From the Limiteds and the Zephyrs to the 21st Century MetroFlyer

(or The Vital Role of Metropolitan Access in Intercity Passenger Transportation)

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The Modern Day Olympian Hiawatha – a "Limited" – at Glenview, Illinois.
Wouldn't it be wonderful if this train, like the North Shore Line, also made stops on the Loop?

THESIS

- Enhancing access is more important than reducing journey time.
  - 110mph is a reasonable top speed for most demographics.
  - Three hours of in-vehicle time between major origin-destination pairs is a reasonable trip length.
  - Three hours of access time from door-to-door is unacceptable!
- Carriers can compete more effectively with other modes if it controlled the local access.

OUTLINE

- North America is a suburban sprawl – getting to the train station or airport is more difficult than getting between train stations or airports!
- Customers would rather sit on the train (and relax or work) than fight traffic on urban highways.
- The objective of the carrier is to maximize passenger utility, not to minimize in-vehicle time.
- Modern technology enables track-sharing, making high-cost urban infrastructure more cost-effective.
- Intercity Rail is not a transit! Customers are not captive, and customers want to be happy. Intercity carriers are selling an experience, not just transportation.

ACKNOWLEDGEMENTS

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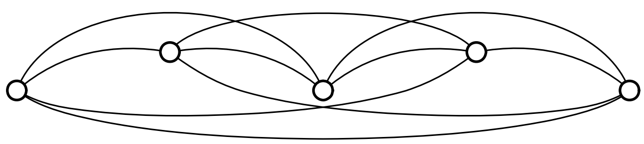
TRAINS ARE NOT PLANES

Why is a train not a plane? The nature of air technology is such that airports requires large amount of land mass and intensive capital investment to support a limited number of take-offs and landings. Once airbourne, infrastructure requirements are relatively modest. The nature of rail technology is completely different – the terminal footprint is small but infrastructure costs rise approximately linearly with distance. Thus, planes are good for long-haul point-to-point trips, whereas trains are good for pick-ups and drop-offs along a corridor.

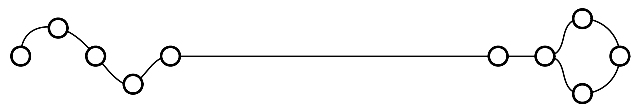
Limited Stop Network Design

Lower per-route-mile costs
High terminal costs
Dispersed demand generators
Focused generation at each node



Zone Express Network Design

High per-route-mile costs
Lower terminal costs
Clustered demand generators
Demand generation not focused



The Future of North American Intercity Transportation…

Which would you *choose?*

High line-haul speed compensates for longer access time

Photo: Ryan Tam, MIT Center for Transportation Studies.

Shorter access time compensates for lower line-haul speed

Photo: Lexcie Lu, MIT Center for Transportation Studies.

This Depends on Economic Geography –

Where the Activity Centers are, and How *Clustered* they are.

U.S. ECONOMIC GEOGRAPHY

North America has a Distributed Economy. Some of the major U.S. economic and population centers are separated by more than 600 miles. In such long-distance markets, air will dominate, since the line-haul speed and the resulting shorter door-to-door trip time drives mode choice.

North America is a Suburban Sprawl. However, access to the airport within a metropolitan area will never be particularly efficient. The high cost of the airport means that the densities in most metropolitan areas are insufficient to support separate airports for each neighbourhood. In fact, airports generate significant externalities and are not welcome in most neighbourhoods. Thus, aside from megacities like New York which are able to support multiple airports, the access to the airport will remain poor for most part of the metropolitan area. Consolidation of demands will necessarily occur, leading to long access times for those who do not live near either conventional high-speed rail's downtown "union station" or the airport.

Here lies an *Opportunity* for Rail Carriers…

Activity centers in North American metropolitan areas are sufficiently dispersed that a rail carrier can take advantage of the inherent nature of rail technology to serve many more flows much closer to the point of origin than an air carrier can practically do so without transfer. Since suburb-to-suburb travel is expected to dominate intercity travel in North America in the foreseeable future, it is conceivable that strategically placed rail stations will make high-speed rail service much more auto-competitive on shorter trips (50~150 miles), while making it much more air-competitive on mid-length trips (150~400 miles).

Only large metropolises like Boston, Massachusetts, can support a busy airport with many international and transcontinental flights.

Photo: Ryan Tam, MIT Center for Transportation Studies

Limited Stop

for longer trips (More than 600 miles)

Demand from a large metro area is consolidated to a "high speed access point" such as an airport for the highest possible port-to-port speed.

However, many Americans live in the suburbia like Harpers Ferry, West Virginia, and don't like to go downtown for intercity transportation..

Photo: Lexcie Lu, MIT Center for Transportation Studies

Zone Express

for mid-length trips (150~400 miles)

Demand from a large metro area is consolidated onto the same vehicle, which makes multiple stops, to avoid the long access time required by local transportation.

WHY ARE THE LIMITEDS NO MORE?

Today's Urban Areas are Different to ones that existed in the Golden Age of the Railway. The limited-stop express business model is simply not applicable anymore. In the days of the famous Limiteds and Zephyrs, metropolitan areas were much smaller and much more concentrated. Intercity travel were dominated by city-center to city-center flows, and the railroad was the quickest practical way to travel overland. Thus, it made sense for the fastest service to depart from the downtown union station (then a "high-speed access point") and consolidate demand from the smaller metro area with streetcars. The consolidation was relatively efficient since the access portion of the trip remained fairly manageable with smaller cities. Today, the fastest service is the air service, and the "high-speed access point" is the airport; the railroad must find a new niche to survive.

Broadway Limited
Super Chief el Capitan

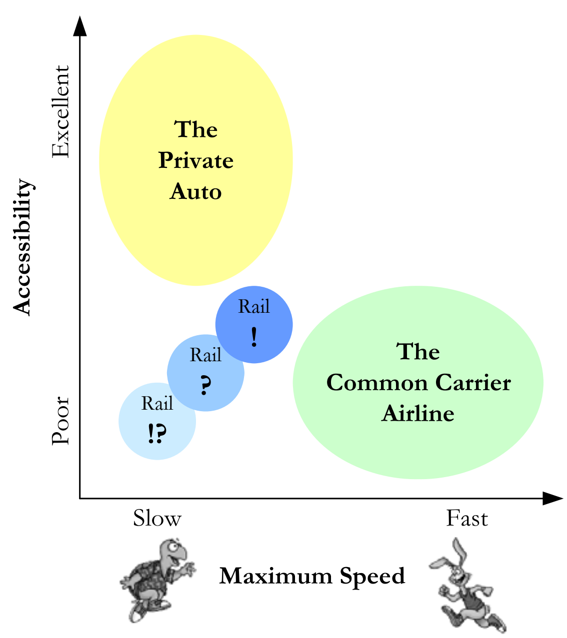
Rail is the fastest
Small metropolitan areas
Streetcar suburbs
Travel between city-centers dominates
Auto use not widespread
Interstate Highways not yet built

Acela Express
Virgin 'Pendelino'

Rail is most comfortable
Large metropolitan areas
Automobile suburbs
Travel between suburbs dominates
Small carless population
Interstates free and convenient

But… *What* new niche?

That New Niche, is Comfort and Accessibility. Today, rail faces tough competition from two sides. The automobile is ubiquitous, have very low up-front, incremental costs per passenger and per trip, and have very good access (especially in the suburbs where parking is a-plenty). The leisure air fares are affordable, the service is frequent, has much lower journey times than most modes; despite the difficulty of access, it is nonetheless a formidable competitor even in rail's "home stretch" of 150~400 mile journeys. The intercity coach continues to dominate the low-end of the market with its very low cost of production. Passenger rail will survive and thrive, if it exploits the competitors' weaknesses; passenger rail will remain a curiosity of the bygone era, if it continues to attempt to emulate its competitors and pretend to be the fastest, the most convenient, or the cheapest mode.



WHY IS ACCESS IMPORTANT?

Access for Service. First and foremost, customers would like better access. While seasoned commuters may not find transfers daunting or inconvenient, these are not our target customers when seeking to expand the rail market share. Evidence from the airline industry suggests that direct flights are preferred by non-regulars, especially those new to flying. Evidence from commuter rail suggests customers with high values of time dislike transfers because they interrupt work. Commuters may be willing to pay a premium for facilities that will eliminate transfers – for instance, Pennsylvania's elimination of Manhattan Transfer through the Hudson Tubes.

Access for Ridership. Secondly, public officials who are concerned about airport capacity and the negative externalities that the airports generate understand that short-haul flights are an inefficient use of airport capacity and would like to see more short-haul trips on rail. Providing better rail accessibility would encourage people who would have never considered rail as a viable mode (perhaps because they live far away from downtown) to use rail at least some of the time. This may reduce airport congestion significantly, since short-haul flights are a significant proportion of total take-offs and landings at hub airports in large metropolises.

Access for Competitive Advantage. Last but not least, intercity rail carriers in Europe and North America, many of whom struggles to make a profit without subsidies, would love to find a lesser capital-intensive way to expand market share and revenues. Instead of investing in a faster railroad with infrastructure subsidies, perhaps enhanced access would offer a lesser capital-intensive way forward.

Access is a *Win-Win-Win* proposition:

There are no losers.

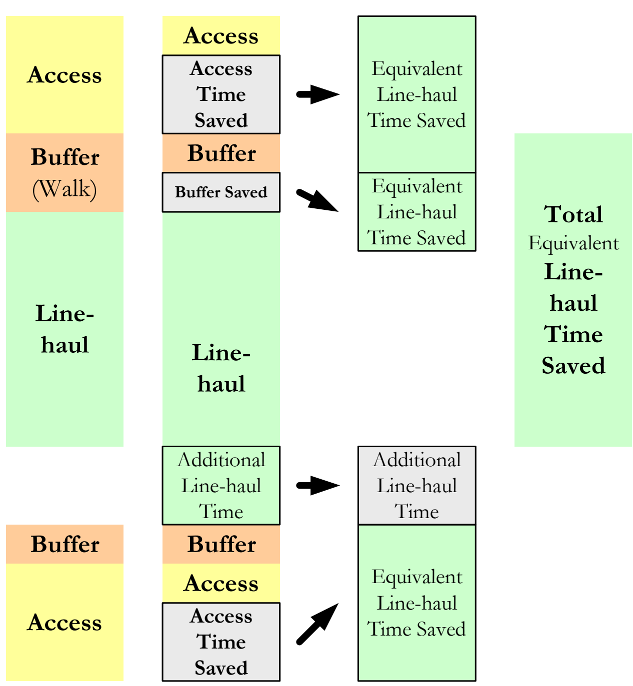
Higher Maximum Speed	**Better Access Multiple Stations**
Existing Customers – faster trip, shorter journey time	**Existing Customers** – service not really much different
Potential Customers – service not really much different	**Potential Customers** – shorter access time friendlier local service
Public Officials – more infrastructure subsidies	**Public Officials** – reduced congestion & externalities
Intercity Passenger Rail Carriers – more maintenance costs	**Intercity Passenger Rail Carriers** – larger market reach
Transferring value from government to consumers is politically popular…	*Providing a service for which consumers are willing to pay is good business.*

WHY DO CUSTOMERS WANT BETTER ACCESS?
(IS TEN MINUTES REALLY TEN MINUTES EVERYWHERE?)

Rail can Reduce Travel Time through Urbanized Areas. Rail is the most efficient mode with which one could travel through heavily congested urban areas – this is widely confirmed in Japan and Europe. Rail has small right-of-way footprint and high carrying capacity, compared with buses, private auto and airlines. Thus, the leveraged portion of the intercity rail trip is the first ten miles and the last ten miles. By substituting rail for auto or subway for the "access" leg of the trip, externalities (highway or subway congestion at peak hours) are reduced, while the traveller saves valuable time.

Even if Travel Time is the Same, the Passenger is Better Off. Instead of an intermodal trip comprising of a 45-minute subway leg, 15-minute transfer time, 30-minute check-in, 1-hour air leg, 15-minute transfer time, and another 45-minute subway leg, the passenger is able to replace the fragmented idle time with 3 hour 30 minutes' of comfortable and perhaps productive time onboard a train to relax, work, or simply enjoy the scenery. If the subway legs are necessary to reach the downtown rail union station, rail's advantages are lost. In Europe, many high-speed rail riders are captive riders who don't have uncongested roadways to drive on! One study has shown that travel time in the air has a twice the disutility of travel time in a railcar. The accessible rail replaces onerous terminal time and access time with comfortable in-vehicle time – unlike the limited-stop high speed rail, which erodes the in-vehicle time in favour of longer access times.

Customers don't like to Get Up and *Walk!*



Equivalent Line-haul Savings can be Substantial

Because Terminal, Buffer and Access Times are particularly onerous, trying to cut access time is a much better goal than trying to cut in-vehicle time.

Generally access time is valued at twice the equivalent in-vehicle time. Line-haul time is much more comfortable.

Frequent Service will cut *Adjustment Time*
Schedule Coordination will cut *Transfer Time*
Reliable Access will cut *Buffer Time*
Terminal Shuttle will cut *Access Time…*

Enhanced Metropolitan Access
will cut **All Of The Above!**

DO YOU LIKE NEXTBUS?

How does NextBus Work? Nextbus works by exchanging uncomfortable terminal time (waiting at a bus stop) for more comfortable adjustment time (waiting at home, at work, or in a café), so that the passengers may arrive in time to meet the vehicle. The fact that many transit authorities are spending not insignificant amounts of money on this technology suggests that the value of time at a terminal, compared with the value of "adjustment time", is clearly different. When studying intermodal itineraries, it is therefore critically important that the modeller should make clear distinctions between in-vehicle time, terminal time, adjustment time, access time, and access time aboard different modes and different vehicle/service types.

At Davis Sq. in Somerville, Mass., you could grab a coffee while you wait for the bus instead of enjoying the crisp fall air, if you knew when the bus would arrive..

Photo: Lexcie Lu, MIT Center for Transportation Studies.

It's the *Value of Time*, Sir.

How does MetroFlyer Work? MetroFlyer works by exchanging uncomfortable terminal time and access time (taking the subway downtown, then waiting for the intercity train to depart) for more comfortable in-vehicle time (the quiet surroundings of a luxurious intercity train is much more comfortable than a taxicab sitting in traffic or the noisy subway). In many cases, the total trip time is actually reduced. Even in the cases where the trip time is not reduced, the quality of the trip is still much better since a greater proportion of the trip is spent on-board a comfortable intercity train.

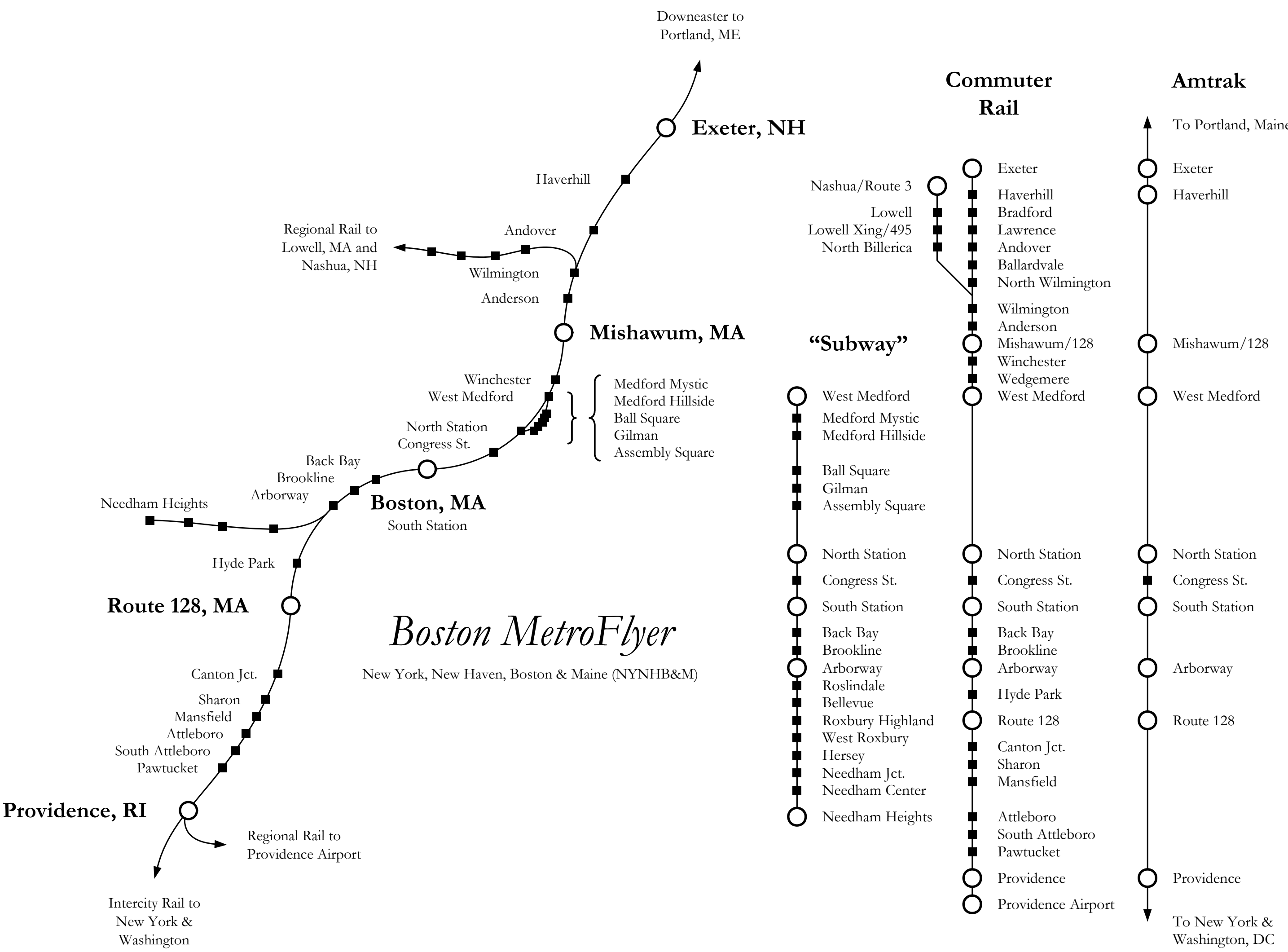
NextBus	MetroFlyer
Stay at Home for Longer – staying at home is better than standing at the curb	**Stay On-board for Longer** – riding a long-distance train is better than standing in a bus or subway
Know your Connexions – reduces buffer time, since real-time information enables tighter connexions	**Know you will Make the Connexion** – reduces buffer time, since access is shorter and subject to less variance
Know when the Bus will Arrive – reduces waiting anxiety, disutility of transfer time reduced	**Reduces Transfers** – less need for schedule coordination; shorter adjustment and transfer time

MODERN TECHNOLOGY ENABLES TRACK SHARING

Rail Infrastructure Offers Opportunities for Smart Growth. With today's intercity rail technology, there are little reasons why infrastructure should not be shared between intercity, commuter, and urban rail operations. Creating a dedicated rail right-of-way within the city (or reusing an old right-of-way) for the purposes of intercity rail is not only beneficial for intercity travellers, but for neighbourhoods en-route which will receive an economic boost, and also creates a corridor for urban regeneration. Intercity and Commuter trains, which may depart every 15-minutes, can share tracks with FRA-compliant urban electric trains which will utilize the remaining corridor capacity to deliver a subway-like service. Sharing of the right-of-way in congested areas is critical and will create economies of density in infrastructure utilization otherwise not possible with commuter rail or subway alone. Higher cosmetic standards would be required than a typical subway installation, but such investment will also encourage more choice riders than otherwise possible.

Intercity Rail is an **Opportunity** for *Transit Authorities…*

…to offer **Additional Subway Service** with *Spare Track Capacity*



WHAT SPARE TRACK CAPACITY?

Modern Technology and Disciplined Operations allow High Track Capacity. On many modern transit systems, headways as low as 90-seconds are routinely maintained. Current moving block signalling technology allows headways down to the 75-second range. However, such headways are not routinely sustainable. Instead, most manually operated transit systems regard 24 trains-per-hour (tph) as the maximum practical limit. Using the hypothetical Boston MetroFlyer example, we found that a feasible operating plan could be created to cater for combined operations of a 12tph Subway, a 4tph Commuter Rail, and a 3tph Amtrak over the same double-track right-of-way – with reasonable margins for recovery should a disruption occur. (The signalling system was assumed to allow trains to follow each other every 90 seconds.) Highly disciplined operations, combined with modern signalling technology, will allow urban infrastructure corridors to be used to the maximum extent, and to cater for trains of varying speeds.

Although the operating and maintenance costs of an FRA-compliant subway will be higher, these costs are smaller than the cost of providing separate rights-of-way through congested urban areas.

Assumptions: Sidings for same-direction passing at West Medford (MFDW), Boston South Station (BOSX), and Brookline (BKLN), with four tracks in the immediate vicinity of South Station. Subways trains may have unscheduled delays of up to 72 seconds due to congestion effects. Points can set-and-lock or reset-and-lock within 36 seconds.

Photo: Joe Testagrose, New York City Subway Resources (*http://www.nycsubway.org/*)

Boston MetroFlyer – **Operating Plan**

	SUBW	R/R	AMTRAK		AMTK-	SUBW	AMTK-	SUBW	RR-HH	SUBW	SUBW	SUBW	RR-NS	SUBW	AMTK-	SUBW	SUBW	RR-HH	SUBW	SUBW	SUBW	RR-NS	SUBW.
	S/S+D	S/S+D	S/S+DWELL		xx/00	xx/01	xx/05	xx/06	xx/10	xx/11	xx/16	xx/21	xx/25	xx/26	xx/30	xx/31	xx/36	xx/40	xx/41	xx/46	xx/51	xx/55	xx/56
EXRX																							
HHLX			23		10.87		10.95		10.72						11.37			11.22					
BRFD		2							10.75									11.25					
LWNC		9							10.90									11.40					
ANVR		5							10.98									11.48					
BLVL		4							11.05									11.55					
NWMT		7							11.17									11.67					
WMTC		15							11.42				11.67					11.92				12.17	
ARTC		5							11.50				11.75					12.00				12.25	
M128		1	31		11.38		11.47		11.52				11.77		11.88			12.02				12.27	
WNTR		6							11.62				11.87					12.12				12.37	
WGME		2							11.65				11.90					12.15				12.40	
MFDW		4	11		11.57	11.47	11.65	11.55	11.72	11.63	11.72	11.80	11.97	11.88	12.07	11.97	12.05	12.22	12.13	12.22	12.30	12.47	12.38
MFDM	4					11.53		11.62		11.70	11.78	11.87		11.95		12.03	12.12		12.20	12.28	12.37		12.45
MFDH	4					11.60		11.68		11.77	11.85	11.93		12.02		12.10	12.18		12.27	12.35	12.43		12.52
BALL	5					11.68		11.77		11.85	11.93	12.02		12.10		12.18	12.27		12.35	12.43	12.52		12.60
GLMN	4					11.75		11.83		11.92	12.00	12.08		12.17		12.25	12.33		12.42	12.50	12.58		12.67
ASMB	4					11.82		11.90		11.98	12.07	12.15		12.23		12.32	12.40		12.48	12.57	12.65		12.73
NSTA	4	13	12		11.77	11.88	11.85	11.97	11.93	12.05	12.13	12.22	12.18	12.30	12.27	12.38	12.47	12.43	12.55	12.63	12.72	12.68	12.80
NSTA-DEP	1	5	5		11.85	11.90	11.93	11.98	12.02	12.07	12.15	12.23	12.27	12.32	12.35	12.40	12.48	12.52	12.57	12.65	12.73	12.77	12.82
CSTA	3	2	2		11.88	11.95	11.97	12.03	12.05	12.12	12.20	12.28	12.30	12.37	12.38	12.45	12.53	12.55	12.62	12.70	12.78	12.80	12.87
BOSX	3	2	2		11.92	12.00	12.00	12.08	12.08	12.17	12.25	12.33	12.33	12.42	12.42	12.50	12.58	12.58	12.67	12.75	12.83	12.83	12.92
BOSX-DEP	1	5	5		12.00	12.02	12.08	12.10	12.17	12.18	12.27	12.35	12.42	12.43	12.50	12.52	12.60	12.67	12.68	12.77	12.85	12.92	12.93
BBYX	4	5	5		12.08	12.08	12.17	12.17	12.25	12.25	12.33	12.42	12.50	12.50	12.58	12.58	12.67	12.75	12.75	12.83	12.92	13.00	13.00
BKLN	5	4				12.17		12.25	12.32	12.33	12.42	12.50	12.57	12.58		12.67	12.75	12.82	12.83	12.92	13.00	13.07	13.08
ABWY	7	6				12.28		12.37	12.42	12.45	12.53	12.62	12.67	12.70		12.78	12.87	12.92	12.95	13.03	13.12	13.17	13.20
HDPK		8							12.55				12.80					13.05				13.30	
R128		5	10		12.17		12.25		12.63				12.88		12.67			13.13				13.38	
CNJN		4							12.70									13.20					
SHRN		6							12.80									13.30					
MSFD		8							12.93									13.43					
CATB		8							13.07									13.57					
SATB		7							13.18									13.68					
PTKT		5							13.27									13.77					
PVDX		5	29		12.65		12.73		13.35						13.15			13.85					

HOW TO PROVIDE DOWNTOWN ACCESS & DISTRIBUTION

Multiple Union Stations. The basic idea for enhancing downtown access and distribution for intercity passengers, is to extend the concept of the "union station", invented by North American railroads in the early 20th century to facilitate interline transfers and to reduce costs. The union station was an appropriate concept of its time, since the smaller cities allowed a single terminal to be conveniently sited for most parts of the city. However, as business district expanded, the important economic activities within a metropolitan area are no longer within walking distance of the union station. Providing a number of union stations (where all terminating trains call) within the metropolitan area will dramatically improve the access to high-speed rail services.

Can you resist the *Ubiquitous* railroad?

City Neighbourhooods have Different Character. When designing one of the many "union stations", it is important to consider how it would be used. In the walkable downtown, business travellers are likely to walk to the station, thus station spacing should be no more than about 1½ miles. In the suburban areas, where densities are too low to justify a "union station" for every neighbourhood, the stations should be designed as intermodal transfer facilities featuring parking and mass-transit access. In many cases, one single union station with Park & Rides on the beltway may be the correct answer. For some cities, a number of downtown access points are clearly needed, especially where the walkable areas of downtown is more than about 1½ mile in diameter.

It is also extremely important to pay close attention to both the needs of the locals and the through-travellers. If the number of stations required to adequately serve the originating local riders is too high, a through by-pass should be considered.

Ten Minutes to the Train

– the ubiquitous railroad

Multiple Union Stations

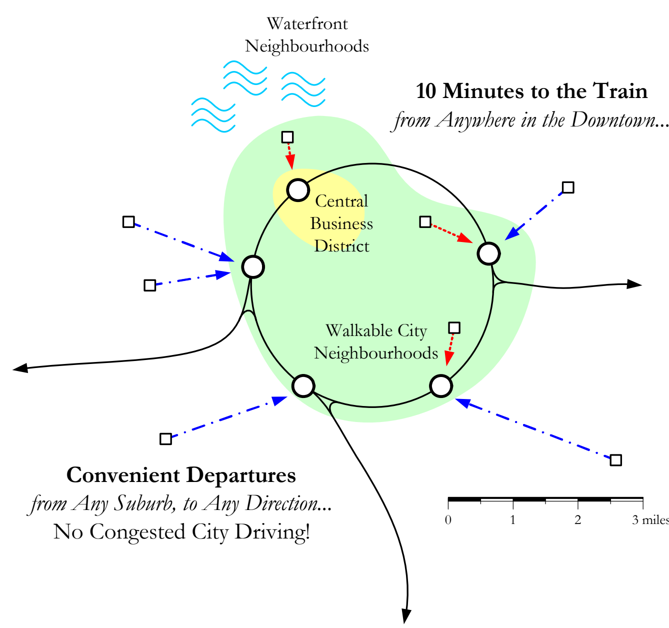
– allows convenient access from all parts of the downtown

Multi-Purpose Neighbourhood Stations

– by putting some of the union stations close to the edge of the walkable downtown, they could become multimodal access points for the inner suburbs

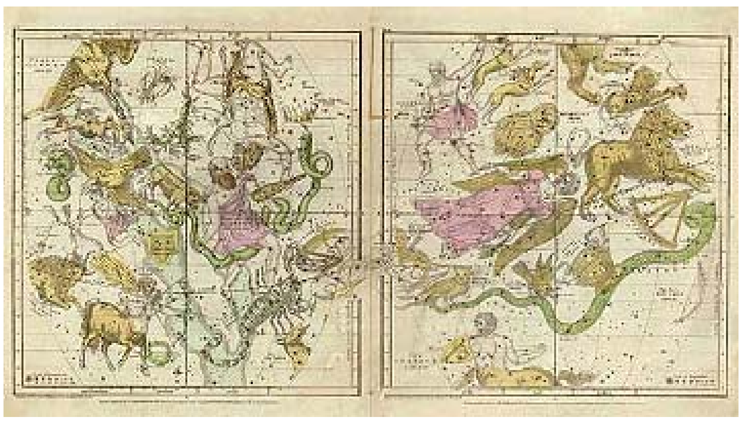
Park & Rides

– provide accessibility for the outer suburbs and edge cities, but these will not be union stations since the time penalty of detour for all trains would be significant



CONNECTING THE DOTS

Different Layouts are Possible. Having determined the number of stations, these stations would need to be linked such that as many of the terminating trains as possible call at as many of the stations as possible, while minimizing the amount of new infrastructure required. In some cities, this is simply a question of changing the service design using existing infrastructure. In other cities, perhaps new spurs or wyes would be required, or "missing links" (because of historical oversight) would have to be built from scratch. Evaluation would be required on a case-by-case basis, where project evaluation techniques could be used to calculate the expected costs and benefits. Popular layouts to consider include: (1) East and West Park & Ride with Union Station, (2) Trunk Distributor, (3) The Inner Ring Railroad. Other layouts are possible, depending on the local situation.

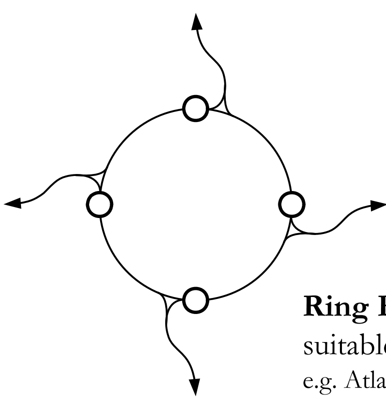


There are many ways of connecting stars to form constellations – and many ways to connect urban stations to form a metropolitan access network. Constellations are constrained by ancient Greek mythology, while urban rail networks are constrained by existing infrastructure, available funds, and planning mythology(?).

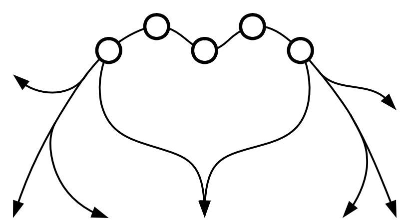
Photo: Celestial map of the constellations from Elijah Burritt's *Celestial Atlas* (1835).

As a counterexample, consider the Penn Station in Baltimore, Maryland. The station never realized its full potential since it was sited on the edge of the downtown and not particularly accessible. The single union station downtown is as accessible to the affluent suburbs as Baltimore Penn Station is to the city!

In Tokyo, a former suburban ring railroad has been adapted as a downtown distributor for commuter and regional interurban rail arrivals as the central business district grew larger and became distributed over a large area. Some Shinkensen is already making edge city stops to facility transfers to these distribution facilities.



Ring Railroad Layout
suitable for inland hub cities,
e.g. Atlanta, London, Montreal

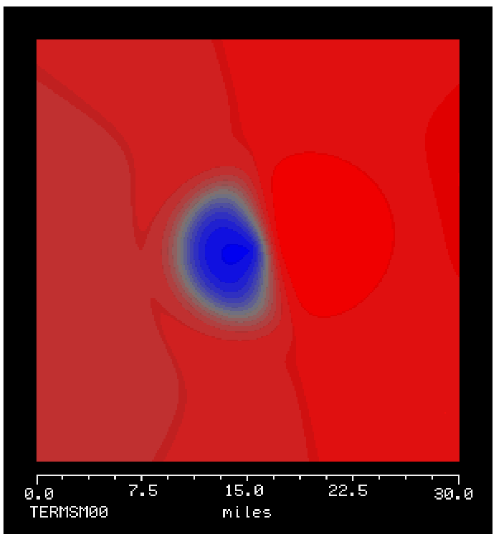


Trunk Distributor Layout
suitable for riverfront or seaboard cities,
e.g. Halifax, Miami, Rotterdam

The ring is theoretically most efficient, in terms of ratio of catchment area to track mileage required. However, there are operational issues associated with the ring, and most cities do not have downtown rights-of-way which can be readily connected to form a ring. Thus, a ring can be a good alternative in a city in the early stages of its development (perhaps in the developing world), whereas trunk distributors may be more realistic in busy cities where new construction is difficult and expensive.

DEMAND & MODE SHARE STUDIES

More than a One-Seat Ride. The purpose of enhanced access to intercity rail is not merely to provide a one-seat ride for intercity riders. Most intercity riders would still need to transfer to a different mode to connect the office or the home to the neighbourhood union station – those who are downtown would need to walk or take a cab, and those in the suburbs would need to drive. The most important aspect of enhancing access is its eefect on mode split. To illustrate this, we used a very simple utility model, based on the methodology discussed in the Performance-Based Technology Scan paper (TRB 03-2545), to show that adding terminals will in fact give intercity rail a big advantage over airlines – possibly more so than spending equivalent amount of money on upgrading the right-of-way and increasing line-haul speed. The mode share projected is based on a decision rule.



Before – *Single Union Station*

Rail Dominates in the City Center
– rail has a significant advantage in the region coloured blue.

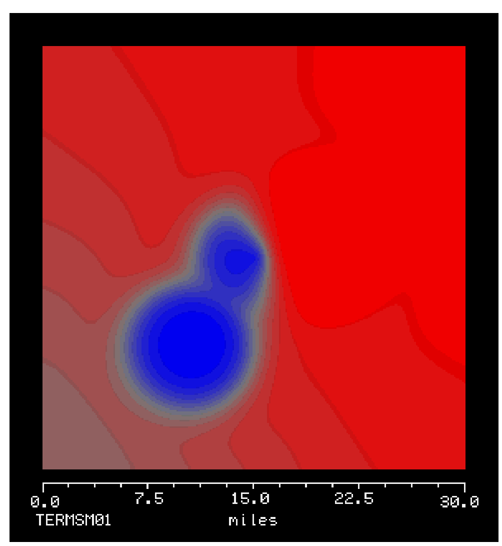
Airlines Dominates the Rest of the Metropolitan Area
– more than about two miles from the union station, the rail advantage disappears. Throughout the metro area, air is the preferred mode because the shorter line-haul time compensates for the access time, which become more similar as the origin moves further away from the union station.

New stations *Significantly* affects local mode share…

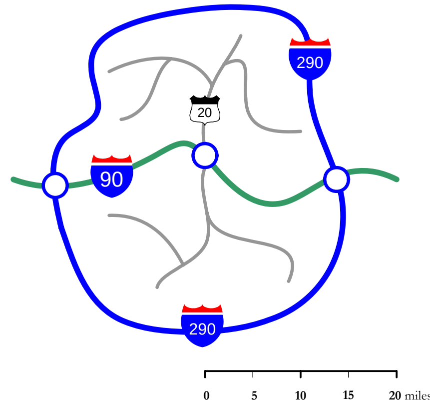
After – *Multiple Access Points*

Rail Dominates around Access Points
– the area of the blue region almost doubles, depending on the location of the new access point.

Air Domination is Decreased
– airlines continue to dominate in areas not covered by rail terminals, but hopefully these are areas of low demand.

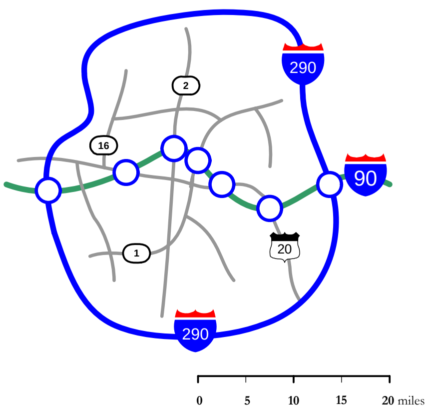


WHY WAS THE INTERSTATE HIGHWAY SUCH A BIG HIT?



For a moment, we would like you to image a possible world in which urban interstate highways were built with just three interchanges in the major cities, and one interchange for the smaller towns. This in fact represents a major saving on construction costs, since finding the land within urban areas to build large and complex interchanges can be a major part of the expense of building urban expressways. However, would the interstate system have been so successful for intercity passenger traffic if it had been built that way?

It's hard to imagine an effective interstate system where exits are constructed every 40 or so miles in the rural areas, and cars would proceed on arterial streets to the downtown before joining an expressway. The current high-speed rail apparently operates on this business model.



The current interstate system have effectively become a predominantly commuter facility. True "interstate" usage on the interstate highways remain very low – as evidenced by the continuing attempts to widen interstates close to urban areas, but not the line-haul portions over the Prairies. Access is the key to the urban expressway's success – both for attracting commuter traffic and encouraging auto use for intercity trips, partly through the convenient provision of the local-portion.

The Interstate is a *Commuter Highway…*

Equity Arguments for Scarce Urban Infrastructure, when framed in the context of serving a greater number of people with transit than intercity and commuter rail, is valid. However, when pitted against the funds continuing to be expended in upgrading urban and suburban expressways and airport access infrastructure to benefit a small proportion of travellers, makes incremental investment in intercity rail transportation look socially just and wise. Most captive transit riders from the city do not drive on interstate expressways, either.

Other Methods of Addressing Inequities

- Differential Intercity Rail Pricing
  - Ticket restriction based (market segmentation based on likely travel purpose, and thus ability to pay)
  - Time-period based (allowing off-peak fares close to marginal cost)
  - Accommodation based (utilizes commuter vehicles in between peaks)
- Explicit Rail Discounts for Low-Income Users
- Congestion Pricing on Urban Highways

Providing the service at the lowest common denominator is not a way to ensure equity – it encourages the rich to drive.

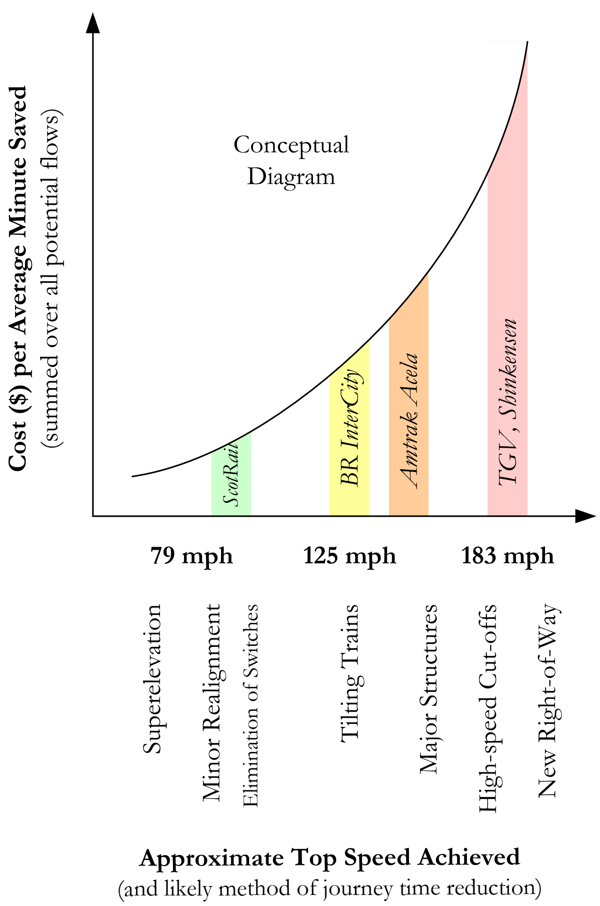
How many people here are really engaging in Interstate Commerce? Even if you removed the commuters, would many people be driving to New Hampshire instead of taking the train if the only exits were downtown and at Route 128?

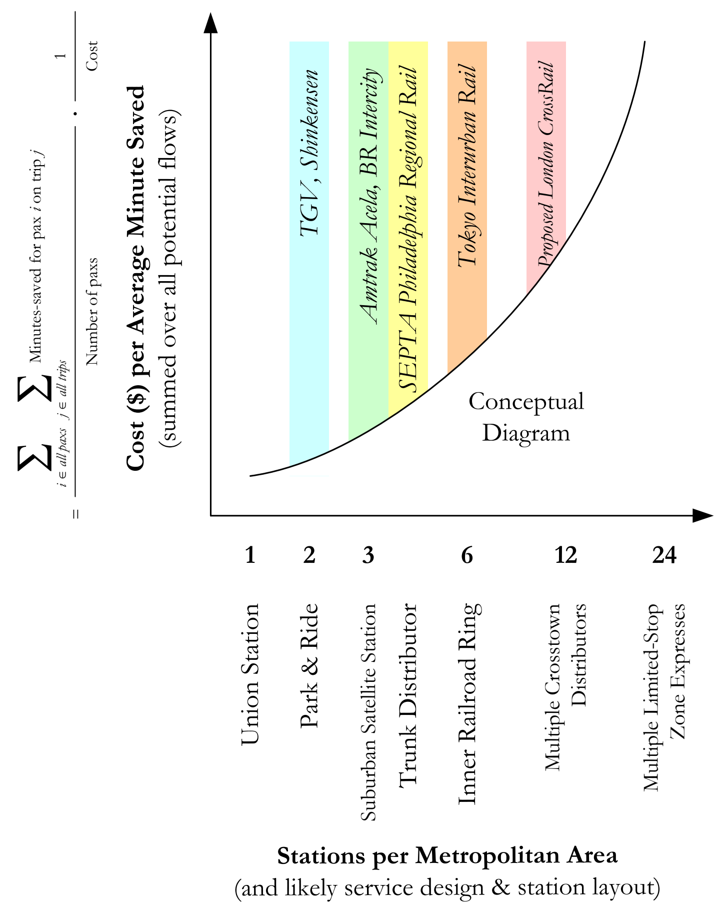
Photo: Dan "SPUI" Moraseski, MIT

RAIL UPGRADE COMPARATIVE EVALUATION

Rail Upgrade Strategies. Invariably, when evaluating rail upgrades, the cheaper (or more cost-effective) options are usually exercised first, followed by more expensive ones, up to the point when the combined values of public benefits and rail operator revenues exceed the fully allocated costs of the upgrade. Thus, there is a point of diminishing return. In many cases, you can achieve the majority of the benefits (say 80%) by investing a little (e.g. 20%), but to achieve the maximum benefit you must invest heavily.

If you accept this hypothesis, then it is possible to conceptualize a graph correlating the cost-effectiveness of upgrades (measured in perhaps cost per average minute saved) against the maximum speed achieved or the method with which journey time reduction is achieved in the quest for speed. Obviously, some methods of increasing speed, such as constructing a new right-of-way, are more expensive than others, such as increasing superelevation by tamping. Increasing accessibility is a totally different way to reduce the trip time, and therefore comes with its own cost-benefit tradeoff. The first station opened apart from the union station would be most effective, and the incremental benefit from each additional station decreases as the number of station increases.





Interestingly, it is the commuter and low-speed interurban carriers that have generally understood the importance of access, while flagship trains like TGV and Shinkensen tended to terminate at a union station. In evaluating further upgrades, additional stations ought to be considered as an alternative to achieving higher maximum speeds – if the maximum speed is already more than about 110mph, often the more effective investment would be in accessibility and not in further raising the speeds.

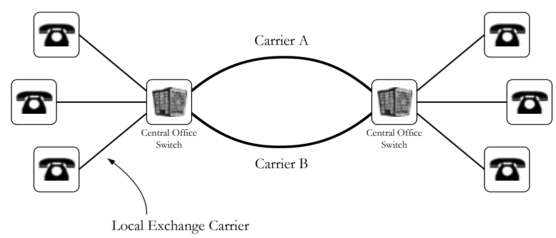
WHY DOES INTERCITY RAIL LOSE MONEY?

The moon glows through a cloud bank, San Diego, California.

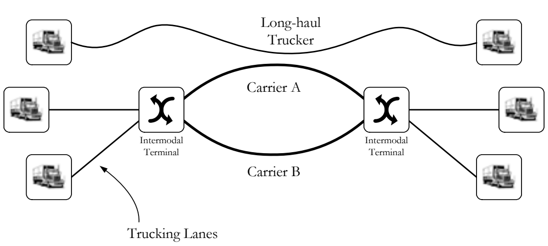
Photo: Joe Klein (*http://skychasers.net/joeklein.htm*)

Where is the Value in this Network? Consider the telecoms network shown. The Local Exchange Carriers (LECs) have direct access to customers, and are a monopoly element of the business. The economies of density in local connections result in a natural monopoly, making competition amongst rival LEC's extremely difficult. The customer is captive to the incumbent LEC.

The Inter-Exchange Carriers (Carriers A and B) on the other hand, is afforded no such protection. Since the number of exchanges are limited, there is no natural monopoly. Depending on the regulation, it is also possible for the LEC to influence competition between Carrier A and B substantially, by choosing to route its traffic differentially.



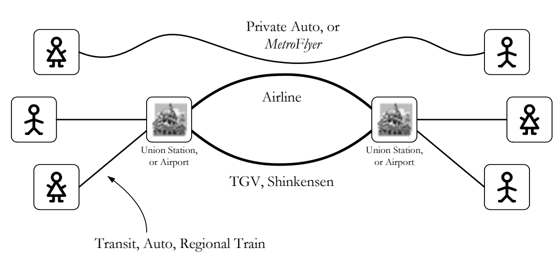
Thus, the value of the network is in the LECs – even if there were specific regulation allowing end-customers to choose between different long-distance carriers, competition is likely to reduce long-distance rates to close to marginal costs. On the other hand, the LECs have substantial pricing power. If LECs were permitted to enter the long-haul business, it would have a substantial competitive advantage.



In the freight industry, the local access carriers (trucking firms) are indeed permitted to enter the long-haul business. Truckers have substantial advantage over the railroads, due in part to its control over the customer interface – and the natural monopoly of urban highways. In effect, the truckers have only passed to the railroads the traffic which is uneconomic to truck – such as container flows over 1,200 miles.

Discarding the Value. Not surprisingly, in the passenger rail industry, even the premier trains of Europe and Japan are not profit-making propositions when fully-allocated infrastructure costs are taken into account. By going head-to-head with the airlines and not focusing on access issues, the high-speed rail has effectively turned over control of the customer interface to transit or highway authorities! High-speed rail technology will simply not win against the airlines on speed alone. In effect, the traditional high-speed rail has discarded the value in the business by competing where it simply cannot win – on the line-haul portion of the trip.

Capturing the Customer. The *MetroFlyer* concept exploits the inherent advantages of rail transportation and captures the customer interface at the local level (and with it much of the value in the business). Rail is most effective in congested urban areas, while airline and auto are least effective. In much of Europe and heavily populated parts of the United States, the population centers are often close enough to allow rail's inherent disadvantage in line-haul to be overcome by much, much shorter access time.



Some Hypothetical Case Studies

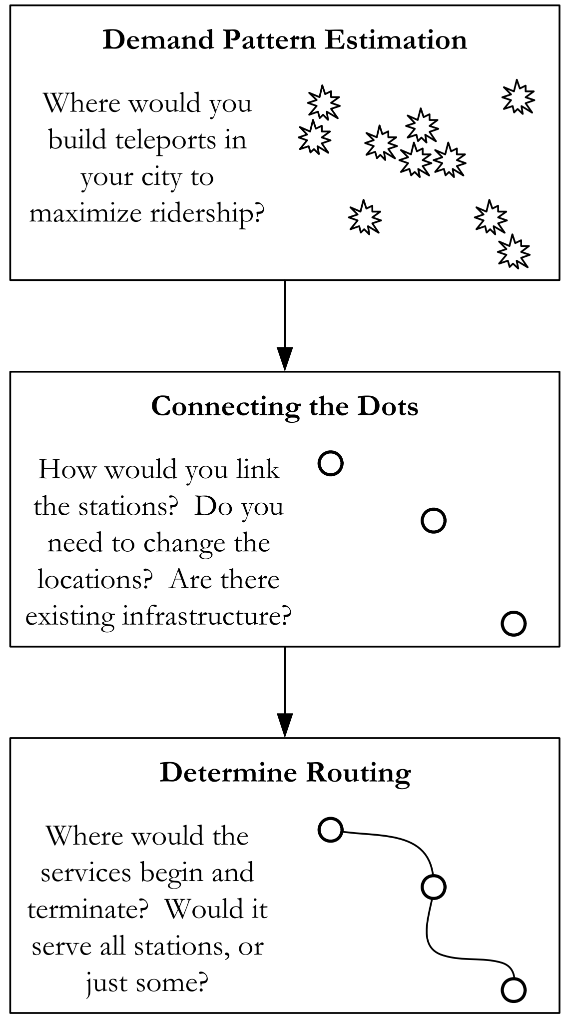
Reality is the Dreams of our Forefathers.

(Norfolk Southern freights passing at Toledo, Ohio, on the former New York Central mainline.)

METHODOLOGY FOR CASE STUDIES

In determining the access requirement for a given city, there are three major considerations:

- Demand Pattern
- Existing Infrastructure and Geography
- Routing



These can be described as something similar to a three-step process.

Demand Pattern. First, the demand pattern is established, using a combination of local knowledge, census data and perhaps limited passenger surveys. The census data at either the census tract, traffic analysis zone or even block level can be very useful, since it carries a wide variety of information. Median household income is a fairly strong predictor of intercity travel demand, since intercity travel is mostly a discretionary activity. Very-high income neighbourhoods should be avoided, as with very-low income neighbourhoods. High-speed rail's target customers lie within the middle income bracket. This enables us to determine the approximate location of the stops. This type of micro-analysis is vital in building an effective local distribution system.

The notion of "teleport" is a useful one to consider at this stage. For the average rail journey of two-hours in duration, if it is possible to save an hour in access time for our target customers, in terms of utility, high speed rail effectively becomes a teleport, since the access time has twice the disutility of in-vehicle time. Thinking about "teleports" also allows the planner to focus merely on the access issues, and not worry about how to route the train – at least, not at this stage. A usual question to ask is: "If you had to plant five intercity teleports in this city to maximize ridership, where would you put them?"

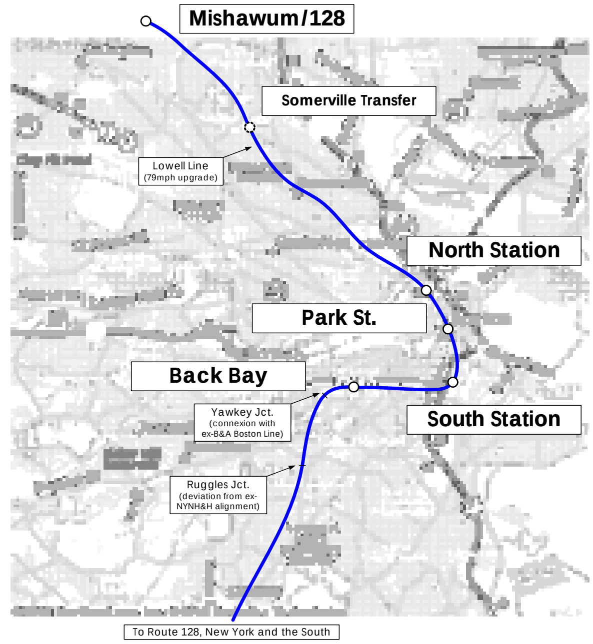
Connecting the Dots. Having determine the location of the "teleports", the planner then attempts to connect them in a logical fashion, keeping in mind the need to maximize the utilization of existing infrastructure and corridors, and the local geographical constraints. At this stage, the locations of the teleports may need to be moved. The extent to which they can be moved will depend on whether it is designed as a walk-up or a drive-through access point. Walk-ups tend to be very sensitive to the exact location to within ¼ mile – thus deviations should be kept within that number.

Determine Routing. Finally, the planner determines the routing by making a service plan – given the routes that will operate through or terminate in the city in question, what would the train service look like? The important issue here is that most trains should be able to depart from most stations. At this stage, the infrastructure may be revised to form a ring-layout, a trunk distributor, or other possible layouts. With the layout, journey time and competitive mode-split analysis can then be carried out. The whole process is not too dissimilar for the planning process used to design urban bus routes. Although the focus is different, the basic ideas are the same. It is likely that similar planning tools as buses could be applied to find the optimal route.

NORTH AMERICAN EXAMPLES

How can the Urban Distributor Concept be Appied? To demonstrate that the journey time savings are real, we evaluated the concept of the intercity urban distributor in Boston, Massachusetts. The journey times shown are based on a variation of the *Boston MetroFlyer* scheme. While the precise alignment must be selected through a rigourous and specific project evaluation process, the sample journey time savings projected here will be fairly robust regardless of the actual alignment eventually selected.

Boston. This is a hypothetical scheme, and is referred to here only to illustrate the order of magnitude of the actual journey time savings possible if a similar scheme was implemented. While this may not be possible in Boston, due to the expense of construction downtown, there may be other cities where such rights-of-way already exist and can simply be interconnected to give rise to journey time savings.



Columbus. For instance, in Columbus, Ohio, existing freight railroads already criss-cross the city. The former Big Four alignment passes within one mile of Ohio State University and I-270/I-71 at Worthington, an ideal site for a Park & Ride. If the Big Four corridor was ever considered for a high-speed passenger rail upgrade, it is important that multiple stops are made in Columbus to ensure the maximum catchment of potential demand.

Before the Railroad Dig (Boston)

Total Journey Time, Boston Residence to New York Penn Sta. (after Acela speed-ups through CT)									
	Road		Air		Bus		Train		Air-Rail Di
	hrs	mins	hrs	mins	hrs	mins	hrs	mins	mins
Mishawum/128	4 hr	35 mins	3 hr	20 mins	6 hr	15 mins	4 hr	28 mins	68 mins
Framingham, MA	4 hr	13 mins	2 hr	50 mins	5 hr	40 mins	3 hr	43 mins	53 mins
North Station	4 hr	39 mins	2 hr	50 mins	5 hr	20 mins	3 hr	38 mins	48 mins
Park Street	4 hr	39 mins	2 hr	50 mins	5 hr	10 mins	3 hr	23 mins	33 mins
South Station	4 hr	39 mins	2 hr	50 mins	5 hr	00 mins	3 hr	08 mins	18 mins
Convention Center	4 hr	39 mins	2 hr	35 mins	5 hr	25 mins	3 hr	15 mins	40 mins
Route 128, MA	4 hr	22 mins	3 hr	05 mins	6 hr	00 mins	2 hr	56 mins	-09 mins
Providence, RI	3 hr	44 mins	2 hr	50 mins	6 hr	20 mins	2 hr	50 mins	00 mins
New York, NY									
[5] Negative is rail faster									

After the Railroad Dig (Boston)

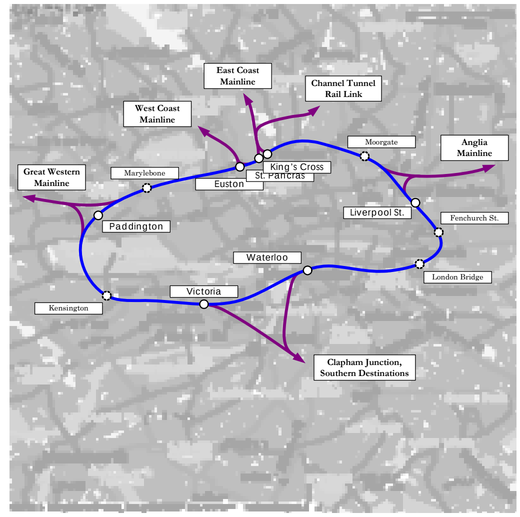
Total Journey Time, Boston Residence to New York Penn Sta. (after Acela speed-ups through CT)									
	Road		Air		Bus		Train		Air-Rail Di
	hrs	mins	hrs	mins	hrs	mins	hrs	mins	mins
Mishawum/128	4 hr	35 mins	3 hr	20 mins	6 hr	15 mins	3 hr	45 mins	25 mins
Framingham, MA	4 hr	13 mins	2 hr	50 mins	5 hr	40 mins	4 hr	13 mins	83 mins
North Station	4 hr	39 mins	2 hr	50 mins	5 hr	20 mins	3 hr	18 mins	28 mins
Park Street	4 hr	39 mins	2 hr	50 mins	5 hr	10 mins	3 hr	13 mins	23 mins
South Station	4 hr	39 mins	2 hr	50 mins	5 hr	00 mins	3 hr	08 mins	18 mins
Convention Center	4 hr	39 mins	2 hr	35 mins	5 hr	25 mins	3 hr	00 mins	25 mins
Route 128, MA	4 hr	22 mins	3 hr	05 mins	6 hr	00 mins	2 hr	56 mins	-09 mins
Providence, RI	3 hr	44 mins	2 hr	50 mins	6 hr	20 mins	2 hr	50 mins	00 mins
New York, NY									
[5] Negative is rail faster									

Orlando. In Florida, where there had been much discussion about a high-speed rail system, rail would likely be much more successful in Orlando if it connected the downtown, the airport, and DisneyWorld® at Kissimmee to Tampa, Miami and beyond. Although new construction would likely be required, an arc connecting the three intercity demand generators would be much cheaper and nicer than a system to funnel people to a downtown collection point. Critically, both the airport and DisneyWorld® is en-route to Tampa and Miami; additional stations will eliminate "backtracking" for rail riders.

OPERATIONS ANALYSIS: LONDON, ENGLAND.

We developed a detailed operational planning model for a hypothetical downtown distributor ring in London for intercity trains to understand the operational feasibility of the idea in more detail.

The hypothetical distributor (for intercity trains) is based loosely on London Underground's Circle Line. The main result of the study was that it was necessary to restrict the number of stops to achieve journey time savings. However, if six key stations (out of 11) around London were designated as "union terminals" where departures were possible in every direction, the average cross-town travel times could be reduced by 11 minutes. This is in addition to enabling a one-transfer ride across London (instead of the present-day two-to-three transfers) and one-seat ride into downtown. In general, transfer times using a "union terminal" is reduced by 20 minutes, while the transfer times from the other terminals remain unchanged. The twenty-minute saving is extremely significant, against Railtrack's 2000 Network Management Statement which calls for a "2020 Vision" of 2~5 mins in-vehicle time reduction on most commuter routes, and ~10 mins on intercity routes.



Cut *Cross-London* journey by **20 minutes**

	Miles	Station Dwell at Arriving Station (min) [1]	Average Running Speed (mph) [4]	Running Time for skip-stops (min)	Station Dwell for Thru Trains (min)	Stage Time Contrib. (min)	Anti-clockwise Timing (min)	Clockwise Timing (min)	Anti-clockwise Time passing KingsX	Station Dwell at Exiting Station (min) [1]
KingsX								16.9		
Euston	0.4	7	12.0	2.0	1	3.0	3.0	13.9	13.9	10
Marylebone	1.2									
Paddington	0.7	7	33.9	1.2	1	2.2	5.2	11.7	11.7	10
South Kensington	1.3									
Victoria	1.2	5	44.0	1.6	1	2.6	7.9	9.0	9.0	5
Waterloo	1.4	7	26.0	3.2	1	4.2	12.1	4.8	4.8	10
London Bridge	1.4									
Fenchurch St	0.7									
Liverpool St	0.5	7	45.8	0.7	1	1.7	13.8	3.1	3.1	10
Islington	0.9									
KingsX	1.5	7	42.3	2.1	1	3.1	16.9		0.0	10
Total	11.2						12.9		120	

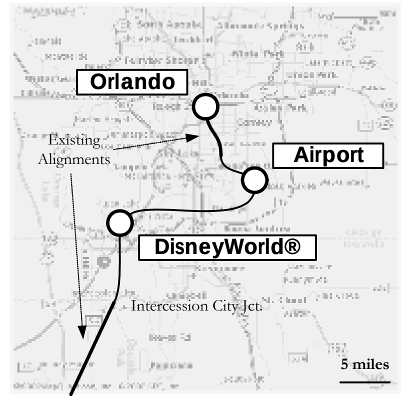
	Cross-London Journey Time [6]	W	1	2	3	4	5	6	7	8	9	10	Station	Tube Stop
W	Walk [1]		12	12	12	15	17	15	18	15	9	10		
1	Anglia	12	25	25	25	28	59	30	37	33	48	40	Liverpool St	Liverpool St
2	ECML	12	30	30	30	30	55	32	39	35	52	56	KingsX	KGX/St Pancras
3	MML	12	40	40	40	40	65	42	49	45	62	66	St Pancras	KGX/St Pancras
4	WCML	15	28	25	25	25	50	24	31	27	58	56	Euston	Euston Square
5	M40	17	74	65	65	65	40	66	76	83	73	76	Marylebone	Baker St
6	Great Western	15	30	27	27	24	51	25	29	25	68	65	Paddington	Paddington
7	South Western/Portsmouth	18	37	34	34	31	61	29	25	26	48	60	Waterloo	Waterloo
8	Brighton	15	38	35	35	32	73	30	31	30	64	60	Victoria	Victoria
9	Kent Coast	9	56	55	55	66	66	76	56	67	33	60	London Bridge	London Bridge
10	Southend (LTS)	10	55	66	66	71	76	80	75	70	67	40	Fenchurch St	Tower Hill

BEFORE					
… % of which		**pax/day**	**Transfer Ti**	**Value $/hr**	**Access Tir**
Cross London Transfer pax (including Commuter Rail	25%	231,393	58	$15	$3,355k
Downtown London Terminating pax	55%	509,064	29	$15	$3,691k
Non-CBD Terminating pax	20%	185,114	58	$15	$2,684k
AFTER					
… % of which		**pax/day**	**Transfer Ti**	**Value $/hr**	**Access Tir**
Cross London Transfer pax (including Commuter Rail	25%	231,393	47	$15	$2,719k
Downtown London Terminating pax	55%	509,064	23.5	$15	$2,991k
Non-CBD Terminating pax	20%	185,114	58	$15	$2,684k
Sum saved per day =					$1,336k

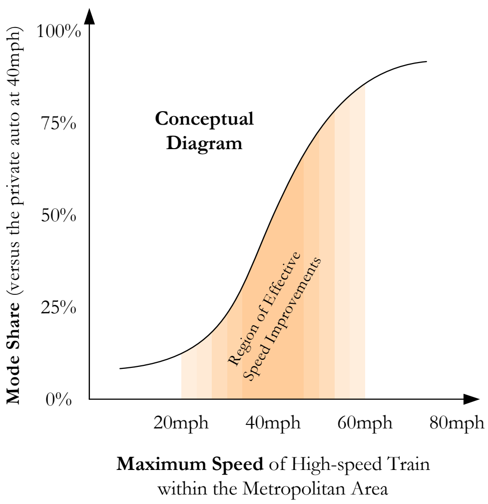
Using a relatively simple methodology and conservative assumptions, we estimated the daily *direct* benefits to commuters and intercity riders to be *at least* $1.34 million *per day* in time saved alone. Although the infrastructure necessary for this type of public works are necessarily expensive, the benefits are substantial and are distributed widely to a large proportion of riders (instead of route-specific high-speed upgrades which only benefit specific origin-destination pairs). By constructing the infrastructure at the focal point of the system, riders on many routes would benefit.

Of course, investment in intercity infrastructure downtown should not divert scarce funds from urban infrastructure. However, track-sharing is possible; re-use of existing urban infrastructure is possible; and removing outer suburban commuters from transit systems at peak hours may actually benefit local transit riders. The environmental concerns of such major works in established urban areas are considerable, but the benefits are also considerable. Downtown distribution is clearly a leveraged area in passenger rail.

CONSTRUCTION IMPACT CONSIDERATIONS: ORLANDO, FL.



Where is it useful? High-speed rail will necessarily involve substantial new construction. When considering constructing a new system, attention should be focused on where the demand generators are – simply linking downtown to downtown in a straight line is not necessarily effective, especially in cities where the downtown may not be the economic, tourism, or cultural focus. The example shown here, a conceptual diagram of how the distribution network around Orlando might look, serves to illustrate how this idea might have practical value. Visitors to DisneyWorld® from Tampa, is unlikely to choose the high-speed train if they have to travel to Orlando and "backtrack" some 12 miles out to the final destination. DisneyWorld® also serves as a Park & Ride for I-4 and the suburbs.



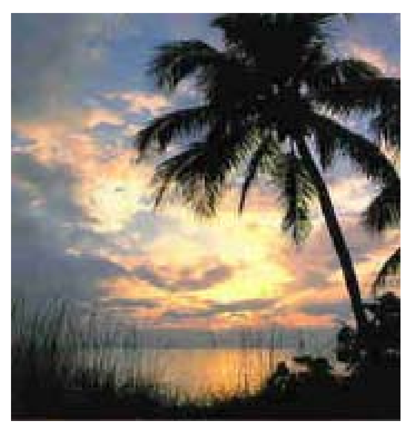
How do we build it? The effective re-use of existing infrastructure and rights-of-way is key to constructing a cost-efficient urban distribution network. By limiting the train speed in the urban area to just a little more than what can be expected from a subway car (say about 45~60 mph), many alignments previously considered too constrained now become viable. The subway-like speed is key: in congested urban areas, the subway remains the most effective way of getting around. Even with urban expressways present, that speed will remain competitive with the private auto as a feeder mode, while the highway network experiences increasing congestion in future. Increasing train speed beyond about 60mph in local portion of intercity trips is expensive, and probably will not lead to significant increase in ridership. In addition, speeds above 60mph make track-sharing with subway-like service extremely difficult.

Re-use of *Existing Infrastructure* is key…

The Florida Example. The existing Atlantic Coast Line alignment is used between downtown Orlando and Bee Line Expressway, where a 3-mile diversion alongside the highway right-of-way would be needed to reach the airport terminal. Exiting to the south, an existing industrial spur could be used to reconnect to the mainline. Another 8-mile diversion alongside the Florida Greenway would be necessary to reach DisneyWorld®. Exiting to the south, another 5-miles of new trackage would be necessary to connect to the mainline at Intercession City. Compared to simply constructing a high-speed cut-off through heavily urbanized areas to reach the downtown perhaps 15 minutes faster, the winding alignment is likely to be cheaper and offer better ridership potential.

Driving to reach the beach once you get to Florida is almost unavoidable, but driving from a Park & Ride with car-hire facilities near a freeway is better than having to drive from a downtown rail terminal.

Photo: Daytona Beach, Florida (http://www.daytonavisit.com/)



Without detailed engineering studies, it is not known if the line will permit the desired speed of 60mph. Since it is mostly laid out alongside existing corridors, disruption will be limited to easing tight curves. Very little wholesale taking of properties would occur.

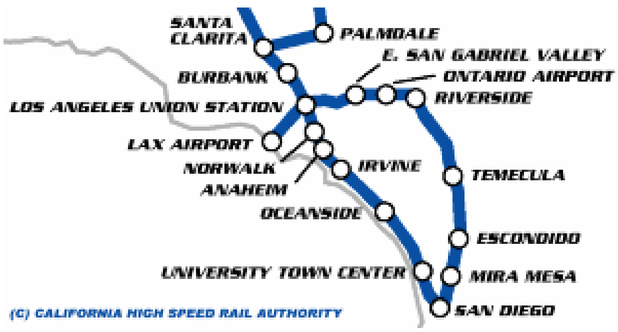
WITHIN-CITY DEMAND ANALYSIS: LOS ANGELES, CA.

Decentralization of Economic Activities. Access is even more important in decentralized cities, although the focus would not be on walk-up demand but on situating Park & Rides such that the high speed rail can be reached from most parts of the city reasonably quickly, and the parking lots do not become so large as to make the auto-to-platform walk substantial.

Even though there is a recognizable downtown in Los Angeles, most of the economic activity occur in suburban business districts.

Photo: Matthew Weathers, *http://www.matthewweathers.com/*

In lesser dense and highly decentralized cities such as Los Angeles, constructing a new right of way to host high-speed rail and give increased access may be easier from an engineering standpoint. However, from a planning perspective, the more suburban living style may mean planning permissions are more difficult to obtain. Nonetheless, a state-level agency may have the authority to bypass local zoning ordinances.

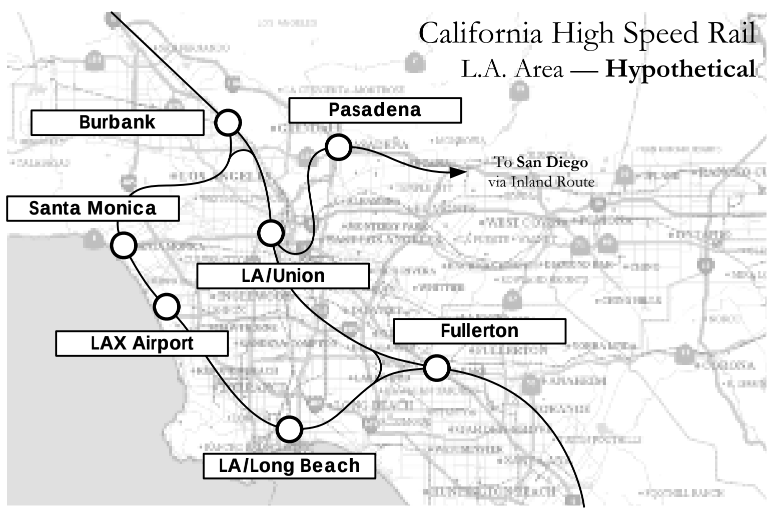


The current plan in Los Angeles calls for study of a number of stations, but does not seem focused on the needs of the core city itself.

The two routes to San Diego follow traditional corridors but the airport spur seems operationally inconvenient and many areas of Los Angeles seems underserved. Potentially, transfers would be required at Union Station, which may also become an operational bottleneck. Los Angeles does not seem to be designed as a through-node, and the routing appears to be based on existing Metrolink services.

Direct service… enables work *without* interruptions

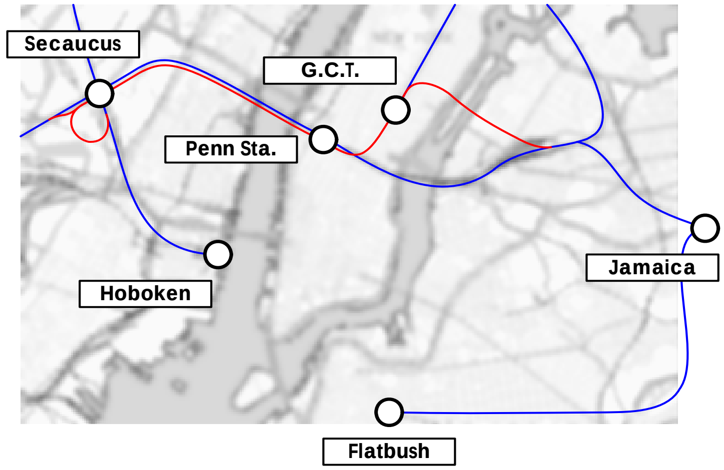
Applying the 'Ring' concept, we believe that Los Angeles's dispersed origin-destination pattern is better served by a high-speed rail network similar to the one shown to the right. By making LAX a through-station and part of the metropolitan ring for LA, we can avoid the awkward spur and serve the busy business districts of Santa Monica, Long Beach, and students at UCLA directly. Terminating trains will travel around the ring and reverse directions, while through-trains will travel either via LAX or LA/Union. Arriving trains on the Inland Route may continue to San Francisco or simply return to San Diego via LAX and the Shore Line.



Too many permutations of services would be confusing to passengers. However, with reasonable service design, many more points on the network would be directly connected without transfer at LA/Union. Not only does this save time for passengers, they may also have luggage and may be travelling with small children, or prefer to work without interruptions. Direct service looks a lot more attractive than a hub-and-spoke type design.

CURRENT ACTUAL PLANNING STUDY: NEW YORK, NY.

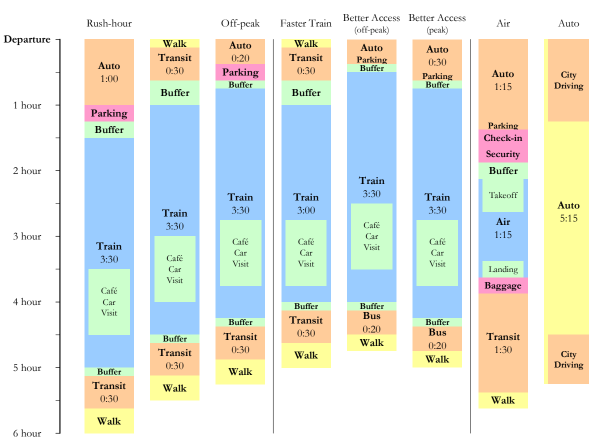
New York's Railroads was like London. Through historical accident, commuter railroads around New York have long terminated at a number of different stations. In the past, each terminal was dedicated to a fixed set of routes, as in London. More recent improvements has allowed some terminals to be reached from more routes, through transfer stations such as Secuacus, Jamaica, Newark, Flatbush and Hoboken. The presence of many terminals recognizes the fact that New York has many activity centers (Midtown, Downtown, Jersey City, Brooklyn Heights) and that a single union terminal would be inappropriate.



Relationship between Local Transit and Intercity Rail. The multiple terminals serve to decentralize the distribution of commuters, reducing the need for very large terminal facilities. Nonetheless, Penn Station continues to experience capacity shortages. The current MTA planning studies "East Side Access" and "Access to the Region's Core" acknowledge the need for regional trains to service more than one location in the downtown by proposing a link-up between Penn Station and Grand Central. Ideally, Downtown, and other activity centers of significance would be directly served by intercity rail, although at present the benefits seem limited, given the high density of local transit.

At off-peak times, when the commuter-oriented downtown distribution infrastructure is not being intensively utilized, it is likely that the mode-share of high-speed intercity trains would benefit from calling at more than one station within the metropolis. Amtrak trains from Boston can call at Baychester/95 Park & Ride, 125th Street, Grand Central, Penn Station, Secaucus/NJ Turnpike Park & Ride, and Newark to maximize accessibility to high-speed rail service.

How does Access Impact Total Trip Time? Taking a trip between Harvard Sq., Cambridge, Mass. and the Upper West Side in Manhattan, New York as an example, improving access reduces the trip time by more than 30 minutes, in addition to allowing a longer in-vehicle time.



Comparing the auto as a feeder mode against transit is appropriate as a faster train that terminates in the downtown will not allow the auto to be used as a feeder mode. Parking & congestion are major issues at downtown terminals.

The high density and quality of local transit options in Manhattan means that incremental benefit of enhancing access for intercity rail is limited. However, access is still an important issue, and needs to be addressed for the intercity rail to compete effectively against those who choose to drive to a Park & Ride on Metro-North or fly into JFK Airport and take Transit.

Both Photos: Father Mark Meyer, Maryknoll Catholic Mission. (*http://www.marksmission.org/*)

MISCELLANEOUS CASE STUDIES

Cleveland. Expert panel analysis suggests the main downtown activity center lies between Public Square (near Cleveland Union Terminal) and I-90, an area of approximately 1.5 miles in length. The current Waterfront station is relatively distant from the main activity centers. MetroFlyer-type approach would restore direct rail service to Cleveland Union Terminal, and open a new station near Cleveland State University to serve both walk-up demand and to provide a downtown Park & Ride. New infrastructure would be required in the form of a new rail line beneath or above I-90.

Pittsburgh. The main constraining factor in Pittsburgh is likely to be the challenging terrain. The downtown is divided into two main activity centers: The Golden Triangle, and Oakland. Using mostly existing rights-of-way, it was found to be possible to serve the downtown, Oakland at Forbes Ave., and a number of Park & Ride options outside the city. The MetroFlyer approach would consider the location of existing mainlines with respect to modern demographics, and re-route trains accordingly (after infrastructure upgrades). For instance, trains departing to the East could exit via the former Pennsylvania, if it happens to serve the best suburban locations, but interchange to the former B&O via the Youngwood/Scottsdale alignment (if the B&O were chosen as the main East-West passenger trunk route).

High Speed Routing. If the U.S. is committed to a high-speed passenger rail system, it is conceivable that the New York Central and Pennsylvania mainlines could be re-constructed as four-track freight arteries, taking the pressure off the B&O, which could then be re-constructed for high-speed passenger use. The current approach of designating existing historical trunk corridors as "high speed corridors" may (1) overlook real opportunities for consolidation and maximizing service-effectiveness by using a combination of old mainlines, branch lines, spare highway rights-of-way width (reserved for widening), and abandoned alignments; (2) require more mitigation for freight customers than otherwise necessary. Fundamentally, there are not many reasons to build more than one dedicated passenger mainline between the Northeast and Chicago (and similarly, not many reasons for more than one dedicated freight mainline).

San Francisco. Although San Francisco is not a city with multiple "walkable" downtown business districts, the current California high-speed rail plan acknowledges that access is an important issue in the greater metropolitan area. Especially in dispersed cities on the West Coast, economic activities occur in many locations other than the downtown. The plan provides for branch to Oakland and stops at Redwood City and San Jose – important suburban city terminals upon which the success of the high speed rail depends.

In San Francisco, the ring concept is inappropriate as the San Francisco Bay Crossing is more than four miles wide and it would be very expensive to connect San Francisco to Oakland. Especially for residents living far from the airport, having a local station within a 15-minute drive is a major advantage for rail service. The stations need to be designed with the local environment in mind – while we can expect some walk-up ridership in downtown San Francisco, the other stations are likely to be more of a Park & Ride nature.

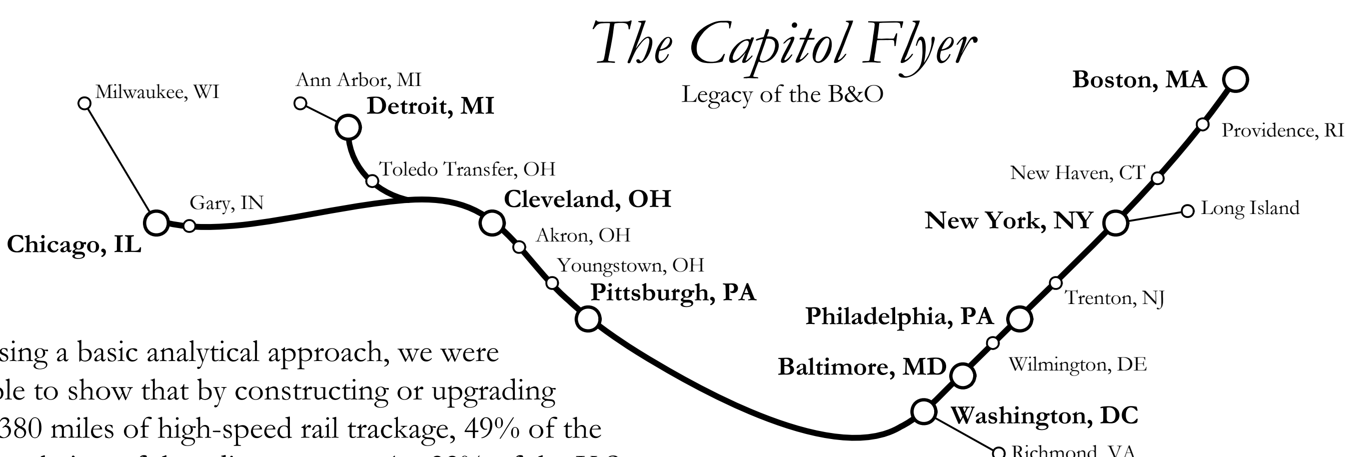
In practice, exiting the Bay Area due South is likely to be the only high-speed alignment in the future, due to the lack of large populations due North and the physical difficulty of constructing a direct line to Sacramento. The Bay Area, being a stub-end type location, the ring concept is not as important as it is in a node where the rail services depart in many different directions.

WHY IS OVERNIGHT RAIL SERVICES IMPORTANT?

In the same way that urban rail corridors could also be used for subway service if the vehicles were made compatible, a series of interconnected high-speed rail and regional rail corridors could be used for overnight services. Given the dominance of infrastructure costs over vehicle costs, if a service could reach operating self-sufficiency at all, it should be operated – the increased utilization of interurban infrastructure (typically not capacity-constrained at night) will increase the benefits leveraged from the investment beyond that available from economic development fostered by high-speed rail corridors.

Overnight Service: journey time *Magically* disappears!

Why is Access Important in Overnight Rail? Overnight Rail's main competitive advantage lies in the fact that, operated over reliable infrastructure, it is able to depart from the originating stations close to the time when the travellers are ready for bed, and arrive at the destination shortly after they have finished breakfast. To the traveller, this feels like being teleported: journey time has magically disappeared. Even if they departed the previous day or early in the morning, they would still have had to sleep at home or in a hotel room. However, that important advantage is eclipsed if the traveller needs to spend more than about an hour at either end getting to and from the rail terminal; over the distances that overnight high-speed rail are typically competitive (600~1,200 miles), a morning flight can just as easily result in an arrival at the same time at the final destination, while allowing the traveller the same amount of sleep, if more than an hour is required in access time. Transfers to and from late-night corridor rail services is not acceptable, since sleep would then be interrupted. Thus, the overnight train must fulfil the functions of both the regional collector and the overnight line-haul. In heavily urbanized areas such as the Northeast, this means station stops are required about every 30 minutes of runtime – even if it is not strictly optimal, as it is necessary to maximize catchment and retain competitive advantage.



Using a basic analytical approach, we were able to show that by constructing or upgrading 1,380 miles of high-speed rail trackage, 49% of the population of the adjacent states (or 22% of the U.S. population) would be within an hour's drive (or transit ride) of a high-speed rail station, where there would be local corridor departures and long-distance overnight departures. Demand analysis demonstrated that all stations would receive at least one train daily, and some will receive two trains, in addition to the corridor services already planned or in operation on these corridors. There are substantial benefits to operating overnight services over interconnected high-speed corridors, and more research, perhaps with GIS, is needed to explore the possibilities.

OVERNIGHT CASE STUDY: THE CAPITOL FLYER

Assuming a service speed of 125mph, we found that overnight services between the Northeast and the Industrial Heartlands are indeed feasible operationally, and could generate considerable demand. Coupled with the corridor services in the Northeast, the Midwest, and perhaps throughout Western Pennsylvania and Eastern Ohio, a credible National Interurban Passenger Rail Network could be built. At a time when air infrastructure is perceived to be subject to disruptions, if the right incentives are offered, broad support from the states may be possible – given the large number of people it would serve.

Who would support this? The urban population would be a core supporter, especially if the investment results in new urban infrastructure for transit, with differential pricing applied such that the urban poor is not disadvantaged. The suburban population perceives a large advantage in no longer having to drive to the airport, and having their own local access point (Park & Ride) to the national network, reducing trip times and providing additional intercity transport options at times of heavy interstate congestion. The rural population, which makes up about half of the U.S. population, have the strongest reason to object, although if the construction leads to economic boost in the short term, and the environmental effects are mitigated in a sensitive fashion, there may be some support from states that are predominantly rural.

Capitol Flyer Service Points							
City	**Counties or Towns Served**	**Population [1]**	**Served by train #**	**State**	**State Catchment**	**State Population**	**% Pop Served (Direct)**
MBTA Area							
Haverhill, MA	Middlesex	1,426,606	3049	MA			
	Essex	704,407	3049	MA			
Boston, MA	Suffolk	641,695	3049	MA			
Route 128, MA	Norfolk	643,580	3049	MA	3,416,288	6,175,169	55%
Providence, RI	Providence	574,108	3049	RI	574,108	990,819	58%
Metro-North Area							
New Haven, CT	New Haven	793,208	3049	CT			
Stamford, CT	Fairfield	841,334	3049	CT	1,634,542	3,282,031	50%
New Rochelle, NY	Westchester	905,572	3049	NY			
Long Island Railroad Area							
Patchogue, NY	Suffolk	1,383,847	3045, 3041	NY			
Hicksville, NY	Nassau	1,305,057	3045, 3041	NY			
Jamaica, NY	Queens	2,000,642	3045, 3041	NY			
New York City Subway Area							
New York, NY	New York	1,551,844	3045, 3041	NY			
	Bronx	1,194,099	3045, 3041	NY			
	Kings	2,268,297	3045, 3041	NY			
	Rockland	284,022	3045, 3041	NY			
	Richmond	413,280	3045, 3041	NY	11,306,660	18,196,601	62%
NJTransit Area							
Newark, NJ	Hudson	552,819	3045, 3041	NJ			
	Bergen	857,052	3045, 3041	NJ			
	Essex	747,355	3045, 3041	NJ			
Metropark, NJ	Union	498,759	3045, 3041	NJ			
	Middlesex	717,949	3045, 3041	NJ			
SEPTA Area							
Trenton, NJ	Mercer	333,861	3045, 3041	NJ	3,707,795	8,143,412	46%
	Bucks (PA)	594,047	3045, 3041	PA			
Philadelphia, PA	Philadelphia	1,417,601	3043	PA			
	Montgomery	724,087	3043	PA			
Wilmington, DE	Delaware (PA)	541,502	3043	PA	5,608,573	11,994,016	47%
	New Castle	487,182	3043	DE	487,182	753,538	65%
MARC Area							
Baltimore, MD	Baltimore County	723,914	3043	MD-VA-DC		5,171,634	
	Baltimore City	632,681	3043	MD-VA-DC		6,872,912	
New Carrollton, MD	Washington PMSA [2]			MD-VA-DC		519,000	
VRE Area							
Richmond, VA	Richmond MSA	961,416	3047	MD-VA-DC			
Fredricksburg, VA	Washington PMSA		3047	MD-VA-DC			
Lorton, VA	Washington PMSA		3047	MD-VA-DC			
Washington, DC	Washington PMSA	4,739,999	3047	MD-VA-DC			
Rockville, MD	Washington PMSA		3047	MD-VA-DC	7,058,010	12,563,546	56%
Total population served East of Sleeping Sidings		31,461,822					

Population catchment estimate for the Northeast Zone, The Capitol Flyer.
(**Source:** *How to Run Overnight Services Profitably – a Case Study in Eastern U.S.*, Alex Lu, 2002.)

	2151	2153	2155	2157	2159	2167	2171	3047	3443	2173	2175
	Acela Express	Acela Express	Acela Express	Acela Express Midwest Direct	Acela Express	Acela Express	Acela Express	The Capitol Flyer	Detroit Congressional	Acela Express	Acela Express
	Coach	Coach	Coach	Coach **	Coach	Coach	Coach	Full	Half	Coach	Coach
Boston, MA	05.25	06.25	07.25	08.25	09.25	13.25	15.25			16.25	17.25
Providence, RI	06.05	07.05	08.05	09.05	10.05	14.05	16.05			17.05	18.05
New York, NY	08.41	09.41	10.41	11.41	12.41	16.41	18.41			19.41	20.41
Newark, NJ	08.76	09.76	10.76	11.76	12.76	16.76	18.76			19.76	20.76
Philadelphia, PA	09.83	10.83	11.83	12.83	13.83	17.83	19.83			20.83	21.83
Baltimore, MD	10.99	11.99	12.99	13.99	14.99	18.99	20.99			21.99	22.99
Washington, DC	11.79	12.79	13.79	14.79	15.79	19.79	21.79	22.00	22.50	22.79	23.79
Pittsburgh, PA				18.48				—	—		
Cleveland, OH				20.12				—	07.33		
Detroit, MI									08.84		
Chicago, IL				22.91				08.37			
Milwaukee, WI				00.25				09.70			

	3043	3143	3449	3041	3045	2391	3067	3245	3049	2371	3149
	Broadway Flyer	Detroit Pennsylvanian	Detroit Flyer	The Early New Yorker	21st Century Limited	Acela Midwest	Midwestern Night Owl		New England Flyer	Acela Midwest	
	Full	Half	Half	Full	Full	Coach	Coach *	Half	Full	Coach	Half
Boston, MA							18.25		21.00		22.00
Providence, RI							19.05		21.80		22.80
New York, NY			22.50	23.00	22.00		21.41	23.00	00.16		01.16
Newark, NJ			22.85	23.35	22.35		21.76	23.35	—		—
Philadelphia, PA	22.00	22.25	23.91	24.41	23.41		22.83	00.41	—		—
Baltimore, MD	23.16	23.41	—	—	—		23.99	—	—		—
Washington, DC	23.96	00.21	—	—	—		00.79	—	—		—
Pittsburgh, PA	—	—	—	—	—		04.48	07.53	—		—
Cleveland, OH	—	07.33	—	—	—		06.12	09.18	—		—
Detroit, MI		08.84	09.29							06.42	09.29
Chicago, IL	08.57			07.80	08.80	08.50	08.91		08.36	09.00	
Milwaukee, WI	09.90			09.13	10.13	09.84	10.25		09.70	10.33	

	3445	2351	2353	2373	2355	2375	2357	2377	2359		
	Cleveland Express	Acela Midwest	Acela Midwest	Acela Midwest	Acela Midwest	Acela Midwest	Acela Midwest	Acela Midwest	Acela Midwest		
	Half	Coach	Coach	Coach	Coach	Coach	Coach	Coach	Coach		
Boston, MA	22.50										
Providence, RI	23.30										
New York, NY	01.66										
Newark, NJ	—										
Philadelphia, PA	—										
Baltimore, MD	—										
Washington, DC	—										
Pittsburgh, PA	07.53		06.56		10.56		16.56		18.56		
Cleveland, OH	09.18	06.41	08.21		12.21		18.21		20.21		
Detroit, MI				10.42		16.42		19.42			
Chicago, IL		09.20	11.00	13.00	15.00	19.00	21.00	22.00	23.00		
Milwaukee, WI		10.53	12.33	14.33	16.33	20.33	22.33	23.33			

Public Timetable, based on Preliminary 125mph Operating Plan, The Capitol Flyer. (**Source:** *How to Run Overnight Services Profitably – a Case Study in Eastern U.S.*, Alex Lu, 2002.)

The broad accessibility of the Interstate Highways helped to secure bipartisan support for its funding. If high speed rail were to become more accessible, both to the rural and the urban population, it may receive similar support.

Operating Plan, The Capitol Flyer. Based on preliminary operations analysis, an electrified double track main line would be sufficient for all services shown in the example public timetable. Using methodology similar to that demonstrated in the earlier Boston MetroFlyer case study, high density signalling in urban areas will further enhance the usefulness the infrastructure by allowing regional rail and urban transit services to be offered. The overnight service will leave from strategic stations at between 9pm and 11pm, arriving at the destinations at between 7am and 9am – in plenty of time for the start of the next business day. Some trains are required to pause at a "Sleeping Siding" near Cumberland, Maryland, to ensure that the trains do not arrive too early. Essentially, this operating plan is based on a linear hub-and-spoke network.

BALANCE SHEET: HIGH SPEED RAIL V.S. METROFLYER

	High Speed Rail	*MetroFlyer*
Typical Route Length	200 miles	220 miles
Typical Scheme	upgrade 100mph to 125mph (rural areas)	10 miles of 60mph new right of way (urban areas)
Typical Costs	$ 1.0 billion	$ 2.0 billion
Ratio of Investment	1	2
Typical Annual Ridership (enhanced facility)		
Intercity	1 million paxs	200,000 paxs
Regional	zero	1,250,000 paxs
Urban	zero	5,000,000 paxs
Typical Time Savings		
Intercity	24 minutes	15 minutes
Regional	zero	12 minutes
Urban	zero	20 minutes (over bus)
Elimination of Transfers	zero	saves additional 10 mins
Pax-hr Savings /year	400,000 hours	**3,041,667 hours**
Values of Time Saved /hr		
Intercity	$25	$35 (saves access time)
Regional	not applicable	$25
Urban	not applicable	$10
Typical Benefits /year (calculated)		
Intercity	$10 million	$2.92 million
Regional	zero	$11.5 million
Urban	zero	$25 million
Total	$10 million	**$39.4 million**
Benefits recoverable through farebox (75% Intercity, 50% Regional)	$7.5 million	$7.92 million
Net Present Benefit (50 yrs, discount rate = 7%)	$138 million	$544 million
Benefit per unit of investment	1.4	**2.7**

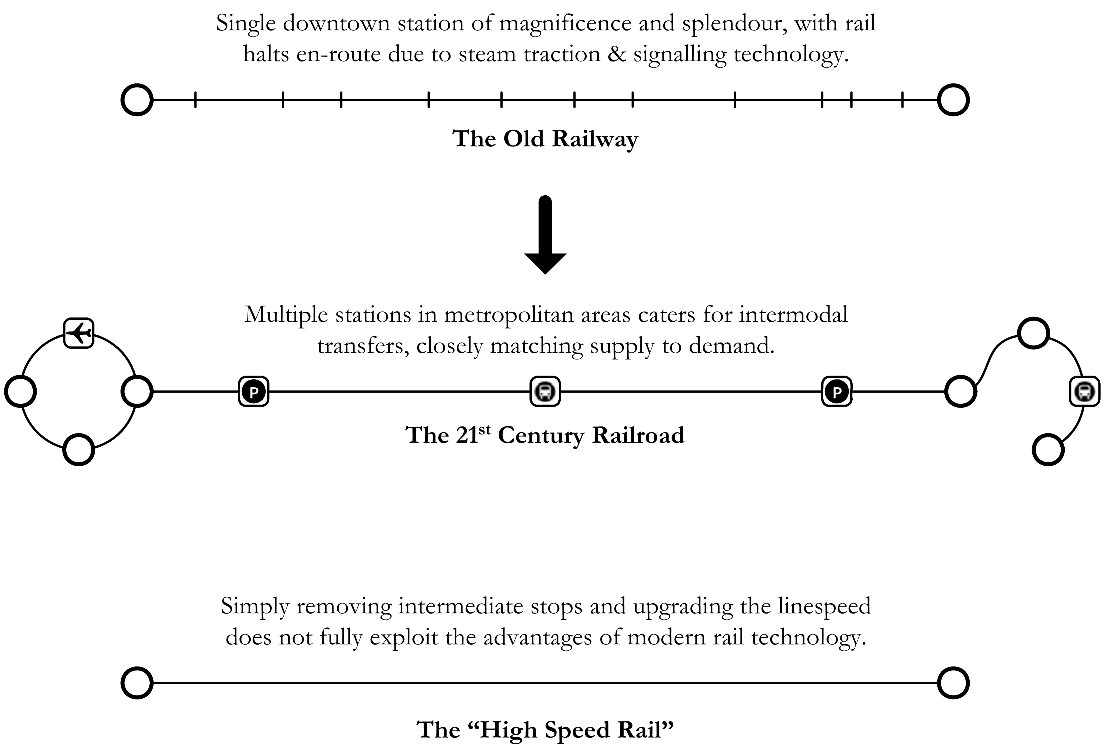
Dollar for $, *MetroFlyer* is about twice as effective as a comparable High Speed Rail scheme.

FROM THE LIMITED EXPRESS TO THE METROFLYER

In the past thirty or so years, high-speed rail has pursued a limited-stop express business model. There are good logic behind this:

- Customers prefer not to stop en-route.
- Short point-to-point times are required to compete with the airlines.
- High speed rail is perceived as a niche product serving the downtown-to-downtown business travel market.

Such a business model has not generally proven to be profitable without government subsidies. Some of this must change in future, to ensure a more sustainable basis for intercity passenger rail. Rail technology, by nature, enjoys greater economies of density, scope, and scale (in seats per vehicle, number of stops en-route) than air technology. Thus, it is in the rail advocate's interest to serve the mass-market, recovering capital costs through Ramsey-pricing.



Better downtown distribution is one way to expand rail's market reach and market share, while realizing potentially cost-saving economies. Having multiple rail terminals in the walkable neighbourhoods of large cities is not only a good competitive response to cities with multiple airports, it is also a good way to serve the large suburban population currently in a better position to access the out-of-town airfields.

The main emphasis should be matching the supply of rail terminals to the originating travel demands within the immediate locale, enabled by technology changes over the last century. Ideally, the "nearest rail terminal" should always be more accessible in any part of the city except for the communities immediately adjacent to the airport. The rail depot could then once again return as the focus of the community in an urban landscape, in a way that airports simply cannot – in addition to providing good transportation services.

MetroFlyer equipment is comfortable, not value-engineered, just like your lounge at home – not a subway car, not a high-speed train, not an aeroplane.

(Amtrak #449 at Albany, New York, waiting for a connexion with #49 en route to Chicago.)