Chapter 8
SPECIALIZED ANALYSES

This chapter presents the results of specialized analyses that offer further insights into the economics and partnership potential of HSGT for America in the 21st century. Specifically, the following sections delve into these questions:

- What happens when an HSGT corridor is extended to a new terminus?
- What happens when "hybrid" HSGT cases, involving more than one technology, are simulated?
- And finally—what happens when key assumptions are altered?

EXTENSIONS OF HSGT

All the illustrative cases described in Chapter 7 would constitute essentially new services, either starting from scratch, substituting for conventional Amtrak operations, or displacing older HSGT. Far different would be the case of an **extension of HSGT service**, in which the ability to generate substantial traffic volumes over long distances might afford special opportunities for partnership potential.

The Empire Corridor (New York to Albany, Syracuse, Rochester, and Buffalo) and the Southeast Corridor (Washington, D.C. to Richmond, Raleigh, Greensboro, and Charlotte) would be natural extensions of Northeast Corridor HSGT services. Through rail passenger services from New York City via Washington to the Southeast developed over a century ago and persisted as transportation evolved in the subsequent decades. While historical factors traditionally impeded direct rail passenger service between the Northeast and Empire corridors, the density of population in both corridors would encourage through traffic there as well.

Either of these extensions would increase the traffic levels on the Northeast Corridor itself, because through passengers from south of Washington and north and west of New York would need to use the Northeast Corridor to access major Northeastern cities.[1] In this manner, traffic densities on the Northeast Corridor would increase, thus creating synergistic ridership, revenue, expense, and income effects that might redound to a single HSGT operator's profitability.

Recognizing the special opportunities posed by Southeast and Empire extensions of HSGT in the Northeast Corridor, this study accorded them exceptional treatment based on the following principles:

[1] In addition, but of lesser importance, any additional Northeast Corridor frequencies necessary to serve the aforementioned through traffic could boost internal Northeast Corridor ridership.

- The study addressed two Northeast Corridor-related systems only[2]:
  - — Southeast Corridor plus Northeast Corridor; and
  - — Empire Corridor plus Northeast Corridor.
- For analytical convenience, each system was assumed to be operated by a **single HSGT entity**: the Northeast Corridor operator.[3]

Technologies in the extensions were matched with technologies in the Northeast Corridor as follows:

- Accelerail 110 (Southeast) and 125F (Empire) with Amtrak's existing[4] electrified Accelerail service in the Northeast Corridor.[5]
- New HSR in the extensions with a hypothetical future New HSR system in the Northeast Corridor.
- Maglev in the extensions with a hypothetical future Maglev system in the Northeast Corridor.

Traffic Base

All the options in the Northeast Corridor extensions draw much of their strength from the synergies inherent in the underlying passenger flows. Specifically, for each extension, the traffic base[6] consists of three parts—(1), (2)(a), and (2)(b) below:

(1) Traffic internal to the extension—for example, between Buffalo and Albany, or between Raleigh and Richmond;

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[2] A combination of HSGT in all three corridors—Northeast, Empire, and Southeast—is conceivable but was not modeled, nor were other potential Northeast Corridor HSGT extensions (e.g., Hartford/Springfield and Harrisburg).

[3] This is a critical institutional assumption; others are conceivable but could yield far different results. Regardless of the institutional framework, issues would inevitably arise over the proper allocation of through-traffic revenues and expenses between the Northeast Corridor and the extension. The treatment in this report does not address those issues and institutional options, which the States, Amtrak, and others may someday wish to explore in depth.

[4] The service capabilities over the Northeast Corridor in the Accelerail extension cases are assumed to be substantially the same as those currently in effect, except that (a) electrification from New Haven to Boston is assumed to be completed and (b) the new "American Flyer" trainsets are assumed to be in service for trips strictly within the Northeast Corridor alone. Both of these exceptions are to be in place by the year 2000, and neither of these exceptions would have a sizable impact on through traffic between the Northeast Corridor and the extensions.

[5] Due to time and resource limitations, and the complexity and length of these incremental corridors, this study addressed only one typical Accelerail option for each. The States may wish to address the full range of options in any subsequent studies.

[6] The term "traffic base" refers to the 1993 traffic flows by existing modes (see Chapter 5).

(2) Cross-traffic that makes use of both the extension itself and the Northeast Corridor—for example, between Philadelphia and Albany, or between Greensboro and New York City. This cross traffic consists of two components:

(a) Passenger-miles accumulated on the extension itself; and

(b) Passenger-miles accumulated on the Northeast Corridor.

The "synergy bonus" consists of item (2)(b) above, since the benefits from increased Northeast Corridor traffic come at relatively low cost. Both the Empire and Southeast Corridors would, indeed, generate significant portions of their transportation production on the Northeast Corridor, as shown in the base traffic data in Figure 8-1 and Figure 8-2.

Figure 8-1
Composition of Empire Corridor Traffic Base

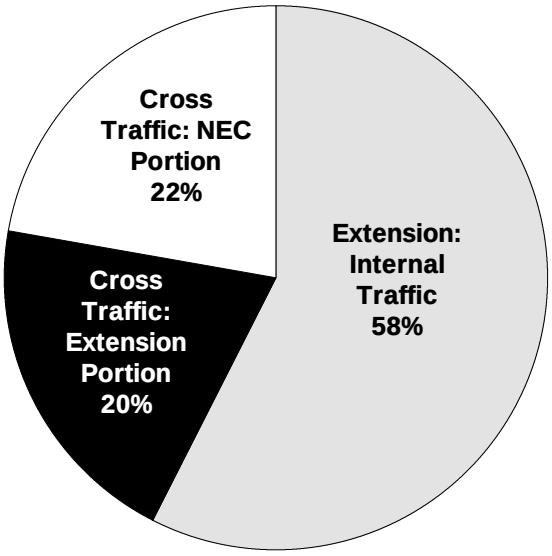
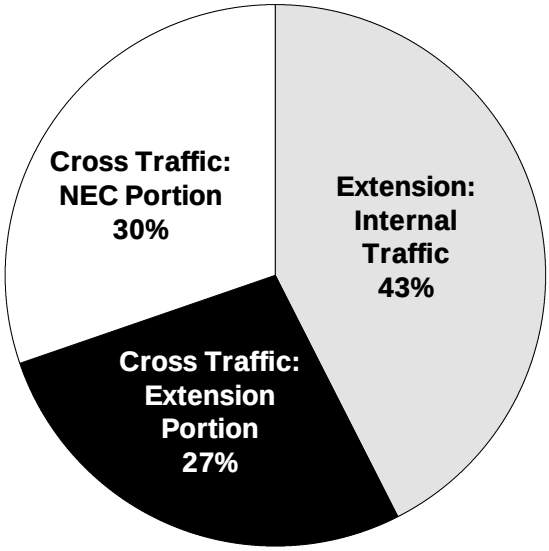


Figure 8-2
Composition of Southeast Corridor Traffic Base



The variations in the traffic base between the Empire and Southeast Corridors reflect their different spatial configurations (see Figure 8-3 and Figure 8-4.) New York City is supreme as a traffic generator; but the Empire Corridor accesses New York directly and is not positioned to divert heavy traffic from New York State to New England via New York City and the "North End" of the Northeast Corridor. Thus the prime opportunity for Empire/Northeast Corridor through traffic is from upper New York State points to New Jersey and Philadelphia, a relatively short distance (about 90 miles) on the Northeast Corridor. By contrast, traffic from the Southeast Corridor to New York, New Jersey, and

Philadelphia must traverse some 150-225 miles of Northeast Corridor trackage and generate the consequent passenger-miles. Factors such as these would account for some of the different traffic characteristics in the Empire versus the Southeast Corridor—for example, an average trip length of 295 miles for Accelerail 110 in the Southeast Corridor, versus 237 miles for Accelerail 125F in the Empire Corridor.

Figure 8-3
Empire Corridor[7]

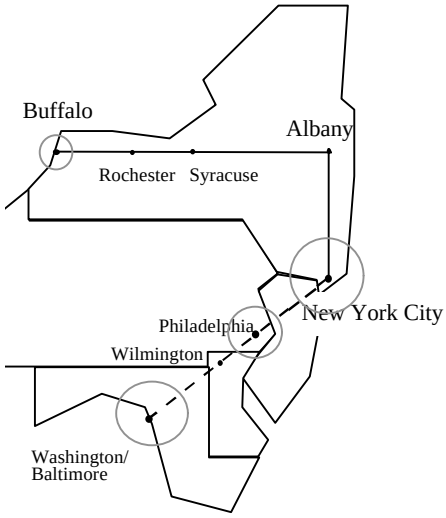


Figure 8-4
Southeast Corridor

Extensions of Existing Accelerail Service in the Northeast Corridor

Only the Accelerail options constitute "extensions" in the strict sense of that term, since only they would "extend" a Northeast Corridor service that currently exists.[8] The Accelerail projections for the Empire and Southeast Corridors therefore address a fundamental question—how would the addition of Southeast or Empire Corridor service to Northeast Corridor service affect a single HSGT entity?—by effectively summing the following:

- All investment requirements, revenues, expenses, and benefits pertaining to the **extension proper**, plus
- Identifiable investment requirements, revenues, expenses, and benefits arising **on the Northeast Corridor proper** as a **direct result of through traffic** between the Northeast Corridor and the extension.

[7] Because of the extreme circuity involved, this study did not address city pair markets linking the Empire Corridor with Northeast Corridor points north and east of the New York CMSA.
[8] Or will be in place by the year 2000; see footnote 4.

Table 8-1 thus approximates the effects of adding Empire or Southeast Corridor Accelerail service to a Northeast Corridor operation similar to that of today.

Table 8-1
Accelerail Projections for Northeast Corridor Extensions

HSGT in 2020:	**EMPIRE CORRIDOR Accelerail 125F (Extension)**	**SOUTHEAST CORRIDOR Accelerail 110 (Extension)**
Line-haul travel time, hours, New York-Buffalo	5.2	
Line-haul travel time, hours, Charlotte-Washington		5.7
Trains per day in each direction, New York-Buffalo	50	
Trains per day in each direction, Charlotte-Washington		27
Average fare per passenger-mile (dollars)	0.192	0.176
Passengers, Millions of Trips (2020)	9.4	5.7
Passenger-Miles, Millions (2020)	2,229	1,689
Average trip length (miles)	237	295
Projection Results (Dollar Amounts are Present Values in Millions for the Period 2000-2040)		
Surplus after continuing investments	**$1,473**	**$1,041**
Total benefits	**$9,681**	**$6,519**
Benefits to HSGT users:		
System revenues	$3,591	$2,561
Users' consumer surplus	$4,374	$2,550
Total benefits to HSGT users	$7,965	$5,110
Benefits to the public at large	$1,716	$1,409
Total costs	**$4,050**	**$2,567**
Components of total costs:		
Initial investment	$1,932	$1,047
O&M expense	$1,930	$1,389
Continuing investments	$188	$131
Incidence of total costs:		
Costs borne by users	$3,591	$2,561
Publicly-borne costs	$459	$7
Total benefits less total costs	**$5,631**	**$3,952**
Benefits to HSGT users less costs borne by users	$4,374	$2,550
Benefits to the public at large less publicly-borne costs	$1,257	$1,403
Ratio of total benefits to total costs	**2.39**	**2.54**
Ratio of benefits to HSGT users, to costs borne by users	2.2	2.0
Ratio of benefits to the public at large, to publicly-borne costs	3.7	[9]
Does this case meet the threshold tests for "partnership potential"?	YES	YES

Under this projection method, Accelerail in both extensions performs better, on a purely commercial basis, than comparable options in the illustrative corridors described in

[9] Since the publicly-borne costs are projected to be nearly zero, this ratio would be inapplicable.

Chapter 7; furthermore, both extensions provide relatively high ratios of benefits to costs. Table 8-2 summarizes these comparatively favorable projections for Accelerail in the Northeast Corridor extensions.

Table 8-2
Accelerail Performance Comparison:
Northeast Corridor Extensions Versus All Other Illustrative Corridors

	Percentage of Initial Investment Covered by Surplus After Continuing Investments		Ratio of Total Benefits to Total Costs	
	Accelerail 110	**Accelerail 125F**	**Accelerail 110**	**Accelerail 125F**
Empire Corridor (Extension)		76%		2.5
Southeast Corridor (Extension)	99%		2.4	
Range of All Other Illustrative Corridors [10]	Between 17% and 39%	Between 11% and 36%	Between 1.1 and 2.5	Between 1.2 and 2.5

These results for the extensions clearly benefit from the "synergy bonus" described above. Figure 5 and Figure 6, in showing the annual passenger-miles (Year 2020) per route-mile of Accelerail infrastructure investment, clearly demonstrate how the cross-traffic between the Northeast Corridor and its extensions enhances the potential of Accelerail in the Empire and Southeast Corridors.

Figure 8-6: Annual Passenger-Miles (Million) Per Upgraded Accelerail 110 Route-Mile

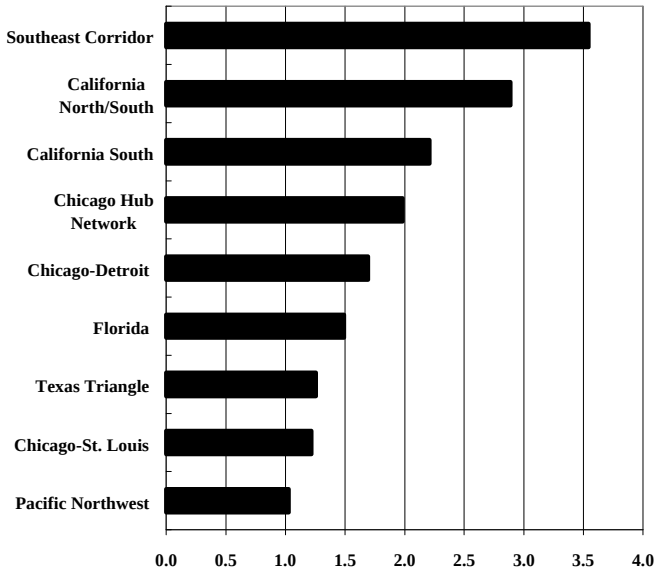
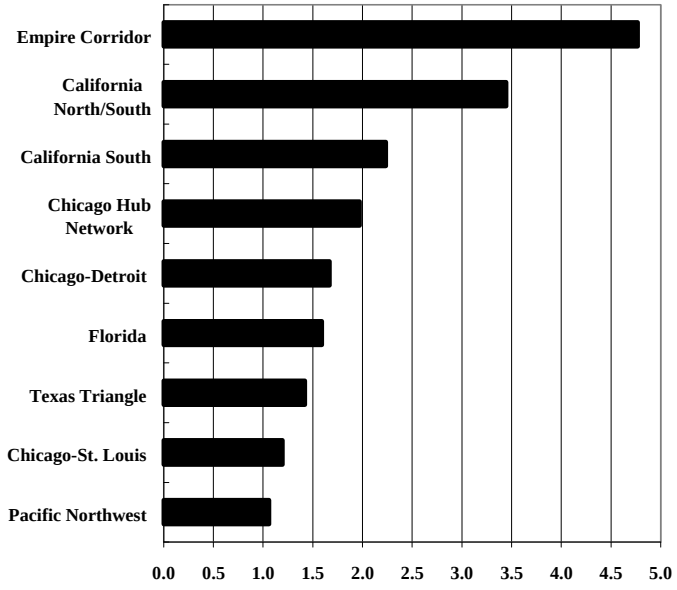


Figure 8-5: Annual Passenger-Miles (Million) Per Upgraded Accelerail 125 Route-Mile



New HSR and Maglev Systems

Accelerail extensions in the Empire or Southeast Corridor were analyzed for their impacts on the operator of a pre-existing Northeast Corridor Accelerail service. Such an approach makes sense because the Northeast Corridor already enjoys Accelerail service. To characterize New HSR and Maglev in the Empire and Southeast Corridors, however, requires a more complex procedure since neither of these technologies exists in today's Northeast Corridor. Specifically, the study assumed that a single operator manages New HSR or Maglev as a integral system in the Northeast and Empire Corridors ("Empire/Northeast System"); or in the Northeast and Southeast Corridors ("Southeast/Northeast System"). The study then projected the requirements and performance, and the benefits and costs, of each integral system.

The results appear in Table 8-4. Both New HSR and Maglev have partnership potential in the two systems, which are comparable in overall performance to the Northeast Corridor taken alone, and to the California Corridor (as exemplified in Table 8-3):

Table 8-3
Ratios of Benefits to Costs for New HSR and Maglev Systems

	Total Benefits to Total Costs		Benefits to the Public at Large, to Publicly-Borne Costs	
	New HSR	Maglev	New HSR	Maglev
Empire/Northeast System	1.0	1.0	0.3	0.3
Southeast/Northeast System	1.1	1.3	0.4	0.5
Northeast Corridor alone	1.0	1.1	0.3	0.4
California North/South	1.2	1.1	0.7	0.6

That these integral systems—each almost 900 miles in length—perform as well as (and, in the case of the Southeast/Northeast System, even better than) the heavily trafficked Northeast Corridor alone stems from two key factors. First, in both integral systems, the traffic levels attributable to origins and/or destinations outside the Northeast Corridor proper are approximately double those which might arise if Washington—Charlotte, or New York—Albany—Buffalo, existed in a population vacuum. (See Figure 8-1 and Figure 8-2.) So great is the "synergy bonus" that approximately 30 percent of the transportation production of the Empire/Northeast System, and 35 to 45 percent of that of the Southeast/Northeast System, services markets anchored in Upstate New York and in Virginia and North Carolina, respectively. Second, the per-mile construction costs for New

[10] See Chapter 7.

HSR and Maglev in Upstate New York and south of Washington are less than the equivalent costs in the Northeast Corridor alone.

Table 8-4
Results for Integral Systems: Empire/Northeast and Southeast/Northeast

HSGT in 2020:	**Empire/Northeast System**		**Southeast/Northeast System**	
	New HSR	**Maglev**	**New HSR**	**Maglev**
Route-miles	880	878	862	861
Line-haul travel time, hours, New York-Buffalo	3.3	2.4		
Line-haul travel time, hours, Charlotte-Washington			3.0	2.1
Trains per day in each direction, New York-Buffalo	50	47		
Trains per day in each direction, Charlotte-Washington			53	65
Average fare per passenger-mile (dollars)	0.309	0.350	0.303	0.327
Passengers, Millions of Trips (2020)	32.6	33.9	32.5	36.5
Passenger-Miles, Millions (2020)	6,885	7,448	7,322	9,152
Average trip length (miles)	211	219	225	251
Percent of air traffic diverted	24.5%	31.8%	25.1%	38.8%
Percent of intercity auto traffic diverted	2.6%	2.6%	2.5%	3.2%
Projection Results (Dollar Amounts are Present Values in Millions for the Period 2000-2040)				
Surplus after continuing investments	**$10,530**	**$15,059**	**$11,576**	**$17,818**
Total benefits:	**$35,643**	**$42,219**	**$37,665**	**$49,920**
Benefits to HSGT users:				
System revenues	$18,129	$22,133	$18,782	$25,205
Users' consumer surplus	$12,479	$14,352	$13,045	$17,236
Total benefits to HSGT users	$30,609	$36,485	$31,826	$42,441
Benefits to the public at large:	$5,034	$5,735	$5,839	$7,479
Total costs:	**$37,339**	**$40,443**	**$33,197**	**$39,836**
Components of total costs:				
Initial investment	$29,739	$33,369	$25,991	$32,448
O&M expense	$6,832	$6,523	$6,531	$6,856
Continuing investments	$767	$552	$675	$531
Incidence of total costs:				
Costs borne by users	$18,129	$22,133	$18,782	$25,205
Publicly-borne costs	$19,210	$18,310	$14,415	$14,630
Total benefits less total costs	**($1,696)**	**$1,776**	**$4,468**	**$10,085**
Benefits to HSGT users less costs borne by users	$12,479	$14,352	$13,045	$17,236
Benefits to the public at large less publicly-borne costs	($14,175)	($12,576)	($8,576)	($7,151)
Ratio of total benefits to total costs	**1.0**	**1.0**	**1.1**	**1.3**
Ratio of benefits to HSGT users, to costs borne by users	1.7	1.6	1.7	1.7
Ratio of benefits to the public at large, to publicly-borne costs	0.3	0.3	0.4	0.5
Does this case meet the threshold tests for "partnership potential"?	YES	YES	YES	YES

In order to analyze the performance and requirements of the Empire/Northeast and Southeast/Northeast Systems, it is essential to divide each of them into two portions: (1) the Northeast Corridor "alone," and (2) the Empire or Southeast Corridor "proper." The latter portion approximates the passenger-miles, revenue, expenses, investment requirements, and other factors that can be fairly attributed to the Empire or Southeast Corridor as part of the integral system with the Northeast Corridor. The attribution of values to the Empire or Southeast Corridor proper, within the respective integral systems, is performed as follows (using passenger-miles in the Empire Corridor for example):

Passenger-miles attributed to the "Empire Corridor proper" EQUALS:
Passenger-miles projected for the Empire/Northeast System
LESS: Passenger-miles projected for the Northeast Corridor alone (as per Chapter 7).

Other attribution methods are possible, and would need to be explored (see footnote 3).

Synthesizing the effects of the traffic synergies and construction cost differentials, Figure 8-7 shows the annual passenger-miles per dollar of initial investment in the Northeast Corridor alone versus the Empire and Southeast Corridors proper. For both New HSR and Maglev, the Empire Corridor generates values only slightly below those of the Northeast Corridor itself, while the Southeast Corridor generates much heavier traffic than the Northeast Corridor per investment dollar.

Figure 8-7
Annual Passenger-Miles Per Dollar of Initial Investment

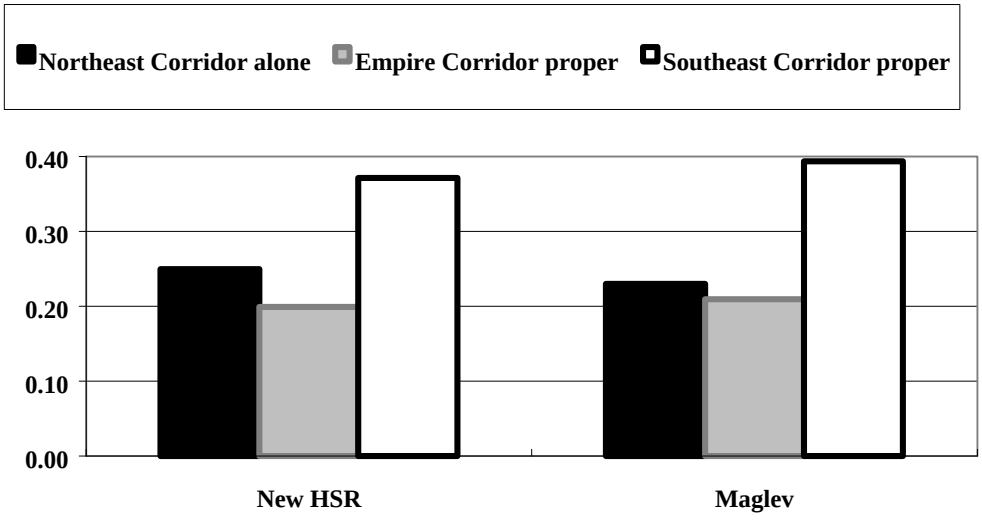
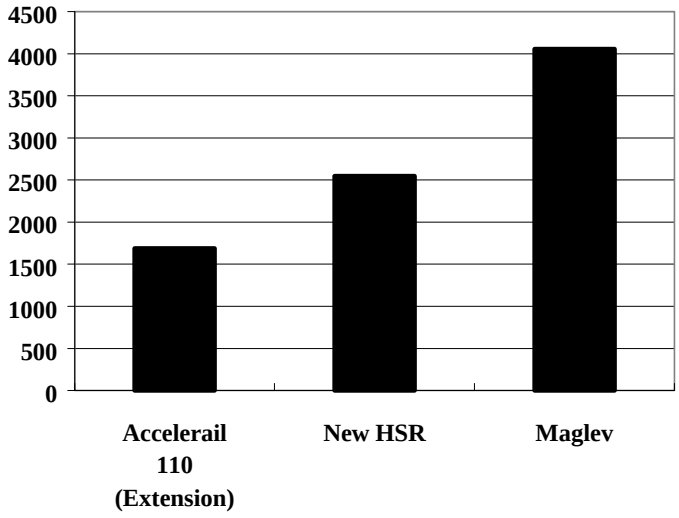


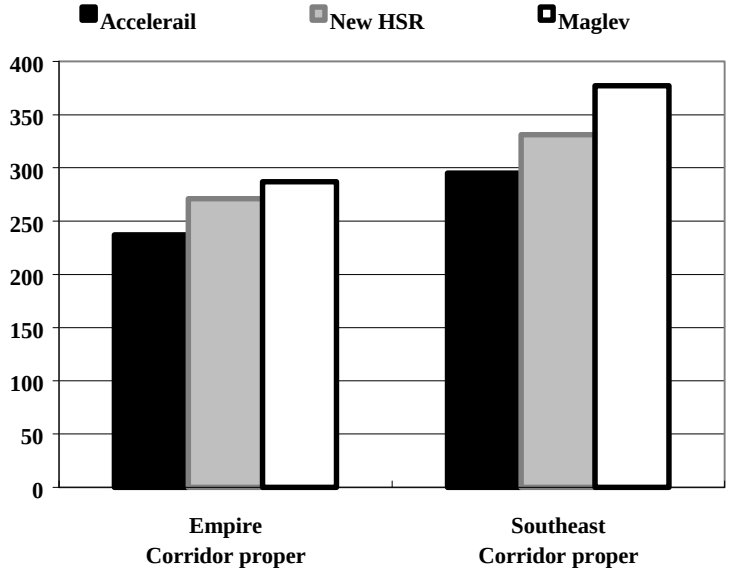
Figure 8-8
Passenger-Miles (in Millions)
Attributed to Southeast Corridor Proper



The especially high traffic payoff for New HSR and Maglev in the Southeast Corridor echoes the "California effect" apparent in the traffic results for California North/South; against the backdrop of a very large, long-distance travel demand (reflecting geographic factors described on pages 8-3 ff.), the trip-time performance of New HSR and especially Maglev competes very strongly with air and diverts sizable numbers of passengers for longer and more profitable trips. (See Figure 8-8.)

While the opportunities for long-haul cross-traffic are more limited in the Empire than in the Southeast Corridor, the average trip length in both corridors proper grows as travel time decreases (Figure 8-9).

Figure 8-9
Average Trip Lengths for Traffic Attributed to
Empire and Southeast Corridors Proper



"HYBRID" CORRIDORS

For the sake of simplicity and consistency, the study ordinarily assumed a single technology for each case.[11] (See Chapter 3, especially Table 3-3.) Since the suitability of a technology modulates with traffic density, and since corridors frequently show patronage levels that vary greatly by segment, a single-technology restriction could produce suboptimal results in a detailed State study of a particular corridor. To demonstrate the potential effects of mixing and matching technologies, the California North/South corridor was analyzed with New HSR north, and Accelerail 125E south, of Los Angeles. (Because the two technologies are fully compatible, no passenger or locomotive transfers at Los Angeles would be necessary.)

The decline in performance at the southern end of the corridor manifests itself in lower traffic, revenues, and operating surpluses for the hybrid versus New HSR:

Table 8-5
Comparative Results of Hybrid Option in California North/South Corridor
(Dollar Amounts are in Millions)

Annual Measures	**Accelerail 125E**	**Hybrid [125E/200]**	**New HSR [200 mph]**	**Maglev [300 mph]**
Trip-time, hours, Los Angeles-San Francisco[12]	5.3	3.6	3.2	2.1
Passenger-Miles, Million	2,116	4,314	4,743	5,888
Revenue	$367	$723	$791	$1,167
Operating and maintenance expense	$223	$386	$394	$389
Operating surplus	$144	$337	$397	$778
Life-Cycle Measures (All amounts are Present Values, as of the Year 2000, of cash inflows/outflows over 40 years)				
Surplus after continuing investments	$864	$2,055	$2,489	$5,584
Initial Investment, Total	$8,948	$12,564	$15,792	$23,430
Percent of initial investment covered by surplus after continuing investments	9.7%	**16.4%**	15.8%	23.8%
Ratio of Total Benefits to Total Costs	1.0	**1.3**	1.2	1.1
Ratio of Benefits to HSGT Users, to Costs Borne by Users	2.3	**2.2**	2.2	2.1
Ratio of Benefits to the Public at Large, to Publicly-Borne Costs	0.6	**0.8**	0.7	0.6

[11] The exceptions were the non-electric Accelerail options in the Southeast and Empire corridors, which were matched with Accelerail 150E in the already-electrified Northeast Corridor.
[12] Note that the California North/South corridor in this report extends the full distance from the San Francisco Bay Area through Los Angeles to San Diego. The trip times reported in this table include a portion of trackage in the Los Angeles region that, under the "hybrid" case, is upgraded to Accelerail 125E instead of New HSR.

However, over time, these traffic, revenue, and surplus impacts amount to little in comparison with the significant saving in initial investment. Because a higher proportion of benefits than of costs is retained in stepping down from a "pure" New HSR technology to the hybrid, the latter offers somewhat better projections for both commercial and benefit/cost measures. Thus, Table 8-5 clearly demonstrates that the more subtle approach—letting the investment follow the revenue, rather than dictating a uniform service level throughout each corridor—may enhance the outcome of the planning process.[13]

The California hybrid case demonstrates how States can fine-tune their corridor studies to maximize the cost-effectiveness of HSGT investments. In addition to mixing and matching technologies, State planners have many other opportunities, far beyond the scope of the present report, for profitably diversifying corridor options. For example:

- **Staging** of options—the gradual implementation of more and more ambitious HSGT solutions, over the 40-year planning period and possibly beyond—merits intensive scrutiny. For example, opportunities may exist for routes to be developed for Accelerail 90 or 110 service, then upgraded to 125F, then purchased from the underlying railroad and converted to 150E, or even (with extensive realignment depending on the locale) to New HSR. As a further hypothetical illustration of this principle: in the Northeast Corridor of the 21st century, burgeoning Accelerail 150E and commuter traffic, coupled with capacity constraints in the tunnels to Manhattan and in Pennsylvania Station, may ultimately require a partnership to build a parallel or significantly expanded route through New York City for both local and intercity traffic. If designed with vision, such a bypass or augmentation could ultimately become the kernel for a New HSR route for the Northeast Corridor, which could, over the course of many decades, gradually extend north and south from New York to supplant portions of the existing alignment.
- **Routing** questions will likewise undergo serious scrutiny at the State and local level, and rightfully so. The need to concentrate traffic on minimal route-mileage—evidenced in the Chicago Hub Network,[14] Texas, and the Southeast Corridor[15]—dictates careful attention to the economic theory of railway location. This may involve multi-State discussions of routing alternatives and extension possibilities.

[13] This has clearly been the approach overseas. In France, for example, a pre-existing electrified network extended the market reach of the Paris—Lyons TGV and helped to make the initial project feasible.
[14] Where the whole was much greater than the sum of its parts due to traffic synergy.
[15] Where incremental traffic over the Northeast Corridor provided a basis for the favorable projections described above.

For analytical convenience, this report adopted existing Amtrak routings wherever possible. This assumption, however, yielded Accelerail route-mileage almost twice as long as that of New HSR and Maglev in at least one corridor (Texas) where other realistic opportunities may exist. California presents routing conundrums that only the State can resolve: for example, the existing through passenger line (via the Coast) serves completely different and less populous intermediate markets than the Central Valley route, while the latter would require a new alignment over the Tehachapi Mountains to achieve truly expeditious service.

In selecting alignments that would demonstrate the full spectrum of graded technological options, this study made no attempt to consider all the theoretical possibilities.

- **Combinations of the above.** In many instances, a comprehensive corridor analysis would need to address mixing and matching, staging, and routing questions simultaneously.

SENSITIVITY ANALYSES

This section describes sensitivity excursions that assessed the effects of changes in assumptions pertaining to two areas—operating and maintenance expenses, and airline fares in competition with HSGT.

Operating and Maintenance Expenses

As incorporated in this report, HSGT operating expenses represent an improvement over those experienced by Amtrak prior to its recent restructuring. For the Texas Triangle, Florida, and California corridors, Table 8-6 shows the ratio of projected HSGT unit expenses to 1993 Amtrak cost levels. In all three illustrations, unit expenses are on the order of 60 percent of Amtrak long-term avoidable costs (less for the high-volume California options).

Thus, the question naturally arises: how would adoption of expense levels more akin[16] to Amtrak's affect the results of this study?

To answer this question, a set of alternate assumptions was applied to three test cases, i.e.:

- Chicago—Detroit 125F;

[16] It would be inappropriate to impose a cost structure **identical** to that of Amtrak on the HSGT cases in this study. For these cases, the significant capital investment (in such support facilities as vehicle maintenance shops), the modern equipment and infrastructure, the high volume of travel, and the frequent train service would make for an operation—and a cost structure—fundamentally different from Amtrak's.

- Chicago Hub 110; and
- California North/South, New HSR.

Table 8-6
Unit Operating Expenses[17] for HSGT as Percent of Amtrak Long-Term Avoidable Unit Expenses in 1993[18]

	90	110	125F	125E	150F	150E	New HSR	Maglev
California North/South	79%	59%	62%	64%	57%	58%	50%	40%
Florida	71%	69%	66%	71%			79%	78%
Texas Triangle	63%	65%	60%	67%	60%	71%	65%	66%

These assumptions reflected changes from the normative operating expenses, as described in Chapter 5, in areas typified by the following:

- Less use of automated ticket dispensing;
- Restoration of on-train ticket control;
- Reintroduction of checked baggage service; and
- Recognition of food-service deficits.

With such changes in assumption, annual operating expenses for the test cases would exceed the normative projections by approximately 25 percent. (See Table 8-7.) All the cases would see a marked decrease in the ratio of operating surpluses to initial investment. The benefit/cost effect of these annual expense increases depends on the relative importance of O&M in the total life-cycle costs of the case—largely a function of the technology. The capital-intensive New HSR case in California, therefore, shows relatively little change in the benefit/cost ratios as a result of the expense hikes. By contrast, the Chicago Hub Network

[17] Operating expenses per passenger mile.

[18] The ratio for each HSGT option is to Amtrak per-passenger-mile long-term avoidable costs as follows:

Expense per passenger-mile (Based on Year 1993)	Source on Amtrak (1993 data)	Applied as denominator in ratios for—
16.5 cents	Combined Metroliner and Northeast Corridor Boston—Washington conventional services	HSGT corridors with 900 million passenger-miles or more
19 cents	Chicago—Detroit; New York—Albany—Buffalo	HSGT corridors with less than 900 million passenger-miles, but with average trip lengths over 100 miles
22 cents	Los Angeles—San Diego	HSGT options with less than 900 million passenger-miles and average trip lengths less than 100 miles

Accelerail 110 case—in which operating expenses normatively make up 42 percent of the total costs—shows a ten percent disimprovement in its total benefit/cost ratio, and a 24 percent reduction in its public benefit/cost ratio.

In this sensitivity test, none of the sample cases loses its partnership potential. Operating surpluses persist, albeit in smaller quantities, and total benefits still exceed total costs. Still, the projects are significantly less capable of financing themselves, the benefit/cost ratios are diminished, and the partnership potential, in practical terms, suffers. For this reason, the attainment of operating economies, just as well as the maximization of net revenues, will remain a guiding principle of HSGT planning and management.

Table 8-7
Results of Sensitivity Analysis—Higher Operating Expense Assumptions

[Dollar amounts are in millions except where noted]	Chicago-Detroit [125 mph fossil]			Chicago Hub Network [110 mph fossil]			California North/South New HSR [200 mph]		
	Norma -tive	Sensi -tivity	Sensitivity higher (lower) than Normative, Percent[19]	Norma -tive	Sensi -tivity	Sensitivity higher (lower) than Normative, Percent[19]	Norma -tive	Sensi -tivity	Sensitivity higher (lower) than Normative, Percent[19]
Annual Measures, Year 2020									
Passenger-Miles, Million	493.84	493.84		1,313.19	1,313.19		4,742.19	4,742.19	
Revenue	87.7	87.7		227.0	227.0		791.3	791.3	
Operating and maintenance expense	56.7	71.2	26%	137.8	172.8	25%	394.4	486.7	23%
O&M expense per passenger-mile (dollars)	0.115	0.144	26%	0.105	0.132	25%	0.083	0.103	23%
Amtrak unit expense[20] (dollars)	0.19	0.19		0.165	0.165		0.165	0.165	
O&M expense per passenger-mile as percent of Amtrak unit expense	60%	76%	26%	64%	80%	25%	50%	62%	23%
Operating surplus	31.1	16.5	(47%)	89.2	54.2	(39%)	396.9	304.6	(23%)
Operating surplus per passenger-mile (dollars)	0.063	0.033	(47%)	0.068	0.041	(39%)	0.084	0.064	(23%)
Life-Cycle Measures (All amounts are Present Values, as of the Year 2000, of cash inflows/outflows over 40 years)									
Surplus after continuing investments	189.2	65.0	(66%)	559.9	264.2	(53%)	2,489.4	1,755.5	(29%)
Initial Investment, Total	1,150.6	1,150.5		1,486.8	1,486.5		15,792.0	15,792.0	
Percent of Initial Investment Covered by Surplus After Continuing Investments	16%	6%	(66%)	38%	18%	(53%)	16%	11%	(29%)
O&M Expense as Percent of Total Costs	29%	36%	24%	42%	53%	26%	17%	21%	22%
Ratio of Total Benefits to Total Costs	1.5	1.4	(6%)	2.5	2.2	(10%)	1.2	1.1	(4%)
Ratio of Benefits to the Public at Large, to Publicly-Borne Costs	1.1	1.0	(11%)	2.8	2.1	(24%)	0.7	0.7	(5%)

[19] Where ratios and percentages are concerned, this column shows a ratio of ratios rather than a percentage-point spread. Slight discrepancies are due to rounding.
[20] Long-term avoidable cost per passenger-mile, for comparable operations as discussed in Footnote 18.

Low-Fare Air Service

In markets not served by low-cost carriers in 1993, baseline air fares for this study are probably higher than they would be if one or more low-cost carriers had been involved. Since low-cost carriers may expand to additional markets, it is possible that HSGT in some corridors would face lower prices on the part of airlines than those characterized in the normative analyses for this study. For this reason, the sensitivity of HSGT traffic projections to the introduction of low-fare air services was examined. This section discusses the extent of low-fare air service in the illustrative corridors and estimates the effect of lower air fares in selected markets.

Extent of Low-Fare Air Service

Table 8-8 lists many of the major air markets[21] in the HSGT corridors and identifies those which had "low-fare air service" in 1993 (the year forming the basis for the analysis) and in March 1996, when this portion of the analysis was completed. Only major markets served with jet aircraft are shown. Markets served predominantly by regional carriers with turboprop aircraft are not included since these markets are not prime candidates for the successful introduction of low fares.

No specific definition of "low-fare" service exists. The fare yields for the highest fare carriers in one market might, if offered in another market, be well below the existing fare yields. Therefore, identifying which markets were served by "low-fare carriers" involved both qualitative and quantitative factors. A list of low-cost carriers likely to offer low fares was developed on the basis of news articles, advertisements, and limited data. Quantitative factors were then used to evaluate the presence of low-cost carriers and low fare levels in specific markets, recognizing that low-cost carriers might not offer low fares in all markets they serve, and that airlines with more traditional service, costs, and fares might offer low fares in selected markets. The quantitative factors used in determining whether a service is considered low-fare for this analysis are:

- At least five jet round trips daily by a single carrier (in the case of Miami-Tampa a combination of two carriers was relied upon to reach that threshold). This criterion avoids classifying a market as low-fare if the low-cost airline has only a minimal presence in a market;

[21] In some cases airport pairs rather than city pairs are shown.

Table 8-8
Illustrative HSGT Corridors: Low-Fare Air Service in Major Air Markets[22]

[See footnote 23 below for carrier designation codes.]

Corridor and Market	*1993*	*1996*
California North/South		
Los Angeles-San Francisco		UA
Los Angeles-Oakland	WN	WN/UA
Los Angeles-San Jose	WN/QQ	WN/QQ
San Diego-San Francisco	WN	WN\UA
San Diego-Oakland	WN	WN
Burbank-San Francisco	QQ	UA
Burbank-Oakland	WN	WN
Burbank-San Jose	WN	WN
San Jose -Orange County		WN/QQ
Ontario-San Francisco		UA
Ontario-San Jose	WN	WN
Ontario-Oakland	WN	WN
San Diego-San Jose	QQ	WN\QQ
California South		
San Diego-Los Angeles		
Chicago Hub Network		
Chicago-Detroit	WN	WN
Chicago-St. Louis	WN	WN
Detroit-St. Louis	WN	WN
Detroit-Milwaukee		

(Table 8-8 continues on the next page.)

[22] 1993 schedules based on North American Edition, Official Airline Guide, December 1993; 1996 schedules based on North American Edition, Official Airline Guide, March 1996

[23] Carrier designation codes are as follows:

CO	Continental “Lite”
J7	Valujet Airlines
QQ	Reno Air
TZ	American Transair
UA	Shuttle by United
WN	Southwest Airlines
WV	Air South

Note: America West is also a low-cost /low-fare carrier, at least is some markets, but did not offer service in any of the markets listed in Table 8-8.

(Table 8-8 continued . . .)

Corridor and Market	*1993*	*1996*
Florida		
Tampa-Miami		WV/TZ
Fort Lauderdale-Tampa	CO	WN
Miami-Orlando		
Northeast Corridor		
New York-Boston		
New York-Washington		
New York-Baltimore	CO	
Boston-Baltimore		
Boston-Philadelphia		
Providence-New York		
Providence-Washington		
Pacific Northwest		
Seattle-Portland		
Vancouver-Seattle		
Vancouver-Portland		
Eugene-Seattle		
Texas Triangle		
Dallas-Houston	WN	WN
Houston-San Antonio	WN	WN
Dallas-San Antonio	WN	WN
Austin-Dallas	WN	WN
Austin-Houston	WN	WN
Empire Corridor		
New York-Buffalo	CO	
New York-Rochester		
New York-Syracuse		
Southeast Corridor		
New York-Raleigh		
Philadelphia-Raleigh		
Washington/Baltimore-Raleigh		J7
New York-Greensboro	CO	CO
Philadelphia-Greensboro		
Washington/Baltimore-Greensboro	CO	
New York-Charlotte		
Philadelphia-Charlotte		
Washington/Baltimore-Charlotte		

- Fares well below those in other similar stage length jet markets in the same area of the country on a continuing basis (not just during "fare wars"); and
- Generally one way, unrestricted ("walk-up") fares are available at no higher than half the round trip, advance purchase excursion fares offered by the major non-discount carriers.

Table 8-8 shows each of the qualifying air markets. The primary discount carrier (or carriers) is shown in each market for December 1993 and for March 1996. In most cases, other carriers serving the market can be assumed to have matched, at least on a limited availability basis, the offerings of the low-fare air carrier. If no carrier code is shown in a box on the chart, there was no low-fare carrier operating in that market.

Table 8-8 shows that, as of 1993, low-fare air carriers had established a significant presence in the California North/South, Chicago Hub Network, Chicago—Detroit, Chicago—St. Louis, and Texas Triangle corridors, and had entered selected markets in the Northeast, Empire, and Southeast Corridors. No low-fare service existed in the California South, Florida, and Pacific Northwest corridors. Thus, the analytical base for this study already includes extensive, although by no means ubiquitous, low-fare operations.

The situation as of March 1996 suggests that considerable fluidity exists in the entry and exit of low-fare carriers in city-pair and airport-pair markets. Although some markets enjoy recently added low-fare service (for example, additional airport pairs in the high-volume Bay Area—Los Angeles market), others—in the Northeast and Empire Corridors, for instance—have seen low-fare service disappear.

Through the 1990s, the absence of low-fare service in the California South and Pacific Northwest corridors, and its paucity in the Northeast Corridor, suggest that such site-specific factors as relatively short average trip lengths and high operating costs may discourage the introduction of low-fare air service, irrespective of the presence of HSGT. Many factors, however, enter into entrepreneurs' decisions to invest in new aviation services,[24] and into established airlines' pricing policies; thus, HSGT has no guaranteed immunity from airline price competition.

Estimate of Effects of Lower Air Fares

Since Florida lacked significant intrastate service by discount airlines in 1993, it provided a useful locale for a sensitivity analysis.[25] The demand model was applied to two

[24] For example, since the 1960s and 1970s, low-fare air service has come and gone in some important Northeast Corridor markets and in San Diego—Los Angeles.

[25] By no means does the selection of these city-pairs, for the purpose of this hypothetical sensitivity check, imply that these markets will be consistently suitable for low-fare air service during the planning period (2000—2040). The distances are relatively short and detailed studies of, and experience with, volume,

city-pairs: Miami—Orlando (189 air-miles) and Miami—Tampa (201 air-miles). Only one change was made: air fares were lowered by 30 percent from their 1993 levels. All other factors were held constant, including HSGT fares and the market sizes of auto and of the hypothetical low-fare air service in the absence of HSGT.

The results, depicted in Table 8-9, suggest that a 30 percent reduction in air fares would reduce diversion rates from air[26] to HSGT by about 24 to 33 percent and total HSGT traffic in these markets by about 10 to 24 percent.

Table 8-9
Estimated Effect of Lower Air Fares on HSGT Traffic Volumes in Two City-Pairs
(New HSR Example—Florida Corridor)

	Market	
	Miami—Orlando	**Miami—Tampa**
(1) Percent reduction in air fare	30%	30%
(2) Percent reduction in diversions from air[26] to HSGT	24%	33%
(3) Net reduction in total HSGT traffic volumes	10%	24%
(4) Reduction in HSGT traffic volumes as percent of reduction in diversions from air to HSGT [= (3)/(2)]	42%	73%

The table reveals that for the two markets studied, and with all other factors held constant, a 30 percent reduction in air fare results in a roughly equivalent drop in projected diversions from air[26] to HSGT. However, since HSGT attracts its traffic base from sources other than air, total HSGT traffic volumes fall less markedly than air-sourced HSGT traffic alone. The degree of mitigation varies between the two markets: whereas total HSGT traffic declines by only ten percent in Miami—Orlando, it falls by 24 percent in Miami—Tampa. (See line (4) in Table 8-9.) Clearly, if the susceptibility of HSGT to airline price competition can change so much from market to market in a single corridor, it can exhibit even more variation among different corridors. In evaluating HSGT options on a site-specific basis, therefore, States and HSGT entities may wish to conduct similar sensitivity tests on key markets with careful attention to localized factors. Such detailed analysis would

capacity, and other important operating, marketing, and financing issues would be prerequisite to an airline's conduct of such service during that period.

[26] That is, diversion from "origin/destination" air traffic only. This traffic consists of air trips the true endpoints of which both lie within the HSGT corridor.

need to consider a number of additional phenomena that do not enter into Table 8-9. These complicating factors include but are not limited to:

- Likelihood of actual entry of low-fare carriers into the corridor's constituent markets (i.e., their prospective investment requirements and results of operations given, e.g., the operating performance and costs at the specific airports involved);
- Long-term effects on the air traffic base in the constituent markets—this involves such factors as induced demand and attracted traffic from competing markets;
- Long-term effects of the presence of low-fare air carriers on the auto traffic base and (where important) on conventional rail and bus ridership; and
- The likely response of an HSGT operator to the entry of low-fare air competition, in terms of pricing, service design, and other factors; and the effects on air and auto diversion of that HSGT response.