



Massachusetts Institute of Technology  
**Engineering Systems Division**

## ESD Working Paper Series

### NEC FUTURE Preliminary Alternatives Report: Public Comment

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## Memorandum

**Date:** June 7, 2013

**To:** Rebecca Reyes–Alicea  
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**From:** Prof. Joseph M. Sussman, Andrés F. Archila, S. Joel Carlson, Maite Peña–Alcaraz, Soshi Kawakami, Ryan J. Westrom, and Naomi Stein  
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**Subject:** NEC FUTURE, Preliminary Alternatives Report

### Introduction

Thank you for the continued opportunities to comment on the NEC FUTURE planning process.

As outlined in our prior study comment, we<sup>1</sup> are members of the Regional Transportation Planning and High-Speed Rail transportation research group at the Massachusetts Institute of Technology (MIT) directed by Professor Joseph Sussman. Over the past two years, we have used the CLIOS Process<sup>2</sup>, scenario planning, and flexibility (real options) analysis to study the implementation of high-speed rail (HSR) in the NEC (Sussman et al. 2012a, 2012b).<sup>3</sup> For further background, refer to prior comments<sup>4</sup> we have provided to the NEC FUTURE process.

This memo contains our group’s comments and questions on the recently released *Preliminary Alternatives Report*, and as well on the process thus far. In general, we found the report contained useful insights into the alternative development process and the alternatives themselves. We would, however, liked to have seen more comparisons within the report of the alternatives side-by-side to summarize the information contained in the diagrams for each of the alternatives (found in the appendix). For example, for Program Level D, a summary of the different possible routes would have been helpful.

Our reactions to the content of the report are summarized into three sections: “Goals and objectives, and evaluation of the alternatives,” “Planning under uncertainty and flexible alternatives,” and “Institutional assumptions.” All three sections are interrelated; the achievement of the goals is obviously dependent on uncertain future conditions, including the institutional structure that will be put in place to manage the

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<sup>1</sup> Authors include: Joseph M. Sussman, Andrés F. Archila, S. Joel Carlson, Maite Peña–Alcaraz, Soshi Kawakami, Ryan J. Westrom, and Naomi Stein. Our group’s website can be found at: <http://web.mit.edu/hsr-group>.

<sup>2</sup> The CLIOS Process is an engineering systems framework for analyzing Complex, Large-Scale, Inter-Connected, Open, Sociotechnical systems.

<sup>3</sup> Sussman, J., Archila, A.F., Carlson S.J., Peña–Alcaraz, M., Stein N. (2012a). Transportation in the Northeast Corridor of the U.S.: A Multimodal and Intermodal Conceptual Framework. <http://web.mit.edu/hsr-group/documents/jiti.pdf>

Sussman, J., Pena–Alcaraz, M., Carlson, S. J., Archila, A. F., Stein, N. (2012b) Analysis of High-Speed Rail Implementation Alternatives in the Northeast Corridor: the Role of Institutional and Technological Flexibility.

<sup>4</sup> <http://esd.mit.edu/WPS/2012/esd-wp-2012-27.pdf>

program.

## Goals and objectives, and the evaluation of the alternatives

When the scoping package was released in 2012, our research group was generally satisfied that NEC FUTURE was considering a comprehensive set of goals. We did, however, suggest that there should be some goals related to the state of good repair and social equity included. We also noted in our memo in response to the scoping package that efforts should be made to define more detailed objectives and performance measures with which to measure each of the goals.

In regards to the goals that we felt should be included, we welcome some of the new goals articulated in the *Preliminary Alternatives Report*, such as to “provide of state of good repair on the NEC” and “provide equitable and fair levels of service across the Study Area.” While we still believe that some effort should be made to study the affordability of the alternatives, we welcome the progress in these areas.

In regards to the level of detail for the goals, we feel that overall the process has not made significant progress further defining the goals for the program (at least as articulated in the *Preliminary Alternatives Report*), and in some respects have taken steps backwards. For example, we were disappointed to see the inclusion of “attempt to meet projected 2040 travel demand” as a goal in the *Preliminary Alternatives Report*. This goal is vague and does not help in defining a vision for the future state of the NEC, an important characteristic of a goal. In addition, due to the simultaneity between transportation capacity and demand, any upgrade is going to change the modal split and induce new transportation demand across all modes, meaning that the selected alternative itself has an impact on the goal itself. As a result, we are concerned that this goal essentially sets up the evaluation to make any of (or none of) the alternatives desirable, simply because it has “attempted” to meet the demand. More focus should be put into refining the existing goals into measurable objectives so that the “vision” against which to evaluate the alternatives becomes clearer.

For example, the scoping package contained a goal to “produce a market-supported intercity rail investment plan that provides near- and long-term solutions to the northeast region’s mobility problems and supports the region’s ability to meet expanding freight rail demand.” In response, the *Preliminary Alternatives Report* contained a goal to “accommodate freight rail growth by preserving windows for rail freight operations, access to freight customers, and access to rail freight main lines,” which contains “measurable” objectives – i.e. “preserving windows,” “access to customers,” and “access to freight main lines” – that can be used to evaluate the alternatives against. Similar refinement should be made to other goals as well.

The research group was also concerned with the statement that “alternatives will be dropped that ...provide similar investment levels and performance characteristics, but with a higher implementation risk...” We agree that issues affecting the “implementability” should be included in the evaluation of the alternatives, but are unclear as to what specific issues will be considered, such as financial feasibility, constructability, safety, etc. Given that the implementability of the alternatives ranges significantly, and that each planner might have his or her own internal belief about what alternatives may be implementable or not, it is critical that the evaluation criteria for this factor is explained in subsequent reports (i.e. What qualitative and quantitative techniques will be used? What assumptions will be made?). This issue is closely connected with the discussion in the subsequent sections on planning under uncertainty and institutional assumptions, particularly since institutional issues increase implementation risk.

## Planning under uncertainty and flexible alternatives

Planning for improved passenger rail service over a 30-year horizon is subject to a great deal of uncertainty. While there would be significant uncertainty with any long-term planning process, it is particularly the case with passenger rail in the NEC, given the tremendous amount of technical and institutional uncertainty.

To account for (some) of this uncertainty, our group conducted a study in which potential high-level strategic alternatives were analyzed under different scenarios (i.e. “stories about the way the world might turn out” but not “predictions of the future” or extrapolations of the past)<sup>5</sup> that provide a wider range of possible futures.<sup>6</sup> The result was a clear prevalence of uncertainty and a broad range of performance for the alternatives, which motivated the incorporation of institutional, technological, and intermodal flexibility into the alternatives.

We operationalized flexibility, which allows decision-makers to respond dynamically to different realizations of the future, using real options. A real option is the “right, but not the obligation, [for the option holder] to take some action at a future date at a predetermined price.”<sup>7</sup> In this sense, institutional flexibility was a set of options to change the institutional structure of Amtrak from a completely vertically-integrated company to two vertically-separated entities (one for infrastructure ownership and one for train operations); technological flexibility a set of options to change from implementing a fully dedicated HSR to making incremental upgrades on the existing network (i.e. a “phased approach”); and intermodal flexibility was set of options to enable intermodal partnerships to form (e.g. providing airport connections). The end-result of this qualitative analysis was that this flexibility, like insurance, may have an up-front cost, but its help improve the outcomes produced by the system when uncertainty dominates. Furthermore, the flexibility may facilitate the implementation of HSR by enabling adaptation of the alternatives to uncertain futures.

We therefore re-emphasize from our earlier memo the importance of considering a wide range of future scenarios with both qualitative and quantitative information when evaluating the alternatives. In addition, we also suggest that as the alternatives are narrowed down, that planners consider how certain alternatives could be used in conjunction with one another sequentially to respond to future realizations of uncertainty. In other words, are there alternatives that make it easier to “jump” from one program level to a higher (or lower) level or to phase the implementation of the alternatives if conditions turn out to be more (or less, respectively) favorable than anticipated? Plausibly, one alternative may perform less well than another alternative using a static analysis, but may be better able to respond more flexibly to different future conditions. Therefore, it is important to consider (in addition to the performance of the alternatives with respect to the other goals established) which alternatives preserve the most flexibility to make phased decisions with respect to uncertain future conditions.<sup>8</sup>

In order to implement “flexible” alternatives, it will be important to have in place an appropriate monitoring system and institutional structure that can respond to future conditions and change course where appropriate. Otherwise, any effort to put in place flexible alternatives will be wasted if the system cannot be altered when warranted. For example, if there is higher than expected demand, but the infrastructure manager cannot seek

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<sup>5</sup> Schwartz, P. 1996. *The Art of the Long View*. New York, NY: Doubleday.

<sup>6</sup> Sussman et al. 2012a and 2012b.

<sup>7</sup> E.g. de Neufville, R., and Scholtes, S. 2011. *Flexibility in Engineering Design*. Cambridge, MA: The MIT Press.

<sup>8</sup> We note that a “phased” plan is a goal in the NEC FUTURE scoping package, but wish to reiterate its importance.

more funding, then the flexibility built into the system might have limited value. Therefore, we believe that uncertainties related to institutional and policy issues should be considered.

## Institutional assumptions

During the December 2012 dialogues, presenters noted that the planning process would take an “institutional-neutral” approach to the planning to ensure that all possible options would be considered. Nonetheless, we continue to believe that the institutional structure should be analyzed in parallel with the determination of the alternatives, since it will largely impact the performance and feasibility of each of the alternatives considered. In fact, we believe that studying potential institutions transparently could make the planning process *more* institutional-neutral, as it would ensure that any plan did not contain any implicit assumptions about the potential institutional structure moving forward.

Take for instance the service types/operational environment alternatives. While NEC FUTURE could come up with a plan for an ideal service plan, the ultimate service pattern that emerges would be highly dependent on the institutions and policies in place after any new infrastructure is built. One concrete example is infrastructure pricing. Before 2015, the possible NEC operators and infrastructure manager must present to the FRA a new pricing mechanism for train operators’ access to the infrastructure (as per the Passenger Rail Investment and Improvement Act of 2008 [PRIIA]). Depending on how infrastructure is priced, train operators could have incentives to provide different service than what is intended in the NEC FUTURE process (e.g. a pricing mechanism with high-fixed charge with a low-variable cost per train mile could potentially lead to a service pattern with more trains as compared to a mechanism with a low fixed charge and high-variable cost). Another service question that would require consideration of institutional issues is “through-running” trains through stations across different states. Therefore, while considering service alternatives is important as it helps ensure that infrastructure is not built needlessly, neglecting to consider institutional and other policy alternatives could mean that the selected alternative proves un-implementable.

In addition, some of the goals identified in the scoping package relate directly to institutional and policy issues. For example, policies such as a new infrastructure pricing mechanism required by PRIIA could represent another financial mechanism for this project. Given the NEC FUTURE scoping goal to “create [a] ...improvement program that reflects funding and financial limitations,” considering institutional structures and policies is a necessity if the planning process hopes to evaluate alternatives against this goal. Some other goals, such as to “produce a cost-effective investment plan that identifies and *encourages private sector* involvement in future corridor improvements and operations, [emphasis added]” explicitly suggest some institutional approaches (i.e. is not institutional-neutral). Therefore, we re-emphasize our above concept, that considering institutional and policy alternatives could in fact make this process more institutional-neutral by ensuring that institutional and policy assumptions are clearly discussed.

Considering institutional issues also has implications for system safety, a goal that should be implicit in the planning process. We regard safety of the system as a core value of the project, and it should not be ignored at any phase of the system design. Although a safety strategy<sup>9</sup>, including safety standards, is being discussed by the FRA and RSAC (Railroad Safety Advisory Committee), the safety discussion should not focus only on technical specifications or operational conditions; the institutional structure should be incorporated into the system evaluation, as system safety is an emergent property, which means that it can only be effectively

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<sup>9</sup> FRA, High-speed passenger rail safety strategy, 2009

considered by looking at the system as a whole.<sup>10</sup> Based on this idea, we believe that it is important to realize that the appropriate safety standards and safety management rules in this industry could vary according to the adopted alternative and institutional structure. With this perspective, there is an opportunity to consider safety in the planning process by taking possible institutional structures into account.

While it is important to consider institutions and policies in this planning process, we emphasize that we are not suggesting that NEC FUTURE try to define what is the “best” institutional structure. We recognize that such an approach could lead to entrenchment by stakeholders of their respective views. However, we believe some approaches could be considered. Right away, a discussion of the potential institutions possible and policy alternatives would be worthwhile, as understanding what could be possible would be useful in framing knowledge. If a particular institutional question were especially important to the performance of the alternatives and uncertain, scenarios could be created to test the performance of the alternative under the different institutional and policy conditions. Another approach could be to identify institutional and policy changes that would be required for each alternative during the evaluation stage, such that decision-makers have this important information when they argue for a particular alternative. In any case, we believe that this information is important to the planning process, and can be laid out in an objective fashion.

## Concluding remarks

Thank you again for this opportunity to comment on this important planning process; we look forward to participating further. If you have any questions about this document, feel free to contact us at [hsr-group@mit.edu](mailto:hsr-group@mit.edu). We have also attached our previous memo for reference.

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<sup>10</sup> Leveson, N.G. 2011. *Engineering A Safer World: Systems Thinking Applied to Safety*. Cambridge, MA: The MIT Press.