), and AMC Capital Investors (Australia). It is now based in Cologne and lists itself as the ‘largest and most diversified’ rail leasing company in Europe. It owns 400 locomotives and 240 passenger trains from a variety of manufacturers that meet the needs for specifications or power for several European operating systems. It does not have high-speed rail inventory. Altogether, its inventory is valued at €1.8 billion. Alpha Trains has expressed frustration at a lack of standardization in specifications and certification across Europe. However, Technical Specifications for Interoperability (TSI) have been in effect incrementally since 2002 in Europe. While not requiring specific equipment, TSI addresses functionality for operation on multiple corridors across country boundaries.

C.4 Japan

In Japan, the rail companies own, maintain, and operate their own equipment. In 2003, the Diet of Japan (legislature) created the Japan Railway Construction, Transport and Technology Agency (JRTT) to manage the majority of rail and public transportation services across Japan. Passenger service in Japan is divided into six operating companies, each referenced by their Japan Railway abbreviation ‘JR’ and their name. The JRTT is a 100% owner of three passenger rail companies (JR Hokkaido, JR Shikoku, and JR Kyushu) and the JR Freight Company, responsible for freight services throughout Japan. The three passenger rail companies offer passenger rail and other public transportation services within their geographic areas. The JRTT owned a 100% stake in JR West and JR Central but shares of those companies have been offered to the public and are owned by a variety of banks, insurance companies, and other private investors. The JR Central Company owns and operates the Shinkansen service in Japan. JR East was offered for public sale prior to the formation of JRTT and is also owned by a variety of private investors. JR West maintains 64 subsidiary companies; JR Central has 39 and JR East 83. These companies are responsible for a vast variety of services for the JR Companies, including stations, station area retail, customer service, operations, and maintenance.
APPENDIX D: COMMUTER RAIL OPERATIONS IN THE U.S.
<table>
<thead>
<tr>
<th>Rank by Size</th>
<th>Agency</th>
<th>Area Served</th>
<th>Lines Operated in Maximum Service</th>
<th>Average Weekday Ridership</th>
<th>In-House/Contracted</th>
<th>System Description</th>
<th>Operations &amp; Maintenance Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LIRR</td>
<td>Long Island, NY</td>
<td>10</td>
<td>1,003</td>
<td>341,200</td>
<td>All 14 lines converge to enter tunnel under East River and terminate in Penn Station. (A small number of trains per day have an alternate terminus at Atlantic Terminal in Brooklyn.) Somewhat less complex than the MBTA in that there is only one terminus, but the limited tracks through the tunnel and at the terminal add complexity.</td>
<td>Maintenance and operation are performed by in-house staff. The LIRR is the busiest commuter railroad in the US.</td>
</tr>
<tr>
<td>2</td>
<td>METRA</td>
<td>Chicago, IL Metro Area</td>
<td>7</td>
<td>1,052</td>
<td>311,500</td>
<td>All lines terminate at Union Station in downtown Chicago.</td>
<td>METRA operates and maintains 7 of its 11 lines.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td>There are two main approaches to Union Station: 6 lines enter from the west (including all 3 UP lines); 5 lines enter from the souths (including the BNSF Line).</td>
<td>BNSF operates &amp; maintains 1 Line. UP operates &amp; maintains 3 Lines. Note: these lines are contracted largely because the ROW is owned by the operating freight RR.</td>
</tr>
<tr>
<td>3</td>
<td>Metro-North Railroad</td>
<td>New York City Metro in State of NY</td>
<td>2 plus</td>
<td>1,109</td>
<td>289,900</td>
<td>All lines operated by Metro North converge to enter the Manhattan from the north, via Harlem and terminate at Grand Central Terminal. This includes the four New Haven branch lines operated under contract for ConnDOT. The two lines operated under contract by NJ Transit enter Manhattan from the west, and terminate at Penn Station.</td>
<td>Metro-North operates and maintains two of their four routes. Metro-North also operates 4 other routes (New Haven Branch Lines) under contract for ConnDOT.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 – O</td>
<td></td>
<td></td>
<td></td>
<td>NJ Transit operates Port Jervis and Pasack Valley Lines under contract to Metro North</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>O&amp;M</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>NJ Transit</td>
<td>New Jersey (mostly Northern &amp; Central)</td>
<td>8</td>
<td>1,276</td>
<td>285,063</td>
<td>5 lines terminate at Penn Station in Manhattan; however, 4 of those lines also have occasional service to Hoboken Terminal in New Jersey. An additional 5 lines merge and terminate at Hoboken for all trips. One line travels only to Newark, N.J. The final route is completely separate from all others, and operates in southern New Jersey between Philadelphia’s 30th Street Station and Atlantic City.</td>
<td>NJ Transit operates and maintains their service with in-house staff.</td>
</tr>
<tr>
<td>5</td>
<td>MBTA</td>
<td>Boston, MA Metro Area</td>
<td>14</td>
<td>406</td>
<td>133,300</td>
<td>Five lines merge to enter North Station via two main approaches. Nine Lines converge to terminate at South Station via two main approaches.</td>
<td>Massachusetts Bay Commuter Railroad – consortium of operator and maintainer</td>
</tr>
<tr>
<td>Rank by Size</td>
<td>Agency</td>
<td>Area Served</td>
<td>Lines O = operated M = maintained</td>
<td>Stations</td>
<td>Route Miles</td>
<td>Vehicles Operated in Maximum Service*</td>
<td>Average Weekday Ridership</td>
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<tr>
<td>-------------</td>
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<td>-----------------------------------</td>
<td>---------</td>
<td>------------</td>
<td>--------------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>6</td>
<td>SEPTA</td>
<td>Pennsylvania</td>
<td>13</td>
<td>150</td>
<td>289</td>
<td>327</td>
<td>114,500</td>
</tr>
<tr>
<td>7</td>
<td>Caltrain</td>
<td>San Francisco, CA to San Jose, CA</td>
<td>1</td>
<td>32</td>
<td>77</td>
<td>100</td>
<td>44,900</td>
</tr>
<tr>
<td>8</td>
<td>Metrolink</td>
<td>Los Angeles, CA Metro Area (extended area)</td>
<td>9</td>
<td>55</td>
<td>512</td>
<td>190</td>
<td>40,300</td>
</tr>
<tr>
<td>9</td>
<td>Maryland MARC</td>
<td>Washington, DC Metro Area In Maryland</td>
<td>3</td>
<td>43</td>
<td>187</td>
<td>132</td>
<td>32,000</td>
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<tr>
<td>10</td>
<td>VRE</td>
<td>Virginia Railway Express</td>
<td>2</td>
<td>18</td>
<td>90</td>
<td>87</td>
<td>18,900</td>
</tr>
<tr>
<td>11</td>
<td>SFRTA Tri-Rail</td>
<td>South Florida Regional Transportation Authority</td>
<td>1</td>
<td>18</td>
<td>72</td>
<td>37</td>
<td>13,000</td>
</tr>
<tr>
<td>12</td>
<td>NICTD South Shore Line</td>
<td>Northern Indiana Commuter Transportation District</td>
<td>1</td>
<td>20</td>
<td>90</td>
<td>66</td>
<td>13,000</td>
</tr>
<tr>
<td>13</td>
<td>Sound Transit Sounder Commuter Rail</td>
<td>Seattle, WA</td>
<td>2</td>
<td>9</td>
<td>80</td>
<td>56</td>
<td>9,800</td>
</tr>
<tr>
<td>14</td>
<td>TRE</td>
<td>Trinity Railway Express</td>
<td>1</td>
<td>10</td>
<td>34</td>
<td>8,200</td>
<td>Contracted</td>
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<tr>
<td>15</td>
<td>NCTD Coaster</td>
<td>North County Transit District</td>
<td>1</td>
<td>8</td>
<td>41</td>
<td>26</td>
<td>6,100</td>
</tr>
<tr>
<td>16</td>
<td>MRCOG</td>
<td>New Mexico Rail Runner Express Mid Region Council of Governments</td>
<td>1</td>
<td>13</td>
<td>97</td>
<td>4,500</td>
<td>Contracted</td>
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<tr>
<td>17</td>
<td>Metro Transit Northstar</td>
<td>Minneapolis, MN Metro Area</td>
<td>1</td>
<td>6</td>
<td>40</td>
<td>20</td>
<td>2,500</td>
</tr>
<tr>
<td>18</td>
<td>ConnDOT Shore Line East</td>
<td>Connecticut</td>
<td>13</td>
<td>59</td>
<td>28</td>
<td>2,200</td>
<td>Contracted</td>
</tr>
</tbody>
</table>