German Transit, Innovations and lessons for US transit agencies

Introduction and Background

Germany enjoys a high transit mode share compared to the US. For example, even in rural areas around Stuttgart, which suffers from the worst congestion of any German city because of its high share of private vehicles, transit ridership is higher than Arlington, Virginia, which is seen as a model for American transit-oriented suburban development.[1] This fact alone makes German transit appear much more advanced in terms of transit innovations and integration into existing land uses than in the U.S. In addition, personal anecdotes of using buses or trains in Germany leave most Americans with the feeling that "they know what they're doing." In many respects they do, and US cities are starting to take some lessons. However, this is not always the case. Many innovations are just beginning in Germany, and German transit agencies are taking some lessons from the US as well. This paper will discuss general trends in transit in Germany and Hamburg, with a focus on buses. It should be noted, however, that higher transit mode share should also be attributed to factors outside of transit operations, especially policies and city planning. Because the focus of my work under the Robert Bosch Foundation Fellowship was focused on Bus planning and innovations, the data I will cite is somewhat dated and comes from non-primary sources. The intent is simply to show general similarities and differences between the German and US transportation systems. In addition, I have found that Ralph Buehler and John Pucher consistently offer some of the best comparative research between the two countries, and are primarily (and shamelessly) cited.

Comparing Transportation in Germany and in the United States[2]

Germany and the US have a lot in common in terms of transportation, and therefore Germany offers many lessons in general for a more sustainable balance to transportation. Both countries are democracies, both have strong automobile manufacturing sectors (and automobile industry lobbying sectors), they are among the wealthiest countries with some of the largest roadway systems in the world. Germany has one of the highest car ownership rates in the world after the U.S., and the trend of car ownership has grown similarly since the 1960s.

Despite the image of the US being the land of suburban sprawl, German cities have also been decentralizing. Indeed, because of bombing and destruction of World War 2, much of the urban development in Germany is new, similar to urban development in the US.

As any American visitor to Germany can see, however, German transportation systems are very different, characterized by much less driving and more transit use, biking and walking. Carbon dioxide emissions from transportation per capita in Germany are about 30% of the amount in the US (2005). German households spend less on transportation costs than American households (14% vs. 19% in 2003), even though gasoline is notoriously less expensive in the US. Traffic fatalities in

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[1] Ralph Buehler, Wolfgang Jung & Andrea Hamre (2014): Planning for Sustainable Transport in Germany and the USA: A Comparison of the Washington, DC and Stuttgart Regions , International Planning Studies, DOI: 10.1080/13563475.2014.989820.

[2] Buehler, Ralph and Pucher, John. "Demand for Public Transport in Germany and the USA: An Analysis of Rider Characteristics." Transport Reviews, Vol. 32, No. 5, 541–567, September 2012

Germany are less than half per 100,000 residents as in the U.S. (6.5 vs. 14.7 from 2002-2005). And transit agency operating budgets are hardly subsidized in Germany compared with the US (26% of operating budgets in Germany vs. 62% of budgets in the US in 2006). Government subsidies for transportation in general are less in Germany per capita than in the US ($460 vs. $625 in 2006). While these figures are somewhat dated, and reductions in driving are occurring in both countries, they highlight the fact that transportation in Germany is cleaner, safer, and less expensive in Germany than in the US. Travel behavior, i.e. how people choose to get around, is the primary determinant, and is influenced by both transportation policies and urban development patterns.

Brief History of Transit in Germany and in the United States[3]

Americans do not take many transit trips, on average. Between 2005 and 2010, the average American made 24 per year. In Germany that number was 139. (Figure 1)

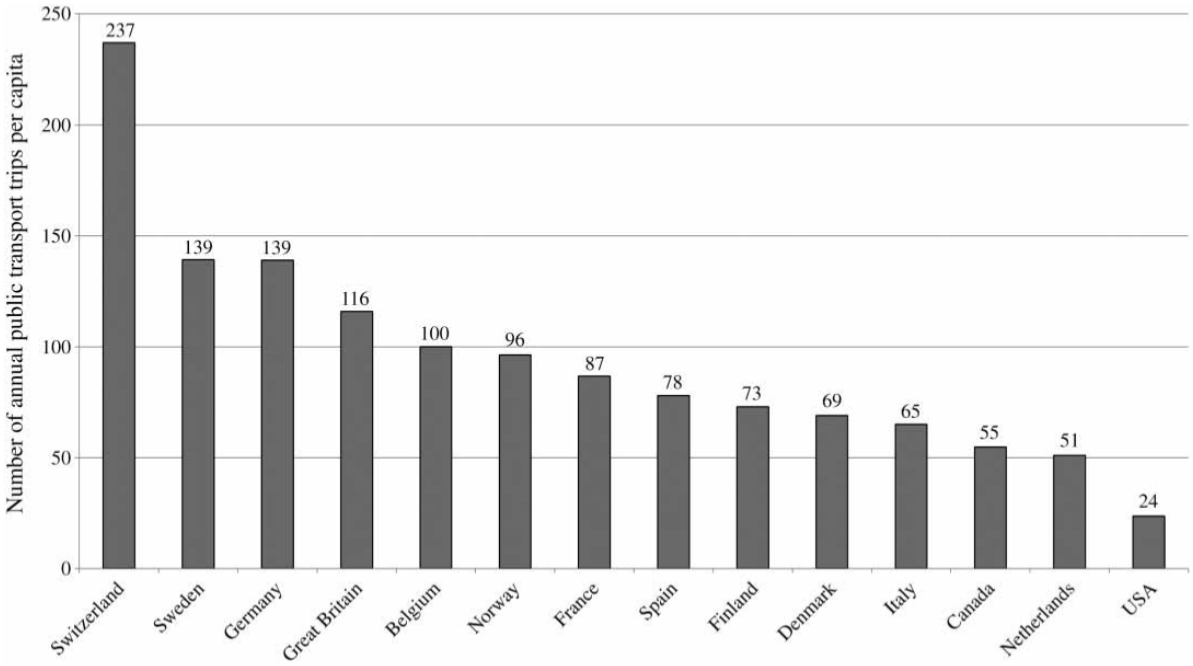

Figure 1. Number of annual public transport trips per capita in Europe and North America, 2005–2010. Note: Due to differences in survey design, trip definitions, and timing, travel survey results among countries are not entirely comparable. Sources: APTA, 2012; BFS, 2011; BMVBS, 1991–2012; CBS, 2011; DfT, 2011; DMT, 2010; ITF, 2011; SIKA, 2007; SOeS, 2010; TOI, 2011; USDOT, 2010; WSP, 2006.

[3] *Ibid.*

And while total number of trips in both countries has been rising, trips per capita have been rising consistently in Germany since the 1990s, where as in the US, they have stayed constant sine the 1970s. (Figure 2)

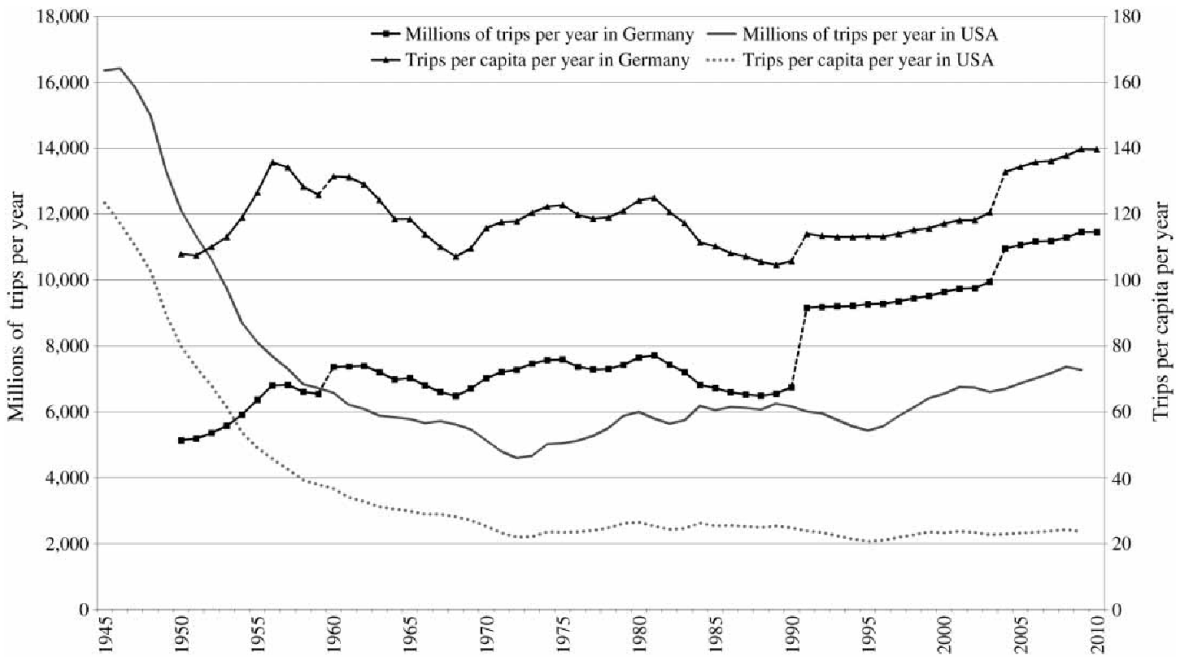

Figure 2. Trend in total public transport trips and trips per capita in Germany and the USA, 1945–2010. Notes: Data from 1950 to 1990 are forWest Germany only.West German data from 1950 to 1960 exclude West Berlin and the Saarland. German data from1991 to 2010 are for the re-unified Germany, including the former East Germany. The strong increase in Germany between 2003 and 2004 is a statistical artifact due to a change in data collection methodology. Public transport trips as shown in this graphic are defined from origin to destination; thus, a trip involving transfers between public transport lines or modes is counted as one trip (technically designated as a linked trip). Since 1970 official data for the USA report unlinked trips, with transfers counted as additional trips. This study converted the unlinked trips to linked trips in order to ensure comparability with Germany, using a methodology explained in Polzin and Chu (2003). Source: APTA, 2012; BMVBS, 1991–2012.

Between the 1940s and 1970s, transit use in the US dropped by 75% due to the ending of wartime rationing, increased automobile production, increasing incomes, and suburban sprawl. This drop was stopped by extensive support from all levels of government, averaging $23 billion per year (in 2010 dollars), which, despite a drop in the 1980s, continues today.

In Germany, most public transportation infrastructure was usable again by the early 1950s after being damaged in World War 2, and the combination of increased work trips, low automobile ownership, and cities crowded with ethnic Germans arriving from Eastern Europe kept transit ridership high. However, by the 1960s, car ownership tripled, sprawl grew on urban fringes, the federal highway network expanded, and cities widened roads and built parking garages. Subsidies in transit operating and capital costs raised ridership as in the US until the 1980s. The large spike in Figure 2 around 1991 represents the reunification; however the increase in ridership between 1991 and the early 2000s occurred almost exclusively in the former West, and offset heavy ridership losses in the former East. Since the early 2000s, ridership gains have been seen throughout Germany. These gains are partly due to a doubling of the gas tax (from $0.41/liter in 1990 to $0.88/liter in 2010), but also to better transit service (regional coordination, vehicles, information, etc.)

Who rides transit and why?[4]

In the US, the biggest share of transit trips is for commuting to work, (35% in 2008/2009, Figure 3), potentially lower than in 2001/2002 due to the recession. Interesting to note is that trips for personal and family visits (shopping, doctor visits, daycare, family events, etc.) rose to almost the same level of commuting (32%) from eight years earlier (29%). Social and recreational trips also increased over eight years to 20% of all trips. In Germany, trip purposes stayed mainly the same over the same eight year period.

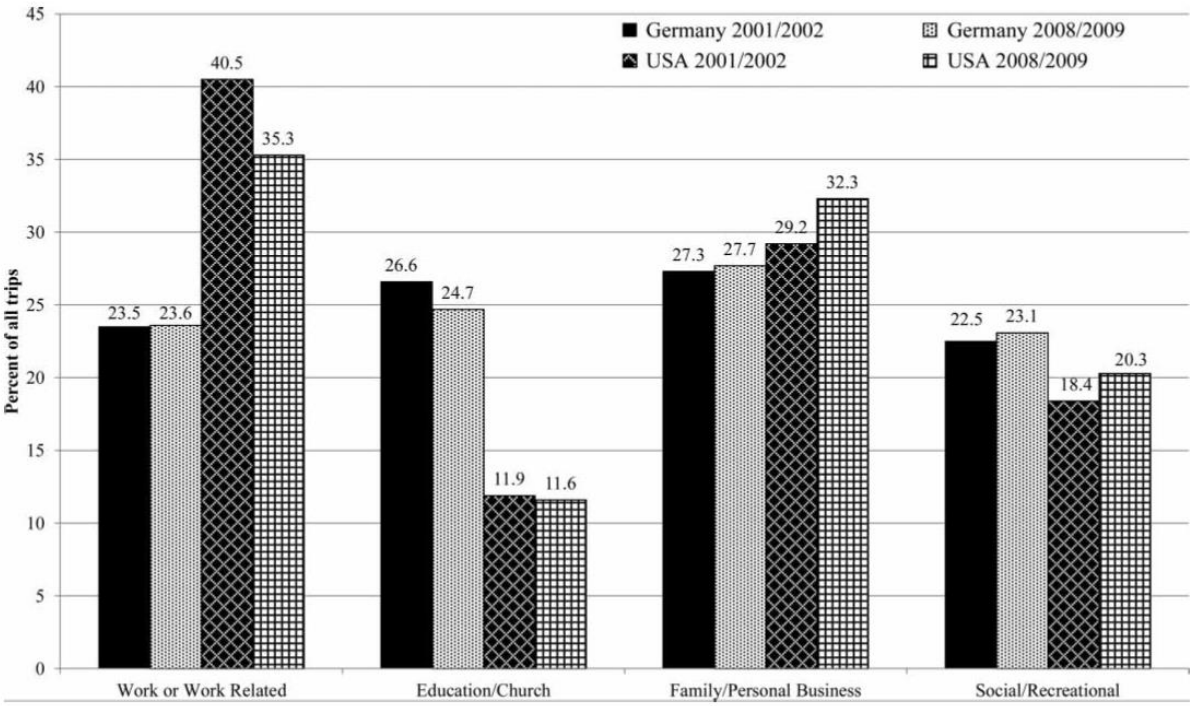

Figure 3. Main purpose of public transport trips in Germany and the USA, 2001/2002 and 2008/2009. Note: The category 'family and personal business' includes trips for shopping, doctor's visits, daycare, dog walking and other animal care, transporting someone else, using professional services, and attending family events. Source: Authors' (Buehler, Pucher) calculations based on NHTS and MiD.

In Germany, riders under the age 24 have the highest percentage of all trips (16-17% in 2008/2009) taken by transit, as opposed to the US where they are similarly as low as other age groups (1-3% in 2008/2009). This may be due to the large fleets of suburban school buses, whereas German students primarily use public transportation (which may increase their acceptance of transit as adults). A key difference is that those over the age of 65 in Germany ride transit at a higher rate than those 25-64. In the US, this age group uses transit even less than working age adults (1.4% compared to 2%), perhaps due to the importance of work-based transit trips.

[4] *Ibid.*

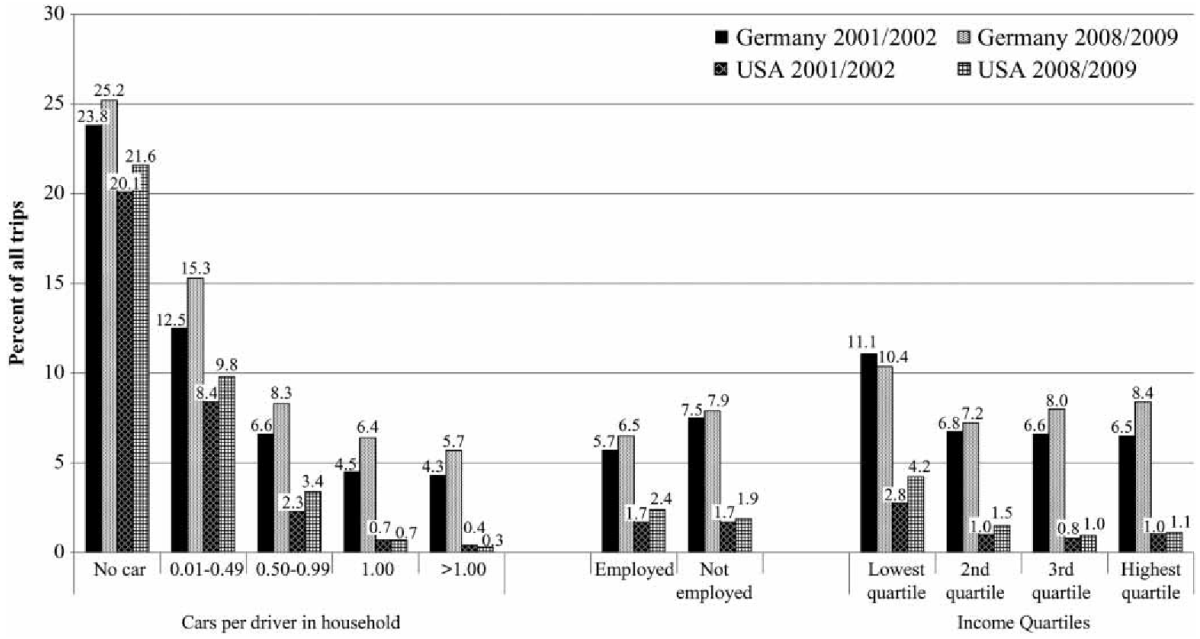

Figure 4. Percentage share of trips by public transport in Germany and the USA by car access, employment status, and income quartile, 2001/2002 and 2008/2009. Source: Authors' (Buehler, Pucher) calculations based on NHTS and MiD.

To no surprise, people with no car in their household had the highest transit usage in both countries (Figure 4). But in households with one or more cars per driver, transit ridership in the US was almost non-existent, as opposed to in Germany where it was still am important mode, perhaps due to the attractiveness of transit or to the costs of driving in Germany. People in the lowest income quartile in both countries had the highest ridership rates, however what is most surprising is that Germans in the highest quartile rode transit about twice as much as Americans in the lowest quartile.

Policy differences in Germany and the United States[5]

Policies are key tools to promote transit ridership, but are usually not under the purview of transit agencies themselves. In Germany, they have been very successful, and generally fall under three themes (summarized in Tables 1 and 2):

- Land use policies – denser development with mixes of uses and restrictions on off-street (private) parking encourage more car-free households, more walking and biking due to short distances, and more efficient transit operations by transporting more people over shorter distances. German planning law requires the integration of transportation planning (as well as water, energy and environmental planning) into land use plans. In the US, land use planning and transportation planning are generally siloed activities that occasionally overlap.
- Restrictions on car use – taxing and pricing are important tools to limit driving. From obtaining a drivers license to sales tax on vehicles to the tax on fuel, Germany's fees are much higher than in the US. The effect is that fuel tax revenue in Germany is 2.5 times higher than roadway expenditures; in the US, fuel tax revenue only covers 60% of roadway costs, the rest made up out of the general fund because it has not been raised in 20 years. In addition, Germany has several policies that restrict car use. For example, highways are generally only found on the fringes of cities,

[5] *Ibid.*

Table 1. Comparison of Polcies and Programs that Encourage Transit

	USA	Germany
Public transport ownership and finance		
Government subsidies	• Most firms privately owned and operated until 1960s; almost all firms publicly owned since 1970s • Sharp rise in federal subsidies during 1970s, but declining federal share of total government subsidies from 1980 (52%) to 2009 (25%) • Steady growth in state and local subsidies from 1970 to 2009, more than offsetting declining share of federal subsidies since 1980	• Public ownership and operation of firms since 1920s • In 1991, EU-mandated open competition for provision of all public transport services, including foreign operators • Federal subsidies for capital investments since mid-1960s • Cross-subsidies from municipal water and energy utilities • Devolution of suburban rail finance from federal to state level
Public transport service		
Quantity of service	• 20 vehicle kilometres of service per capita per year: regional rail and metro: 6 km; bus and light rail: 14 km	• 59 vehicle kilometres of service per capita per year: regional rail and metro: 28 km; bus and light rail: 31 km
Quality of service	• Many systems have modernized their vehicles and stations • Little coordination of services and ticketing across modes and operators	• All systems have modernized their vehicles and stations offering low-floor boarding and comfortable seating • Full coordination of schedules and routes across modes and operators
Traffic priority	• Some cities have dedicated bus lanes or high occupancy vehicle lanes that can be used by buses • Over 20 cities have bus rapid transit (BRT), with varying degrees of separate right of way and traffic priority	• Many cities have special bus lanes and traffic signal priority for buses • Many cities operate express bus services that are similar to BRT in the USA
User information	• Fragmented, incomplete, and often undependable information • Real-time information rare even on trains, almost never on buses (except BRT) • Bus stops usually lack timetables, maps, and route information	• Convenient online information about regional, state-wide, and even national routes, timetables, and fares • Real-time information at most rail stops, some bus stops, and on-board most trains and buses • All bus stops provide schedules and route information
Fares and ticketing		
Discounts	• Public transport commuter tax benefits • Slightly discounted monthly tickets for regular commuters • Discounts for off-peak travel provided by some systems	• Tax benefit based on daily commute distance • Discounts for children, university students, and seniors • Deeply discounted monthly tickets available to all groups • Entrance tickets for large events include free public transport
Region-wide fare integration	• Fares and ticketing are rarely integrated across operators and jurisdictions	• Urban areas have regional public transport authorities that fully integrate fares and ticketing across operators and jurisdictions • State-wide coordination of schedules, fares, and tickets

Table 2. Comparison of Polcies and Programs that Encourage Transit (Cont'd)

	USA	Germany
Regional and intermodal coordination		
Regional integration	• Regional transport planning authorities in most cities, but with much less coordination and integration of services than in Germany	• Full coordination of operation and financing of public transport through regional public transport authorities since late 1960s
Multimodal coordination	• Limited integration of bus and rail • Bike racks on 75% of buses; bike parking at many rail stations • Park and ride lots in suburbs at rail stations and key bus stops • Inconvenient walking and cycling access to bus and rail stops	• Convenient transfers between bus and rail • Extensive, high-quality bicycle parking at rail stops • Park and ride facilities for cars at suburban rail stations • Bike and car rental programmes run by public transport firms
Pricing and restrictions of car ownership, use, and parking		
Sales tax for new car purchase	• State sales taxes for new car purchases range from 0% to 8.25%, with an average of 4.9%	• 19% in all states
Driver licensing and cost	• Easy and cheap driver training and licensing, costing about $100 in most states	• Strict and expensive driver training and licensing, costing over $2000 per license
Price of gasoline	• In 2011: $0.91 per litre (15% of price is tax)	• In 2011: $2.09 per litre (61% of price is tax)
Road revenues and expenditures	• Road user taxes and fees account for 60% of roadway expenditures by all levels of government	• Roadway user taxes and fees are 2.5 times higher than roadway expenditures by all levels of government
Traffic calming and speed limits in cities	• Few cities have any traffic-calmed neighbourhoods • Speed limits on most city streets range from 35 to 45 mph (56–72 km/h)	• Most residential streets are traffic-calmed at 30 km/h or less, with speeds reduced to 7 km/h on some residential streets • General speed limit of 50 km/h (33 mph) in cities
Road supply and car restrictions	• High-speed motorways and arterials criss-cross cities and suburbs • A few cities have pedestrian malls, but not extensive zones	• High-speed motorways rarely penetrate into city centres • Extensive car-free zones in centres of most city centres
Parking supply and cost	• Municipal zoning codes require high levels of minimum parking • 95% of all car parking is free of charge • Free parking is provided by most firms for their employees and customers; cheap and convenient on-street parking in most cities	• Most cities have reduced car parking in downtowns and increased parking fees since the 1960s • German cities have only 39% as many parking spaces per job than US cities
Land-use policies		
Coordination with public transport	• No coordination of public transport with land use, except for some TOD focused around rail stations	• Strict land-use controls limit low-density sprawl and encourage compact development around public transport stops
Land-use planning process	• No federal land-use planning at all • Very limited state land-use planning • Metropolitan planning organizations can propose land-use plans, but have no power to enforce plans • Fragmented, uncoordinated, and often conflicting land-use planning by local jurisdictions	• Federal, state, regional, and local land-use plans backed by power of law • Coordination of land-use plans among levels of government and across jurisdictions • Integration of land-use, transport, and environmental planning at all levels of government

cities are reducing parking in downtowns and increasing parking pricing, and most cities have extensive traffic calming in their residential neighborhoods.

- Transit-focused policies, programs and practices – Germany has three times as many transit services kilometers per capita as the US (59 vs. 20). Policies and practices that favor transit, such as transit signal priority and other bus infrastructure, modern buses, coordination between different providers and between different modes, all make transit more attractive. Unlimited ride passes (daily, monthly, annual, etc.) are very common, offering up to 60% reductions over single fares. This eliminates the marginal cost structure of rides in favor of a fixed cost, similar to monthly parking rates. And there have been deep reductions in fares for special tickets, such as student, elderly, disabled, etc. tickets. Additionally, vehicles themselves are on average newer, and it is much more common to have bus shelters and better information at these stops. All these measures make transit much more affordable and attractive.

Important to note, therefore, is that transit ridership depends on a lot more than factors that a transit operator has control over. However, the point of this paper is not to lay blame elsewhere, but rather to look at what transit organizations themselves can do to be more effective.

Transit in Hamburg – the HVV and the Hochbahn

Since my year of work placements was with the Hamburger Verkehrsverbund (HVV – The Hamburg Public Transportation Association) and the Hamburger Hochbahn AG, my research is Hamburg-focused, primarily regarding buses, with an eye towards the rest of Germany. First, an introduction to the agencies.

The Hamburger Public Transportation Association - HVV

In 1965, faced with mounting competition from the newly popular automobile, the four biggest transit providers in the Hamburg area, the Hamburger Hochbahn AG (Hochbahn, operating most bus lines and the U-Bahn), the Verkehrsbetriebe Hamburg-Holstein (VHH, operating buses in Hamburg and nearby in the state of Schleswig-Holstein), the Hamburger S-Bahn (a subsidiary of the German Rail, operating the express trains), and the HADAG (operating Hamburg's ferry service), recognized that using transit in and around the city needed to be simpler and more efficient for passengers. At that time, it was possible that a passenger would need up to seven different transit tickets to travel from one side of Hamburg to the other. Therefore, the HVV was formed as a regional association of transit providers with three goals:

- One ticket – passengers would need only one fare pass to reach their destination, regardless of provider.
- One fare structure – passengers would always pay the same fare regardless of provider or mode.
- One schedule – schedules were coordinated so that transfers between different modes and different providers were possible.

Thus the HVV became the first the regional transportation association in the world. In the late 1960s, the above goals were realized, and further improvements were accomplished, for example unlimited tickets and combination tickets with concerts and other events. The HVV also played a large role in transit planning and negotiating operating contracts on behalf of municipalities and states. Because

of its role in contracts, in 1996 it changed from an association of transit providers to an association of transit contractors (read local, county, and state governments) to avoid conflicts of interest. It therefore manages contracts between the governments and the transit providers, enforces quality standards, and coordinates regional priorities. These include marketing and appearance, customer service and information, planning and coordination of schedules, and new services such as electronic payment and ticketing, and coordinating mobility services like carsharing. The service area of the HVV has expanded over the years (Figure 5) , far into the neighborstates of Schleswig-Holstein and Niedersachsen, as the popularity of the HVV convenience makes smaller cities more attractive to new residents working in Hamburg.

Figure 5. HVV Service Area

Today, the HVV's role continues to be a coordinator of regional transportation, and must balance competing priorities between providers, passengers, and politicians (Figure 6). Because it no longer represents the transit providers, much of its planning work involves persuasion and approval instead of definitive project management. In addition, it has also taken on the role of passenger representation, as opposed to the economic feasibility of changes that the transit providers have a good grasp of. The HVV plays this role especially in negotiating service changes, such as frequency, stop locations, and transfers.

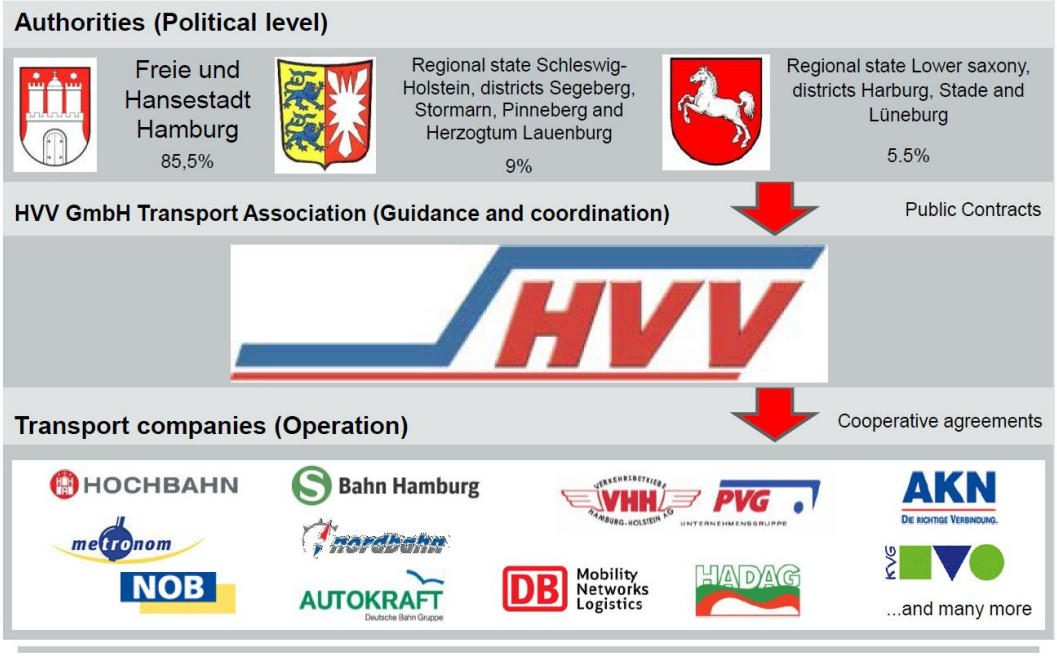

Figure 6. Organization of Transit Provision in HVV Area

HVV also has the challenge of planning the fare structure and service levels for both city and rural service. This is difficult because of the very different natures of the two services, and being owned by various government entities, the HVV must also balance political priorities. An example of this is the desire by various politicians in the past to have a short journey ticket (Kurzstrecke), then a local journey ticket (Nahstrecke), in addition to the standard ticket, and the tickets involving several rings. In most cities there is only a short trip ticket, which generally means simply four or so stops. However, because of different distances between rural and urban, four stops can either be 800 meters or 8 kilometers. Therefore HVV developed the zone map in Figure 7. This is generally unintelligible, unless one travels regularly. But it responds to both the mandate for a unified fare structure and political wishes.

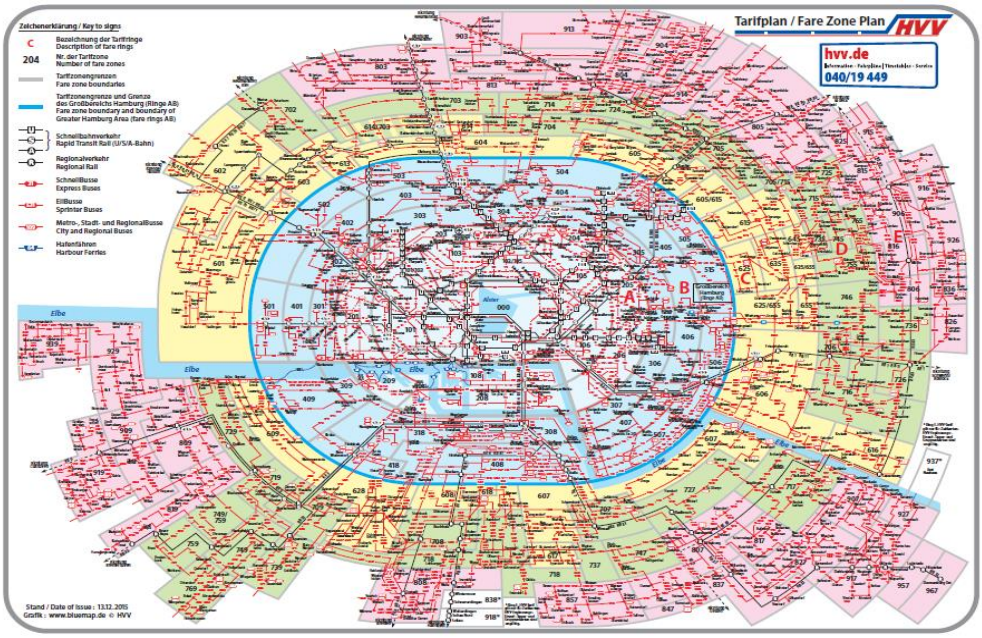

Figure 7. Complicated Fare Zone Map of HVV

Proof-of-payment vs. payment upon entry, and *Vorne Einsteigen*

Important to note is that this fare structure is only necessary and required because Hamburg's transit, like almost every transit system in Germany, uses the proof-of-payment method of ticketing. A passenger buys her ticket, enters the bus, and is randomly checked and fined if she does not have a ticket. There are many operational advantages, for example boarding/alighting delays are shorter and the driver can focus more on driving (however in Germany, the driver still sells tickets and gives change, to the dismay of transit providers due to the irregular delays it causes).

In the US, where most bus and subway service is paid per ride, this system is not necessary. This varies a lot, of course, and some payment is distance-based (such as the Washington DC Metro), but as passenger volumes increase and so their respective delays, many transit agencies are introducing proof-of-payment. New York City uses this method on its Select Bus Service lines to speed boardings and alightings, and some new light rail and street car services use this too.

An obvious disadvantage of the proof-of-payment is fare evasion (*Schwarzfahren*). Besides being a cultural norm for many high-school aged kids, this presents obvious revenue reductions. In theory, passengers are checked for tickets randomly, which encourages tickets to be bought, especially for frequent riders. Historically, however, the bus service was seen as a feeder to the rail service, and enforcement was only done on the rails with the idea that anyone evading the fare on the bus would be caught on the train, so there was little to no enforcement on buses. In the early 2000s when it became evident that this was in fact not the case, the HVV addressed this with *Vorne Einsteigen*, or boarding in front, whereby passengers must show their ticket to the driver while entering. Revenues increased by millions of euros, but bus times have slowed. Other transit agencies (i.e. the BVG in Berlin) have also adopted this to raise revenue without having to increase service. However, because of high volumes, the HVV and Hochbahn have abandoned this on the busiest bus lines (4, 5, 6).

Marketing and Branding

Another important role of the HVV is branding and marketing, either new services or transit in general for the area. The desire is to have unity in transit, therefore the HVV brand is desired so that passengers know that the fare structure, etc. Also, most advertisements, for new services like MetroBus or Night buses, or simply to take transit, are seen as regional priorities not specific to one provider. Therefore they are treated as regional priorities and fall under the responsibilities of the HVV. Below are some examples:

Figure 8. Examples of HVV Marketing

Funding and Financing of Transit in Hamburg

Transit in the HVV service area is a complex web of 10 different government entities and almost 29 different transit providers. With regards to financing, certain transit providers are tasked with fare collection (primarily the Hochbahn and S-bahn through ticketing machines and on-bus ticket purchases). This portion makes up about 67% of all operations costs. Another 3-5% is funded through specific subsidy programs, such as student tickets, senior discounts, and accessibility-related programs. The rest is then subsidized by various levels of government depending on the specific contract. The Hochbahn, for example, covers 90% of its operating costs, and receives its subsidy directly out of the City's general fund. Other municipalities have specific contracts and their transit service is thus subsidized according to these contracts. The HVV reimburses the providers for service based on a complicated equation that combines service kilometers driven with passenger levels to balance the natures of urban service with more passengers with rural service with longer routes.

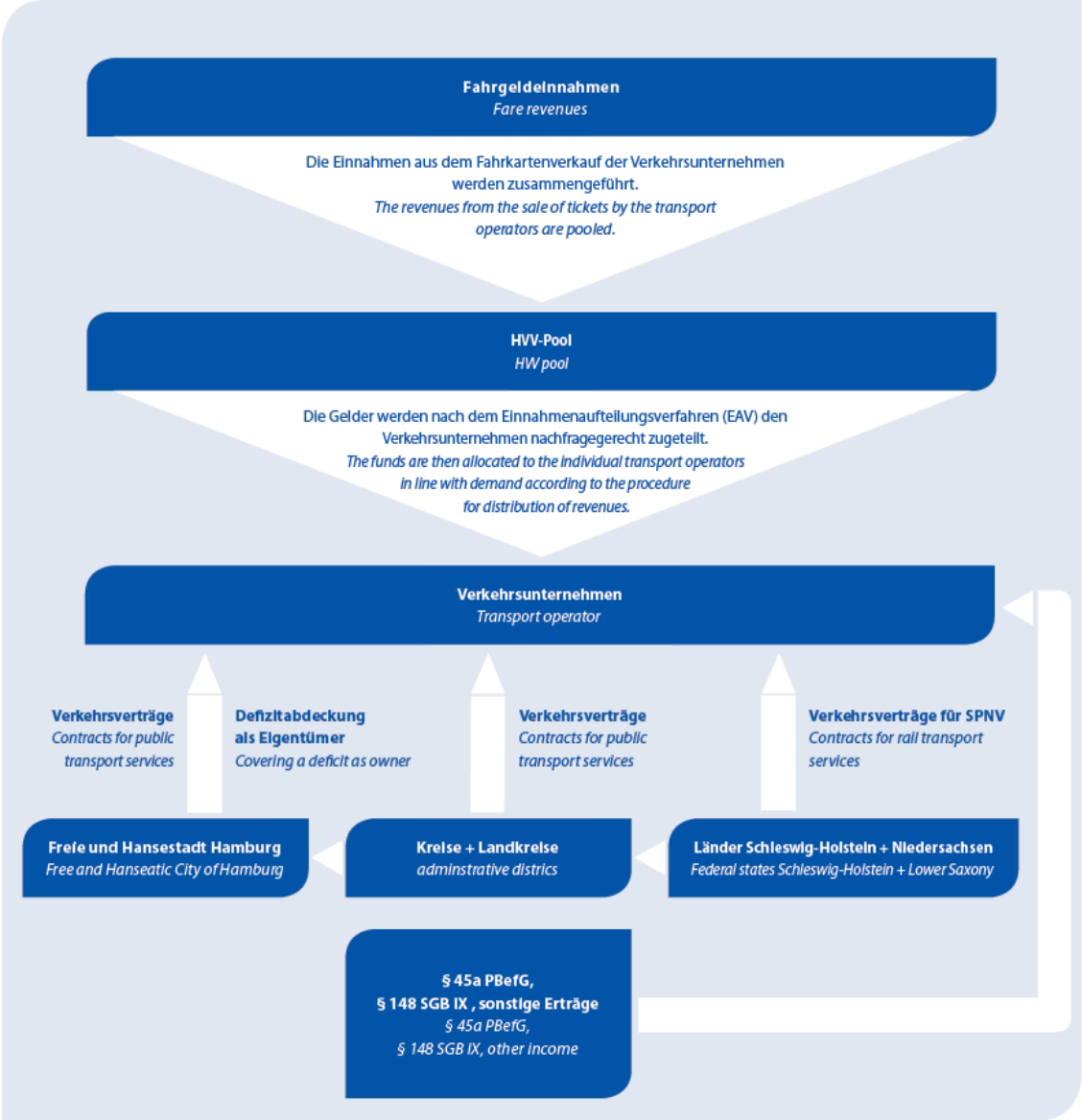

Figure 9. Funding Structure of Transit in HVV Service Area

Past innovations and the current situation

As previously mentioned, Hamburg was the frontrunner in many respects related to transit. Here are some of the most important.

Abo-Cards – Unlimited Rides, and Kombi-tickets

Abonnement-Cards (or *Abo-cards*, translated as "Subscription transit passes") are unlimited ride cards, a.k.a. daily, weekly, monthly, and annual passes that renew automatically, are seemingly ubiquitous in Germany today, but were a novelty that Hamburg helped pioneer in the late 1960s. Today, 85% of passengers ride transit in the HVV region using these fares. From an economic perspective, it makes transit more attractive by converting transit use from a marginal cost (i.e. cost per use) to sunk cost (paid regardless of use). This brings transit riding to the same economic rationale as driving, in that 75% of the costs of driving are sunk costs (vehicle costs, insurance, etc.), making individual trips more attractive and less expensive (only paying for fuel and parkng)This is also the force behind the fact that monthly parking passes encourages driving. The cost of using transit for an individual trip, therefore, is already paid for.

The HVV has aggressively marketed these farecards, which are heavily discounted from the price of an individual trip. For example (Figures 10 and 11), the single-ride standard ticket costs 3.20€, where as the standard monthly ticket costs 103.70€. If one were to ride only for commuting (averaging 21 days/month), the monthly pass represents a 23% reduction. Annual cards are even more heavily discounted, providing two months per year free. The HVV also created "*Profi-karten*", cards that are sold in bulk to employers at a discount, and employers can then sell these to employees at a discount and as non-taxable benefits. In addition, the HVV created Kombi-tickets which are transit fare cards that also provide discounts for museums and other attractions, and is working with other providers (such as soccer teams and the German Railway) to provide easy ticketing as well. These tickets, as well as group tickets which can be used for up to five people, have become standard in German cities and regional rail service today. These fare policies make transit much more attractive not only for regular commuters, but also for non-work-based trips, especially on weekends and at night.

Overview of Single and Day tickets

Areas / Fare zones	Single Ticket (Einzel-karte) 1 person price in €	9 am Day Ticket (9-Uhr-Tageskarte) * 1 person + 3 children aged 6-14 price in €	All Day Ticket (Ganztages-karte) 1 person + 3 Kinder (6-14 Jahre) price in €	9 am Group Ticket (9-Uhr-Gruppen-karte)* up to 5 persons any age price in €	Single Ticket Child (Einzelkarte Kind) (aged 6-14) price in €	9 am Day Ticket Child (9-Uhr-Tageskarte Kind)* (aged 6-14) price in €
Greater Hamburg Area (fare rings AB) **or** 1–2 rings (rings AB)	3,20	6,20	7,60	11,60	1,20	2,30
3 rings	5,10	10,20	11,60	18,00	-	-
4 rings	7,10	12,40	15,20	23,20	-	-
Entire network (fare rings ABCDE)	8,70	16,40	19,00	26,00	2,40	4,60

Standard Ticket

Fares from 01.01.2016

* valid Mon – Fri from 0.00 am to 6 am and from 9 am until 6 am the following morning, all day on Sat, Sun and public holidays

Single tickets inside Greater Hamburg Area (rings AB)	€
Short journey (Kurzstrecke)	1,50
Local journey (Nahbereich)	2,20
Short trip (Express bus) (Kurzfahrt SchnellBus)	2,10

Figure 10. Individual and Day HVV Tickets

Standard Ticket

Area of Validity	Flexible weekly season tickets (Price per week in €)	Flexible monthly season tickets (Price per month in €)	Abo-Karte all year travel pass (Price per month in €)	*Abo-Karte saving per year in €**
1 fare zone only outside Greater Hamburg Area (Großbereich Hamburg Ringe AB)	13,10	49,70	40,80 Order	*106,80*
2 fare zones	17,10	65,00	53,30 Order	*140,40*
3 fare zones	23,80	90,60	74,30 Order	*195,60*
Greater Hamburg Area (Großbereich Hamburg Ringe AB) **or** 4 fare zones	27,30	103,70	85,00 Order	*224,40*
Greater Hamburg Area (Großbereich Hamburg Ringe AB) + 1 fare zone **or** 5 fare zones	34,30	130,70	107,20 Order	*282,00*
Greater Hamburg Area (Großbereich Hamburg Ringe AB) + 2 fare zones **or** 6 fare zones	41,30	157,20	128,90 Order	*339,60*
Greater Hamburg Area (Großbereich Hamburg Ringe AB) + 3 fare zones **or** 7 fare zones	48,30	183,80	150,70 Order	*397,20*
Total HVV Network (Gesamtbereich Ringe ABCDE)	54,50	207,40	170,00 Order	*448,80*
Upgrade ticket for SchnellBus limited-stop/1. class services	13,50	51,00	42,30	*104,40*

Figure 11. Unlimited Ride HVV Tickets

MetroBus

Before 2001, there was very little to differentiate high service vs. low service bus lines in Hamburg. All had very normal numbers, even though some came every 20 minutes and others every 5. In 2001, HVV, the Hochbahn and the VHH implemented the MetroBus system. High service lines were renumbered (1-29) and others were consolidated to form a priority bus network that guarantees at least 10 minute headways throughout most of the day (Figure 12). Operationally not much changed, but psychologically this elevated level of priority buses is important to show passengers the strong bus connections between rail lines and to downtown, and internally to focus discussions on where to improve bus service. Today, the Metrobus lines carry approximately 60% of all bus passengers.

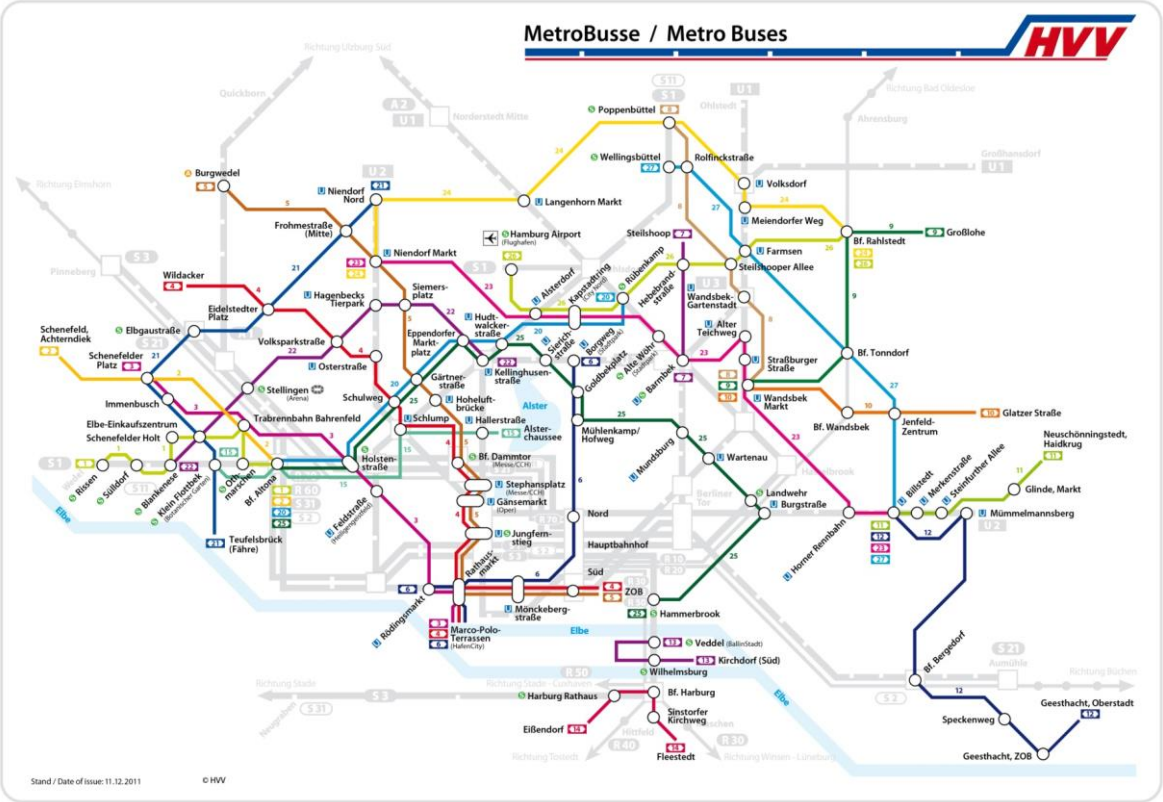

Figure 12. Metrobus Sylized Network Map

The Hamburger Hochbahn AG

The Hochbahn, which literally means “high rail,” gets its name from the very first urban train line in Hamburg (the U3), a mostly elevated rail that makes a ring around the central Alster Lake and provides one of the best views of the harbor. Since its founding in 1911, the Hamburg Hochbahn AG has evolved into the largest transit provider in the HVV network, operating the entire U-Bahn (subway) network and most of the bus lines. Here’s some quick facts:

- Daily Ridership: ~1.2 million
- Annual ridership: 438 million (almost exactly evenly split between bus and rail)
- Subway lines: 4
- Bus routes: 111
- Train stations: 91

- Bus Stops: 1,321
- Train cars: 232
- Buses: 803
- Annual budget: 424.3 € (~$478 million)
- Employees: ~5,000

The Hochbahn is a private corporation, but 100% of the shares are owned by the city of Hamburg (through another entity, Figure 13). This is a typical model in Germany for services that are semi-public in nature (water, electricity, etc.), with the advantage that the budgets can be more easily isolated and analyzed. The Hochbahn also owns several subsidiaries, including two smaller bus companies that serve smaller markets in less populated areas of Hamburg, the ferry service, another tourist boat line, and the Intercity bus station.

Figure 13. Ownership Structure of the Hamburger Hochbahn AG and other Utilities

A key difference is that many services that in the US would either be part of a transit authority's standard personnel or outsourced to another company are also provided by Hochbahn-owned subsidiaries, such as bus and rail maintenance operations, security service (similar to a transit police), IT service, advertising, housing for employees, and the cleaning service. This gives these subsidiaries the opportunity to also provide services to outside customers to increase revenue. (The Hochbahn covers 90% of its own costs, receiving a very small subsidy compared to US transit agencies. This includes not only revenue from passengers, but advertising, storefront rentals, etc.)

Current Projects and Trends

Busbeschleunigung, Hamburg's Bus Rapid Transit

Busbeschleunigung literally translates to "Bus Acceleration," a program that is focused on infrastructure improvements to speed buses, similar to Bus Rapid Transit projects in the US. Transit ridership in Hamburg has been growing faster than the national average for the last several years, and many major MetroBus lines are at capacity. In addition, congestion is becoming an increasing problem, as is passenger crowding and bus stop accessibility is gaining attention.

The Bus Acceleration Program has its roots in a tram system plan that was put forth for the city to increase capacity in the 2000s, but encountered resident resistance and was to be costly. Therefore, when the current mayor started office in 2011, he rejected the plan in favor of prioritizing buses. In his official statement, he stated:

- "Hamburg shall receive one of the most modern bus systems in Europe"
- "We want to increase the capacity of the bus system by 1/3"
- "We want to construct new bus lanes and install signal preemption for busses"

The result is the *Busbeschleunigungprogramm*. This is a cooperation of several agencies: The Office of Transportation, Economic Development and Innovation, (essentially the transportation planning agency), the Department of Streets, Water and Bridges (essentially the public works agency), the HVV, the Hochbahn, and the VHH. After the team finished the concept plan highlighting where capacity needs were greatest, it outlined the routes, segments, and improvements. This first plan, started in 2011, is set to be complete in 2018 at a cost of 157 € million (Figure 14).

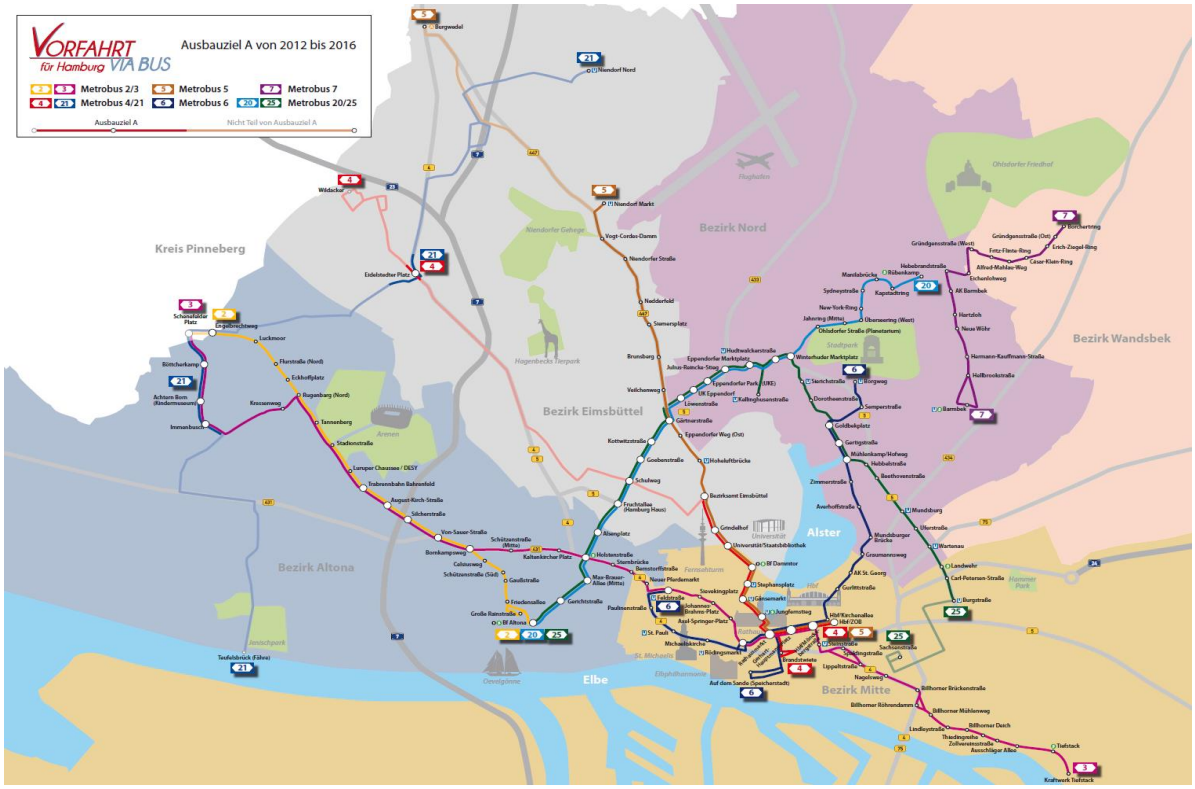

Figure 14. Plan A of Bus Acceleration Program Improvements

Looking at the actual improvements, When looking at its components, it looks very similar to, and even more ambitious than, what many US cities call Bus Rapid Transit (still far from Latin American or Asian standards). Below (Figures 15-18) are examples of improvements, including bus stop upgrades, bus lanes, transit signal priority, and complete intersection redesigns.

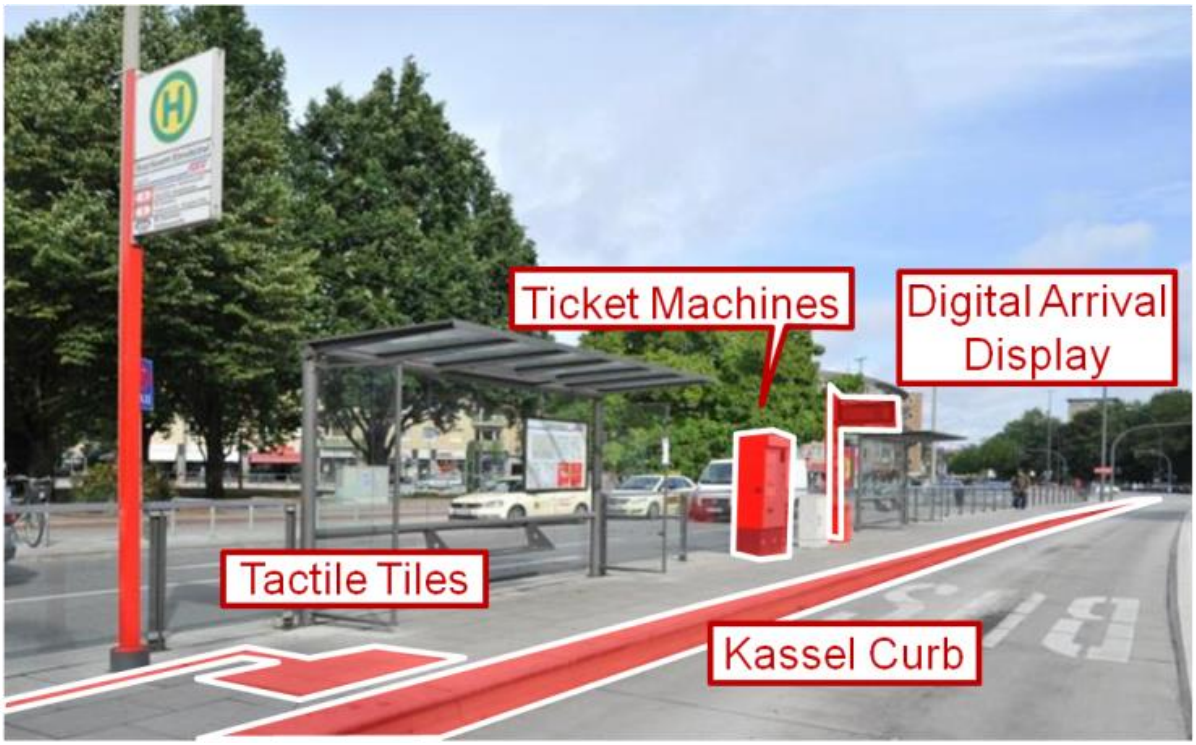

Figure 15. Bus Acceleration Improvements - Standard Elements of Bus Stop Improvements

Figure 16. Bus Acceleration Improvements - Bus Lanes

Figure 17. Bus Acceleration Improvements - Intersection Redesign. Notice Bus Islands

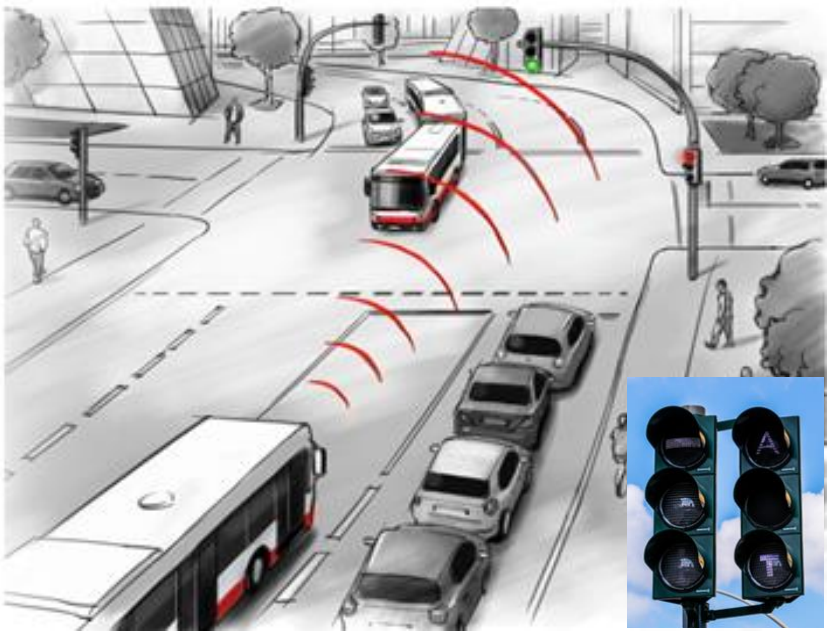

Figure 18. Bus Acceleration Improvements - Transit Signal Priority with Signal Head

MetroBus line 5 was the first route to receive treatments under this program. This route is the highest ridership bus route in Europe with 60,000 passengers per day, and regularly runs bi-articulated buses that are 82 feet long with a capacity of 140 passengers at 5 minute headways. The improvents to the route include all of the above, and it has the potential for an 18% reduction in travel time from 56 minutes to 46 (Figure 19).

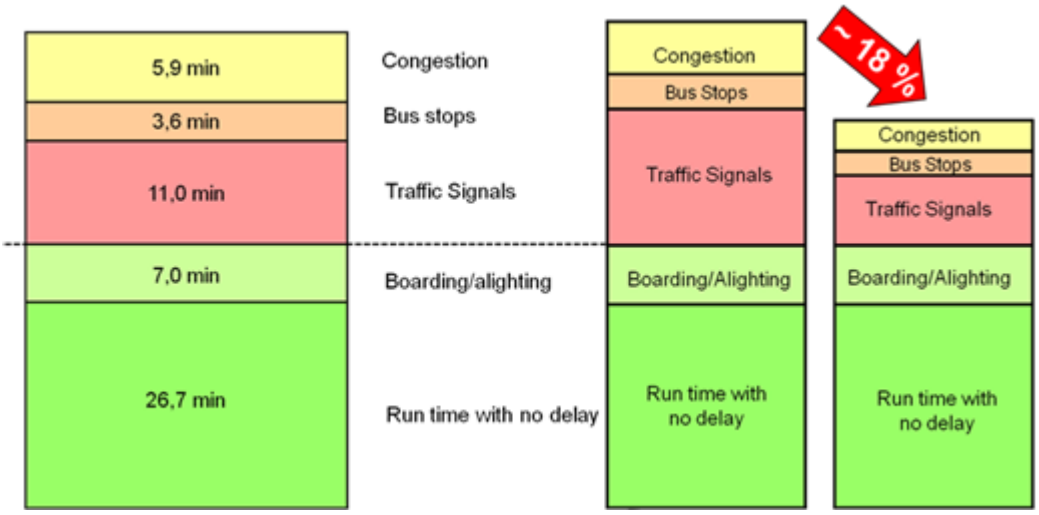

Figure 19. Sources of Delay and Potential Time Savings on MetroBus Line 5 through the Bus Acceleration Program

Alternative Fuel Vehicles

Hamburg's mayor has set the goal of procuring only no-emission buses starting in 2020. To this end, the Hochbahn has been working with vehicle manufacturers to develop and test low and no emission buses on bus line 109, which has been therefore called the Innovation Line, the first in Europe. There are several advantages to using this line to test different vehicle technologies. The route itself runs through an attractive area of Hamburg (Figure 20), including the inner city which provides good publicity and awareness; there are various types of charging stations at each end (electric, fuel cell); and the route is short for the battery operated bus (the battery has a limit of 12 km). The types of vehicles used are:

- Fuel Cell
- Electric only – 12km range, charges in 7 minutes
- Electric only with fuel cell "range extender"
- Diesel Plug-in (charges overnight, diesel to extend range)
- Diesel Hybrid

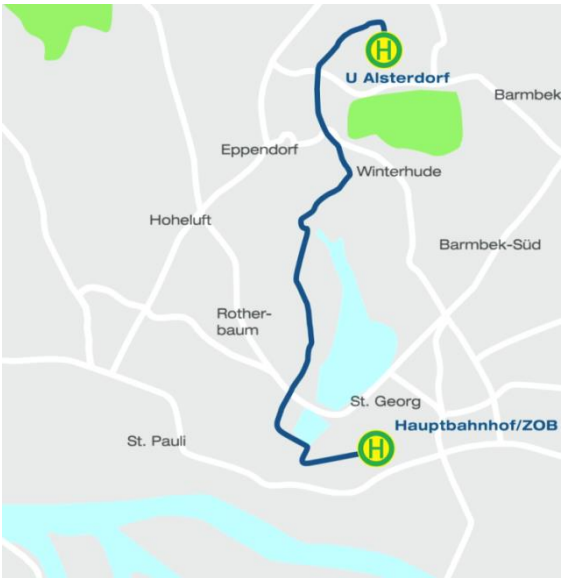

Figure 20. Innovation Line 109 Route.

Despite the fact that some bus manufacturers in Europe already produce electric buses with long ranges, for example Irizar in Spain, German transit operators prefer to continue working with Mercedes' Evobus and Volvo because of good experiences with service and maintenance needs. In

2018, Evobus is expected to roll out a new type of electric bus.

Hochbahn as a Mobility Provider – switchh

With the goal of reducing private vehicle ownership in Hamburg and winning more passengers, the Hochbahn has partnered with carsharing, car rental, and bikesharing services to transform itself from a transit provider to a mobility provider. In Hamburg, carsharing is beginning to emerge as a popular mobility alternative, and the Hochbahn sees it as a good complement to its traditional transit service, especially for last mile mobility. The Hochbahn has developed a mobility platform (called switchh) which calculates the mode to get somewhere among the several partners. It has given space to car2go carsharing vehicles at many stations U-Bahn stations (called switchh points, Figure 21), including converting public parking spaces. And switchh members receive discounts for car2go, Stadtrad (the local bikeshare system), and Europcar car rentals.

Figure 21. switchh point, Berliner Tor

Digitization and E-Cards

In the US, the trend has been for over a decade towards electronic farecards. A passenger has an electronic farecard, they load money into their account or buy an unlimited pass, and every time they enter (and sometimes exit) the transit system, they tap it and the system registers them and adjusts the amount in the account appropriately. The technology speeds boardings, compared to paying cash, and it also allows the transit provider to gain data on travel behaviors, potentially leading to better optimized service.

Hamburg, like many cities, is also looking into this technology. The key difference, as mentioned above, is that Hamburg uses a proof-of-payment system, where passengers only prove they paid a fee when checked by enforcement personnel; passengers board and alight quickly already, which

eliminates the time savings as in US systems, and an electronic system could potentially impose new delays.

The biggest source of delay now that transit providers would like to eliminate is that from buying farecards from the driver. Today, a passenger can buy a farecard from the driver and receive change back, which seems like a luxury to most transit American transit passengers. The delay comes not only from selling the ticket (including figuring out the best fare) and giving change, but also from missing a traffic signal cycle (especially if transit signal priority is involved), and having to wait for more passengers to board because the bus dwells too long at a stop. In addition, it represents an unpredictable delay because service planners cannot accurately accout for if or how many passengers will buy a farecard. This reduces the reliability of a line, making scheduling difficult. For this reason, automated farecard machines, like those in the U-Bahn, are standard now at high-passenger stops.

Another challenge is the complicated fare structure of the HVV. It is not enough to tap a card upon entering a bus, for example. To be able to charge appropriately, the card must also know when a passenger leaves transit in order to charge for a short, local, standard, or multiple-ring journey. This would involve the installation of elctronic farecard readers everywhere, as well as require the passenger to remember to tap upon exit. This adds a high cost to the program, and introduces a new complexity to the passenger.

HVV, the Hochbahn, and other transit providers are currently in discussions to provide the advantages of electronic ticketing without delaying service or making transit use more complicated for the customer. The HVV already provides an app for passengers to buy tickets, at a small discount (Figure 22). It also provides the possibility to buy the best ticket by entering the origin and destination.

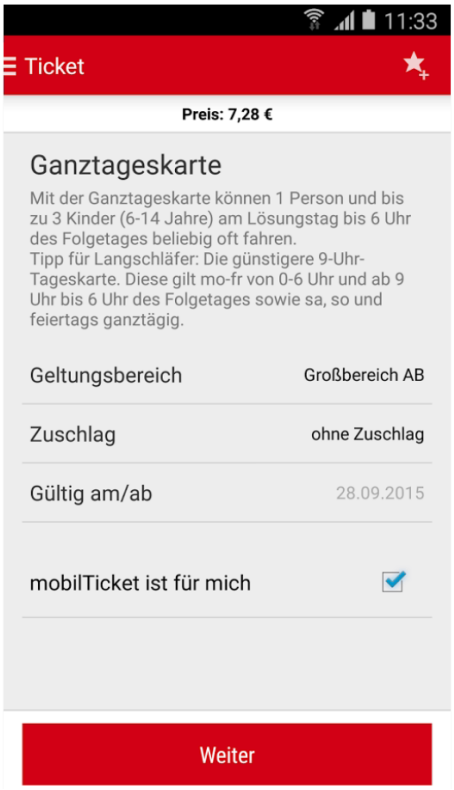

Figure 22. Buying a Farecard through the HVV App

One possibility under discussion is a form of self-reporting e-ticketing, whereby a scanner would detect a passenger's farecard, and recognize where the passenger boards and alights. A passenger's trips could then be analyzed and s/he would be charged the lowest fare, as is done in London. For example, if the system detects that a passenger made five single trips in one day, the system would only charge for a daily pass. In addition to obvious data privacy concerns, and whether the technology actually exists today to reliably achieve this, other questions arise. For example, what if a customer does not have an electronic farecard (tourists, for example)? And what are the revenue impacts of providing the lowest price?

Since passengers who pay single-ride fares only account for 15% of all passengers, some question the need for such an investment for so few passengers. However, these 15% provide 30% of HVV revenue, and there is an obvious desire to gain more ridership by making transit more attractive and easier to use.

Accessibility

One topic that is interesting to follow is the emphasis on accessibility for those with disabilities. The US has been incorporating accessibility into transit investments since the passage of the Americans with Disabilities Act (ADA) in 1990. The updated German version, "*Personenbeförderungsgesetz (PBefG)*" requires transit providers to complete accessibility upgrades by 2022. Part of this push comes from demographic trends, in that Germany's birth rate is one of the lowest in the world and the population is aging. Whatever the reason, Germany is a different pace than in the US, where ADA primarily applies to new construction, and older facilities are grandfathered in and only required to be upgraded when rehabilitated. Even then it does not always apply, for example many were surprised that the Damen Blue Line station in Chicago was allowed to be rehabilitated without adding ADA accessibility.

In February, 2016, Hamburg released its guidelines for accessible bus stops, including standards and other recommendations ("Barrierefreier Neu-, Um- und Ausbau der Bushaltestellen im Hamburger Verkehrsverbund, Feste bauliche Standards und weitere Empfehlungen, Ein Leitfaden für Baulastträger"). In it are several recommendations on the construction and renovation of bus stops, such as higher curbs, tactile tiles, etc.

In addition to bus stops, the Hochbahn and the Hamburger S-Bahn have been busy updating their stations. This includes elevators, and for the Hochbahn, raising passenger platforms (Figure 23), either in part or completely, to eliminate the larger than expected step up into the U-Bahn cars. Some of the challenges are not untypical of US legacy systems, including narrow platforms, space constraints around the stations, low ceilings, existing fixtures, fire protection, and of course historical preservation.

Figure 23. Elevator and Raised Platform for Accessibilty. Partly raised platforms in red ovals.

As of 2016, most U-Bahn stations were accessible, with several more beginning construction in the next several years (Figure 24).

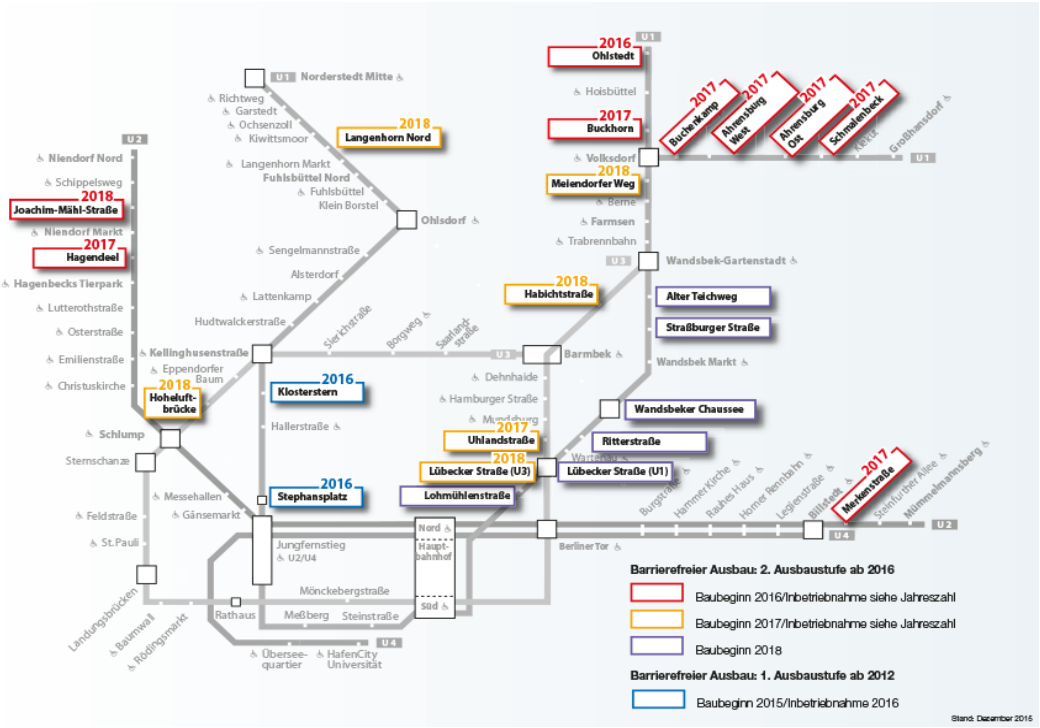

Figure 24. U-Bahn Stations with Upcoming Accessibility Work

The HVV also has several online tools, including detailed diagrams of elevator placements and a live elevator condition map, available on its website (Figures 25 and 26).

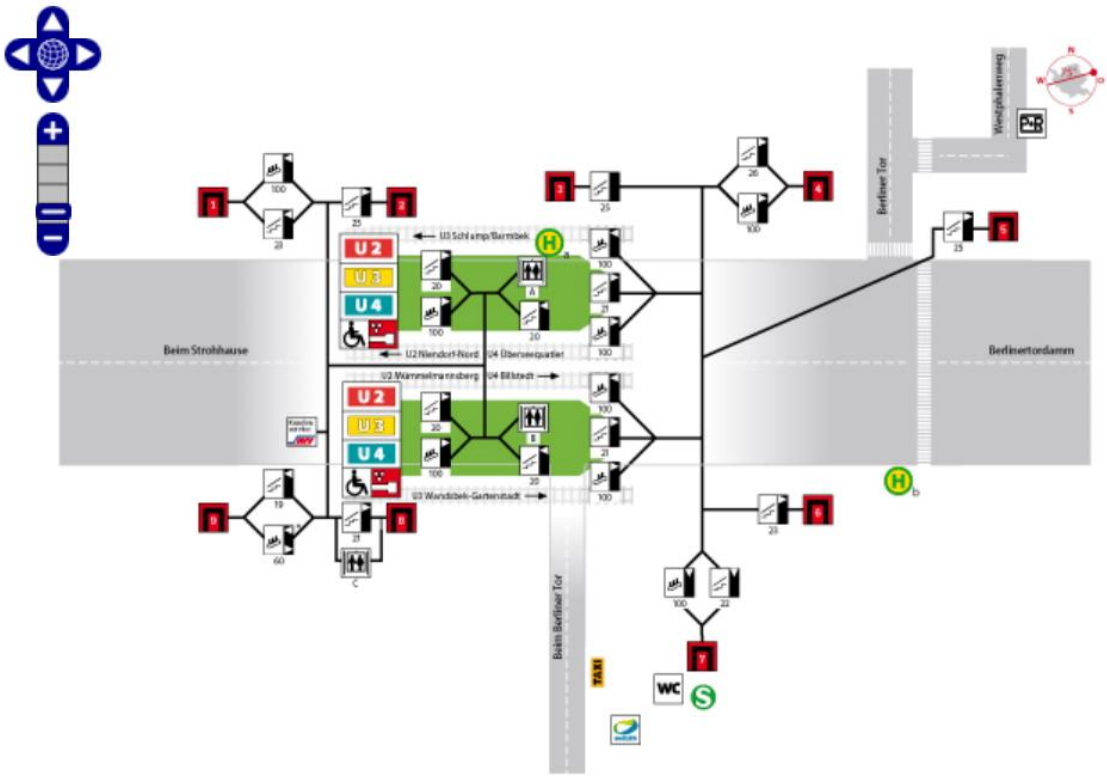

Figure 25. Example of Online Diagram of U-Bahn Station and Elevators

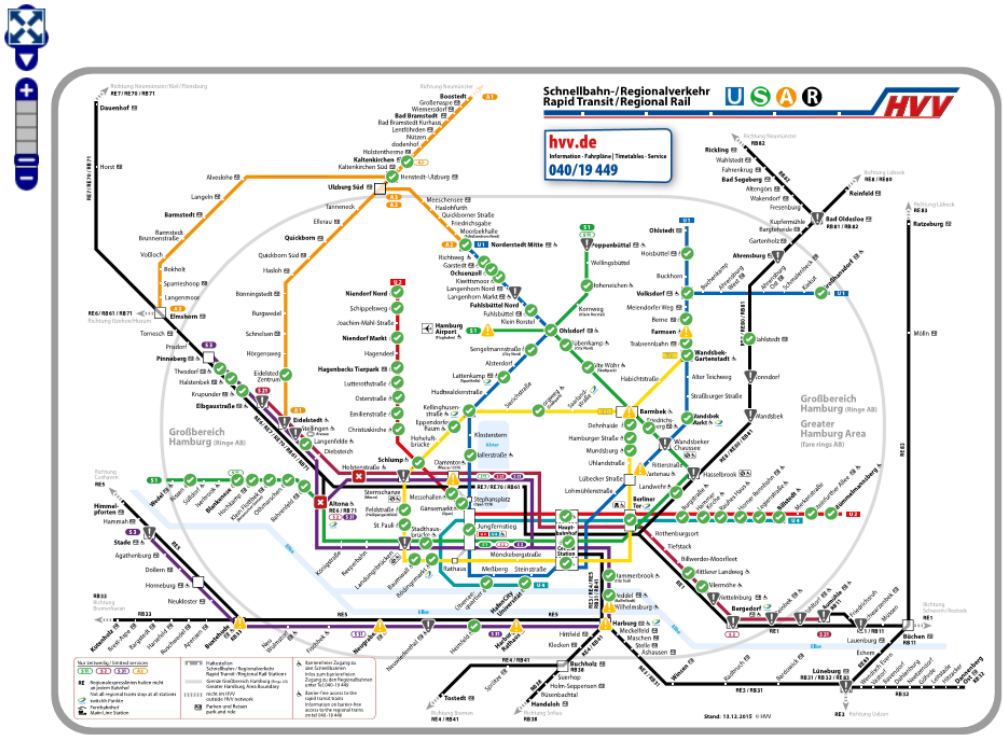

Figure 26. Live Online Map of Elevator Operation Status

New Projects: U-Bahn Additions, Schnellbus, and Public Outreach

U4, U5, Oldenfelde

Even though Hamburg has said no to trams, it is still the U-Bahn system expansion (Figure 27). The U4, which was built to serve the new HafenCity priority development project, only has 2 stations of its own (mostly shares the rail with the U2). There is currently construction to extend it to the south (Elbbrücke), and the Hochbahn is developing plans to extend the line to the Northeast to connect two neighborhoods that are lacking rail access (Horner Geest). In addition, the Hochbahn is planning a new stop, Oldenfelde, in the Northeast of the city along the U1 where there is a substantial gap between stations. Finally, a brand new U-Bahn line, the U5, is currently in the planning phases. This line came from political promises to connect the neighborhoods of Bramfeld and Osdorfer Born to the rail network, and from the recognition of the capacity needs of the MetroBus 5 line between Siemersplatz and the downtown.

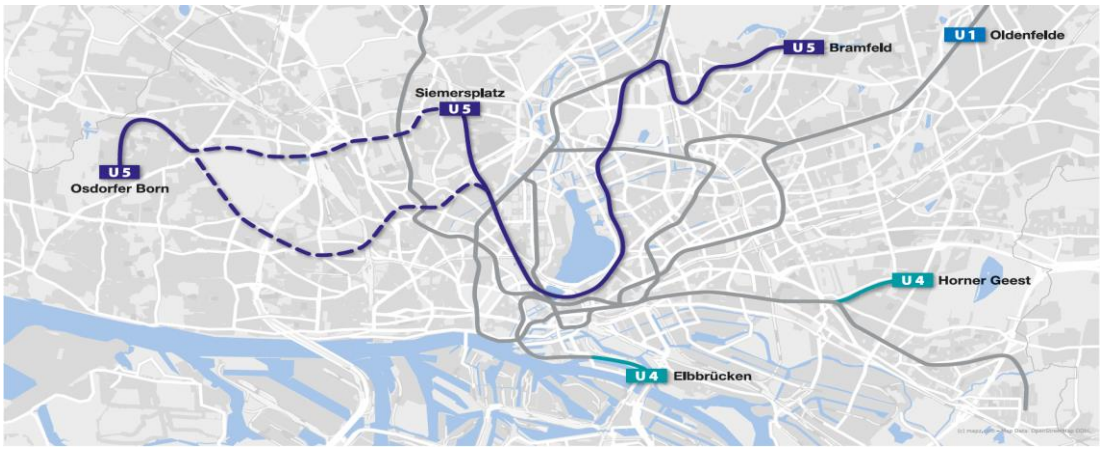

Figure 27. New U-Bahn Projects: U4 extension, New U1 Station at Oldenfelde, and New Line U5

Schnellbus

The Schnellbus network (Figure 28) of six routes (and two highly-specialized routes that are not normally included, the 48 and 49) provide fast, direct, transfer-free access from far-away neighborhoods to the inner city for an up-charge of about 50%, although many passengers, almost 50% in fact, do not pay this because of specific exceptions (disabilities, between-peak farecards, senior discounts, etc.). These routes were originally created by the Hochbahn and VHH as competition to the S-Bahn before the formation of the HVV. This network has atrophied and no longer serves its original purpose, but until now has been politically impossible to eliminate or modify. Last summer, the city council tasked the HVV, Hochbahn, and VHH to analyze impacts on modifying these lines. The results will be out later this summer.

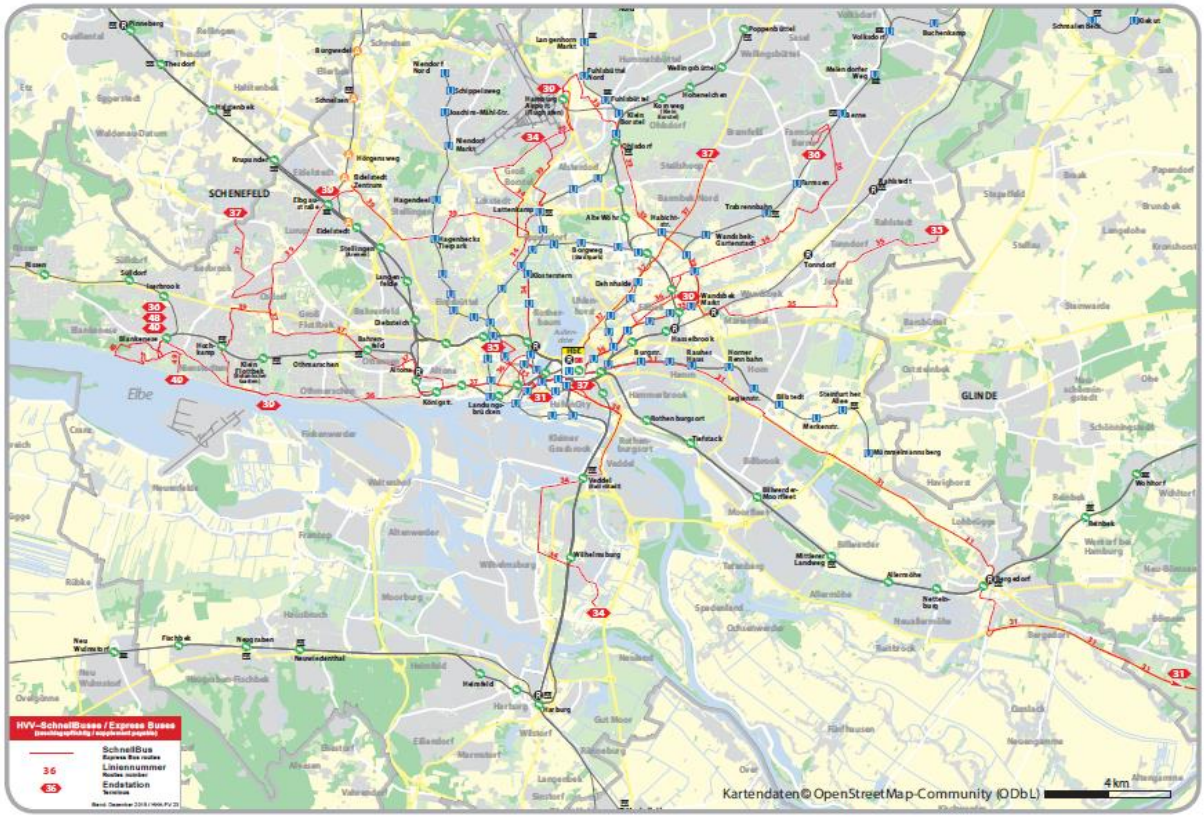

Figure 28. Map of Schnellbus Network

Public Involvement

In the US, the National Environmental Policy Act (NEPA) has required public involvement in major transportation projects. As a planner myself and AICP member, public involvement is crucial to any planning project both to gain resident perspective and public support for a project. This was rarely done in Germany, especially with transportation projects. However in the last 10-15 years, infrastructure projects have been gaining much more attention and citizens have felt left out of the process. This has led to resistance and even demonstrations. Therefore the Hochbahn started a formal public involvement process about five years ago with the goal of gaining enough public acceptance to be able to proceed with the process. They seem to be relying heavily on experiences from other cities and countries, including the US. It will therefore be interesting to see how this develops.

Conclusions

Germany and the US both share a love for their cars, with high car ownership in both countries, especially relative to the rest of the world. However in the US, this is in many cases not so much of a love, but a perception of the car as a necessity for mobility, and most Americans in fact rarely question this. In Germany, despite high car ownership rates, transit is still considered a necessary part of a transportation network, where even the richest quarter of the population use transit more that the poorest quarter of Americans. In Germany, transit requires less government subsidy, and per capita there is about three times more service. Large factors that account for this are policies and programs independent of transit providers, primarily those that restrict car use either through cost or low, or those promoting better land use that encourage dense development, short trips through mixed-use, and limited parking.

The question remains: how can US transit agencies use lessons from German transit systems to increase cost coverage, increase ridership, and provide better service? The HVV provides lessons in regional coordination such as pricing and ticketing, schedule coordination, and branding. The Hochbahn provides lessons, which some US cities are already adopting, such as infrastructure improvements and electronic ticketing. Some US transit agencies are looking to new mobility providers like car-, ride-, and bikesharing to either make new connections or to provide mobility where traditional bus service wouldn't make sense. The Hochbahn can provide lessons in this respect with the switchh program. In addition, the Hochbahn's Innovation Line 109 is noteworthy, representing a collaboration between a bus operator and manufacturer to test new fuel technologies for future use on its own routes.

Transit in Germany can also learn many things from from US transit providers. Electronic farecards are the norm in most systems, and public involvement has been a key part of transportation projects for decades. The US has a lot of experience with providing accessibility, to the point that it is usually second nature.

With the growth trend in US cities, hopefully other areas of administration can see the benefits of transit not only for green mobility or providing the economically disadvantaged access to employment, but for the general improving of quality of life and quality of the city itself.