Sandnes Benchmarking

PT issues: key facts, numbers, approaches

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Sandnes Kommune

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AUAO	L'**A**gence d'**U**rbanisme de l'**A**gglomération **O**rléanaise
BHNS	**B**us á **H**aut **N**iveau de **S**ervice (High Quality Bus)
CERTU	**C**entre d'**E**tudes sur les **R**éseaux de **T**ransport et l'**U**rbanisme (French National Research Centre for Mobility and Urban planning, now CEREMA)
ENDURANCE	European Research and Cooperation project
EVEOLE	Brand name for Douai PT-network
HITRANS	**Hi**gh Quality **Trans**port for medium-sized cities (INTERREG NorthSea research project 2003-2005)
GVB	**G**eraer **V**erkehrs**B**etriebe (PT-operator of Gera)
HQ/ HQPT	High Quality / High Quality Public Transport
INTERREG	European programme to stimulate cooperation between regions
KOLUMBUS	PTA for Rogaland County
KVU	**K**onsept**V**alg**U**tredning
LEMET	LeMet – brand name for Metz PT-network
MOBILITOURS	Brand name used for the Tours Tramway project
ÖBB	**Ö**sterreichische **B**undes-**B**ahnen (Austrian State Railway)
PDU	**P**lan de **D**eplacements **U**rbains (Transport Masterplan)
PT	Public Transport
PTA	Passenger Transport Authority
RUTER	PTA for Greater Oslo
SSB	**S**tatistisk **S**entral**B**yrå (Norwegian State Authority for Statistics)
SUMP	**S**ustainable **U**rban **M**obility **P**lans
SVT	**S**tadt**V**erkehr **T**übingen
SWT	**S**tadt**W**erke **T**rier (PT-operator of Trier)
TaM	**T**ransports de l'**a**gglomération de **M**ontpellier (Montpellier PT-authority)
TAN	Réseau de **T**ransport en commun de l'**A**gglomération **N**antaise (Nantes PT-authority)
VBSH	**V**erkehrs**B**etriebe **S**chaff**h**ausen
VCÖ	**V**erkehrs**C**lub **Ö**sterreich (Austrian Lobbyorganisation for sustainable transport)
VDV	Verband Deutscher Verkehrsbetriebe (German association of PT-operators)
VRT	Verkehrsverbund Region Trier (PTA Trier region)
VVS	Verkehrsverbund Stuttgart (PTA Stuttgart region)

Sources

Information used by the consultant is properly sourced below pictures, diagrams, maps etc.

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The client has been provided with a variety of background information related to the cities and schemes discussed in this report.

A Background and understanding of study request

Sandnes Kommune is currently engaged with developing a local transport plan using ENDURANCE/SUMP methodology where accessing available data is a recommended early stage activity. As part of this activity there is the aim for both an external review of existing strategies in the PT-field (network structure, stop strategies, nodes and interchange hubs etc) and establishing some benchmarking in regard of public transport which allows comparing Sandnes with other Norwegian and European cities of similar size.

Sandnes Kommune has assigned Axel Kuehn to deliver the benchmarking part, which should, however, not exclude commenting on strategical aspects and differences which may surface during the review of other case study cities.

Three main tasks are part of the assignment:

- Updating the benchmarking for the Nord Jaeren region delivered in 2008 by Axel Kuehn -assigned by Rogaland Fylkeskommune back then- and setting Sandnes as part of the wider region in a context (similarities, differences ... between Sandnes and the wider region).
- Establishing a new benchmarking which allows comparing Sandnes with similarly sized Norwegian and European cities.
- Identifying any key differences arising from the benchmarking along with likely reasons and identifying good practice and trends elsewhere which make a contribution to performance.

It should be understood that the cities (city areas / agglomerations) used in 2008 for comparing with the Nord Jaeren region are not respectively not all suited for comparison with Sandnes. This is a size issue on one side but more importantly the cities chosen for the 2008 benchmarking have been to a larger extent tramway cities – with tramways either existing or in the planning stage. This means that a new set of case study cities needs to be established for the current task.

With regard to the limited budget and time available the number of case studies had to be kept on a smaller level (2008: about 20, data mostly available from another study; 2016: about 8-10). It was also necessary to reduce the number of parameters and to concentrate on a selection which is most relevant from a transport planning perspective.

The consultant’s activities did include:

- Proposing a set of case study cities and parameters.
- Collecting of relevant data, documentation, statistics.

- Producing suitable diagrams which illustrate the position of Sandnes in comparison to other cities.
- Describing the international approaches and highlighting of “lessons to be learnt”.

B Benchmarking

B.1 Data issues

The following chapter highlights the data sources used and the ambitions respectively limitations around data quality. It should be acknowledged that there was neither time nor budget to hunt for highest thinkable data accuracy (“ideal world”) and also that the “benchmarking 2016” is an update of the “benchmarking 2008” which implies that the quality (respectively any quality deficiencies) accepted in 2008 need still to be accepted in 2016.

Data availability and suitability was a big issue and some cities planned initially for the 2016 benchmarking had to be replaced for these reasons.

The consultant is, however, convinced that for the purposes of the benchmarking and the parameters involved in it, any deficiencies do not endanger the results and conclusions.

B.1.1 Data sources

Data has been collected from a variety of sources including state or state-wide statistics (Norway, France) but also single information on specific networks compiled from annual reports, operator websites etc.

All data used within the Sandnes related 2016 benchmarking relates to city bus traffic. If city bus networks operate beyond city borders population and density data has been adapted accordingly. The 2008 benchmarking did willingly look at a variety of cities including some with tramway, light rail or tram-train schemes in place (context were the Kombibane plans!). For these cities/agglos certainly the total amount of vehicle-kms offered to citizens and the combined patronage (bus + tramway etc) has been taken into account. For the update of the 2008 benchmarking these cities with the exception of Bergen and Angers have not been used anymore. Railway passengers generally are not accounted for (exception was certainly the Oslo Navet KVU benchmarking which is here only mentioned as a reference).

It should be understood that data stems from differing years within a 2-3 year range. Again here an availability issue is to be accepted. This was the case for the benchmarking of 2008 (data from 2005-2007 used) and is still a case for the 2016 benchmarking for which data from 2012-2014 had to be used. For this reason the consultant uses the expressions “Benchmarking 2008” and “Benchmarking 2016” in a number of diagrams as there can’t be given a single year for all data used in the database.

B.1.2 Data quality

Due to the different sources there is certainly no 100% assurance that all data fulfills the very same requirements. On the other hand the scope for major deviations appears in regard of the chosen parameters rather limited.

Vehicle-kms are often questioned regarding their suitability due to different vehicle sizes and potential multi-traction (in the rail sector). As long as one stays, however, within the bus world (usual range from 12-18m, sometimes up to 25m), the differences between using seat or vehicle-kms appears rather neglectable. The same counts for standard tramway systems (usual range from 30-40m, sometimes down to 20m or up to 60m). Especially when vehicle-kms are used as a parameter representing kind of a “service availability” for the citizens (like timetable hours which is used eg in Denmark for statistics), the actual vehicle size as represented in seat-kms is less important. It needs also to be acknowledged that most PT-statistics offer vehicle-kms while other parameters are not offered to the same extent.

When comparing French cities with other European cities it is necessary to take into account that the “political city” in France is usually rather small (sometimes kind of CBD-format) compared to other cities. This is reasoned by the fact that organisational reforms which forced smaller municipalities to merge with others or being integrated as sub-urbs into bigger cities have been very limited. Such mergers have, however, been the case in most other countries. To ensure compatibility from a benchmarking perspective it is therefore necessary to use for French cities the urban region or agglomeration as represented by the formal cooperations of cities with their surrounding towns and villages. These urban regions are in most cases also identical with the service area of the urban public transport network.

When discussing data quality it should be also acknowledged that even within Norway the data used by SSB and obviously furnished by regional entities is not always identical with other data used and published by regional entities (see below in B.4.2.1).

The consultant has therefore seen it necessary to apply certain pragmatism. Where questions have immediately arisen from the data review the consultant has tried to solve these issues by asking for clarification and when required refining and adapting of input data.

B.2 Selection of parameters 2008 and 2016

The 2008 benchmarking included a number of more general benchmarking parameters as e.g. age structure, unemployment etc.

For the 2016, due to the budget and time limitations, the focus was purely on a few transport related parameters. These are:

- Vehicle-kms per inhabitant and year (“input”)
- Passengers/trips per inhabitant and year (“output”)
- Passengers/trips per vehicle-km (“efficiency”)

Furthermore networks have been reviewed in regard of the number of buses, drivers, lines and maximum frequencies.

B.3 Benchmarking on agglomeration level

“Benchmarking on agglomeration level” means looking at the Nord Jaeren region together, thus the four municipalities of Stavanger, Sandnes, Sola and Randaberg. This was the approach used also for the 2008 benchmarking.

B.3.1 Selection of cities 2008 and 2016

The 2008 benchmarking was comparing Nord Jaeren with 22 cities from 6 European countries including Bergen and Trondheim as Norwegian cases. The average population of the cities was 138000, the average population of the agglomeration 195000.

Bergen (No)	Saarbrücken (Ger)
Trondheim (No)	Würzburg (Ger)
Lund (Sw)	Aalborg (Dk)
Norrköping (Sw)	Aarhus (Dk)
Bremerhaven (Ger)	Groningen (NL)
Gera (Ger)	Angers (F)
Göttingen (Ger)	Caen (F)
Heilbronn (Ger)	Douai (F)
Ingolstadt (Ger)	Clermont-Ferrand (F)
Lübeck (Ger)	Mulhouse (F)
Regensburg (Ger)	Nancy (F)

With 9 cities Germany had the biggest share followed by France with 6 cities. As already mentioned, the mix of cities covered the full range of PT-modes including bus, busway, tramway on tyres, tramway, light rail and tram-train. Such mix was reasoned by and consistent with the Kombibane ambitions in Nord Jaeren at the time. The problem of data availability was less a problem in 2008 as the basic research for the majority of cases had been performed before within another study.

With regard to the changed focus nowadays and the need to work with a smaller selection of cases, the consultant has used the following cities for the 2016 update. The selection reflects also the need to concentrate on cases with easy data availability based on statistics in the public domain.

Bergen (No)	Angers (F)	Metz (Fr) *new*
Trondheim (No)	Caen (F)	
Bremerhaven (Ger)	Douai (F)	
Ingolstadt (Ger)	Nancy (F)	

It should be noted that Bergen and Angers have in the meantime implemented their first tramway line while Caen and Nancy are under way to replace their rubber-tyre tramways (Caen going for a real tramway, Nancy using a standard busway approach for their line 2). Metz has been added as a case with regard to the new busway system inaugurated in autumn 2013. A description of the cities is furnished in annex 1.

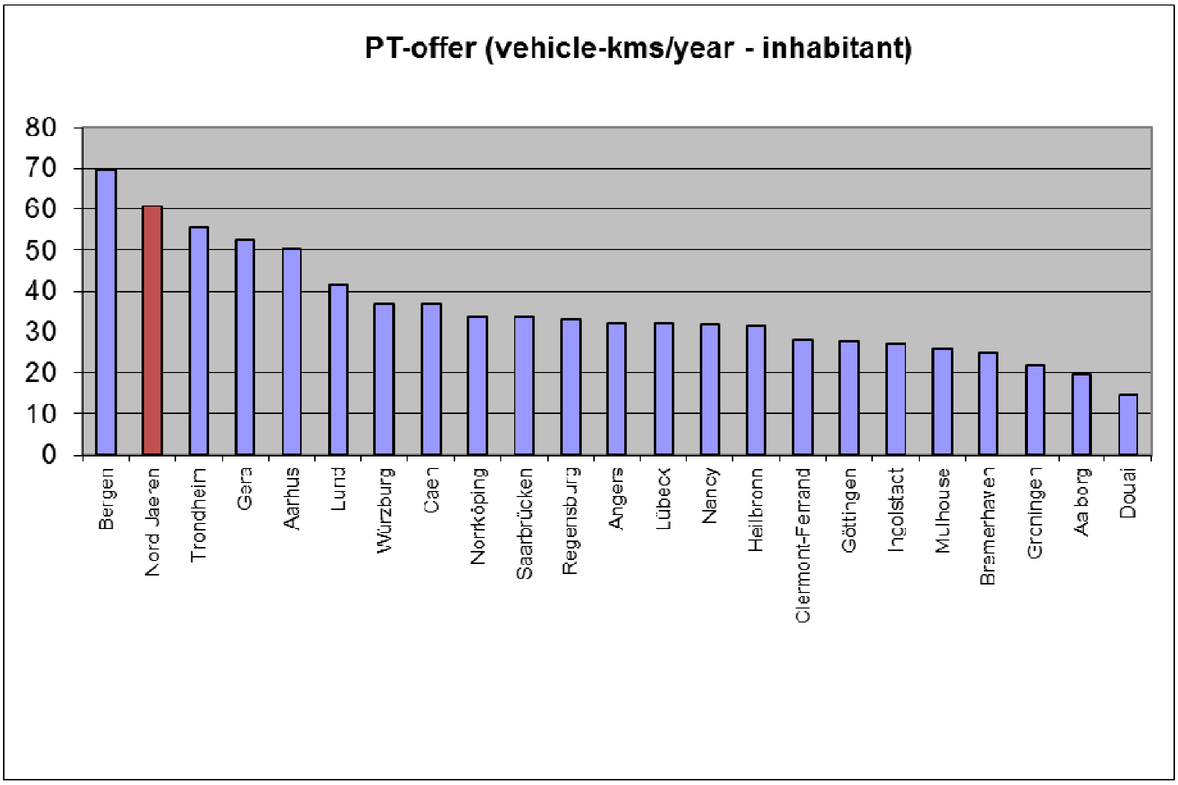
As mentioned above in chapter B.1, the statistical data used, does, like it was the case in 2008 too, not stem from the same year (SSB data in Norway of 2014, French data 2012 etc). However, as changes from one year to the next (or two) for the parameters discussed here are usually differing only slightly, this inconsistency does not endanger the benchmarking results.

B.3.2 Benchmarking results 2008 and 2016

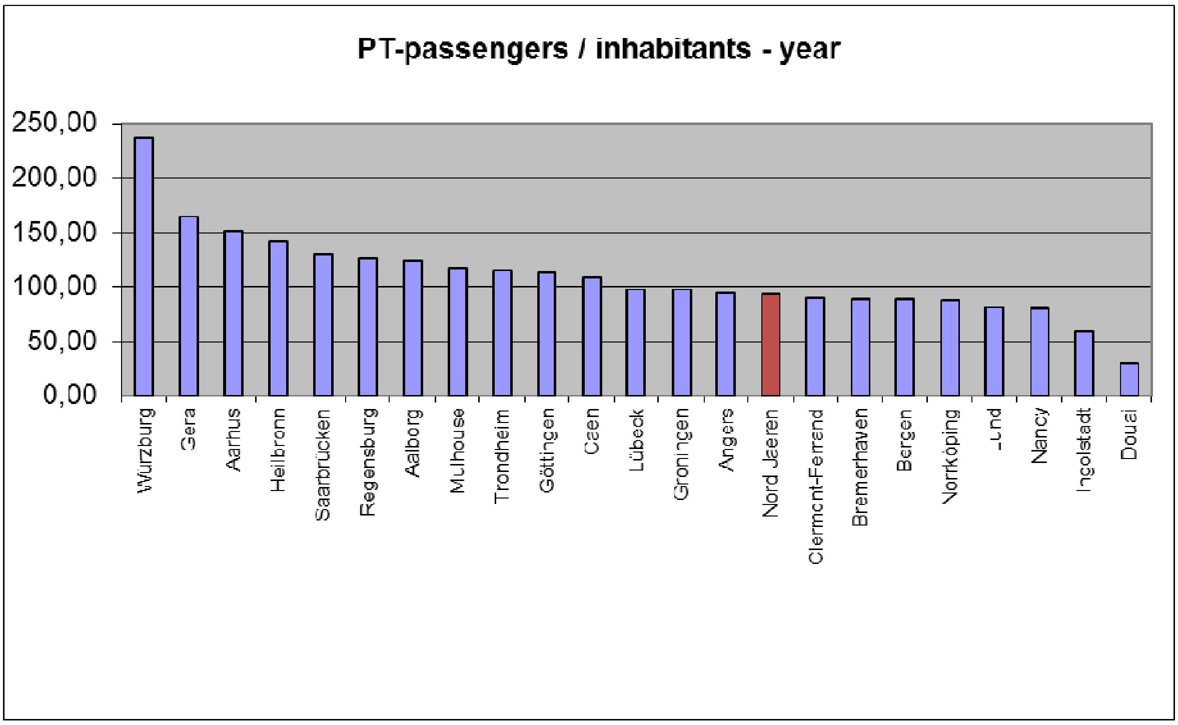
B.3.2.1 Review of 2008 benchmarking results

The most significant conclusion of the 2008 benchmarking was the high production of vehicle kilometres (“input”) by the three Norwegian agglomerations Nord Jaeren, Bergen and Trondheim which appeared about twice as high as for all the other European cities respectively city regions while at the same time the number of PT-passengers/trips (“output”) doesn’t show a similar result (see pictures B-1 to B-3 below).

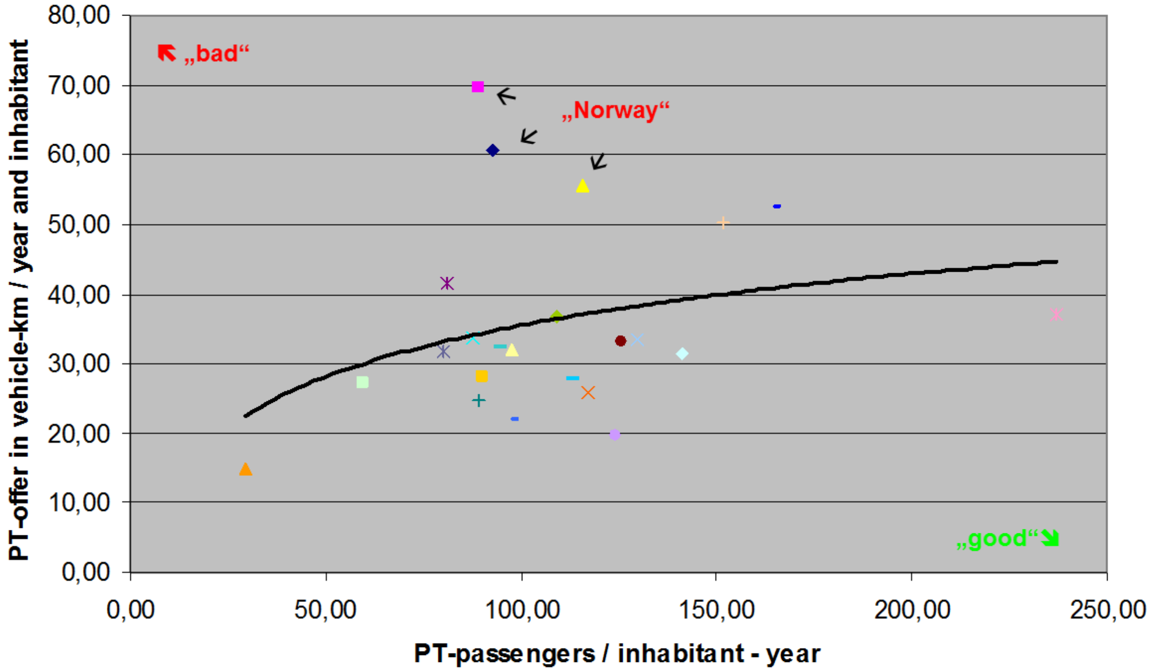
With a focus on medium-sized cities such production levels were explained mainly by rather different settlement structures and densities which require more bus lines to serve the widespread community. However, the concentration of PT-offers in the range of 20-40 vehicle-kms per inhabitant in other European countries is confirmed eg for France by the results of CERTU (see picture B-4) below. The results shown here highlight that the offer level is rather independent from the modes being used in particular cities and the size of cities.



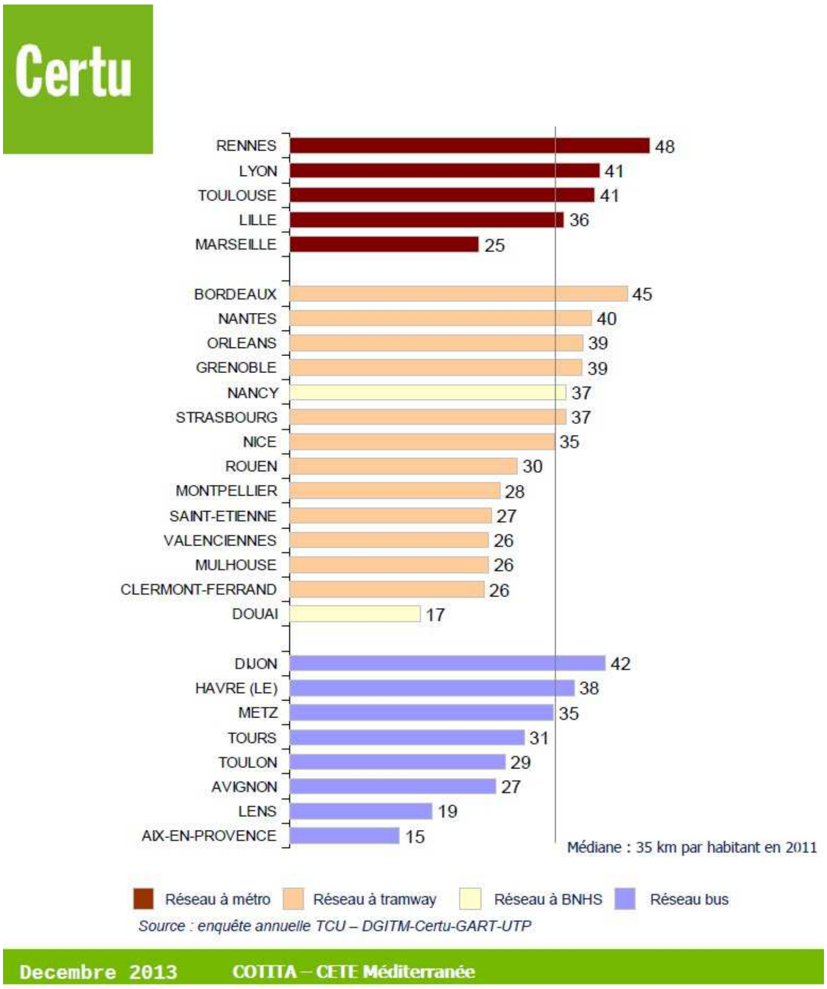
Picture B-1: PT-offer related to population 2008



Picture B-2: PT-passengers related to population 2008



Picture B-3: PT-offer vs PT-passengers 2008

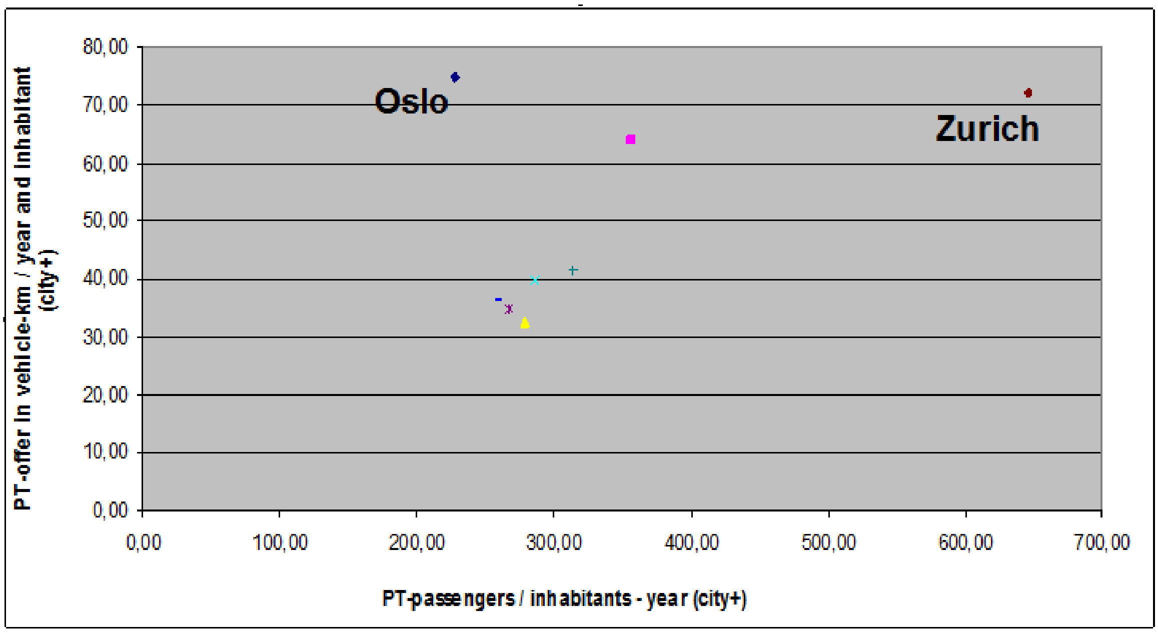


Picture B-4: PT-offer in French metro, tramway, busway and bus cities

Source: COTITA-CETE/DGITM-CERTU-GART-UTP

That the size of cities as such is not influencing the offer level (per inhabitant!) was also to be seen within another benchmarking study performed within the recent Oslo Navet KVU (see picture B-5). Here the comparison dealt with bigger cities/agglomerations comparable to Oslo (Gothenburg, Stuttgart, Frankfurt, Leipzig, Zurich, Lyon, Amsterdam, Manchester).

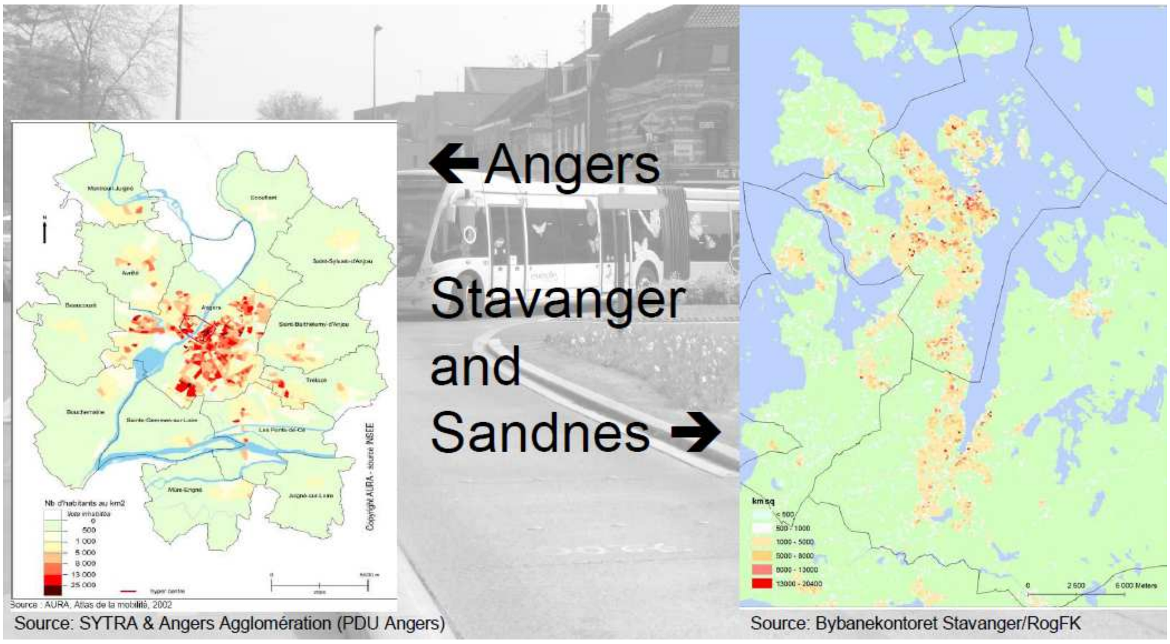
The astonishing result was to see Oslo in regard of “input” on the same (high) level as Zurich, while the “output” stays at about one third of Zurich! Also here most of the cities stay below 40 vehicle-kms per inhabitant. Not surprising, however, that the amount of trips per inhabitant in Oslo is about twice as high than seen in the medium sized cities before.



Picture B-5: PT-offer vs PT-passengers (agglomerations comparable to Oslo)

Density (and size of the urban area!) being an issue is nicely visible from the comparison of two maps (picture B-6; same scale!) from Angers and Nord Jaeren which make rather clear that the highest density in the Angers map is more or less non existing in Nord Jaeren. Still the average density of Nord Jaeren and the Angers agglomeration is rather identical (see annex 1).

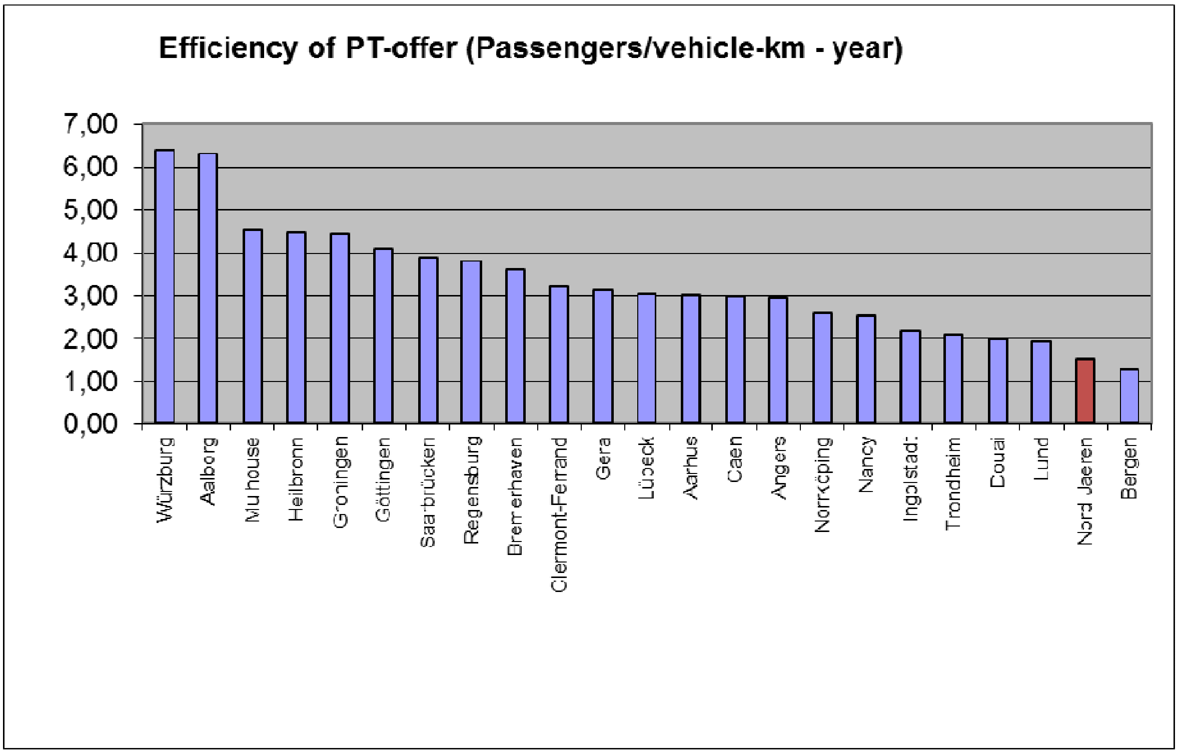
Density issues will also play a role for this size of cities but clearly, there must be more/other factors involved. Those were identified in the overall network organisation with all modes doing the same (“running to the city centre”) and competing with each other. Also visible was a certain reluctance to adapt operational patterns to the demand in differing areas of the network by either reducing frequencies in the outer parts or reducing train length for off peak times etc. While the latter features are more related to metro and rail services, network organisation and the inter-working of modes appears to be a common feature for all city sizes (see also chapter B.4.2).



Picture B-6: Density comparison Angers vs Nord Jaeren

Source: given in picture

The efficiency of PT-networks is usually measured also by the ratio of passengers/trips vs vehicle-kms (“input” vs “output”). For the 2008 benchmarking the cities in the comparison showed a range between about 1 and 6 with Bergen and Nord Jaeren being at the low end.

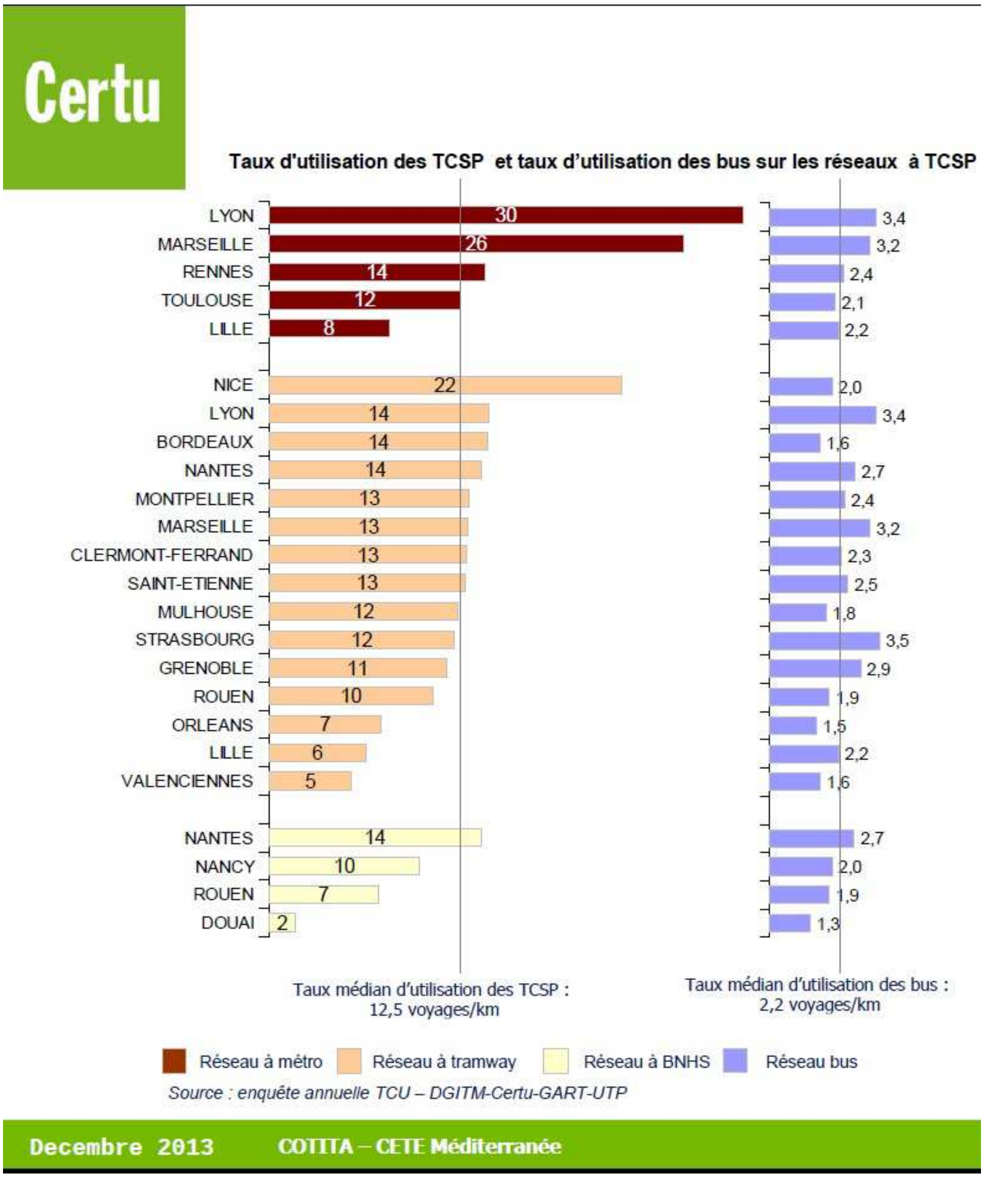


Picture B-7: Efficiency of PT-offer 2008

Looking here again at a CERTU-evaluation one can notice that there seem to be major differences between HQ-systems (metro, tramway, busway…) and standard bus systems.

The diagram in picture B-8 below shows in the left column the ratios for the HQ-parts of relevant networks and in the right column the ratios for the bus part of these networks.

If one uses Lyon as an example one notices a ratio of 30 for the metro part of the network, a ratio of 14 for the tramway part and a ratio of 3.4 for the bus part. The average ratio for the total network is given for 2012 with 7.6. Nancy and Mulhouse, which are visible in the 2008 benchmarking with 2.5 and 4.5 are given in the CERTU evaluation with ratios of 10 and 12 for the rubber tyre tramway respectively tramway and 2.0 / 1.8 for the bus part – the 2012 statistics gives average values of 2.7 and 3.5, thus principally confirming the 2008 numbers for these cities.



Picture B-8: Efficiency (trips per vehicle-km) of different modes in French networks

Source: COTITA-CETE/DGITM-CERTU-GART-UTP

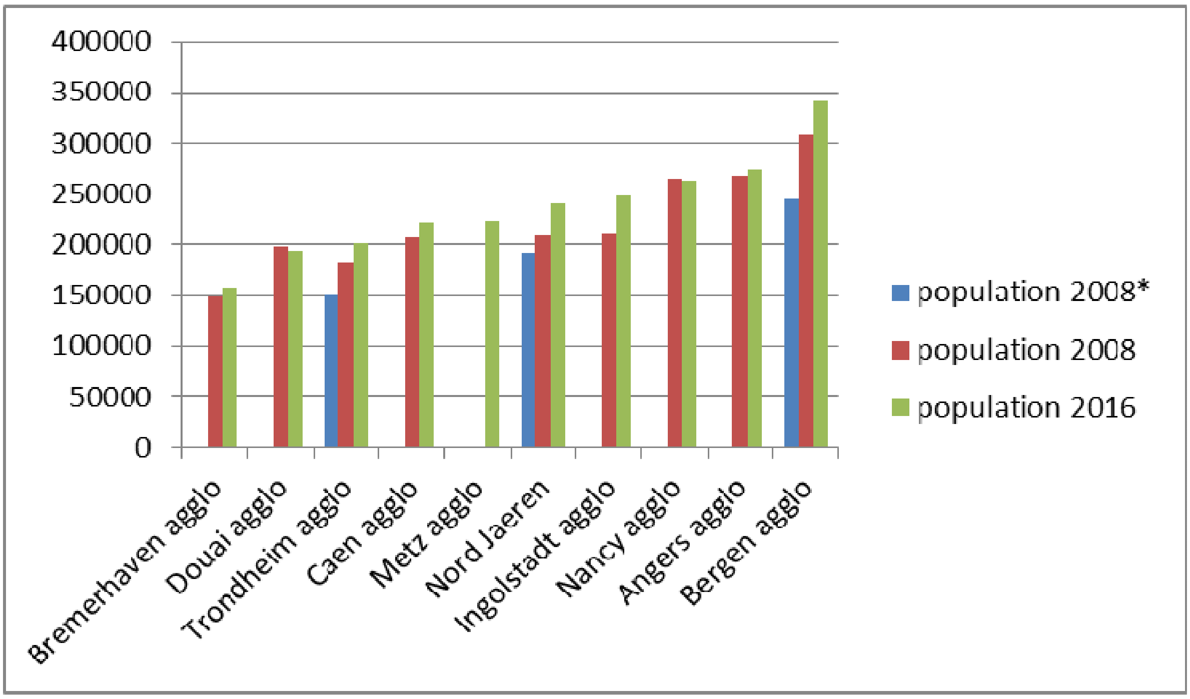
The CERTU diagram also indicates that standard bus systems will likely show a range from 1 to 3.5, which correlates nicely with the results of the 2008 benchmarking (see picture B-7 above) where those cities which rank better than 4.0 all own HQ features (tramway, light rail, metro bus or similar).

B.3.2.2 Benchmarking results 2016 compared with 2008

The following four diagrams (pictures B-9 – B-12) highlight the changes between 2008 and 2016 benchmarking results for population, vehicle-kms ("input"), passengers/trips ("output") and passengers/trips per vehicle-km ("efficiency").

It should be understood, as mentioned already in chapter B.1, that 2008 and 2016 are being used here as the years in which the benchmarking has been performed. The actual statistical data used was from 2005-2007 (for 2008) respectively 2012-2014 (for 2016). This means for instance that the numbers for Metz (2012) represent still the time before the opening of the busway.

Regarding the 2008 benchmarking it needs to be mentioned that for the three Norwegian agglomerations local data has been used and not the SSB statistics! The differences are rather small for Nord Jaeren, as the area considered was the same (Stavanger, Sandnes, Sola, Randaberg) while for Bergen and Trondheim smaller agglomeration sizes as according to the SSB definition (see annex 1) have been used. The biggest impact is to be seen for Bergen. To allow better comparisons the 2008 benchmarking has been re-calculated according to the SBB-approach and both results are shown in the diagrams.

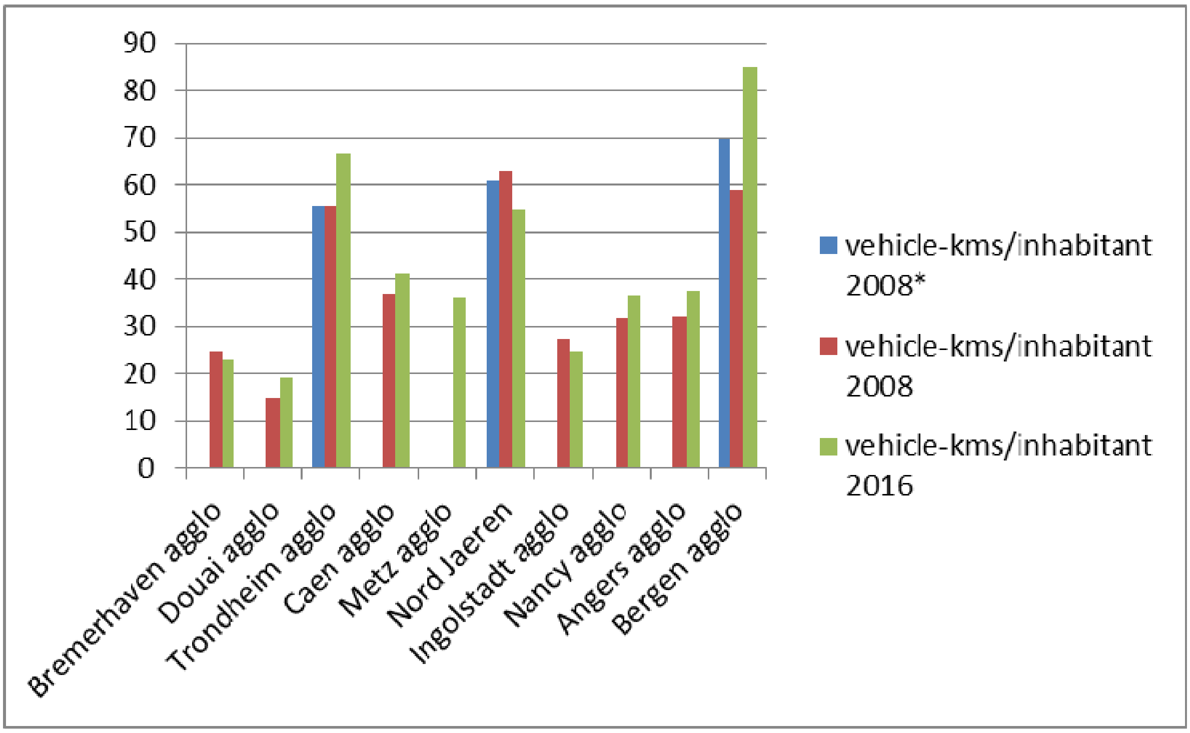


Picture B-9: Population of benchmarking cities 2008 and 2016

The following comments relate first of all to a comparison of the SSB derived data. The differences resulting from the 2008 data sources are only commented when necessary.

In regard of population it is noticable that all three Norwegian agglomerations have seen considerable increases. Only the German city of Ingolstadt shows similar or even higher increases. Some of the cities show stagnating or decreasing population.

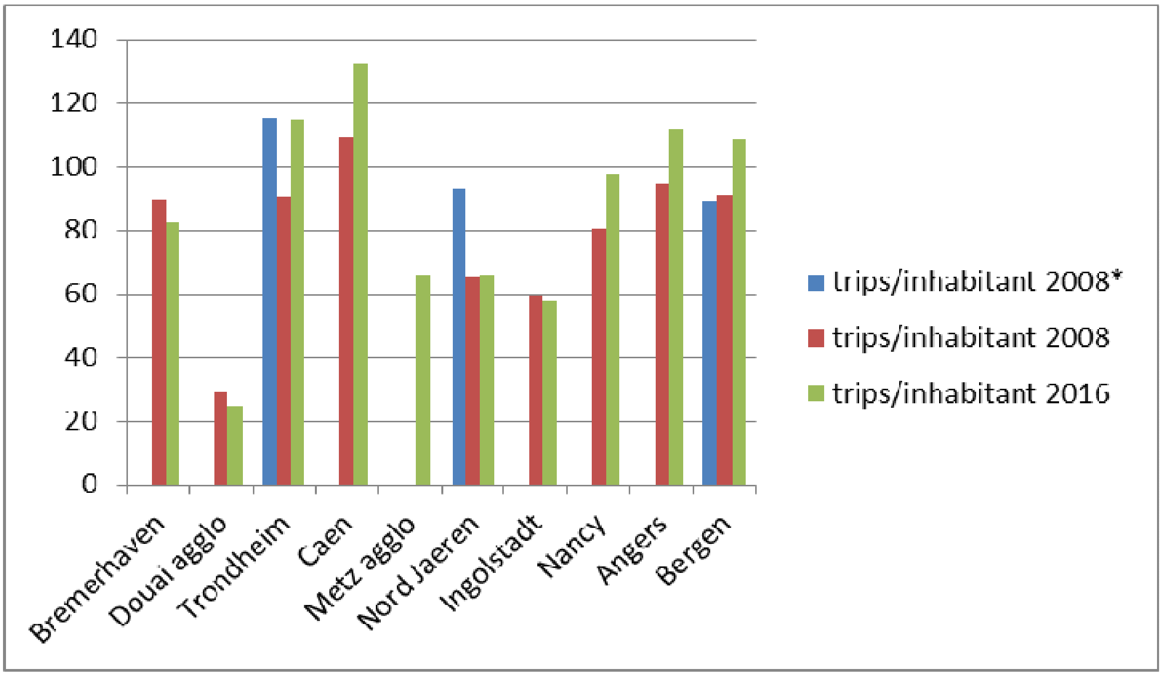
In regard of vehicle-kms it is astonishing to see rather extreme increases in Bergen which are reasoned by massive additional (and also parallel!) bus services taken into service together with the opening of light rail services in 2010. There is also a considerable increase in Trondheim while Nord Jaeren shows a decrease – certainly reasoned by a strong population increase. Most other cities show small increases but the discrepancy between Norwegian cities and the others regarding their input levels remains unchanged or it has become even stronger.



Picture B-10: PT-offer vs population of benchmarking cities 2008 and 2016

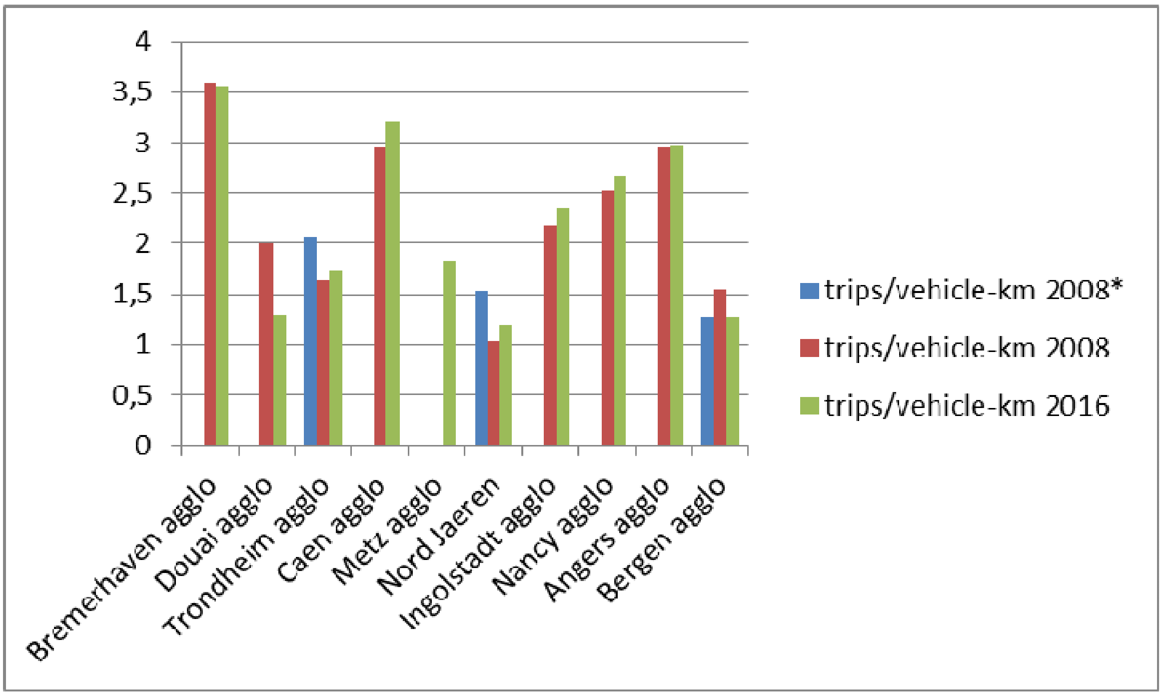
For passengers/trips it is visible that both the Bergen and Trondheim numbers have increased, thus being consistent with the increased input, while Nord Jaeren has stayed at the same level. Here the difference between the local and SSB derived data is significant and not just connected to differing population data. Locally furnished patronage data of 2008 appears much higher than given in SSB statistics but it is neither possible nor necessary to clarify these differences today. Considerable increases can be noted for all French cities except Douai. In Angers this should be reasoned by the opening of tramway operation in 2011, for Caen and Nancy it is not directly possible to relate the increases to major network changes. Douai has certainly suffered from the huge delays until the busway became finally operational in 2010 and even after this date the operation had to deal with problems which finally have lead to the replacement of rolling stock in 2014.

Ingolstadt appears without major changes, Bremerhaven shows a decrease.



Picture B-11: PT-trips vs population of benchmarking cities 2008 and 2016

Combining the vehicle-kms and passenger/trips into the efficiency ratio highlights Bergen as decreasing but Nord Jaeren and Trondheim as increasing. This means that the increased input for Bergen has not to the same level shown increased patronage. Ingolstadt, Angers, Caen and Nancy with increases, Douai decreasing.

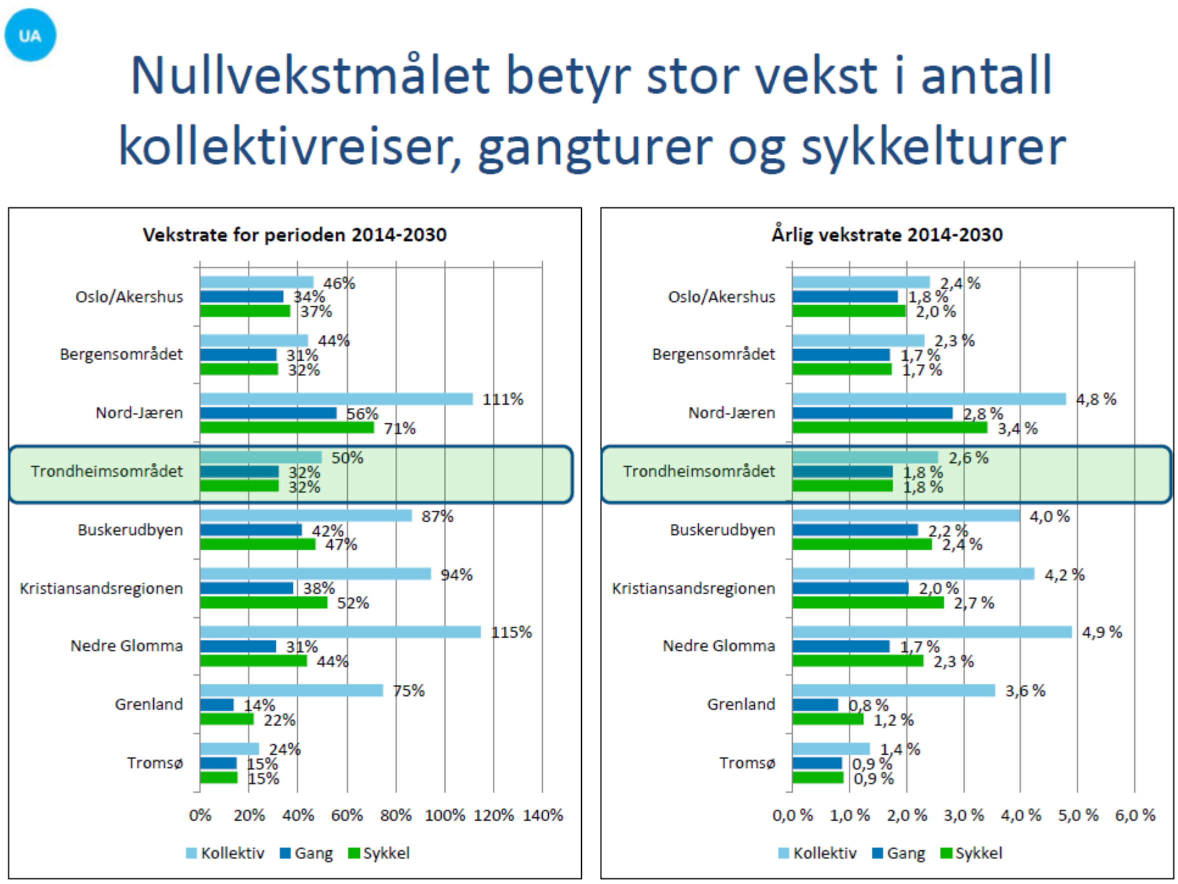


Picture B-12: PT-trips per vehicle-km of benchmarking cities 2008 and 2016

Without trying to explain the Nord Jaeren trend in more detail it can be assumed, however, that the PT-strategies having made operational in recent years -admittedly in a region with structural conditions which make PT-success not an easy job- have not resulted in a positive result so far. The economical crisis since 2014 is certainly an additional but very recent influence factor; however, it does not suit to explain the downward trend as such.

It should be hoped that the busway scheme under development now is being used not just as an additional mode respectively “infrastructure” but also as a catalysator for a new PT-thinking in the region, thus a network reshape as it accompanies almost any new HQPT-scheme in other countries respectively using strategies applied for PT-networks in general (see chapter C). Such reorganisation should in the view of the consultant aim also for a better efficiency of the high expenditure of vehicle-kms. The visible bad performance of the Douai scheme which has created rather nice infrastructure but appears not to be successful in patronage terms should be seen as a warning sign that there is no “success automatism” included to big infrastructure projects.

A rather difficult position of Nord Jaeren has been indicated recently also in regard of the zero growth target by a comparison of Norwegian agglos (see picture B-13 below).



Picture B-13: Required PT, cycling and walking increase in view of zero growth target
Source: Urbanet Analyse

It is shown there that Nord Jaeren requires 111% increase in PT, 71% in cycling and 56% in walking. This appears as a very ambitious target compared to what other agglomerations need to achieve and especially when taking into account the downward trend which needs to be broken. Looking at an obviously rather low acceptance of the current PT-offer, the consultant is in doubt whether such “quantum jump” increases can be efficiently achieved just by increasing already high offer levels further?

B.4 Benchmarking on city level

“Benchmarking on city level” means looking just at the city of Sandnes in comparison with bus cities of similar size.

B.4.1 Selection of cities

The selection of cities consists of 15 new cases with 3 cases from Norway, 7 from Germany, 2 from Switzerland and France respectively 1 from Austria. All are representing bus systems. The average size of the cities/agglos is 80000 inhabitants.

Grenland (No)	Tübingen (Ger)
Kristiansand (No)	Gütersloh (Ger)
Tönsberg (No)	Schaffhausen (Sui)
Lemgo (Ger)	Winterthur (Sui)
Bruchsal (Ger)	Dornbirn (Au)
Trier (Ger)	Colmar agglo (F)
Hürth (Ger)	Boulogne agglo (F)
Friedrichshafen (Ger)	

A description of the cities is furnished in annex 2.

It should be acknowledged that the consultant had originally proposed to include also Danish (Kolding, Vejle) , Swedish (Uddevalla) and Belgian (Namur, Kortrijk) cities but data availability forced to replace these cities by others.

While some of the cities listed above are rather well known in the PT-world for innovative approaches or qualities (eg Lemgo, Dornbirn, Schaffhausen), others have been chosen with the intention not only to use “five star cities” but also very average cities to allow a fair comparison with Sandnes.

The described approach and the selection of cities has been discussed with and approved by the client.

B.4.2 Benchmarking results 2016

B.4.2.1 Sandnes results in Nord Jaeren context

It needs to be understood that data availability for the city region of Sandnes presented some challenge as described below.

For the vehicle-kms spent within Sandnes city limits it was Sandnes Kommune who was calculating this parameter based on bus line lengths operated within the city limits, relevant timetables and also taking into account service reductions in the summer period. Calculations were calibrated by comparison with KOLUMBUS data for specific lines operating completely within Sandnes city limits.

See annex 3 for a detailed description.

The result of the calculations was a total of 2.8 Mio vehicle kms spent within Sandnes compared with 13.1 Mio spent in whole Nord Jaeren. This means a share of 21.4%.

For the passengers/trips the following table (see picture B-14) provided information how these are distributed between different areas of Nord Jaeren.

Kommune	2012	2013	2014	2015
Stavanger	11.769.243	11.737.721	11.651.943	11.616.987
Sandnes	3.650.310	3.953.786	4.053.573	4.043.438
Sola	811.709	845.612	892.576	804.881
SUM avtalekommunene	**16.231.262**	**16.537.293**	**16.598.092**	**16.465.306**
Omkringliggende kommuner	901.177	957.877	1.004.143	995.511
SUM	**17.132.439**	**17.494.996**	**17.602.235**	**17.460.817**

Picture B-14: PT-trips in Nord Jaeren 2012-15

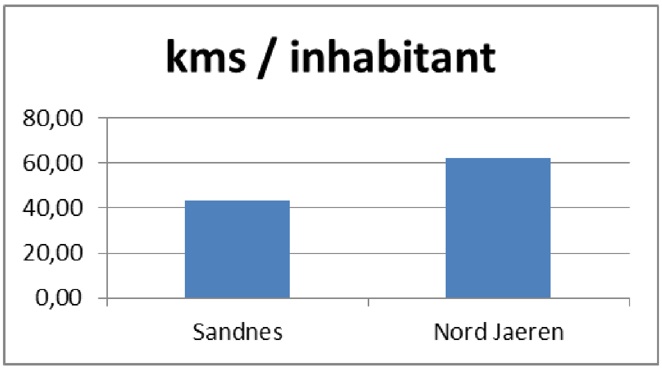
Source: KOLUMBUS/Rogaland Fylkeskommune

The share of Sandnes compared to Stavanger, Sandnes and Sola varies between 22.4% in 2012, 23.9% (2013), 24.4% (2014) and 24.7% (2015). When including also the surrounding communes Randaberg, Gjesdal and Rennesøy the percentage varies between 21.3% and 23.2%.

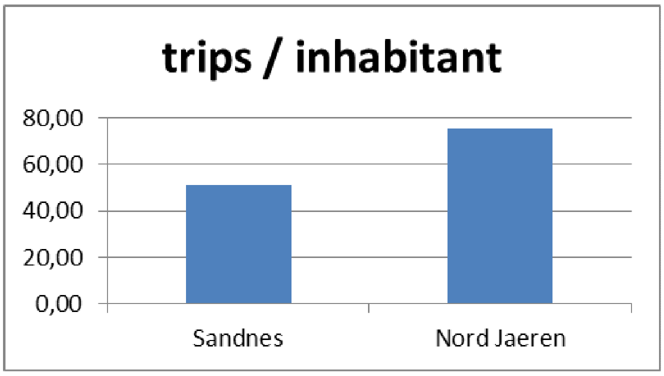
However, the numbers used here are not identical with the information published in SSB statistics where 15.87 Mio passengers/trips are given for 2014. The definition for Nord Jaeren in SSB statistics includes Stavanger, Sandnes, Sola and Randaberg. The exact reasons for the different numbers can’t be verified within this study. To allow comparisons with other Norwegian cities/agglomerations (also to allow comparisons 2008 <> 2016; see chapter B.2) the consultant sticks to using the SSB statistics even if this gives a slightly lower patronage. To identify the Sandnes share of the SSB-total for 2014 a percentage of 23.5% is used. This can be seen as the average between 23.0% (related to Stavanger, Sandnes, Sola, Randaberg, Gjesdal and Rennesøy) and 24.4% (related to Stavanger, Sandnes and Sola), assuming that Randaberg may be responsible for about 0.5% of the difference.

This percentage results in a number of 3.729 Mio passengers/trips for Sandnes in 2014 which is used for benchmarking purposes in this study.

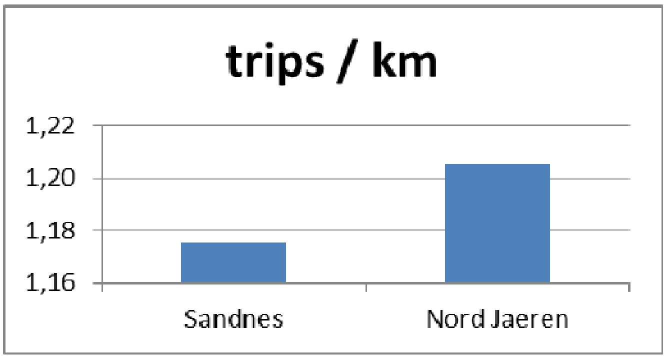
These assumptions both for the production (vehicle kms / “input”) and patronage (passengers/trips; “output”) result in the following comparison of Sandnes and the whole of Nord Jaeren (SSB definition):



Picture B-15a: Vehicle-kms Sandnes vs Nord Jaeren 2016



Picture B-15b: Trips Sandnes vs Nord Jaeren 2016



Picture B-15c: Trips per vehicle-km Sandnes vs Nord Jaeren 2016

Sandnes shows a considerably lower input in vehicle-kms but also a considerably lower output in passengers/trips compared to Nord Jaeren as a whole. In effectivity terms there is no major difference to be acknowledged (scale of diagram is a bit misleading).

However, the information provided by Rogaland Fylkeskommune indicates interesting trend differences between the different communes:

Kommune	2014-2015	2012-2015
Stavanger	-0,3%	-1,29%
Sandnes	-0,3%	10,77%
Sola	-9,8%	-9,82%
SUM avtalekommunene	**-0,8%**	**1,44%**
Omkringliggende kommuner	-0,9%	10,47%
SUM	**-0,9%**	**1,92%**

Picture B-16: Patronage changes in different Nord Jaeren communes 2012-15
Source: KOLUMBUS/Rogaland Fylkeskommune

The statistics confirm a considerable increase of patronage for Sandnes in the period 2012-2015 while Stavanger and Sola results have been negative. Sandnes appears having been responsible "alone" for an average increase in Nord Jaeren during this period. It is not possible for the consultant to explain these differing trends within this study. One can assume, however, that Sandnes started from a lower profile and has now "returned to normal" while other municipalities have not been able to keep their originally higher profile.

KOLUMBUS has also furnished Sandnes municipality data in regard of boardings at all stops within Sandnes city limits for the years 2013 and 2014. The total amount of all boardings for 2014 is 3.45 Mio which means in principle that 3.45 Mio trips have started in Sandnes with either destinations in or outside Sandnes. This number does represent only a part of the total number of trips as an unknown amount of trips may have entered into Sandnes after having boarded at stops outside Sandnes. Picture B-14 gives a number of 4.05 Mio trips for Sandnes in total. This seems to indicate that about 0.6 Mio trips enter Sandnes from the outside. Assuming that about the same number of trips needs to be accounted for having started in Sandnes for destinations outside (O-D trips = D-O trips) one sees about 1.2 Mio trips related to traffic beyond city limits and 2.85 Mio trips related to internal traffic within Sandnes? This appears to be a surprisingly high percentage of internal traffic (70%!?).

The issue is not just relevant from a scientific perspective – the level and importance of internal respectively external traffic is usually taken into account for the strategic orientation of networks: what should they concentrate on?

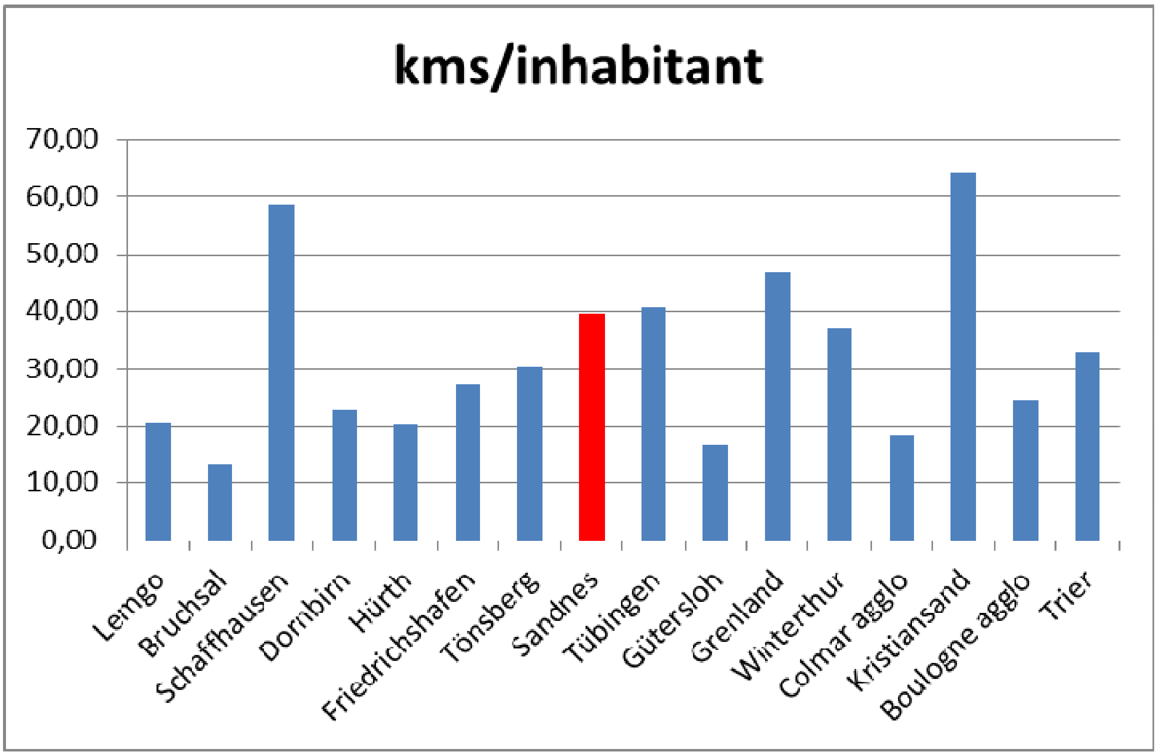
If internal traffic would be that high it would clearly speak for a much more urban network in Sandnes. However, are those numbers really representing the current situation? One reason for the results, but possibly not the only one, could be that interchanges to / from the railway at Sandnes S / Ruten create confusion here. Due to the separate treatment by both KOLUMBUS and NSB, combined trips will likely not be accounted as such! From a KOLUMBUS (data) perspective, trips just terminate / start at Ruten and appear thus as internal traffic even if the passengers in reality leave Sandnes by train or arrive there from outside of Sandnes. This means there is also relevance with regard to the interchange issue and identifying the real numbers will help a lot for dimensioning and designing network and facilities.

The discussion highlights also the need to develop a proper understanding of traffic flows (in totality - not just those who are using public transport today) and the role(s) of interchanges.

B.4.2.2 Sandnes compared with others

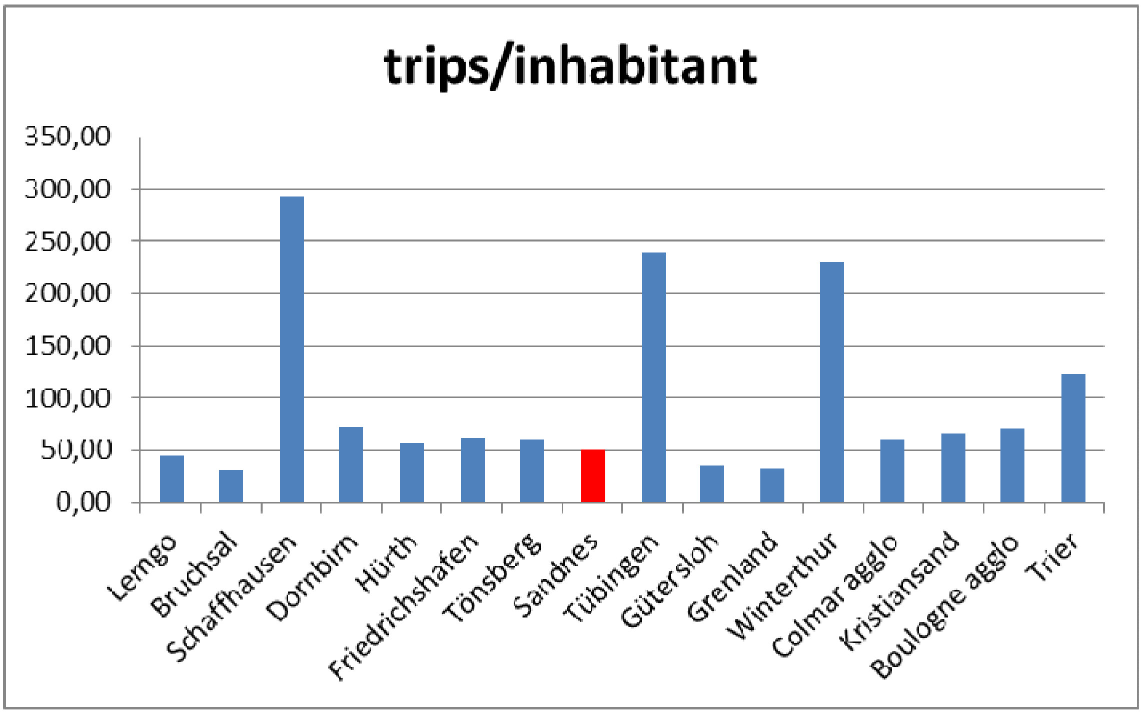
The following chapter with diagrams B-17a to B-17c is now comparing Sandnes with the benchmarking cities selected (see B.4.1). Cities have been sorted by size for these diagrams.

It is visible for the input side (vehicle-kms per inhabitant) that Sandnes appears -even with a lower offer level than the Nord Jaeren average- as one of those cities with a higher input level – only the two Norwegian cities/agglomerations Kristiansand and Grenland respectively Swiss Schaffhausen are showing a higher offer per inhabitant, Tönsberg and the Swiss respectively German cities Winterthur and Tübingen are in the same range.



Picture B-17a: Vehicle-kms vs population Sandnes vs others 2016

The patronage level (see picture B-17b) appears to be in a low, respectively midfield position. As visible there are only 4 cities which show a ratio beyond the 100 trips/inhabitant threshold: the two Swiss cities Schaffhausen and Winterthur and the two German cities of Tübingen and Trier.



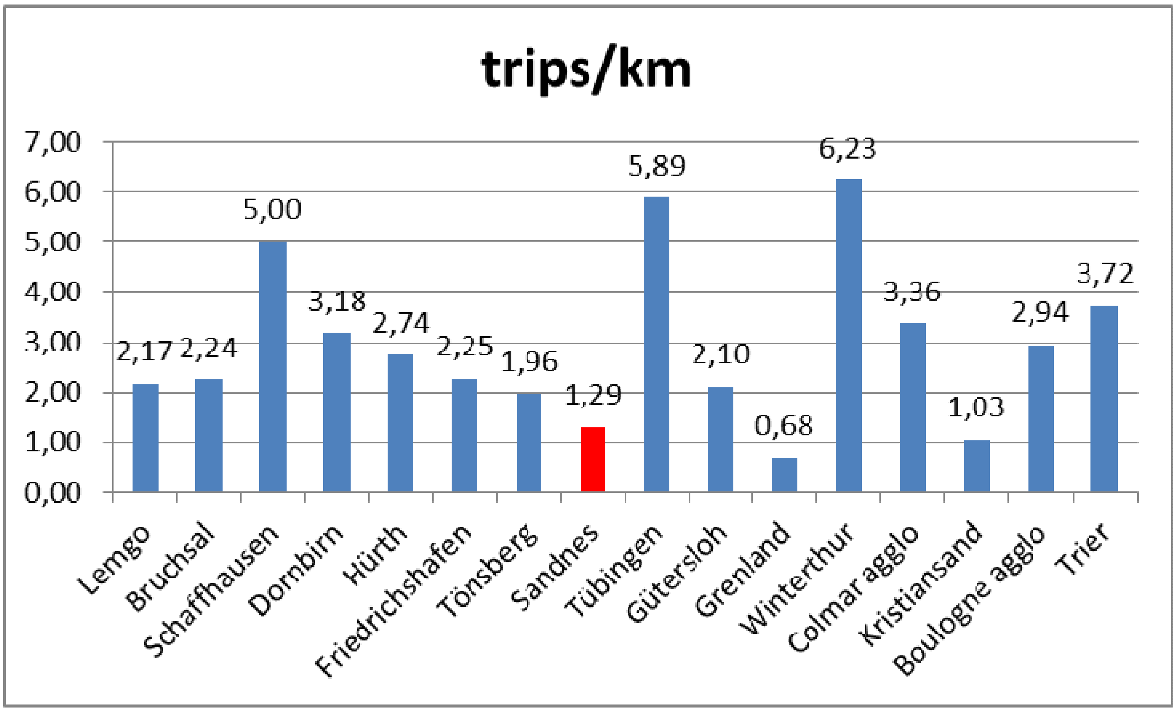
Picture B-17b: Trips vs population Sandnes vs others 2016

It should be understood that some of these cities represent so-called “Stadtbus” schemes which should be seen as additional urban offers on top of other PT available to citizens (regional bus services, light rail etc; see descriptions in annex 2). If some of those cases show rather low levels (e.g. Bruchsal) results should be seen in such context.

The comparison with the other Norwegian cities shows Grenland with a lower patronage per inhabitant, Tönsberg and Kristiansand with a slightly higher one.

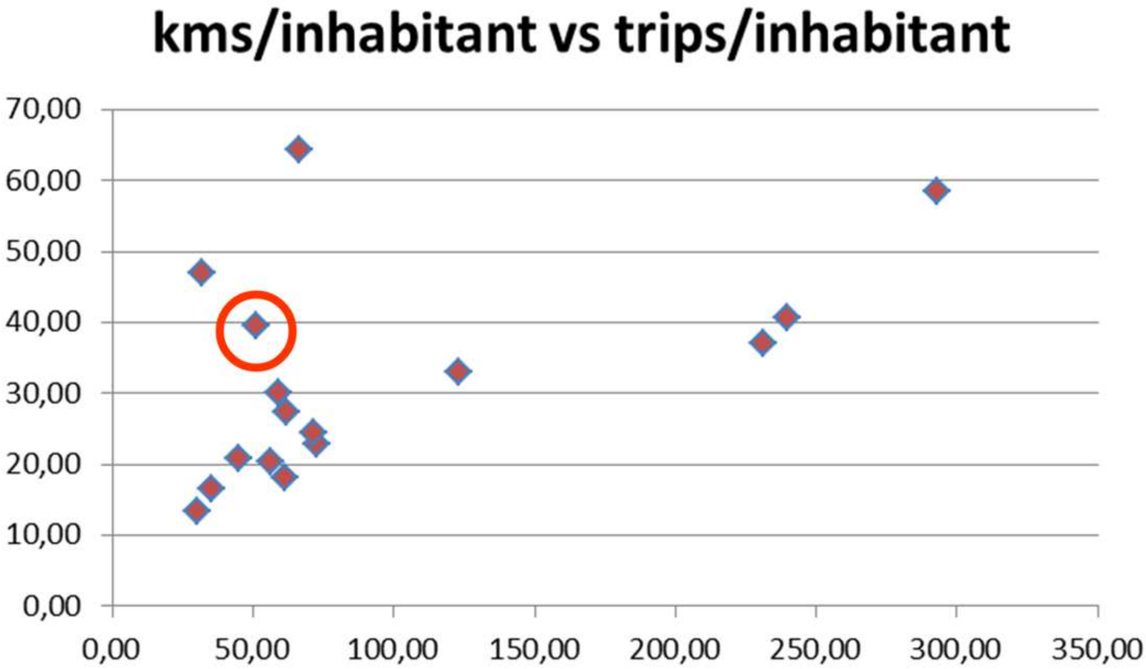
When looking at the efficiency ratio (trips/km, see picture B-17c below), the message is a bit different. The three Norwegian cities Sandnes, Grenland and Kristiansand are showing the lowest ratios – only Tönsberg appears better here, obviously a result of the lowest “input” level of the Norwegian cases (see picture B-17a).

The diagram confirms again what has been mentioned in chapter B.3.2.1 – the range for ordinary bus systems is in a range of 1 to 3.5 regarding this parameter. Only the two Swiss and two German cities mentioned before (Schaffhausen, Winterthur – Tübingen, Trier) are above the 3.5 threshold. The best practice chapter will try to take a deeper look into these schemes to identify any success reasons (see chapter C below).



Picture B-17c: Trips vs vehicle-kms Sandnes vs others 2016

The following diagram (picture B-17d) follows the principle in pictures B-3 and B-5 and compares input and output in another format – "good" is bottom right, "bad" is top left.



Picture B-17d: Vehicle-kms and trips vs population Sandnes vs others 2016

The Sandnes position is visualized by the red ring. The three neighbouring dots in the left upper corner are the three other Norwegian cities. The diagram confirms more or less exactly what has been indicated by the 2008 benchmarking for medium-sized cities and within the 2014 benchmarking (KVU Oslo Navet) on "big city/agglo" level – comparing with the latter one (see picture B-5), one could say that Kristiansand (left top) and Schaffhausen (right top) take the roles of Oslo and Zurich.

However, we had seen that Zurich with the same input as Oslo “produces” three times more trips – here Schaffhausen is even increasing the gap, having more than four times as many passengers per inhabitant!

Sandnes and Tönsberg, with their rather low input levels, are at least nearer to an imaginary trend line. There are, however, also for this input level, cities with much higher patronage per inhabitant (Tübingen, Winterthur) and many cities which produce similar output with even lower input.

Looking at an overall positive trend (patronage increase, see B.4.2.1) in Sandnes there seem to be at least positive general conditions for further improvements.

C Best practice considerations

The following chapter is using some of the best practice cities as sources for reporting approaches being used elsewhere in bus networks respectively more general in PT-networks. Beyond lessons to be learnt from cities represented in this report, the consultant is also furnishing other information based on his widespread experience.

Basically the best practice information can be grouped in four chapters looking at:

- Network and stop configuration
- Role and layout of interchanges
- Scope for central bus stations
- Timetable issues

Without going into any detail here it should be understood that an overarching principle that public transport is moving towards is that of universal accessibility within a mode and in integrating modes. This can be a challenging issue for traditional bus services, but is one capable of solution at least within high quality modes.

C.1 Network and stop configuration

The examples presented hereafter are twofold – on one side more general about PT- network configuration and going beyond pure bus systems, on the other specific examples of bus networks.

C.1.1 General network issues

For the discussion of general network issues it should be understood that principally there are no differences between network philosophies used for a new tramway or those for a new busway: one could speak of common philosophies for HQPT-networks.

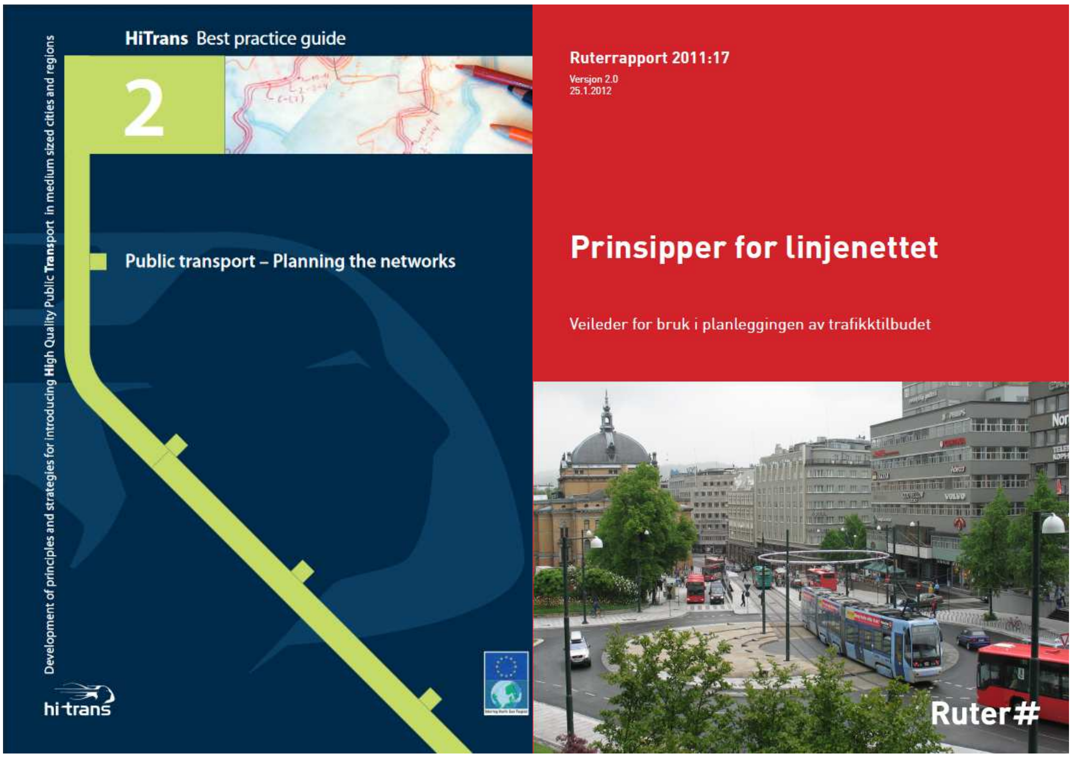
The INTERREG North Sea-project HITRANS (2003-2005), which saw Rogaland Fylkeskommune as the lead partner and Oslo Sporveier and Jernbaneverket as other Norwegian partners, has collected and presented best practice for a variety of PT-issues.

Strand 2 dealt especially with networks and has become kind of a standard applied in various places. RUTER presented in 2011 “principles for PT-networks” which were based on the HITRANS-report (see picture C-1 below).

Picture C-2a to 2d highlight some of the basic principles presented in the Ruter report.

Those could be summarised under the heading “less is more”, meaning less lines with low frequencies, less complexe networks and less meandering routes to be replaced by few strong lines with high frequencies, good interchanges and straight alignments.

Picture C-2e presents another highly important and often used principle, both before HITRANS and without flagging it as HITRANS-principle, which is to combine different lines frequency-wise in joint corridors.

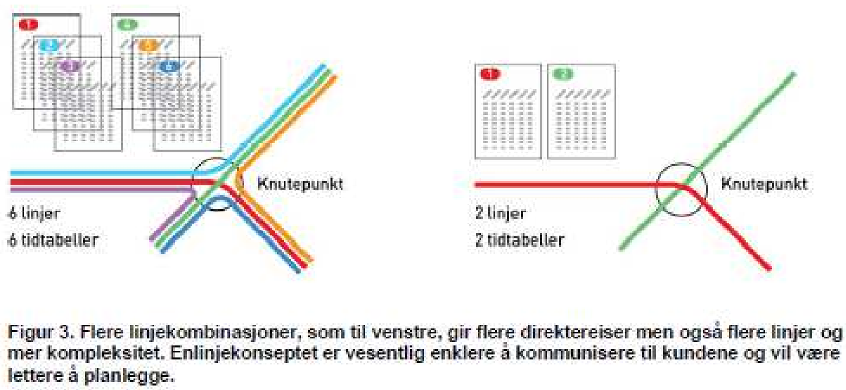


Picture C-1: Hitrans and Ruter reports on network principles

Source: HITRANS / Ruter

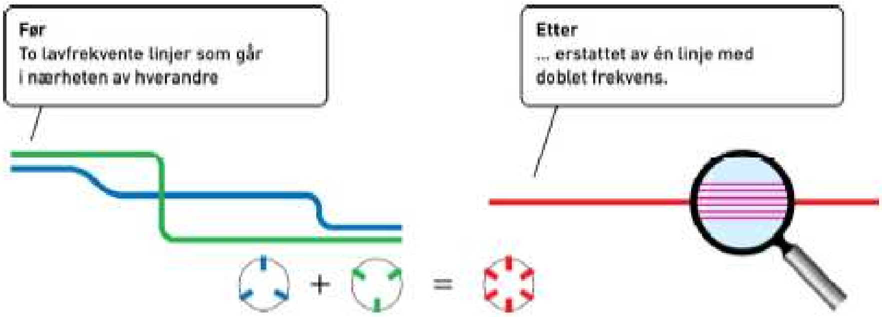
Picture C-2a: Excerpt from Ruter network principles

Source: Ruter



Picture C-2b: Excerpt from Ruter network principles

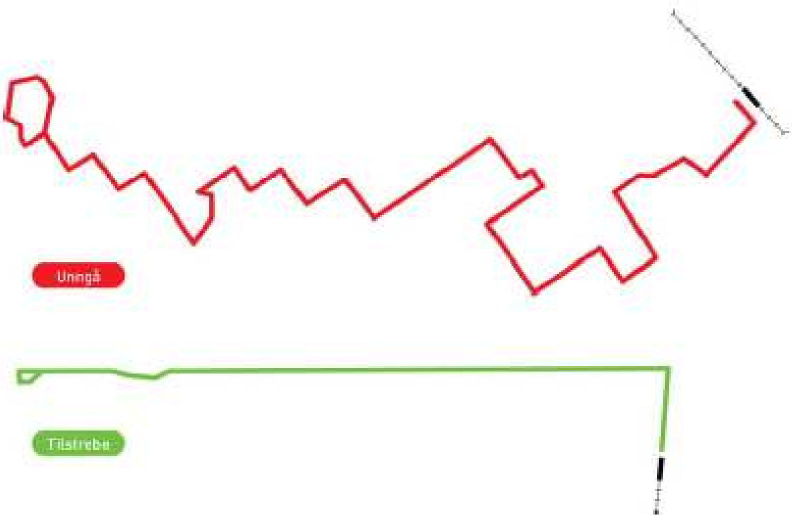
Source: Ruter



Figur 4. Samling av linjer i samme korridor kan gi høy frekvens med samme ressursbruk.

Picture C-2c: Excerpt from Ruter network principles

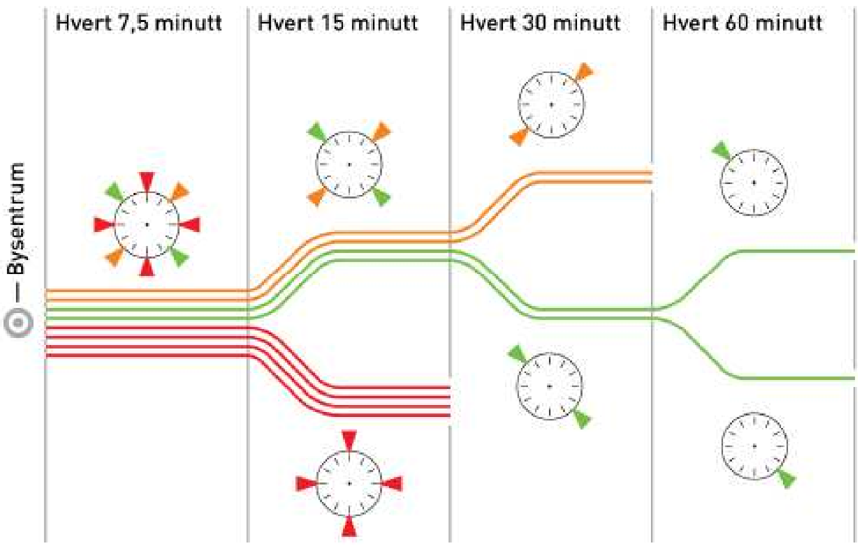
Source: Ruter



Figur 7. Det vil være en fordel å ha en så direkte linjeføring som mulig. Dette gir kortere kjørestrekning og dermed både raskere fremføring for kundene og reduserte driftskostnader.

Picture C-2d: Excerpt from Ruter network principles

Source: Ruter

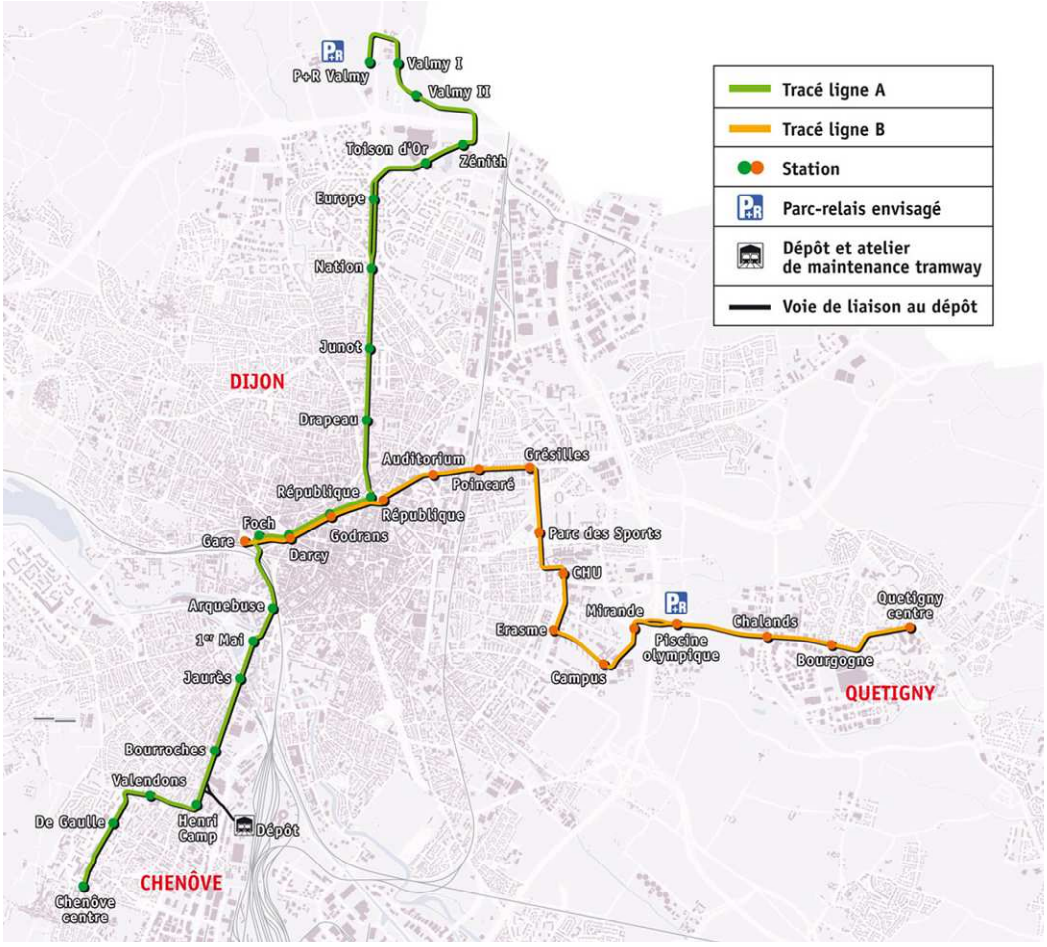


Figur 10. Koordinering av flere linjer vil gi lav ventetid for dem som skal til holdeplasser på fellesstrekningen nær sentrum/knutepunkt. Dette gjør det også mulig å tilpasse frekvensen til kundegrunnlaget.

Picture C-2e: Excerpt from Ruter network principles

Source: Ruter

However, principles are principles and should also not be used in an over-dogmatic way. There exist also different approaches which are reasoned. One of such is applied strongly in France and needs to be tabled and compared here. Picture C-3 highlights the Dijon tramway network and both lines seem not really to fulfil HITRANS-principles when it comes to “straight routes”.

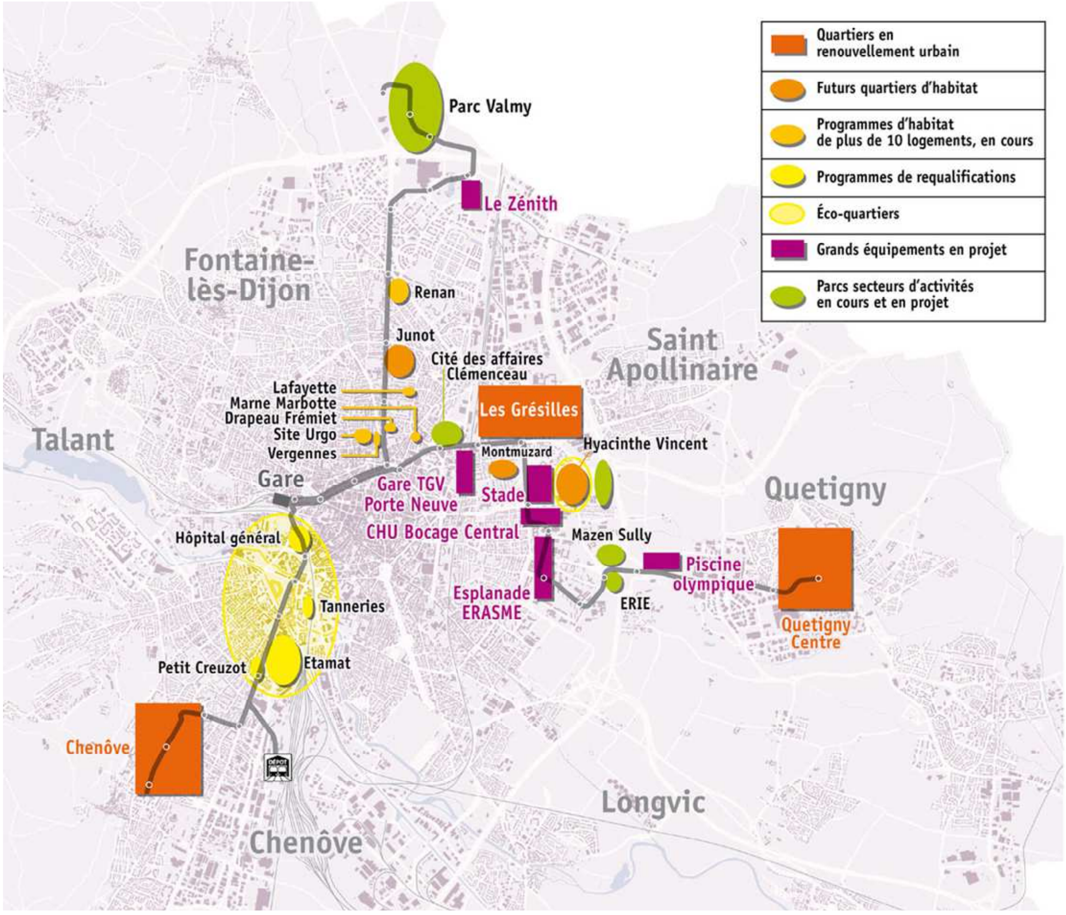


Picture C-3a: Dijon tramway network

Source: : http://www.letram-dijon.fr

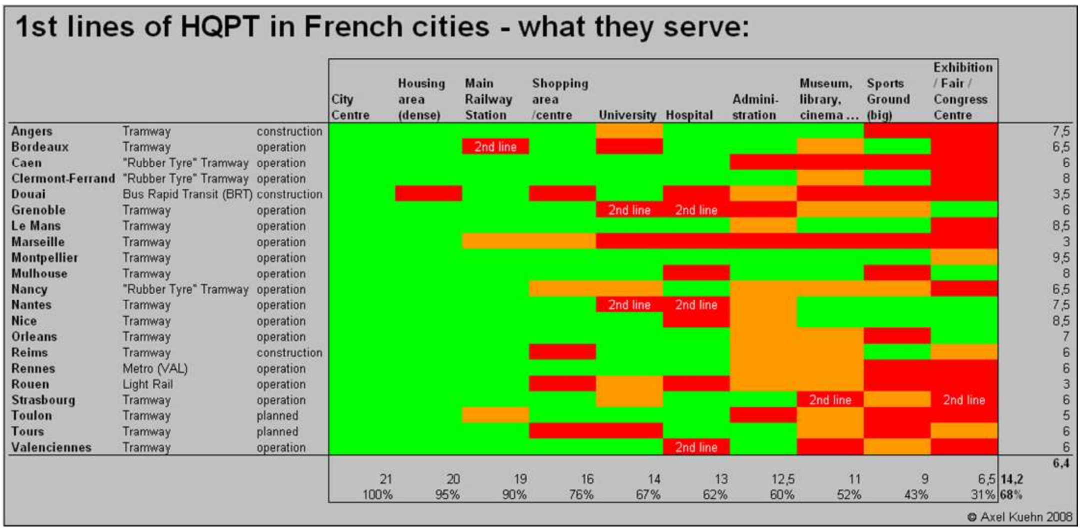
The reasons for the obvious “deviations” are clearly visible when looking at the land-use background respectively programme (see picture C-3b). The Dijon approach is fully in accordance with strategic policies being or having been used when designing any future HQ-system (tramway or busway) as the backbone of an integrated network (see picture C-4).

This policy is to have first a look at all important traffic generators within a city / agglomeration area and then to try and link those with the first stage of eg a new tramway scheme. In the Dijon case this needed to establish already in the initial phase two lines to fulfil the requirement. Hospitals, universities, main railway stations, museums, opera houses, fair and exhibition grounds are therefore crucial “not to be neglected” destinations which must be served by a new HQ-system. To do so deviations are sometimes to be accepted (see pictures C-5a and 5b) – means that the French approach clearly puts accessibility in the foreground and accepts lower commercial speeds. The French approach is also linked to an attitude which sees major urban PT-projects not just as transport projects but as urban development projects supporting urban renewal and requalification.

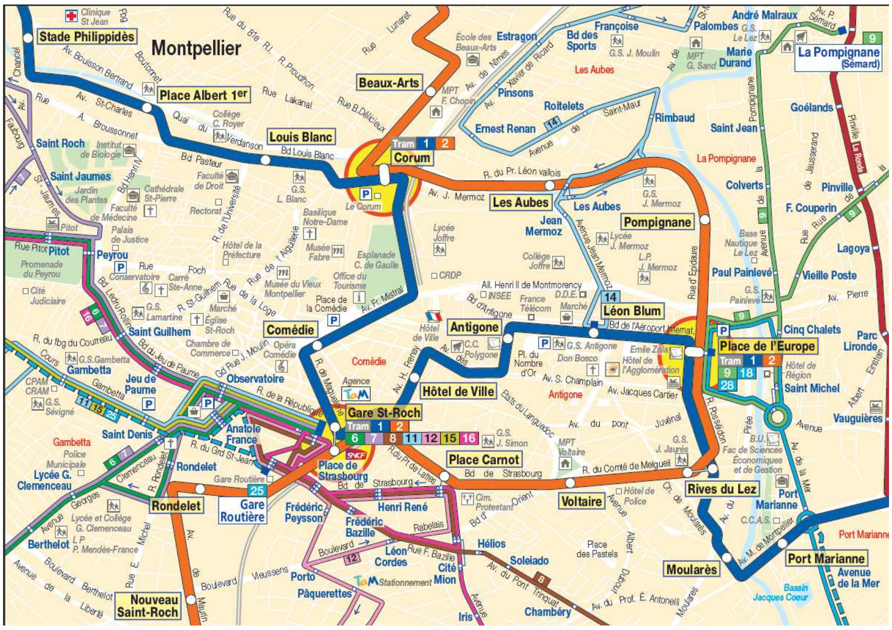


Picture C-3b: Dijon tramway network (land use background)

Source: : http://www.letram-dijon.fr

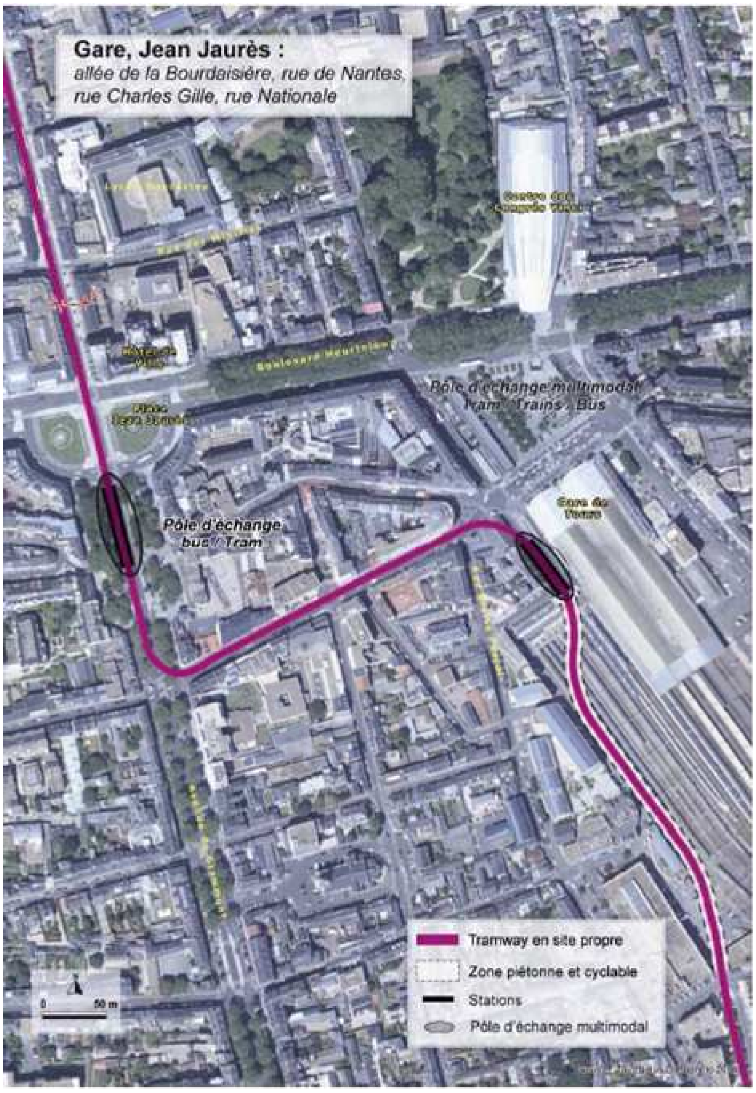


Picture C-4: Tasks of new tramway / busway lines in French cities



Picture C-5a: Tramway network in Montpellier centre

Source: TaM



Picture C-5b: Tramway “deviation” in Tours centre in regard of railway station

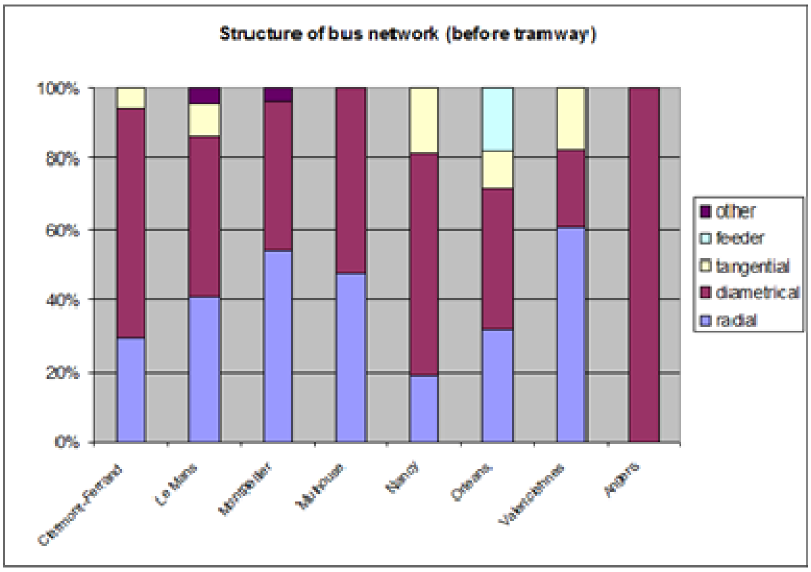
Source: Mobilitours

Also important to understand is the clear network thinking applied around the introduction of any new tramway or busway scheme. Such implies rather comprehensive network re-shapes strengthening the role of the new backbone scheme and reducing parallel bus traffic towards the centre (see pictures C-6 and C-7a/7b).

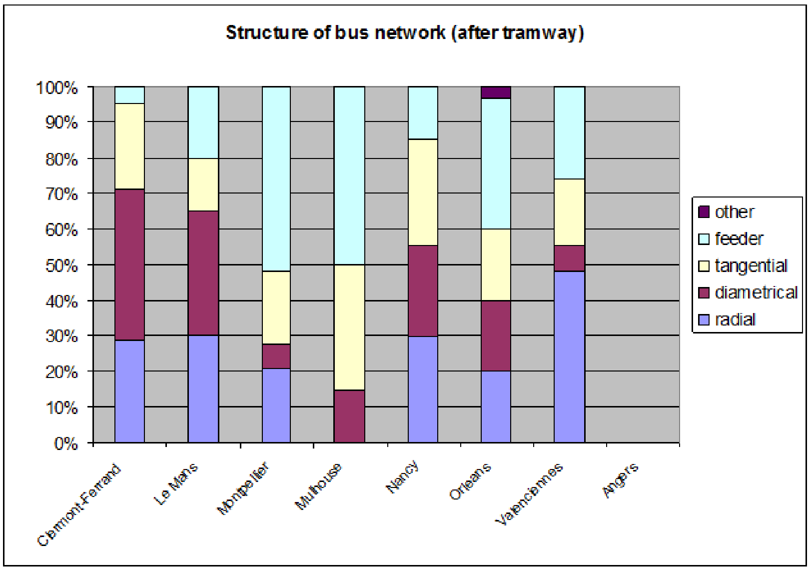
Picture C-6: PT-offer before and after opening the Orleans tramway

Source: AUAO - PDU2005

Picture C-6 shows the vehicle-kms spent in Orleans before 2000 (bus only) and after (bus + tramway). It is visible that bus production remains still dominating by far but also that there are no major reductions in the bus sector. Bus kilometers saved from reduced radial or diametrical lines are principally re-invested into feeder services – an approach which is underlined by the two diagrams in pictures C-7a and 7b.



Picture C-7a: Structure of bus networks before tramway introduction



Picture C-7b: Structure of bus networks after tramway introduction

The discussion about the need to consider major changes to bus services and to reduce the parallel operation has also taken place intensively within the recent Oslo Navet KVU. There was a clear recommendation to build up a very efficient network using the advantages of each PT-mode and giving high quality interchange nodes a crucial role in the network.

The general best practice recommendations above relate to a major extent to the wider picture of new HQPT-projects. With the responsibility for the busway scheme in Nord Jaeren being with Rogaland Fylkeskommune, Sandnes is certainly limited in applying these recommendations directly in regard of the layout of the busway project as a whole. However, there is still scope to use these recommendations when it comes to specific Sandnes related issues as the use of Sandnes S / Ruten as a high quality interchange or the reshape of the bus network in Sandnes to better fulfil urban needs.

C.1.2 Specific bus network examples

The specific bus network examples include a few of the case study cities used in the benchmarking part: Douai and Metz from the agglomeration part, Schaffhausen, Tübingen and Trier from the city part. Douai and Metz are also representing two busway agglomerations.

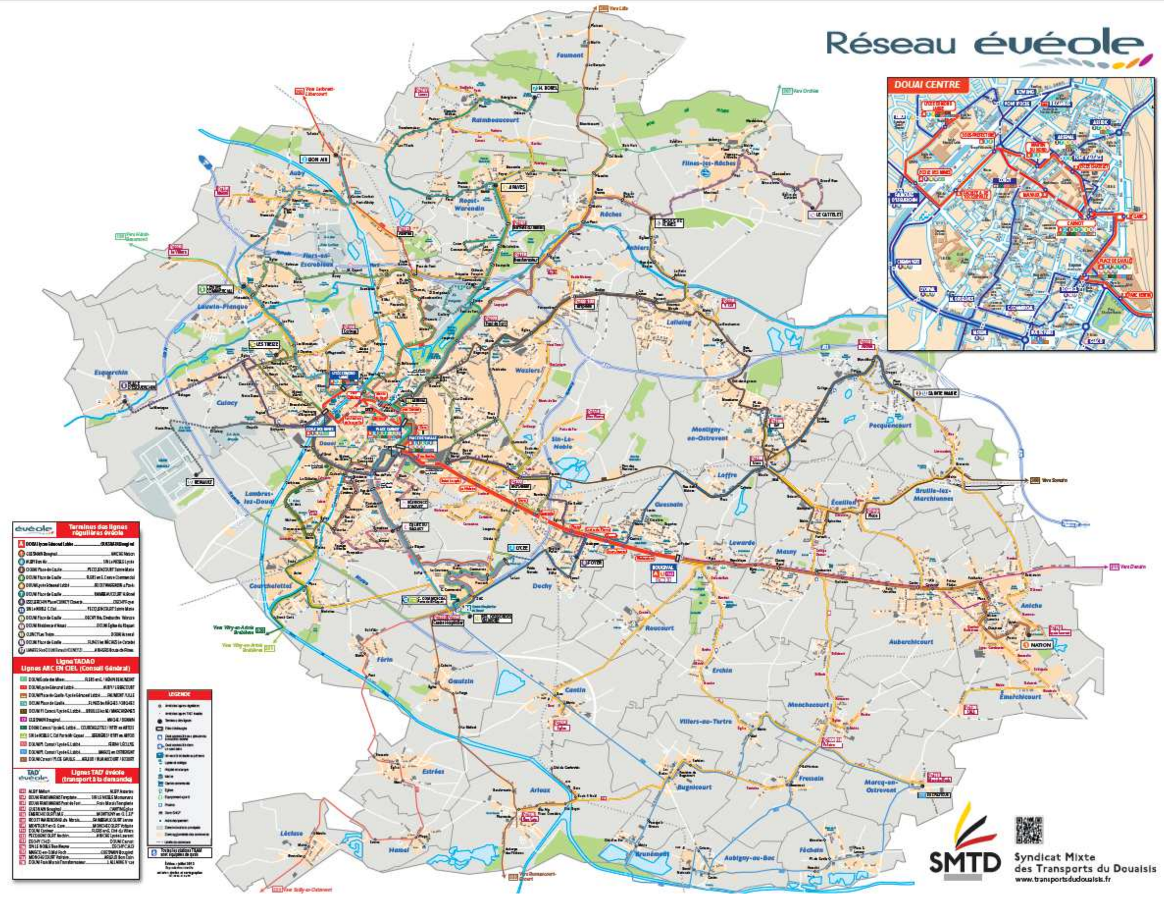
Douai

Douai (see also appendix 1) is an interesting case for a variety of reasons and has some good practice features, however, it does not present 100% best practice.

The former mining region is also not fighting with growth. The situation is actually quite comparable with the neighbouring tramway city of Valenciennes where especially line 2 owns quite similar characteristics as the Douai busway corridor. Both projects have to be seen as development projects to support an otherwise suffering region.

The Douai scheme definitely owns best practice features in regard of the busway infrastructure and its urban integration. However, there have been huge delays in achieving homologation of over-complicated rolling stock and when homologation had been achieved the bus vehicles did never operate with the technical features for GPS-positioning at stops (in order to ensure minimum horizontal gaps for level access!) which had caused the problems and delays. In the meantime the vehicles have been even completely replaced by more standard products. Visible from the benchmarking is also that patronage numbers don't show quantum jump increases.

The network map below (see picture C-8) shows that the whole PT service area appears rather wide-spread and of low density. This remark is also to be made for the busway corridor. Douai with its 41000 population is the core of an agglomeration of 150000 inhabitants (35 municipalities) with a density of just 640 inhabitants / km². The service area of the PT-network is even going beyond the agglomeration and covers 193000 inhabitants.



Picture C-8: Douai network map

Source: EVEOLE

The busway corridor East of Douai (orange line in map) shows rather rural characteristics with very little densification options. Also it appears that there seems rather little scope for network optimization by using the busway as a backbone and building up major interchange nodes served by feeder bus lines. This is confirmed by the schematic route description below (see picture C-9).

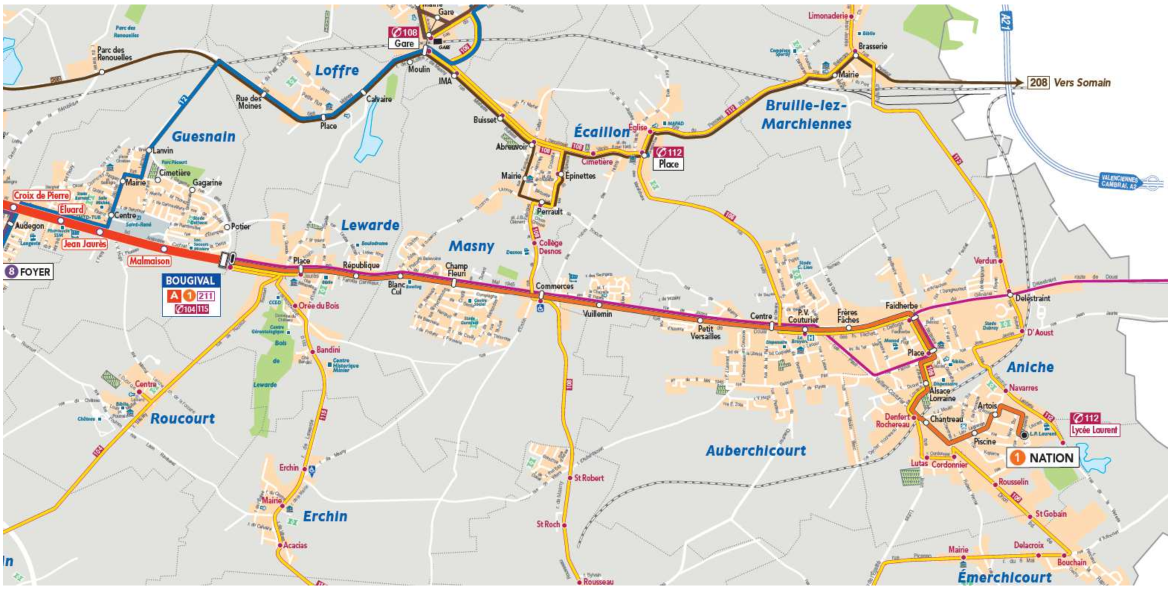
Picture C-9: Douai Line A (busway) – stops and interchanges

Source: EVEOLE

Most of the interchanges are actually located within the city area of Douai. The terminus at Guesnain involves interchange to bus line 1, one regional bus line and two bus-on-demand lines. The two bus lines meeting the busway in between – line 12 and 13 – are operating with rather low frequencies (below 30min).

The busway itself operates with a 10min frequency during peak periods and with a 12min frequency off-peak. This appears as oversized for the regional corridor looking at the catchment areas and population. The average offer for the total network (busway + bus) is with 20 vehicle-kms / inhabitant very low – even for French bus cities. Without having time to investigate this in more depth the consultant would guess that one sees on one side the need to operate the “beacon project” with a relatively dense frequency costing a lot of vehicle-kms, which meant, in order to let the overall expenditures not increase too much, to reduce on other regional lines. Now neither the busway offer nor the "standard" offer in other parts of the network seems to be appreciated by the citizens (compare B.3.2.2).

Nevertheless, it appears that one is trying to increase attractivity further by extending the scheme! The extension will cover today's line 1 between Guesnain and Aniche.



Picture C-10: Douai Line A (busway) – extension

Source: EVEOLE

To return to best practice network features it is worth taking a look at the city centre of Douai (see picture C-11).

Picture C-11: Douai Line A (busway) – city centre alignment

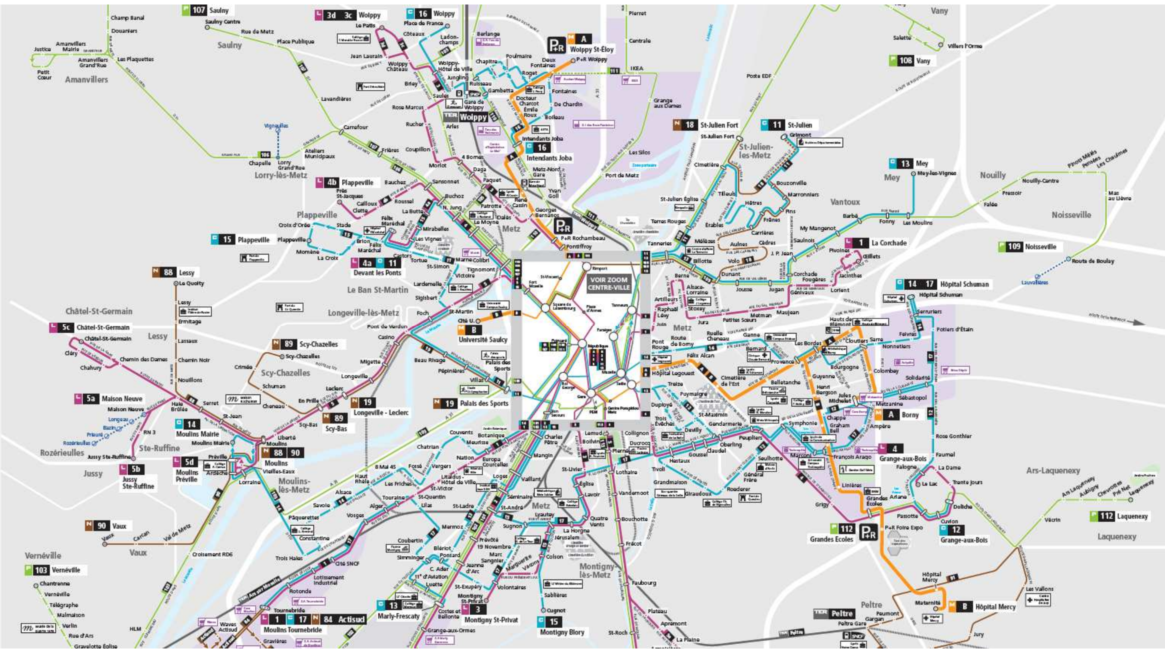
Source: EVEOLE

Visible is first of all that the alignment has been split in two parallel corridors in the centre to enable crossing the rather narrow historical centre. Also interesting is the existence of two urban interchange nodes – one stop before and one after the main railway station! The last section of the busway alignment in the west highlights what has been mentioned in chapter C.1.1 – to serve attractivity nodes deviations are accepted.

Metz

Metz (see also appendix 1) is clearly one of those cities/agglomerations in France which are sizewise located in the “grey zone” between the tramway and busway world where one can go either way. Metz decided for a high quality bus system but there are several other cities in France of similar or even smaller size which have decided for a tramway.

As mentioned in C.1.1 there are no or only little differences in the principal approaches for a new tramway or busway system in regard of the applied planning philosophy. This is clearly visible by the alignment choice for the busway network. Decisions were taken for two busway lines overlapping in the central area (see picture C-12a below) which connect all major attractivity nodes respectively demand generators. Those include the regional hospital as the Eastern end of line B or the university as the western terminus of line B, the fair and exhibition area served by line B, the city centre and the railway station served by both lines, dense housing areas served by either lines, the new Centre Pompidou museum (and neighbouring development areas as a new shopping centre) served by both lines.



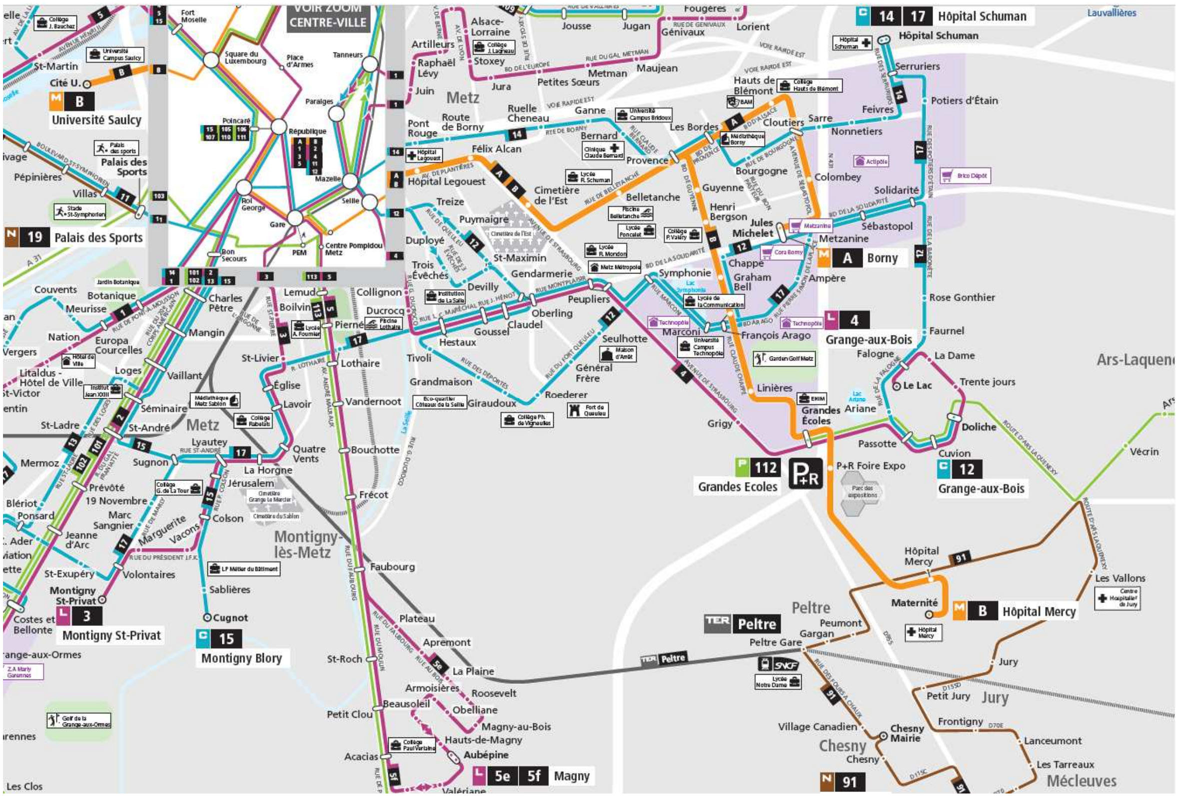
Picture C-12a: Network map Metz

Source: LEMET

The alignment is basically exclusive for the busway services but there are pragmatic exceptions in critical, narrow sections where other buses join the alignment. Without detailing on this topic within this study, Metz shows the same planning pragmatism in regard of integrating the alignment sensibly into the urban realm and at the same time reducing through car traffic as almost all French tramways or busways do.

Republique square functions as the main interchange node which is also giving nearest access to the historic city centre.

A more detailed look at the network in the East gives nice insight into the interworking of the busway and other bus lines in the network. Other bus services are using different corridors towards the city centre, may partly overlap and allow interchanging to/from the busway but act also as feeders from outer areas of the network.



Picture C-12b: Network map Metz (excerpt)

Source: LEMET

Dornbirn

The Austrian city of Dornbirn has over the years gained a lot of reputation for being kind of the "mother of STADTBUS" schemes. The system was opened in 1991.

"Stadtbus" schemes are usually based on fixed frequencies of the different lines and a meeting stop ("rendezvous") where all bus lines meet and enable interchanges between all lines. This means also that such schemes are normally requiring some kind of terminal facility to allow coping with all buses at a time. "Stadtbus" schemes are normally in use for smaller cities in a range from 20000-50000 population.

A major change for the Dornbirn scheme has been the year 2004 when the bus terminal at the main railway station was opened and the network adapted to the new core (see picture C-13 below. The interchange node is presented in C.2.2.

Picture C-13: Dornbirn network map

Source: Stadtbus Dornbirn

Urban and regional lines are clearly separated and branded as a "STADTBUS" (city-bus) and "LANDBUS" (regional bus) offer.

The urban services operate in either a 15 (line 1, 1a and 4) or 30min frequencies (all others). Several corridors with two 30min lines are operated with a 15min frequency (line 8 + 9) or with a 10-20-10-20 frequency (line 4+5).

Details in regard of the interchange arrangements from a time table perspective are presented further below.

Schaffhausen

The Schaffhausen network maps for urban and regional services highlight some interesting features.

For the benchmarking chapter only the data for the urban network has been used – the regional services with about 1.9 Mio vehicle-kms and an additional 2 Mio passengers have not been included. For the best practice chapter both network parts are looked at. It may appear astonishing that a region with just 80000 population (Canton Schaffhausen) organises public transport in two different networks (with two brand names!) which however are well integrated. This allows, however, to give specific roles and features to the services which get often lost when regional lines are taking offer urban functions and vice-versa.

Picture C-13a: Network map Schaffhausen – urban buses

Source: VBSH

The urban network owns 7 lines which are all linking to the railway station. Most of these lines are not terminating at the railway station but just passing through.

The regional network owns another 8 lines. 5 of the regional bus lines are terminating at the main railway station, 3 have different functions. The latter deserve some attention and a closer look.

Railway services seem to play an important role within the public transport network with 7 stops within the canton. Since the last timetable change Schaffhausen owns a dedicated 30min frequency to Zurich and the bus services have been adapted accordingly to ensure quality interchanges.

When looking at the regional bus services it is interesting to take a look at the three lines which are not serving the city centre of Schaffhausen.

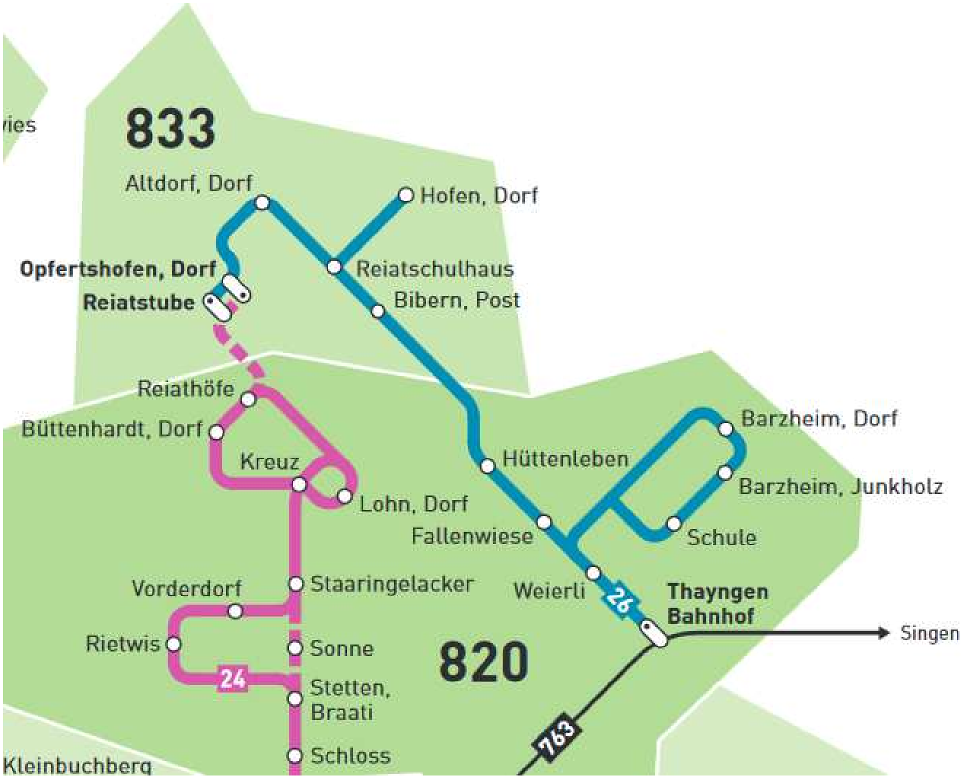
Picture C-13b: Network map Schaffhausen – regional buses

Source: Schaffhausen Bus

Line 26 (see picture C-13c) is serving a number of smaller villages as Thayngen, Hofen, Opfertshofen – with a strong concentration on school traffic. The line connects to Thayngen railway station and at certain times of the day at the other end to bus line 24 which offers a direct connection to the city centre. For timetable details see under C.4.

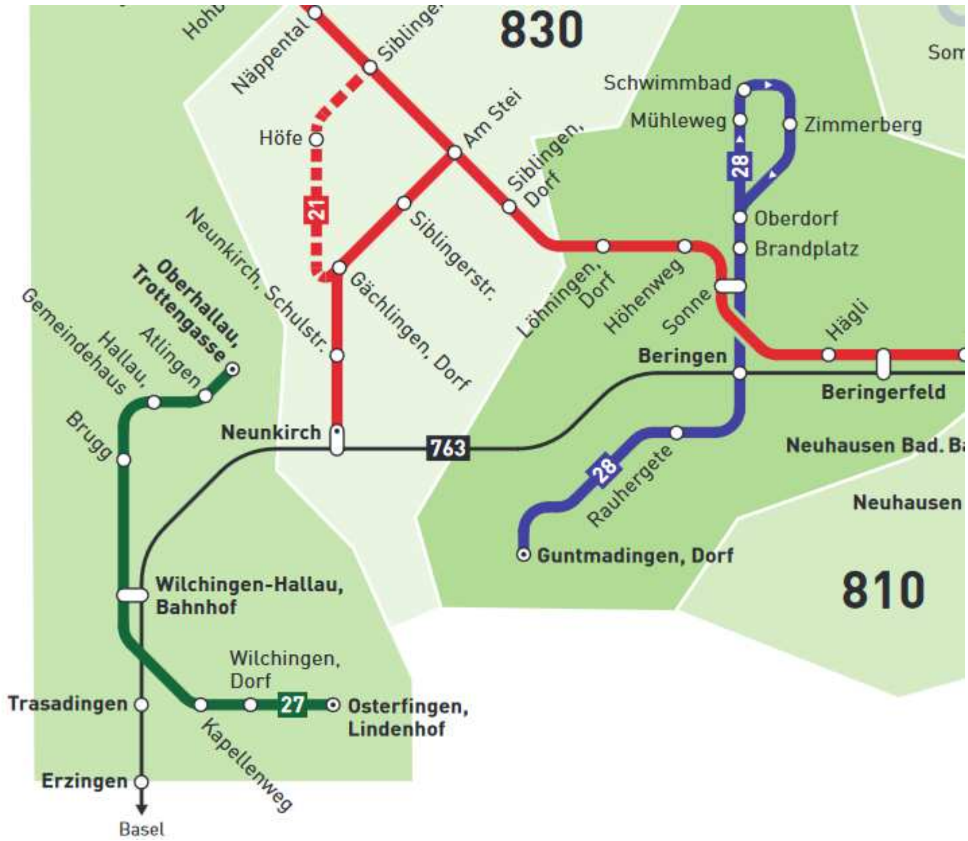
Line 27 plays a similar role at the other end of the canton (see picture C-13d). It connects the four villages Hallau, Oberhallau, Wilchingen and Osterfingen with the railway station Wilchingen-Hallau (see C.4 for details).

Line 28 (see also picture C-13d) has a double function as it connects both to the Beringen railway stop but allows also interchanging to bus line 21. Both interchanges are clearly dedicated in the timetable (see C.4 for details).



Picture C-13c: Network map Schaffhausen – excerpt line 26

Source: Schaffhausen Bus



Picture C-13d: Network map Schaffhausen – excerpt lines 27/28

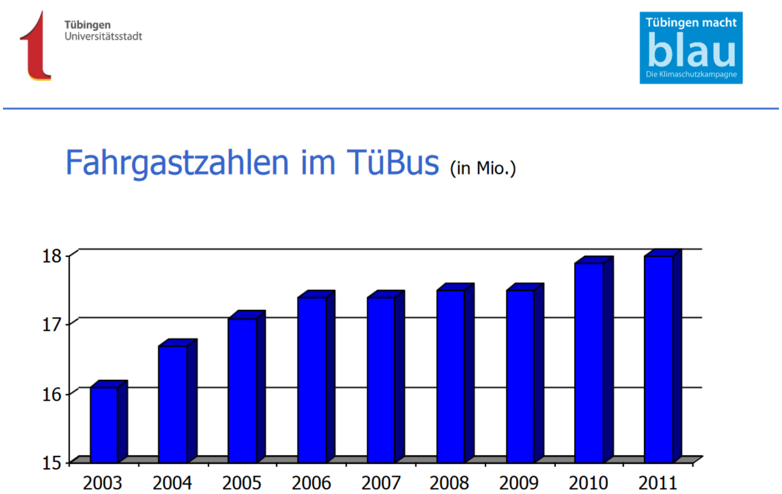
Source: Schaffhausen Bus

Tübingen

Tübingen has been identified in the benchmarking chapter as a rather successful bus city with a very high patronage (trips per inhabitant) and effectivity (trips per vehicle-km) – both ratios about five times the results of Sandnes while the input / offer (vehicle-kms per inhabitant) is about identical (btw rather high for Germany, see picture C-16 further below). This gives good reasons for taking a deeper look into the Tübingen network.

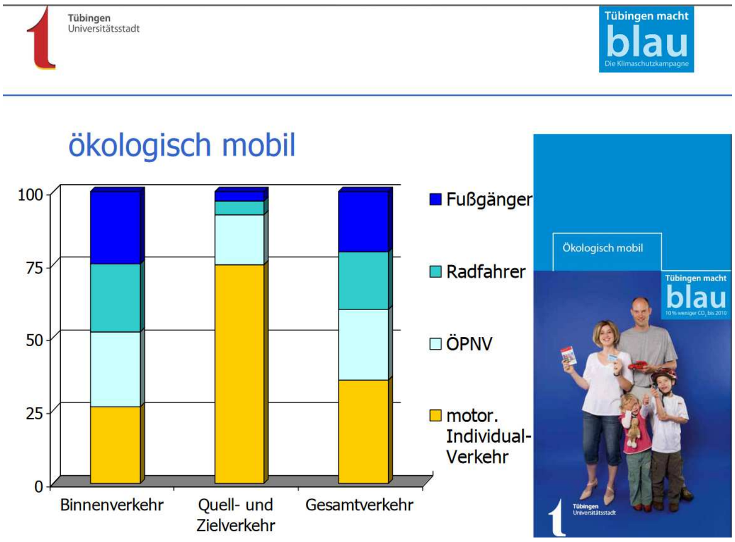
It should be understood that Tübingen is possibly one of the “greenest” cities in Germany with a clear environmental policy for many years (“lately branded as the blue campaign”). The public transport concept is supported by an integrated land-use policy and other mobility measures in the field of cycling and car-sharing. As a big university hub the city can also count on a rather young population for German conditions.

The land-use strategy focuses clearly on densification of existing and central areas – the city has not been developing any new housing area since 2007!



Picture C-14a: Patronage growth in Tübingen

Source: Tübingen municipality



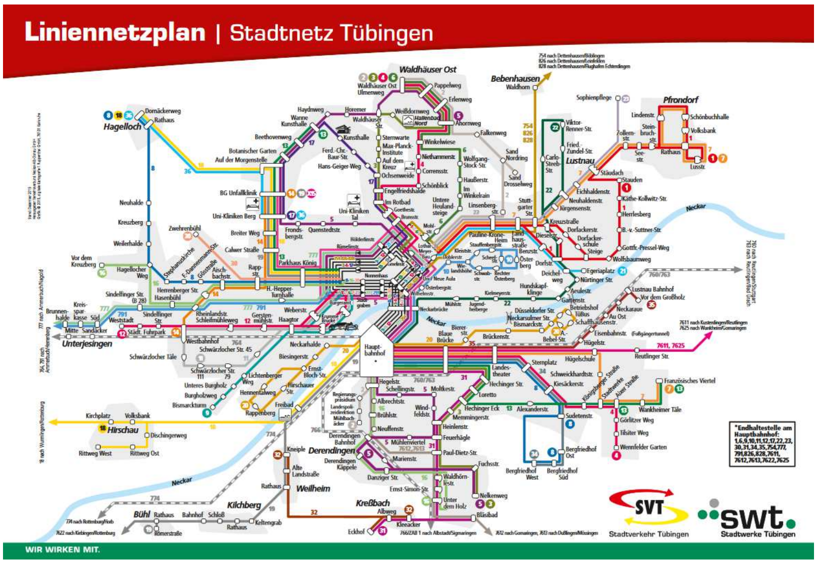
Picture C-14b: Modal Split in Tübingen

Source: Tübingen municipality

Picture C-14a above confirms a very promising patronage trend of the Tübingen bus network in the period 2003-2011, the latest number of 20.4 Mio passengers / trips for 2014 shows that this trend has been continuing further.

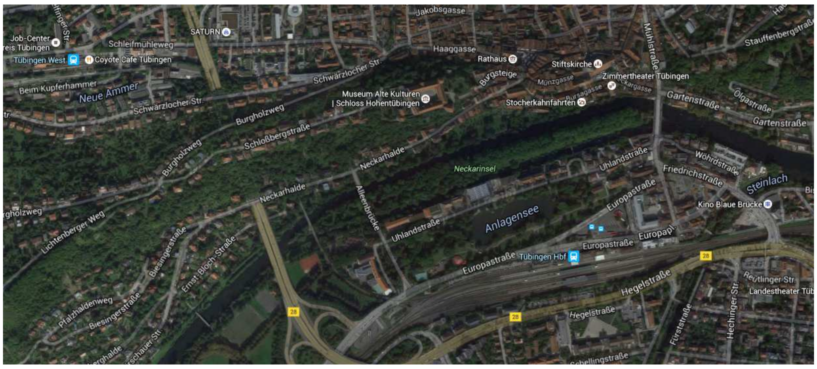
Picture C-14b highlights a very favourable modal split situation with a share of 25% for each of the four modes car, PT, cycling and walking for internal traffic. Certainly this split is more car oriented with about 75% car share – this being a target for a more regional TramTrain scheme which is being developed for the Tübingen/Reutlingen agglomeration (Stadtbahn Neckar-Alb). The modal split situation for all traffic is still in a "dream position" with car traffic counting only for about 30% and rather high PT and cycling shares for a city of this size.

The network map in picture C-15a below becomes more understandable when taking a look at the city structure (see picture C-15b). Visible is the situation with the Neckar river valley forming a barrier with few available crossings separating also the railway station from the city centre.



Picture C-15a: Network map Tübingen

Source: SVT



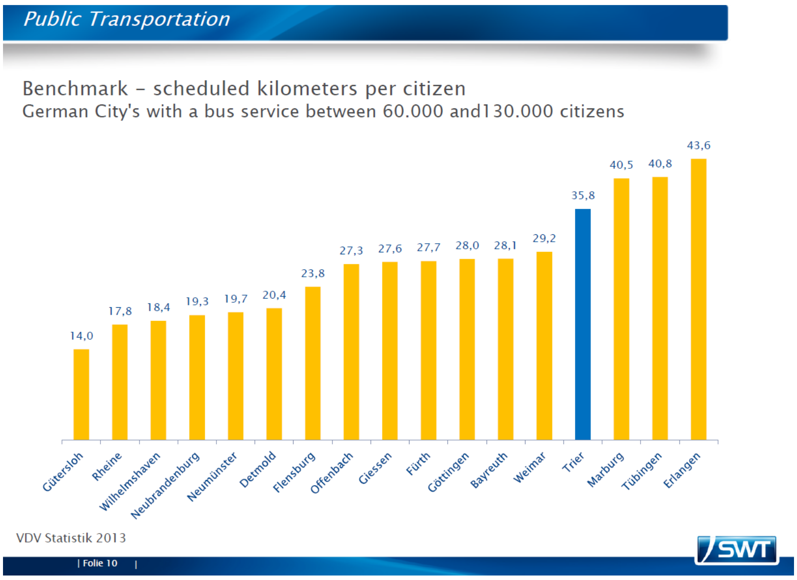
Picture C-15b: Tübingen aerial view

Source: Google Earth

Bus services operate in either 15min or 30min frequency with lines complementing to denser frequencies on joint corridors – of which there are many due to the limited road network in a historic and topography-wise difficult city. There exists no central (city) bus terminal, buses are just passing through the centre. Few of the lines terminate at the railway station – for the “terminal” there plans are progressed to make it another “mobility turntable”.

Trier

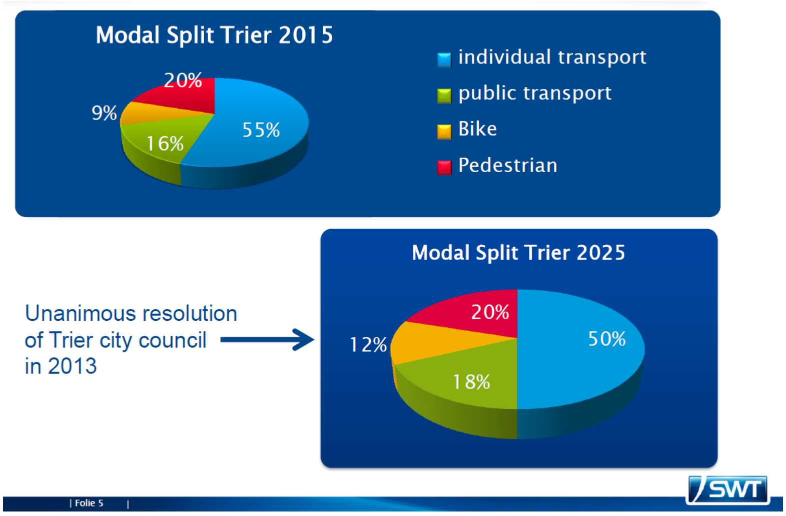
Trier would very likely not be an immediate best practice choice when looking for German bus cities. It appears first of all as a standard bus network without anything particularly fancy: no busway features, no buses camouflaged as trams, no architectural award for an interchange facility. However, the benchmarking results in chapter B confirmed Trier as being one of the better -in the sense of effective- networks which recommended taking a deeper look. Picture C-16 below shows Trier in a VDV-comparison of medium sized bus cities in Germany in regard of vehicle-kms spent per citizen. The diagram includes also two other cities included in the 2016 benchmarking (Gütersloh and Tübingen). It confirms both the wider use of this ratio for benchmarking purposes and the standard offer range between 15 and 45 vehicle-kms / inhabitant for such cities. It shows also that Trier is to be seen as one of the cities with a relatively high offer (compare Gütersloh).These 2013 results are very similar to the benchmarking results in chapter B for Gütersloh, Tübingen and Trier.



Picture C-16: VDV-benchmarking of medium sized German bus cities

Source: SWT

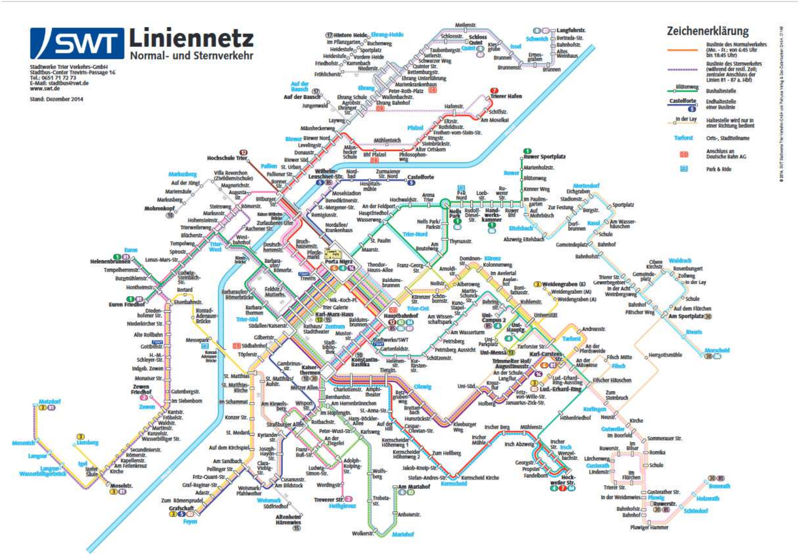
Picture C-17 below shows the current modal split in Trier with 16% share for PT which can be seen as near to the top in Germany achievable with bus systems. It also shows the targets of the Trier mobility plan until 2025 which is to increase PT to 18% and to reduce car traffic to 50% (from 55%). Such straight forward mobility targets are rather typical for German or French mobility plans.



Picture C-17: Trier mobility targets until 2025

Source: SWT

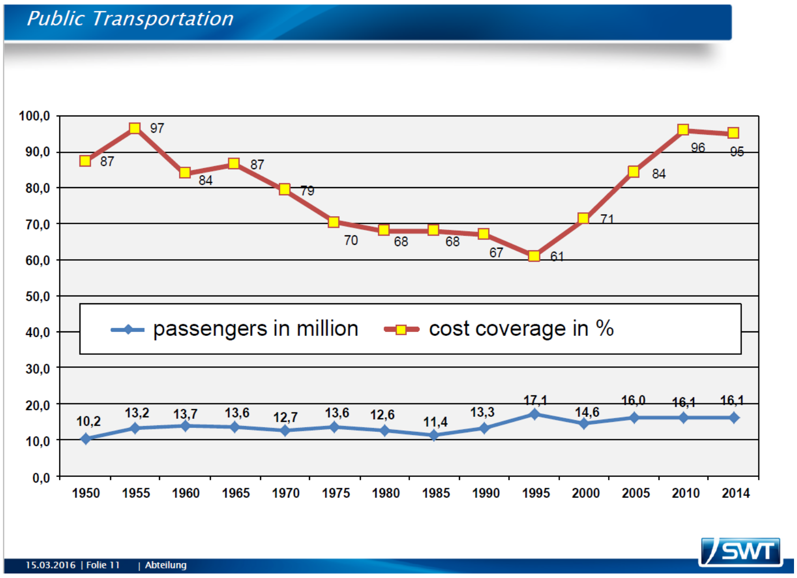
A look at Trier network map in picture C-18 reveals nothing spectacular on first sight; one needs, however, to understand the geographical and topographical conditions in the Mosel valley with hills on both sides. Visible is a quadratic structure in the city centre, a limited number of river crossings (one dominating) and some lines on either side of the river following it.



Picture C-18: Trier PT-network map

Source: SWT

Very interesting is a look at the development of patronage and cost coverage development for the PT-network over a period of 65 years. One notices a huge increase of cost coverage ratios during the last 20 years while at the same time patronage stayed more or less at the same level. According to information received from Trier officials this trend has been enabled by major efficiency increases – both network related but also regarding the staffing, especially in the workshop part. Looking at these results together with the benchmarking results (see chapter B.4) one must conclude that a good deal of success is not just dependent on the implementation of major infrastructure measures but can be achieved by proper organization.



Picture C-19: Development of patronage and cost coverage for the Trier PT network

Source: SWT

C.2 Role and layout of interchanges

There has been a lot of discussions over the years about PT-success being highly dependent of avoiding interchanges. “The private car does not require interchanges - therefore PT will only be accepted if it offers similarly direct connections!” has been a typical argumentation in this regard. The consultant agrees that there is some truth in this but as always there are two sides of a coin. PT-users certainly will not like unnecessary interchanges of bad quality (long waiting times) and/or low reliability (risk of losing connections and even longer waiting times). At the same time PT-networks aiming for taxi-like door-to-door services are just to be seen as very expensive and are therefore not seen as a viable approach in most countries. This means in the view of the consultant that a compromise strategy will be to base networks on quality interchanges which then will not at all be seen as a major travel hindrance. As described in the network chapter above (C.1.1) almost all new tramway or busway systems implemented over the last 20 years have embedded the new mode into a framework of accompanying measures of which a reorganisation of the PT-network and adaptation towards the “backbone scheme” has been one. Offering “intermodality” has become an absolute request all over the world and high quality interchanges are the major tool in any such strategy.

The discussion below gives both insight into some general principles but also highlights some specific examples from the benchmarking cases and beyond.

C.2.1 General principles in regard of interchanges / interchange nodes

The following two examples from Australia are highlighting very basic principles of interchange nodes in different configurations. They show how the different interfaces may be handled at such nodes.

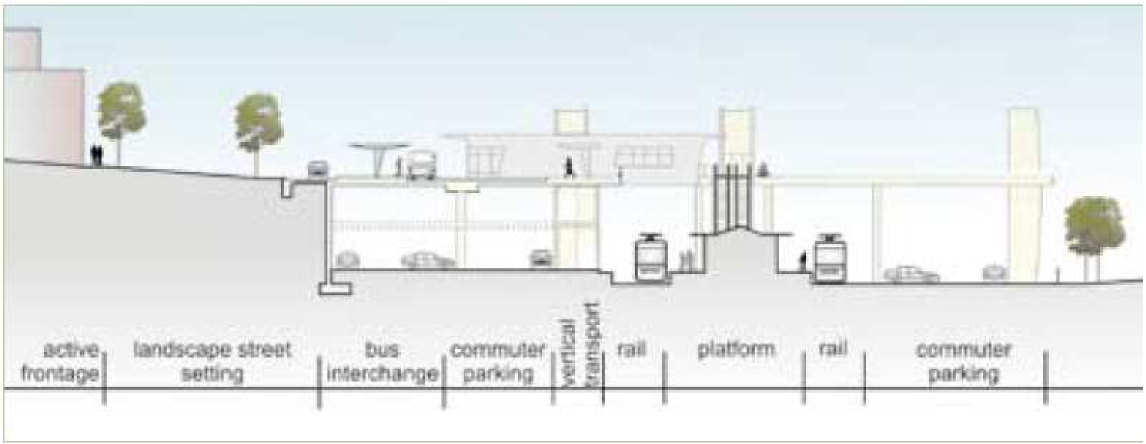


Figure 37: Model interchange design option for Principal Activity Centre

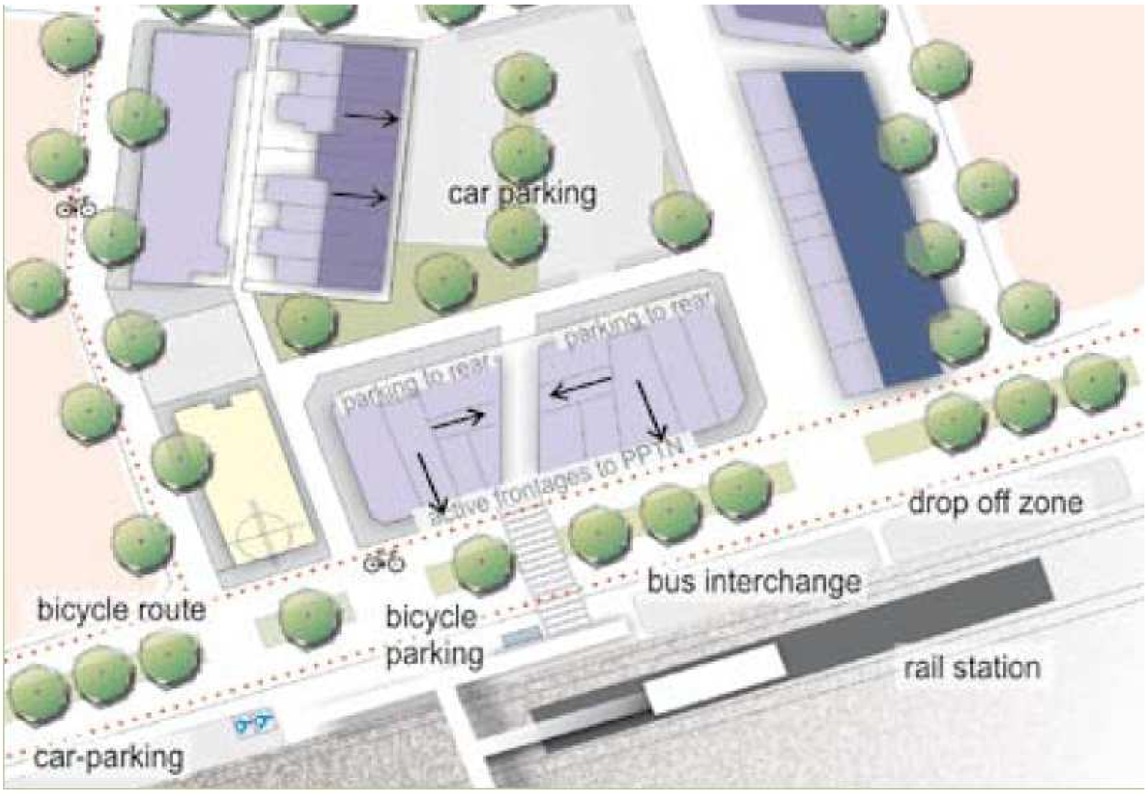


Figure 44: Development orientation around public transport nodes

Picture C-20: Layout principles for PT-interchange nodes

Source: DoT Victoria

From an European perspective commuter car-parking may be too dominating and cycle parking possibly not valued enough but what the consultant wants to demonstrate with the principles is not the detail but the general approach of using dedicated and identifiable configurations. A railway station with some bus stops outside on the streets is not yet an "interchange node". The wording "principal activity centre" highlights another important feature which is offering an environment where waiting times between train and bus or vice versa are not just a boring necessity but possibly a time slot which can be used positively.

C.2.2 Specific examples for interchanges / interchange nodes

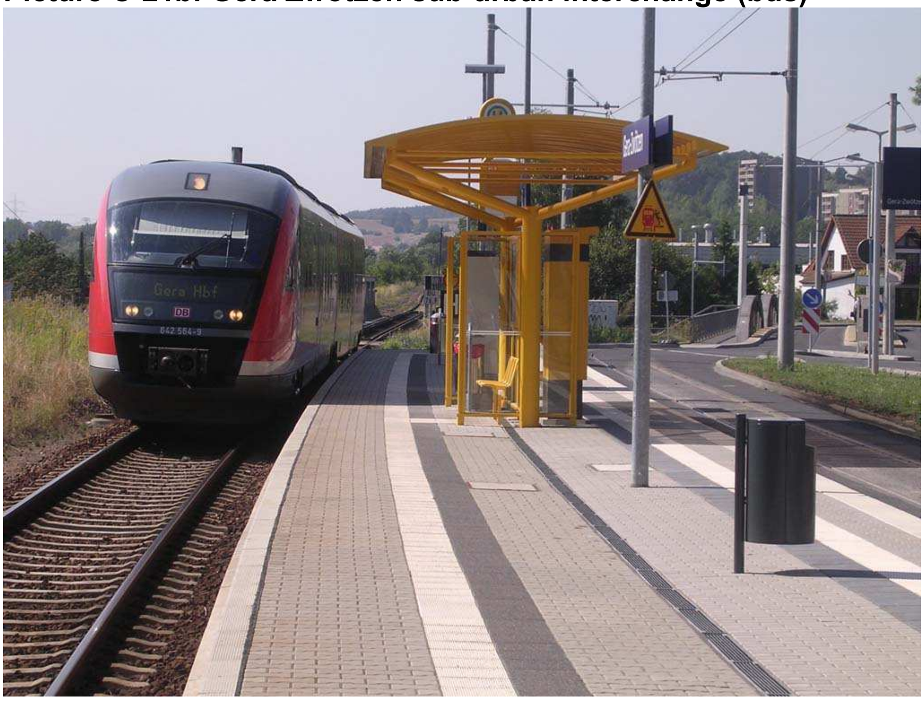
Gera

The Gera-Zwötzen interchange is an example for a small, suburban interchange node where regional rail services meet with urban tram and bus services. It has received some public attention with regard to the technical solution with a joint platform used by all passengers (see pictures C-21a – 21c below).

Looking at this example one should take into account the prevalent conditions in the East of Germany which in many regions have meant dealing with shrinking cities. Understandably this has also meant in many cases reducing the PT-offer to keep the services still economically viable. Therefore today's actual use of the interchange may not be seen as 100% best practice – what is more a target for the consultant is showing what technical interchange qualities can be achieved with rather lean financial input. Also interesting, connected to what has been said before about "networking", is to see the role of the stop and of the lines serving it in a wider network perspective.

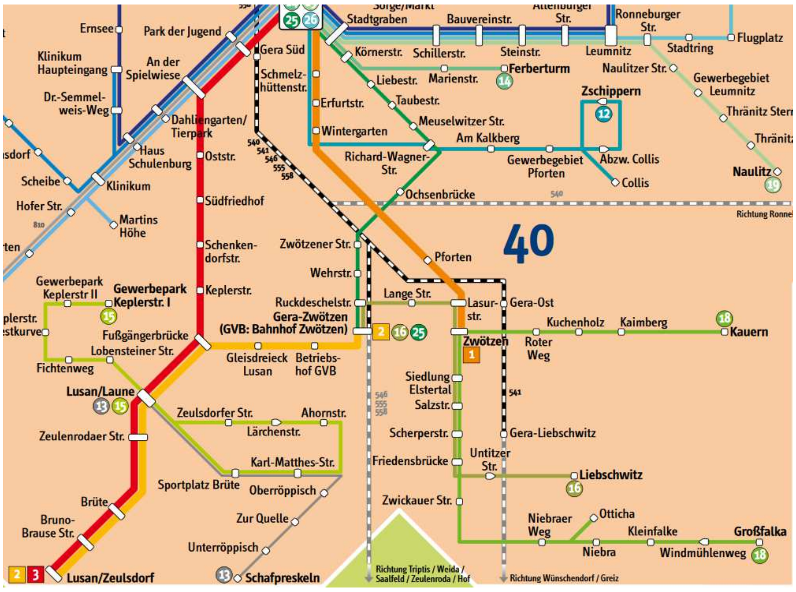
Picture C-21a: Gera Zwötzen sub-urban interchange (tramway)

Picture C-21b: Gera Zwötzen sub-urban interchange (bus)



Picture C-21c: Gera Zwötzen sub-urban interchange (railway)

Taking a look at the network function (see picture C-22 below) one can notice that the tramway line 2 serving the stop is more a sub-urban tramway feeder linking Zwötzen with Lusan and allowing further interchanges there – it has, however, no function for serving the city centre directly. The two bus lines serving the interchange have different functions: line 16 is another feeder linking to Zwötzen centre and further and allowing interchange to tram line 1 while line 25 is going to the city centre in a different corridor as line 1.



Picture C-22: Gera PT-network (excerpt – Zwötzen related)

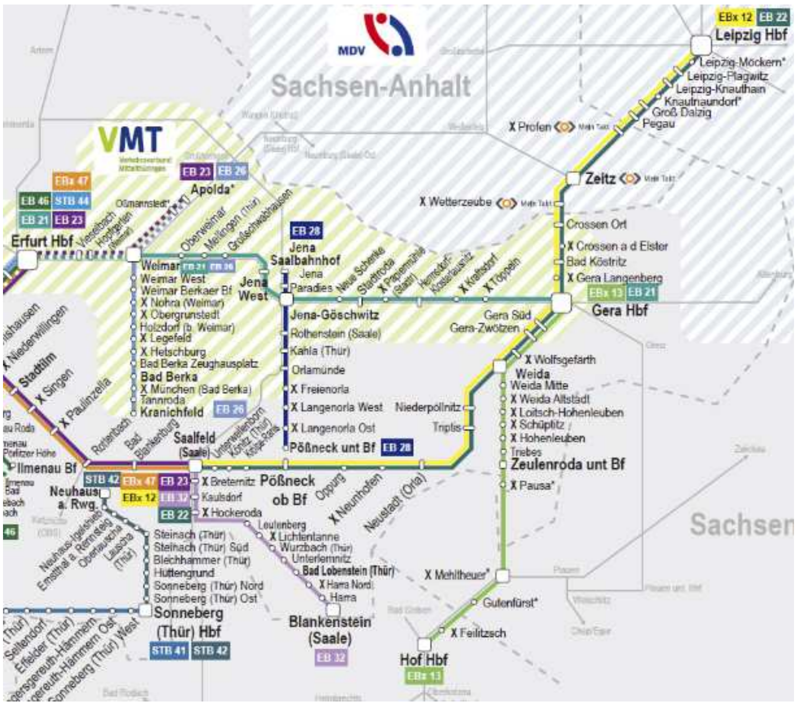
Source: GVB

Looking at the rail function of Gera-Zwötzen (see picture C-23), one notices three lines serving the stop:

EBx 12 Leipzig-Saalfeld (2h frequency)

EBx 13 Gera-Hof (2h frequency)

EB 22 Leipzig-Saalfeld (2h frequency)



Picture C-23: Erfurter Bahn rail network (excerpt – Gera related)

Source: Erfurter Bahn

EBx 12 and EB22 are together offering a 1h frequency, EBx 13 plays in between every two hours. Peak hours show some additional services.

Different to many other regional stops, Zwötzen is a regular stop and not just served on demand as many other (those with an X). However, the level of rail services means just one arrival/departure per hour plus an additional one every second hour. The urban services are all operating in a 30min frequency. Understandably this makes it very difficult to achieve real interchange quality from a timetable perspective. Gera Zwötzen is nicely confirming that a HQ-interchange requires both a proper technical solution with short ways for the passengers and very good timetable integration of rail vs tram/bus. This is not fully achieved here when it comes to the rail interchange but the stop definitely functions as a node for interchanging between the tram and the two bus lines (rendezvous principle).

Dornbirn

The Dornbirn railway station has seen major improvements in the years 2007 and 2008 making it a real “mobility turntable” (“Mobilitätsdrehscheibe”). The project has been awarded the 2009 prize for mobility of the Austrian VCÖ association. Awarding reasons have been - beyond the pure bus terminal- the improved accessibility for pedestrians and cyclists including add-on features as a bike & ride facility, cycle boxes, a cycle hire and a car sharing office. Also added have been park & ride and kiss & ride facilities.

There should be no doubt – compared to the Gera Zwötzen example – that this facility “plays in another league”.

Gewinner
VCÖ-Mobilitätspreis 2009

GESAMTSIEGER
ÖBB Infrastruktur Bau AG & Amt der Stadt Dornbirn
Mobilitätsdrehscheibe Bahnhof Dornbirn

Picture C-24: 2009 Mobility Award of Dornbirn “mobility turntable”

Source: VCÖ

In 2015 the railway station of Dornbirn has been voted the best medium-sized railway station in Austria within a VCÖ-“railway test”. The following pictures give some more impressions of the facility which also offers a completely sheltered way between bus and railway.

Picture C-25a: Dornbirn station (aerial view)

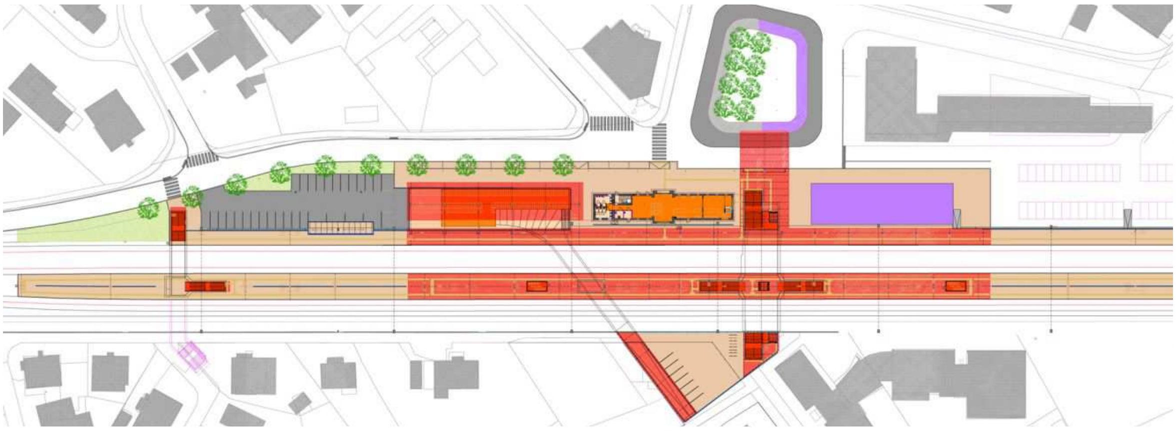
Source: Dornbirn municipality

Picture C-25b: Dornbirn station

Source: ÖBB / Richard Günther Wett

Picture C-25c: Dornbirn station

Source: ÖBB / Richard Günther Wett



Picture C-25d: Dornbirn station layout plan

Source: Arno Reiter Architektur

C.3 Scope for central bus stations

The consultant has recently delivered a special report within the KVU Oslo Navet dealing with the layout and role of bus services in agglomeration areas. Even if most of the agglomerations have been of bigger size, quite some of the findings (and examples) are still relevant from the perspective of smaller agglomerations and cities.

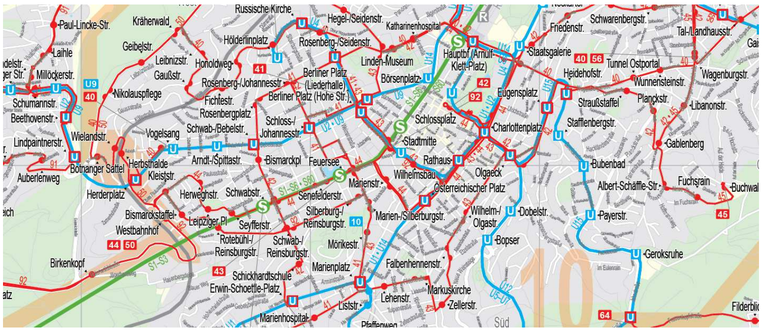
Basic conclusions have been:

- The "mode portfolio" decides on the use and role of bus services:
  - cities which have no tramways, but "only" S-Bahn / railway and metro, use buses also in city centres (Hamburg), same is the case in cities which do not have a metro system (Nantes) or a metro system which is nearer to a light rail system (Stuttgart).
  - Cities which own three high quality rail systems, S-Bahn / railway, metro and tramway / light rail, use buses dominatingly only in the region, respectively sub-urban areas (Munich, Vienna)
- Regional bus lines are regularly "broken" at regional node stops (S-Bahn / railway) but may sometimes be extended to sub-urban nodes where more interchange options exist (eg also metro).
- In all cases bus lines with centre destinations are mostly diametrical, thus running through centres or nodes, thus reducing the need for big terminals in dense areas.
- Interchange quality and thus the quality of interchange nodes is a big issue.

Two of the examples used in the Oslo report are worth repeating here:

Stuttgart

It is visible that there are very few terminus stops for bus lines in this central area. Only at the "Stadtmitte" stop two bus lines (42 and 92) are terminating / starting. The majority of bus lines starts and ends in suburban areas on either hillsides of the valley at metro stops or bypassing those after fulfilling an initial or final feeder function.



Picture C-26: Stuttgart city PT-map (excerpt)

Source: VVS

Two typical city bus routes are described in maps below. The routes may not appear ideal from a HITRANS-perspective but one should acknowledge the Stuttgart topography. Also the task of showing these examples here is not to present “ideal bus lines” but just to highlight the by-passing (and not terminating!) of bus lines at main interchange nodes.

Picture C-27a: Stuttgart line 40

Source: VVS

Picture C-27b: Stuttgart line 42

Source: VVS

Regional buses are not touching the central area at all – they are linked completely to sub-urban or regional S-Bahn stops.

Nantes

The city of Nantes was the first French city which re-introduced the tram. Today three tram lines (thick green, thick red and thick blue in map below) and one “busway” (sort of BRT, thick yellow in map below) constitute the backbone of the PT system. A widespread bus route network is linking the backbone corridors with node stops at strategic places. There is no central bus terminal.

Picture C-28a: Nantes PT-network map

Source: TAN

The organisation of the bus network becomes easy to understand when looking at some specific lines in map below. Typical for the Nantes bus network is the interworking of all modes. Buses are going through the city centre but never competing with the tramway lines – they are using different corridors.

Picture C-28b: Nantes PT-network map (excerpt)

Source: TAN

Bus line 42 (green, right down corner) starts in the centre of Vertou, links to the local railway station, touches the busway at three stops and continues as a local bus to the sub-urban Pirmil PT-node which is offering various interchange options including two tramway lines.

Nicely visible is the function of Pirmil which is the terminus for several buslines reaching in from the South. However, quite some of the bus lines are taken a few stops beyond to reach the Greneraie stop and to allow also interchanging to the busway.

Picture C-28c: Nantes PT-network map (excerpt)

Source: TAN

Line 70 is another typical example: starting at “Boulevard de Doulon” stop (tramway 1) and running tangentially around the North of the centre, meeting numerous bus lines, the other two tramway lines and terminating at a sub-urban railway station “Gare de Chantenay”.

C.4 Timetable issues

The following chapter highlights a few examples for timetable arrangements in connection with rail-bus interchanges.

Dornbirn

Dornbirn has been mentioned above in regard of general network aspects and details of the interchange node at Dornbirn railway station. Here a quick look into the timetable situation at the interchange is given.

Train services are based on half hourly S-Bahn-services with departures at minute 00 and 30, respectively 29 and 59 in the opposite direction (some long distance service in addition). Arrival times are one minute before.

The table below gives an overview of the arrivals and departures of the urban bus services:

	Dornbirn station							
Bus line	**Arrivals**				**Departures**			
	58-8	**13-23**	**28-38**	**45-53**	**0-10**	**17-25**	**30-40**	**47-55**
1	0	15	30	45	2	17	32	47
1a	0	15	30	45	5	20	35	50
2		15		45	3		32	
2a	8		38			25		55
3		18		48	0		30	
4	58	13	28	45	5	20	35	50
5	58		28		10		40	
6		18		48	0		30	
7	3		33		10		40	
8		23		53		20		50
9	8		38		5		35	

Picture C-29: Bus arrivals / departures Dornbirn station

It is visible that buses arrive within 8-10min slots with proper distance to the train departures but certainly not with any direct and close correspondance. Departures are within similar slots and interchange times after train arrivals.

In case of (major) changes to the train times bus services will be re-arranged accordingly. This has been the case eg in 2010 when also all bus lines have been linked to the railway station.

Additional interchanges exist with the regional bus services.

Schaffhausen

Also Schaffhausen has been discussed above in regard of general network features. Different to the Dornbirn “STADTBUS” approach the urban bus network in Schaffhausen does not use a terminal structure at the interchange.

The similarity is to be seen in the clear policy regarding intermodality and the use of the railway station in this regard. Picture C-… below shows the press notice for the time table change in December 2015 when Schaffhausen achieved a complete 30min rail frquency towards Zurich and bus services have been adapted to the new situation.

FAHRPLANWECHSEL AM 13. DEZEMBER 2015

Halbstundentakt nach Zürich bedingt Anpassungen bei den Busfahrplänen

Mit dem Fahrplanwechsel am 13. Dezember 2015 erhält Schaffhausen einen sauberen Halbstundentakt nach Zürich. Um allen Passagieren mit einer möglichst kurzen Wartezeit zu dienen, werden die Abfahrts- und Ankunftszeiten der Busse optimiert und dem neuen SBB-Fahrplan angepasst.

Picture C-30: Time table change – adaptation of bus services Schaffhausen

Source: VBSH/Schaffhausen Bus

Especially interesting for Schaffhausen is the use of some regional railway stops for local interchanges to the bus network and also the coordination of bus services to allow internal interchanges (see pictures C-31a and 31b).

The examples make evident that interchange options are presented as intended and planned offers.

It is also visible that these feeder bus lines are rather short with just 7 or 8 stops and a total travel time of only about 10min.

27 Oberhallau - Wilchingen-Hallau Bhf - Osterfingen

24+31 Dez Samstagfahrplan

→		Montag - Freitag					Samstag					Sonn- und Feiertag			
Oberhallau, Trottengasse		5.12	5.42	alle	23.12	23.52	5.12	5.42	alle	23.12	23.52	5.42	alle	23.12	23.52
Hallau, Gemeindehaus		5.16	5.46	30	23.16	23.56	5.16	5.46	30	23.16	23.56	5.46	30	23.16	23.56
- Brugg		5.17	5.47	Min	23.17	23.57	5.17	5.47	Min	23.17	23.57	5.47	Min	23.17	23.57
Wilchingen-Hallau, Bahnhof	an	5.21	5.51		23.21	0.01	5.21	5.51		23.21	0.01	5.51		23.21	0.01
Zug Wilchingen-Hallau	*ab*	*5.24*	*5.54*		*23.24*		*5.24*	*5.54*		*23.24*		*5.54*		*23.24*	
Zug Schaffhausen	*an*	*5.39*	*6.09*		*23.39*		*5.39*	*6.09*		*23.39*		*6.09*		*23.39*	
Zug Schaffhausen	*ab*		*5.49*		*23.19*	*23.49*		*5.49*		*23.19*	*23.49*	*5.49*		*23.19*	*23.49*
Zug Wilchingen-Hallau	*an*		*6.03*		*23.33*	*0.03*		*6.03*		*23.33*	*0.03*	*6.03*		*23.33*	*0.03*
Wilchingen-Hallau, Bahnhof	ab	5.34	6.04		23.34	0.04	5.26	6.04		23.34	0.04	6.04		23.34	0.04
- Kapellenweg		5.36	6.06		23.36	0.06	5.28	6.06		23.36	0.06	6.06		23.36	0.06
- Dorf		5.37	6.07		23.37	0.07	5.29	6.07		23.37	0.07	6.07		23.37	0.07
Osterfingen, Lindenhof		5.41	6.11		23.41	0.11	5.33	6.11		23.41	0.11	6.11		23.41	0.11

Picture C-31a: Time table line 27 – presentation of interchange options

Source: Schaffhausen Bus

28 Guntmadingen - Beringen

24 + 31 Dez Samstagfahrplan; Nachtbus Guntmadingen siehe Linie N77

➔ **Montag - Freitag**

VERKEHRSHINWEIS		28006	28008	28010	28012	28014	28018	28022	28026	28028	28030	28032 B	28034	28038	28042 B
Guntmadingen, Dorf	ab	6.21	6.51	7.17	7.51	8.21	9.21	10.21	11.21	11.53	12.21	13.10	13.29	14.21	15.13
Beringen, Rauhergete		6.24	6.54	7.20	7.54	8.24	9.24	10.24	11.24	11.56	12.24	13.13	13.32	14.24	15.16
- Bahnhof	an	6.25	6.55	7.21	7.55	8.25	9.25	10.25	11.25	11.57	12.25	13.14	13.33	14.25	15.17
Zug Beringen	*ab*	*6.30*	*7.00*	*7.30*	*8.00*	*8.30*	*9.30*	*10.30*	*11.30*	*12.00*	*12.30*			*14.30*	
Zug Schaffhausen	*an*	*6.39*	*7.09*	*7.39*	*8.09*	*8.39*	*9.39*	*10.39*	*11.39*	*12.09*	*12.39*			*14.39*	
- Bahnhof	ab	6.33	7.03	7.21	7.55	8.33	9.33	10.33	11.33	11.57	12.33	13.14	13.33	14.33	15.17
- Sonne	an	6.34	7.04	7.22	7.56	8.34	9.34	10.34	11.34	11.58	12.34	13.15	13.34	14.34	15.18
21 Schaffhausen, Bahnhof	*ab*	*6.20*	*6.50*			*8.20*	*9.20*	*10.20*	*11.20*		*12.20*		*13.20*	*14.20*	
21 Beringen, Sonne	*an*	*6.33*	*7.03*			*8.33*	*9.33*	*10.33*	*11.33*		*12.33*		*13.33*	*14.33*	
- Sonne	ab	6.34	7.04	7.22	7.56	8.34	9.34	10.34	11.34	11.58	12.34	13.15	13.34	14.34	15.18
- Brandplatz		6.35	7.05	7.23	7.57	8.35	9.35	10.35	11.35	11.59	12.35	13.16	13.35	14.35	15.19
- Oberdorf		6.35	7.05	7.23	7.57	8.35	9.35	10.35	11.35	11.59	12.35	13.16	13.35	14.35	15.19
- Mühleweg		6.36	7.06	7.24	7.58	8.36	9.36	10.36	11.36	12.00	12.36	13.17	13.36	14.36	15.20
- Schwimmbad	an	6.37	7.07	7.25	7.59	8.37	9.37	10.37	11.37	12.01	12.37	13.18	13.37	14.37	15.21

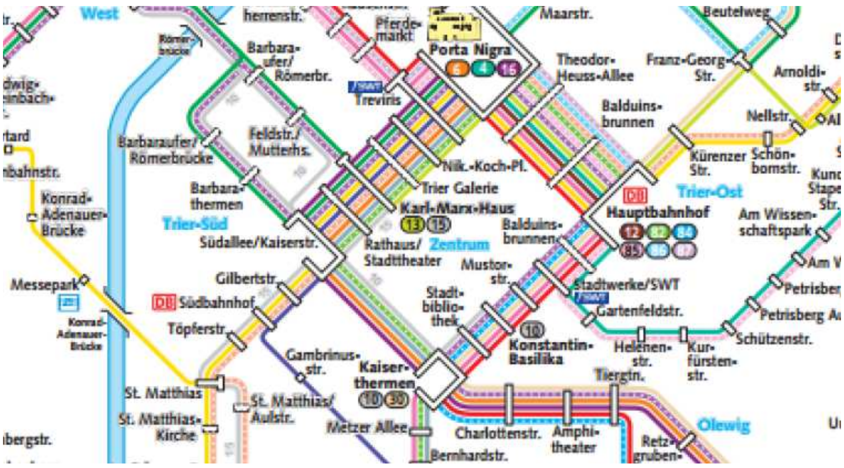
Picture C-31b: Time table line 28 – presentation of interchange options

Source: Schaffhausen Bus

Trier

The Trier network, as mentioned above, is first of all just an ordinary bus network without any special features from a German PT-perspective. However, it is a very good example highlighting the use of different bus lines with differing frequencies and to combine them on joint corridors to give a maximum offer for the citizens.

If one takes a look at the main railway station as a major interchange node, one notices, as mentioned also above, that only a few, mainly regional bus lines terminate there while almost all urban bus services are just passing the stop (see picture C-32). The bus station at Trier main station again does not present anything fancy as the aerial view and the layout plan are indicating (see pictures C-33 and 34). Visible, however, is that rather few platforms are needed to serve a quite intensive bus traffic. The central island platform (stop 4 and 5) is dealing with the complete urban bus traffic while the other platforms are mainly used by regional bus services.

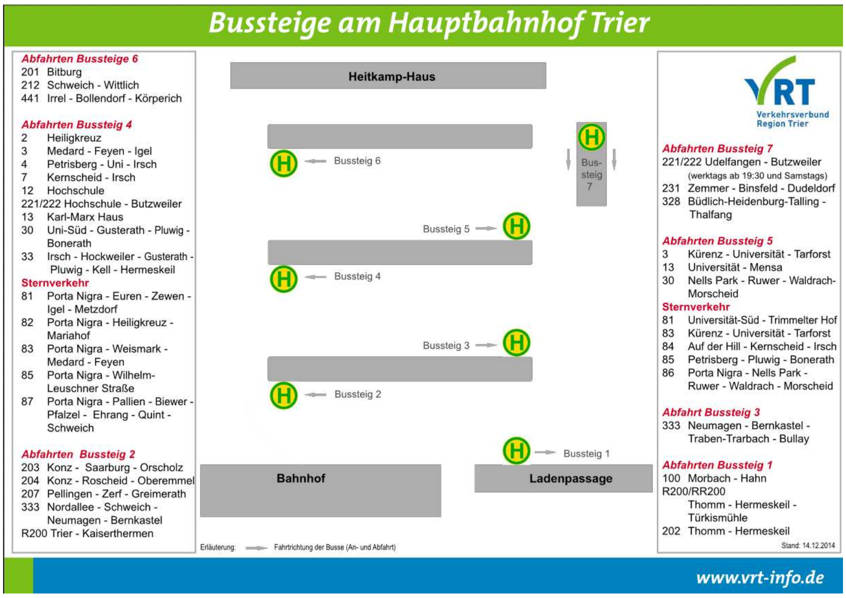


Picture C-32: Network plan Trier (excerpt)

Source: SWT

Picture C-33: Aerial view Trier Main Railway Station

Source: Google Earth



Picture C-34: Organisation of bus stops at Trier Main Railway station

Source: VRT

Timetable excerpts for urban bus lines passing the railway station are given below in pictures C-35a to C-35f. Visible is that some of the bus lines operate with nothing more than a 30min frequency, certainly not what one would call immediately a HQ-offer or best practice. Some of the lines are dealing with university traffic (in 10min frequency!) and are only running during the operation times of the university.

However, when looking at the departure times at one particular stop, eg the main station, direction towards Porta Nigra, one notices weekday peak hour departures as follows:

Minutes 01, 04, 09, 14, 17, 19, 24, 27, 29, 31, 34 etc

This means there is a departure every 2-5min!

2 Heiligkreuz - Konstantin Basilika - Balduinsbrunnen/Hbf. - Porta Nigra - Pallien - Euren - Zewen SWT

	Montag - Freitag										
Beschränkungen						S					
Heiligkreuz, Trevererstraße	6.40	7.10	alle	12.10	12.40		13.10	13.40	alle	17.40	18.10
- Werdingstraße	6.41	7.11	30	12.11	12.41		13.11	13.41	30	17.41	18.11
- Adolph-Kolping-Straße	6.41	7.11	Min	12.11	12.41		13.11	13.41	Min	17.41	18.11
- An der Ziegelei	6.42	7.12		12.12	12.42		13.12	13.42		17.42	18.12
- Franz-Buß-Straße	6.43	7.13		12.13	12.43		13.13	13.43		17.43	18.13
- Straßburger Allee	6.44	7.14		12.14	12.44		13.14	13.44		17.44	18.14
- Am Kiewelsberg	6.45	7.15		12.15	12.45		13.15	13.45		17.45	18.15
- Rotbachstraße	6.46	7.16		12.16	12.46		13.16	13.46		17.46	18.16
- Wisportstraße	6.47	7.17		12.17	12.47		13.17	13.47		17.47	18.17
- Im Hopfengarten	6.47	7.17		12.17	12.47		13.17	13.47		17.47	18.17
- Bernhardstr.	6.48	7.18		12.18	12.48		13.18	13.48		17.48	18.18
- Metzer Allee	6.49	7.19		12.19	12.49		13.19	13.49		17.49	18.19
Trier, Kaiserthermen	6.51	7.21		12.21	12.51	13.06	13.21	13.51		17.51	18.21
- Stadtbibliothek	6.52	7.22		12.22	12.52	13.07	13.22	13.52		17.52	18.22
- Konstantin Basilika	6.53	7.23		12.23	12.53	13.08	13.23	13.53		17.53	18.23
- Mustorstraße	6.54	7.24		12.24	12.54	13.09	13.24	13.54		17.54	18.24
- SWT Stadtwerke	6.55	7.25		12.25	12.55	13.10	13.25	13.55		17.55	18.25
- Balduinsbrunnen/Hbf	6.57	7.27		12.27	12.57	13.12	13.27	13.57		17.57	18.27
- Theodor-Heuss-Allee	6.58	7.28		12.28	12.58	13.13	13.28	13.58		17.58	18.28
- Porta Nigra (Stg. 8)	7.00	7.30		12.30	13.00	13.15	13.30	14.00		18.00	18.30
- Treviris (Stg. 4)	7.01	7.31		12.31	13.01	13.16	13.31	14.01		18.01	18.31
- Bruchhausenstraße	7.02	7.32		12.32	13.02	13.17	13.32	14.02		18.02	18.32
- Zurlaubener Ufer	7.04	7.34		12.34	13.04	13.19	13.34	14.04		18.04	18.34
Pallien, Bitburger Straße	7.06	7.36		12.36	13.06	13.21	13.36	14.06		18.06	18.36
- Augustastraße	7.07	7.37		12.37	13.07	13.22	13.37	14.07		18.07	18.37
- Römerstraße	7.07	7.37		12.37	13.07	13.22	13.37	14.07		18.07	18.37
Trier-West, Steinsweg	7.08	7.38		12.38	13.08	13.23	13.38	14.08		18.08	18.38
- Markusstraße	7.09	7.39		12.39	13.09	13.24	13.39	14.09		18.09	18.39
- Hohensteinstraße	7.10	7.40		12.40	13.10	13.25	13.40	14.10		18.10	18.40
- Trierweilerweg	7.10	7.40		12.40	13.10	13.25	13.40	14.10		18.10	18.40
- Blücherstraße	7.11	7.41		12.41	13.11	13.26	13.41	14.11		18.11	18.41
- Tempelweg	7.12	7.42		12.42	13.12	13.27	13.42	14.12		18.12	18.42
- Spirostraße	7.12	7.42		12.42	13.12	13.27	13.42	14.12		18.12	18.42
Euren, Lenus-Mars-Straße	7.13	7.43		12.43	13.13	13.28	13.43	14.13		18.13	18.43
- Ludwig-Steinbach-Straße	7.14	7.44		12.44	13.14	13.29	13.44	14.14		18.14	18.44
- Hontheimstraße	7.15	7.45		12.45	13.15	13.30	13.45	14.15		18.15	18.45
- Eisenbahnstraße	7.16	7.46		12.46	13.16	13.31	13.46	14.16		18.16	18.46
Zewen, Diedenhofener Straße	7.18	7.48		12.48	13.18	13.33	13.48	14.18		18.18	18.48
- Gottbillstraße (Stg. 2)	7.19	7.49		12.49	13.19	13.34	13.49	14.19		18.19	18.49
- Monaiser Straße	7.20	7.50		12.50	13.20	13.35	13.50	14.20		18.20	18.50
- Im Siebenborn	7.21	7.51		12.51	13.21	13.36	13.51	14.21		18.21	18.51
- Kantstraße (Stg. 2)	7.22	7.52		12.52	13.22	13.37	13.52	14.22		18.22	18.52
- Friedhof	7.24	7.54		12.54	13.24	13.39	13.54	14.24		18.24	18.54

ZEICHENERKLÄRUNG: S = nur an Schultagen

Montag-Freitag im Frühverkehr bis 6:45 Uhr und ab 18:45 Uhr, am Samstag und Sonn-/u. Feiertag siehe Sternbusverkehr, Linien 81 - 87

In den Schulferien / Rosenmontag / Fastnachtdienstag / 06. Mai 2016 / 27. Mai 2016 entfallen die Fahrten, die an Schultagen verkehren.

Picture C-35a: Bus line 2 Trier timetable

Source: SWT/VRT

3 Tarforst - Weidengraben - Universität - Hauptbahnhof - Porta Nigra - Karl Marx Haus - Feyen - Zewen - Igel - Liersberg - Metzdorf SWT

	Montag - Freitag																				
Beschränkungen			S			S			S												
Hinweise			SB			SB			SB												
Tarforst, Ludwig-Erhard-Ring		6.44			7.04			7.24			7.44		8.04		8.24		8.44		9.04		9.24
- Karl-Carstens-Straße		6.45			7.05			7.25			7.45		8.05		8.25		8.45		9.05		9.25
- An der Pferdsweide		6.46			7.06			7.26			7.46		8.06		8.26		8.46		9.06		9.26
- Andreasstraße		6.47			7.07			7.27			7.47		8.07		8.27		8.47		9.07		9.27
- Tarforster Straße (Stg. 3)		6.49			7.09			7.29			7.49		8.09		8.29		8.49		9.09		9.29
Kürenz, Am Weidengraben (E)	6.39	|		6.59	|		7.19	|		7.39	|	7.59	|	8.19	|	8.39	|	8.59	|	9.19	|
Tarforst, Universität	6.42	6.52		7.02	7.12		7.22	7.32		7.42	7.52	8.02	8.12	8.22	8.32	8.42	8.52	9.02	9.12	9.22	9.32
Kürenz, Kohlenstraße (Stg. 1)	6.43	6.53		7.03	7.13		7.23	7.33		7.43	7.53	8.03	8.13	8.23	8.33	8.43	8.53	9.03	9.13	9.23	9.33
- Bonifatiusstraße	6.44	6.54		7.04	7.14		7.24	7.34		7.44	7.54	8.04	8.14	8.24	8.34	8.44	8.54	9.04	9.14	9.24	9.34
- Avelerhof	6.45	6.55		7.05	7.15		7.25	7.35		7.45	7.55	8.05	8.15	8.25	8.35	8.45	8.55	9.05	9.15	9.25	9.35
- Im Avelertal	6.46	6.56		7.06	7.16		7.26	7.36		7.46	7.56	8.06	8.16	8.26	8.36	8.46	8.56	9.06	9.16	9.26	9.36
- Kolonnenweg	6.47	6.57		7.07	7.17		7.27	7.37		7.47	7.57	8.07	8.17	8.27	8.37	8.47	8.57	9.07	9.17	9.27	9.37
- Domänenstraße	6.48	6.58		7.08	7.18		7.28	7.38		7.48	7.58	8.08	8.18	8.28	8.38	8.48	8.58	9.08	9.18	9.28	9.38
- Arnoldistraße (Stg. 1)	6.49	6.59		7.09	7.19		7.29	7.39		7.49	7.59	8.09	8.19	8.29	8.39	8.49	8.59	9.09	9.19	9.29	9.39
- Nellstraße	6.50	7.00		7.10	7.20		7.30	7.40		7.50	8.00	8.10	8.20	8.30	8.40	8.50	9.00	9.10	9.20	9.30	9.40
- Schönbornstraße	6.51	7.01		7.11	7.21		7.31	7.41		7.51	8.01	8.11	8.21	8.31	8.41	8.51	9.01	9.11	9.21	9.31	9.41
- Kürenzer Straße	6.52	7.02		7.12	7.22		7.32	7.42		7.52	8.02	8.12	8.22	8.32	8.42	8.52	9.02	9.12	9.22	9.32	9.42
Trier, Hauptbahnhof (Stg. 4)	6.54	7.04	7.04	7.14	7.24	7.24	7.34	7.44	7.44	7.54	8.04	8.14	8.24	8.34	8.44	8.54	9.04	9.14	9.24	9.34	9.44
- Balduinsbrunnen/Hbf	6.56	7.06	7.06	7.16	7.26	7.26	7.36	7.46	7.46	7.56	8.06	8.16	8.26	8.36	8.46	8.56	9.06	9.16	9.26	9.36	9.46
- Theodor-Heuss-Allee	6.57	7.07	7.07	7.17	7.27	7.27	7.37	7.47	7.47	7.57	8.07	8.17	8.27	8.37	8.47	8.57	9.07	9.17	9.27	9.37	9.47
- Porta Nigra (Stg. 7)	6.59	7.09	7.09	7.19	7.29	7.29	7.39	7.49	7.49	7.59	8.09	8.19	8.29	8.39	8.49	8.59	9.09	9.19	9.29	9.39	9.49
- Treviris	7.00	7.10	7.10	7.20	7.30	7.30	7.40	7.50	7.50	8.00	8.10	8.20	8.30	8.40	8.50	9.00	9.10	9.20	9.30	9.40	9.50
- Nikolaus-Koch-Platz	7.02	7.12	7.12	7.22	7.32	7.32	7.42	7.52	7.52	8.02	8.12	8.22	8.32	8.42	8.52	9.02	9.12	9.22	9.32	9.42	9.52
- Trier Galerie	7.03	7.13	7.13	7.23	7.33	7.33	7.43	7.53	7.53	8.03	8.13	8.23	8.33	8.43	8.53	9.03	9.13	9.23	9.33	9.43	9.53
- Karl-Marx-Haus	7.04	7.14	7.14	7.24	7.34	7.34	7.44	7.54	7.54	8.04	8.14	8.24	8.34	8.44	8.54	9.04	9.14	9.24	9.34	9.44	9.54

Picture C-35b: Bus line 3 Trier timetable

Source: SWT/VRT

4 Porta Nigra - Hauptbahnhof - Gartenfeld - Petrisberg - Uni Campus 2 - Universität - Filsch - Irsch SWT

	Montag - Freitag													
Beschränkungen		U	S				U		U					
Trier, Porta Nigra (Stg. 1)	7.15	7.40		7.45	8.15	8.45	9.15	9.15	9.45	9.45	10.15	alle	17.45	18.15
- Hauptbahnhof (Stg. 4)	7.18	7.43		7.48	8.18	8.48	9.18	9.18	9.48	9.48	10.18	30	17.48	18.18
- Balduinsbrunnen/Hbf	7.20	7.45		7.50	8.20	8.50	9.20	9.20	9.50	9.50	10.20	Min	17.50	18.20
- SWT Stadtwerke	7.21	7.46		7.51	8.21	8.51	9.21	9.21	9.51	9.51	10.21		17.51	18.21
- Gartenfeldstraße	7.23	|		7.53	8.23	8.53	|	9.23	|	9.53	10.23		17.53	18.23
- Helenenstraße	7.24	|		7.54	8.24	8.54	|	9.24	|	9.54	10.24		17.54	18.24
- Kurfürstenstraße	7.25	|		7.55	8.25	8.55	|	9.25	|	9.55	10.25		17.55	18.25
- Schützenstraße	7.26	|		7.56	8.26	8.56	|	9.26	|	9.56	10.26		17.56	18.26
Tarforst, Petrisberg Aussicht	7.29	7.52		7.59	8.29	8.59	9.27	9.29	9.57	9.59	10.29		17.59	18.29
Trier, Petrisberg	7.30	7.53	7.55	8.00	8.30	9.00	9.28	9.30	9.58	10.00	10.30		18.00	18.30
Tarforst, Am Wasserturm	7.31	7.54	7.56	8.01	8.31	9.01	9.29	9.31	9.59	10.01	10.31		18.01	18.31
Kürenz, Am Wissenschaftspark	7.32	7.55	7.57	8.02	8.32	9.02	9.30	9.32	10.00	10.02	10.32		18.02	18.32
- Kuno-Stapel-Straße	7.33	7.56	7.58	8.03	8.33	9.03	9.31	9.33	10.01	10.03	10.33		18.03	18.33
- Martin-Schunck-Straße	7.34	7.57	7.59	8.04	8.34	9.04	9.32	9.34	10.02	10.04	10.34		18.04	18.34
- Universität, Campus 2	7.35	7.58	|	8.05	8.35	9.05	9.33	9.35	10.03	10.05	10.35		18.05	18.35
- Behringstraße	7.36		8.00	8.06	8.36	9.06		9.36		10.06	10.36		18.06	

Picture C-35c: Bus line 4 Trier timetable

Source: SWT/VRT

7 Irsch - Kernscheid - Hill - Konstantin Basilika - Balduinsbr./Hbf - Porta Nigra - Pallien - Biewer - Pfalzel - Trierer Hafen — SWT

	Montag - Freitag							
Irsch, Hockweiler Straße (Stg. 1)	6.47	7.17	alle	15.47	16.17	16.47	17.17	17.47
- Fandelborn	6.48	7.18	30	15.48	16.18	16.48	17.18	17.48
- Propstei	6.50	7.20	Min	15.50	16.20	16.50	17.20	17.50
- Georgstraße	6.51	7.21		15.51	16.21	16.51	17.21	17.51
- Abzw. Irsch	6.51	7.21		15.51	16.21	16.51	17.21	17.51
- Mühlenstraße	6.52	7.22		15.52	16.22	16.52	17.22	17.52
- Irscher Berg	6.53	7.23		15.53	16.23	16.53	17.23	17.53
- Irscher Mühle	6.54	7.24		15.54	16.24	16.54	17.24	17.54
Kernscheid, Kirche	6.56	7.26		15.56	16.26	16.56	17.26	17.56
- Stefan-Andres-Straße	6.57	7.27		15.57	16.27	16.57	17.27	17.57
- Jakob-Kneip-Straße	6.58	7.28		15.58	16.28	16.58	17.28	17.58
- Zum Hellberg	6.59	7.29		15.59	16.29	16.59	17.29	17.59
- Höhenweg 2	7.01	7.31		16.01	16.31	17.01	17.31	18.01
- Höhenweg 1	7.02	7.32		16.02	16.32	17.02	17.32	18.02
Olewig, Caspar-Olevian-Straße	7.03	7.33		16.03	16.33	17.03	17.33	18.03
- Auf der Hill	7.04	7.34		16.04	16.34	17.04	17.34	18.04
- St. Anna Straße	7.05	7.35		16.05	16.35	17.05	17.35	18.05
- Tiergarten	7.07	7.37		16.07	16.37	17.07	17.37	18.07
Trier, Amphitheater	7.08	7.38		16.08	16.38	17.08	17.38	18.08
- Charlottenstraße	7.09	7.39		16.09	16.39	17.09	17.39	18.09
- Kaiserthermen	7.11	7.41		16.11	16.41	17.11	17.41	18.11
- Stadtbibliothek	7.12	7.42		16.12	16.42	17.12	17.42	18.12
- Konstantin Basilika	7.13	7.43		16.13	16.43	17.13	17.43	18.13
- Mustorstraße	7.14	7.44		16.14	16.44	17.14	17.44	18.14
- SWT Stadtwerke	7.15	7.45		16.15	16.45	17.15	17.45	18.15
- Balduinsbrunnen/Hbf	7.17	7.47		16.17	16.47	17.17	17.47	18.17
- Theodor-Heuss-Allee	7.18	7.48		16.18	16.48	17.18	17.48	18.18
- Porta Nigra (Stg. 8)	7.20	7.50		16.20	16.50	17.20	17.50	18.20
- Treviris (Stg. 4)	7.21	7.51		16.21	16.51	17.21	17.51	18.21
- Bruchhausenstraße	7.22	7.52		16.22	16.52	17.22	17.52	18.22

Picture C-35d: Bus line 7 Trier timetable

Source: SWT/VRT

12 Hauptbahnhof - Porta Nigra - Hochschule Trier — SWT

	Montag - Freitag																				
Beschränkungen																					
Trier, Hauptbahnhof (Stg. 4)	7.04	7.19	7.29	7.34	8.04	8.34	8.44	9.04	9.14	9.19	9.34	9.44	10.04	10.14	10.34		11.04	11.14	11.34	11.44	
- Balduinsbrunnen/Hbf	7.06	7.21	7.31	7.36	8.06	8.36	8.46	9.06	9.16	9.21	9.36	9.46	10.06	10.16	10.36		11.06	11.16	11.36	11.46	
- Theodor-Heuss-Allee	7.07	7.22	7.32	7.37	8.07	8.37	8.47	9.07	9.17	9.22	9.37	9.47	10.07	10.17	10.37		11.07	11.17	11.37	11.47	
- Porta Nigra (Stg. 5)	7.09	7.24	7.34	7.39	8.09	8.39	8.49	9.09	9.19	9.24	9.39	9.49	10.09	10.19	10.39	10.49	11.09	11.19	11.39	11.49	12.19
- Nordallee/Krankenhaus	7.11	7.26	7.36	7.41	8.11	8.41	8.51	9.11	9.21	9.26	9.41	9.51	10.11	10.21	10.41	10.51	11.11	11.21	11.41	11.51	12.21
- Zurlaubener Ufer	7.13	7.28	7.38	7.43	8.13	8.43	8.53	9.13	9.23	9.28	9.43	9.53	10.13	10.23	10.43	10.53	11.13	11.23	11.43	11.53	12.23
Pallien, Bitburger Straße	7.15	7.30	7.40	7.45	8.15	8.45	8.55	9.15	9.25	9.30	9.45	9.55	10.15	10.25	10.45	10.55	11.15	11.25	11.45	11.55	12.25
- Hochschule Trier (Stg. 2)	7.17	7.32	7.42	7.47	8.17	8.47	8.57	9.17	9.27	9.32	9.47	9.57	10.17	10.27	10.47	10.57	11.17	11.27	11.47	11.57	12.27
- Hochschule Trier (Stg. 1)				7.47			8.57		9.27	9.32		9.57		10.27		10.57		11.27		11.57	12.27

Picture C-35e: Bus line 12 Trier timetable

Source: SWT/VRT

13 Uni Mensa - Kürenz - Hauptbahnhof - Porta Nigra - Karl Marx Haus — SWT

nur an Vorlesungstagen der Universität Trier

	Montag - Freitag																			
Tarforst, Universität Mensa	7.55	8.05	8.15	8.25	8.35	8.45	8.55	9.05	9.15	9.25	9.35	9.45	9.55	10.05	10.15	10.25	10.35	10.45	10.55	11.05	11.15
- Universität	7.57	8.07	8.17	8.27	8.37	8.47	8.57	9.07	9.17	9.27	9.37	9.47	9.57	10.07	10.17	10.27	10.37	10.47	10.57	11.07	11.17
Kürenz, Kohlenstraße (Stg. 1)	7.58	8.08	8.18	8.28	8.38	8.48	8.58	9.08	9.18	9.28	9.38	9.48	9.58	10.08	10.18	10.28	10.38	10.48	10.58	11.08	11.18
- Bonifatiusstraße	7.59	8.09	8.19	8.29	8.39	8.49	8.59	9.09	9.19	9.29	9.39	9.49	9.59	10.09	10.19	10.29	10.39	10.49	10.59	11.09	11.19
- Avelerhof	8.00	8.10	8.20	8.30	8.40	8.50	9.00	9.10	9.20	9.30	9.40	9.50	10.00	10.10	10.20	10.30	10.40	10.50	11.00	11.10	11.20
- Im Avelertal	8.01	8.11	8.21	8.31	8.41	8.51	9.01	9.11	9.21	9.31	9.41	9.51	10.01	10.11	10.21	10.31	10.41	10.51	11.01	11.11	11.21
- Kolonnenweg	8.02	8.12	8.22	8.32	8.42	8.52	9.02	9.12	9.22	9.32	9.42	9.52	10.02	10.12	10.22	10.32	10.42	10.52	11.02	11.12	11.22
Trier, Franz-Georg-Straße	8.05	8.15	8.25	8.35	8.45	8.55	9.05	9.15	9.25	9.35	9.45	9.55	10.05	10.15	10.25	10.35	10.45	10.55	11.05	11.15	11.25
Kürenz, Kürenzer Straße	8.07	8.17	8.27	8.37	8.47	8.57	9.07	9.17	9.27	9.37	9.47	9.57	10.07	10.17	10.27	10.37	10.47	10.57	11.07	11.17	11.27
Trier, Hauptbahnhof (Stg. 4)	8.09	8.19	8.29	8.39	8.49	8.59	9.09	9.19	9.29	9.39	9.49	9.59	10.09	10.19	10.29	10.39	10.49	10.59	11.09	11.19	11.29
- Theodor-Heuss-Allee	8.12	8.22	8.32	8.42	8.52	9.02	9.12	9.22	9.32	9.42	9.52	10.02	10.12	10.22	10.32	10.42	10.52	11.02	11.12	11.22	11.32
- Porta Nigra (Stg. 9)	8.14	8.24	8.34	8.44	8.54	9.04	9.14	9.24	9.34	9.44	9.54	10.04	10.14	10.24	10.34	10.44	10.54	11.04	11.14	11.24	11.34
- Treviris	8.15	8.25	8.35	8.45	8.55	9.05	9.15	9.25	9.35	9.45	9.55	10.05	10.15	10.25	10.35	10.45	10.55	11.05	11.15	11.25	11.35
- Nikolaus-Koch-Platz	8.17	8.27	8.37	8.47	8.57	9.07	9.17	9.27	9.37	9.47	9.57	10.07	10.17	10.27	10.37	10.47	10.57	11.07	11.17	11.27	11.37
- Karl-Marx-Haus	8.19	8.29	8.39	8.49	8.59	9.09	9.19	9.29	9.39	9.49	9.59	10.09	10.19	10.29	10.39	10.49	10.59	11.09	11.19	11.29	11.39

Uni-Vorlesungszeiten: WiSe 15/16 = bis 26.10.-18.12.15 / 04.01.-19.02.16 / SoSe16 = 11.04.-13.05. / 23.05.-15.07.16 / WiSe16/17 = 24.10.-23.12.16 / 07.01.-17.02.17
Montag-Freitag im Frühverkehr bis 6:45 Uhr und ab 18:45 Uhr, am Samstag und Sonn-/u. Feiertag siehe Sternbusverkehr, Linien 81 - 87
Am 24., 31.12. und Rosenmontag gilt der Samstagfahrplan
Den Linienverlauf mit allen Haltestellen siehe Liniennetzplan.
Vorlesungszeiten ohne Gewähr

Picture C-35f: Bus line 13 Trier timetable

Source: SWT/VRT

Even if the Trier network as such may not fulfil HITRANS-requirements, owning quite some lines in a rather complex network, some of the lines not with dense frequencies, it gives a decent “city offer” to the citizens for reasonable cost. And the timetable approach allows good interchange quality from the railway with little waiting times – at the same time not requiring extensive bus terminal infrastructure.

D Summary, conclusions and recommendations

The aims of Sandnes municipality in connection with the benchmarking study have been to gather information to support the development of its Local Transport and Mobility Plan, to help broker good public transport solutions with Rogaland Fylkeskommune and to support strategies to achieve the "zero growth" target.

The study delivers twofold information:

- a classic, quantitative benchmarking,
- a collection of more qualitative best practice examples.

Benchmarking

The benchmarking consists basically of three parts:

- Updating the 2008 benchmarking for Nord Jaeren in a reduced format,
- Comparing Sandnes with Nord Jaeren as a total,
- Comparing Sandnes with other comparable cities / city regions.

The following conclusions can be drawn:

- Results appear plausible with regard to other benchmarking sources, eg in regard of PT-growth required to fulfill "zero growth" targets.

So far as Nord Jæren is concerned:

- The results of an earlier benchmarking for Nord Jaeren performed in 2008 are principally confirmed, results for Nord Jaeren have even worsened.
- While vehicle-kms as the parameter describing the offer for the population have stayed on about the same level, passenger numbers show a decline and therefore also the efficiency expressed by a ratio of trips per vehicle-km has decreased.
- Efficiency results are at the low end of what appear to be standard results for pure bus schemes.
- All Norwegian cases (Nord Jaeren, Bergen and Trondheim) confirm again that the input / offer level is very high (vehicle-kms spent) while the output / patronage (passengers / trips) level is too low compared to the input level. However, Bergen and Trondheim show patronage increases while Nord Jaeren appears with a negative trend in this regard.

So far as Sandnes is concerned:

- The comparison of Sandnes with Nord Jaeren allows the conclusion that Sandnes comes along with a lower offer level and correlating lower patronage (per inhabitant), resulting in efficiency being principally on the same level as Nord Jaeren as a whole.

- However, it appears that Sandnes has in recent years shown a passenger increase while Stavanger and Sola have faced decreasing patronage.
- The comparison of Sandnes with other bus cities in Norway and Europe reveals that the offer level, even if relatively low for Norway, is still higher than the apparent average.
- Patronage per inhabitant for Sandnes appears average, efficiency (trips per vehicle-km) at the low end.

It appears recommended for both Sandnes and Nord Jaeren to look deeper into possible reasons for the obvious differences. Settlement density may not be the only reason. Network configuration and the principal attitude to intermodality (integration of rail and bus services) could be other reasons which are outlined within the scope of this study only by presenting alternative approaches ("best practice"). The fare and zone systems could also be of bigger influence – this hasn't been touched here at all.

Data review has revealed an important issue in regard of the share of internal traffic in Sandnes and connected to this the number of interchanging passengers at Sandnes S / Ruten. It is recommended to investigate in more detail in complete trip chains to better understand travel behaviour and resulting needs of today's and -even more important- potential future passengers.

Best practice

The best practice part of the report concentrated on four main themes:

- Network and stop configuration
- Role and layout of interchanges
- Scope for central bus stations
- Timetable issues

Understandably these themes are well interwoven.

Best practice examples have been dominatingly taken from the benchmarking cities in this report but some other examples have been also included. It should be understood that the number of examples had to face some limitation in this study and a deeper look would recommend including some more.

Results can be summarized as follows:

- Network principles as eg presented within the HITRANS project are useful but aren't used (shouldn't be used) in a dogmatic way. Local conditions (eg topography, city structure etc) will also have major influence.
- French approaches appear less speed oriented but focus much more on accessibility, means that it is seen as crucial that any HQ-system be it tramway or busway is

serving first of all the major attractivity nodes in a region (railway station, city centre, hospital, university etc).

- It also appears that neither the size of offer nor the implementation of large infrastructure alone will automatically lead to success – the complete package decides.
- Several cities make evident that even in rather small cities / agglomerations there is a clearly distinguished city and regional bus offer with dedicated branding.
- Urban bus networks are -depending on size- based on either through running lines not requiring a real terminal infrastructure (bigger cities) or on rendezvous principles (smaller cities, eg STADTBUS approach).
- Independent from a terminal strategy there is a clear message in regard of intermodality and integrated railway and bus services which are offered to the citizens as a joint offer (with bus services often clearly adapted to the rail offer).
- Also independent from the terminal strategy appears to be the favouring of operational concepts which combine different bus lines on joint network sections to gain denser frequencies.
- High quality interchange nodes are to be seen as a crucial part of PT-networks; if they are established the focus needs to be on both attractive infrastructure (eg short ways for passengers, easy to understand, offering add-on services which allow for the productive use of “waiting times”) and suited timetable configurations allowing reliable connections, the latter supported by quality information for passengers.
- Even if not discussed further in the report it should be understood that in most countries presented in the benchmarking the local municipality (or agglomeration) owns the political powers to organize city bus operations as they want to see them in place for their city. Only regional bus transport is in the responsibility of counties or regions.
- Another organizational difference is visible in regard of the function of PTAs as umbrella organisations ensuring timetable and fare integration across the “borders” of railway and urban transport.

From a Sandnes perspective, several of the findings documented in this report appear as suited to be used in upcoming planning steps. This would be especially so when it comes to the future layout of the Stavanger S / Ruten interchange node and the configuration of the urban bus services in Sandnes to assist in achieving a growth in public transport, contributing to a better city and the achievement of the ‘zero growth’ target.

Karlsruhe, 14.04.2016 Axel Kuehn

Annex 1

Short descriptions of case study cities / agglomerations (Nord Jaeren focus)

Nord Jaeren

Nord Jaeren is an agglomeration in the Norwegian county of Rogaland. It has a population of 240300. The area size is 448km² (land only) which results in an average density of 535 inhabitants / km². The SSB-definition applied for the “Stavanger agglomeration” includes the municipalities of Stavanger, Sandnes, Sola and Randaberg.

For the built up areas (“tettsteder”) in the four cities SSB delivers 210874 inhabitants and 73km² area size which would result in an average density of 2880 inhabitants/km².

Consistent with SSB, which also uses the complete population for calculating population related ratios, a population of 240000 has been used for Nord Jaeren in the benchmarking.

It is to be noted that the 2008 benchmarking used locally furnished, non-SSB data both for population and vehicle-kms / patronage. SSB-data being used consequently as a basis for the 2016 benchmarking, required a re-calculation of the 2008 results with SSB-data of 2007. This showed some differences for the 2008 results which are largely reasoned by the different area definitions (for Bergen and Trondheim). See also in the main report where the different results are visualized.

Nord Jaeren’s two main cities Stavanger and Sandnes are connected to the main railway line from Stavanger to Egersund (“Jaerbanen”) which connects further to Kristiansand and Oslo. The Stavanger – Sandnes corridor has been extended to complete double track and is operated with a 15min frequency. The railway appears well used but with scope for better integration with the bus offer (and vice versa).

Some ferry services compliment the regional PT-offer.

The Nord Jaeren bus network which is currently in an upgrading process to see a busway concept replacing earlier tramway and tramtrain (Kombibane) plans.

The bus offer appears as both regional and urban but with out any clear separation or branding. The network is oriented to two bus terminals in Stavanger and Sandnes which are both located in the vicinity of the railway stations. The huge business area of Forus which has been established rather artificially outside the three centres of Stavanger, Sandnes and Sola over the last 30 years presents a huge challenge for the public transport services in Nord Jaeren. Other challenges are the university area and the to be relocated hospital area which are outside the main rail and road axes.

The offer was amounting to 13.166 Mio vehicle-kms in 2014; the resulting patronage is given with 15.87 Mio passengers / trips (both according SSB-statistics). Rogaland Fylkeskommune sources indicate slightly different numbers (e.g. 16.6 Mio passengers / trips in 2014 for Stavanger, Sandnes, Sola).

To allow comparisons with other Norwegian agglomerations and cities the SSB-numbers have been used within the benchmarking.

Use in the report: Benchmarking (focus agglomeration)
Link: https://www.kolumbus.no/

Bergen

Bergen is a harbour city in the Hordaland county at the west coast and the second biggest city in Norway. It has a population of 272000 (2014). With an area size of 445km² (land only) the average density is 586 inhabitants / km².

The SSB-definition applied for the "Bergen agglomeration" includes the municipalities of Bergen, Askøy, Fjell and Os (also known as "Bergensområdet"). The population for this area (2014) has been 342000; the area size was about 850km² which results in average density of 402 inhabitants / km².

Consistent with SSB, which also uses the complete population (and not only "tettsteder") for calculating population related ratios, a population of 342000 has been used for Bergen in the benchmarking.

It is to be noted that the 2008 benchmarking used locally furnished, non-SSB data both for population and vehicle-kms / patronage. SSB-data being used consequently as a basis for the 2016 benchmarking, required a re-calculation of the 2008 results with SSB-data of 2007. This showed some differences for the 2008 results which are largely reasoned by the different area definitions (for Bergen and Trondheim). See also in the main report where the different results are visualized.

Bergen is connected to Oslo by a main railway line.

Some ferry services compliment the regional PT-offer.

The Bergen light rail system has been opened in 2010 with a first section to Nesttun (10km) and since extended further to Flesland airport. Even with the light rail system in place and possibly to be extended further in other corridors, the PT-network is still largely dependent on bus services which are oriented to a central bus terminal in Bergen in the neighbourhood of the main railway station and several sub-urban terminals.

The offer was amounting to 29.066 Mio vehicle-kms in 2014; the resulting patronage is given with 37.275 Mio passengers / trips (both according SSB-statistics). Local data (SKYSS) indicates other and higher numbers (45.5 Mio passengers / trips for “Bergensområdet”) of which Bergen Bybane had 9.4 Mio passengers / trips in 2014. Bybane passenger numbers have been increasing strongly since 2010.

To allow comparisons with other Norwegian agglomerations and cities the SSB-numbers have been used within the benchmarking.

Use in the report: Benchmarking
Link: https://www.skyss.no/

Trondheim

Trondheim is a harbour city in the Sør Trøndelag county at the west coast and the third biggest city in Norway. It has a population of 182000 (2014). With an area size of 342km² (land only) the average density is 534 inhabitants / km².

The SSB-definition applied for the “Trondheim agglomeration” includes the municipalities of Trondheim, Klæbu and Malvik. The population for this area (2014) has been 202000; the area size was about 687km² which results in average density of 294 inhabitants / km².

Consistent with SSB, which also uses the complete population (and not only “tettsteder”) for calculating population related ratios, a population of 202000 has been used for Trondheim in the benchmarking.

It is to be noted that the 2008 benchmarking used locally furnished, non-SSB data both for population and vehicle-kms / patronage. SSB-data being used consequently as a basis for the 2016 benchmarking, required a re-calculation of the 2008 results with SSB-data of 2007. This showed some differences for the 2008 results which are largely reasoned by the different area definitions (for Bergen and Trondheim). See also in the main report where the different results are visualized.

Trondheim is connected to Oslo by a main railway line.

Some ferry services compliment the regional PT-offer

There exists one sub-urban tramway line which, however, does play only a minor role within the wider PT-network. There are plans to develop a so-called “Superbuss” concept (busway) in the next years.

The offer was amounting to 13.483 Mio vehicle-kms in 2014; the resulting patronage is given with 23.26 Mio passengers / trips (both according SSB-statistics).

Use in the report: Benchmarking

Link: https://www.atb.no/

Bremerhaven

Bremerhaven is a German harbour city of 110121 population at the mouth of the Weser river in the state of Bremen. It was historically the biggest fishery harbour in Germany and also having an important shipbuilding industry. Today one of Germany's biggest container terminals is located there.The area size is about 94km² which results in an average density of 1174 inhabitants / km². An exchange of areas between Bremerhaven and Loxstedt in 2010 has also increased the Bremerhaven area size compared to earlier years.

Bremerhaven is connected to Bremen with a main railway line which has an important freight function. Passenger trai connections exist to Bremen (which connects further), Cuxhaven and Stade where connection to Hamburg is given.

A ferry service across the Weser to Nordenham complements the PT-network.

The urban PT-network crosses the city limits and serves a number of neighbouring municipalities. The population of this "service area agglomeration" is calculated as about 158000 – this number has been used for the benchmarking on agglomeration level (149000 had been calculated for the 2008 benchmarking). Area size for this region is about 470 km².

The PT-network is bus-based and appearing rather complex without a visible terminal function. Bus lines are operating with frequencies in a range of 15-30min with additional services in peak hours.

The statistical yearbook of Bremerhaven gives for 2014 3.64 Mio vehicle-kms and a patronage of 12.98 Mio passengers / trips. This is related to 20 bus lines with a total length of 325km. The data given on the website of Bremerhavenbus is 13.23 Mio patronage, also for 20 lines and 325km network. The latter source claims a service area of 470km² and a population of 325000! This source gives no vehicle-kms (only seat-kms) – the vehicle-kms are, however confirmed by the numbers in VDV-statistics.This area should likely include the regional bus lines, appears far too big and would not fit with the 2008 approach.

The network information on Bremerhavenbus webpage speaks of 16 lines which are grouped as "STADTBUS" and shows 11 (!) regional lines – there is some confusion to be admitted which can't be verified within the scope of this study.

The consultant has used the statistical yearbook data for the benchmarking.

Use in the report: Benchmarking

Link: www.bremerhavenbus.de/startseite/

Ingolstadt

Ingolstadt is a German city of 131000 population in the state of Bavaria. The area size is about 133km² which results in an average density of 982 inhabitants / km². Car industry (AUDI) is a major employer in the region which is also destination for a number of specific bus services.

Ingolstadt is connected to the main railway network being located at the Nuremberg-Munich corridor; other connections are to Augsburg, Regensburg and Treuchtlingen. The city is served by two railway stations, the main station South of the Danube river and the North station on the Northern side.

The PT-network organised by the local PTA (INVG) crosses the city limits and serves a number of neighbouring municipalities. The population of this "service area agglomeration" is 248000 – this number has been used for the benchmarking on agglomeration level. This area covers about 840km² which results in an average density of 296 inhabitants / km².

The urban network alone is branded as STADTBUS Ingolstadt. It is responsible for about 70% of the scheduled services in the region.

Bus lines are operating, depending on their function, in a 15 – 60min frequency. The network is oriented towards a central bus terminal, but also the two railway stations own a certain node function. Most lines are operated as through lines by-passing these nodes.
The Audi factory complex is served by a number of stops and lines, some specifically adapted for this service.

The corridor North station – ZOB (central bus terminal) – Main Station appears as a backbone axe of the network which is served by about a dozen of bus lines!

The offer for the described network with both urban and regional function was 6.1 Mio vehicle-kms in 2014, resulting patronage was 14.34 Mio passengers / trips.

Link: http://www.invg.de/
http://www2.ingolstadt.de/Leben_in_Ingolstadt/Verkehr/Stadtbus_Ingolstadt_GmbH

Angers

Angers is a French city in the Pays de la Loire region about 300km west of Paris. The city itself has a population of 150000 (2013). With an area size of 42.7km² the resulting average density is 3500 inhabitants / km².

As explained in the main report, French "political" cities are usually rather small compared to cities in other European countries which is a result of missing mergers of smaller villages or integration in bigger "neighbours". Therefore the agglomeration of French cities is often more comparable with other cities in view of any benchmarkings. It is usually also identical with or near to the service area of the urban PT-network which is regularly organised on agglomeration level.

The agglomeration of Angers has a population of 272000 (2013). It consists of 33 municipalities which cover an area of 540km². The average density on agglomeration level is 504 inhabitants / km².

French national PT-statistics (Annuaire statistique: transports collectifs urbains; by CERTU) give very detailed information on the results of all French PT-operators including population in the service area of the netwoks. These numbers may differ from the actual city or agglomeration numbers. For Angers the population for 2012 is given with 273680 based on 33 municipalities while for the same year the population in the service area is given with 273550 (32 municipalities). To be consistent with other information from the same source this number has been used for the benchmarking.

Angers is linked to the main railway network and has direct connections to Paris and Nantes.

The PT-network consists since 2011 of one tramway line as the HQ-backbone system and an underlaying bus system, which has been re-arranged with the opening of the tramway. The network is oriented towards two interchange nodes at the main railway station and a second one near the city centre.

The tramway operates with an off peak frequency of 8-9 min and a peak hour frequency of 5-6 min. The bus lines operate, depending on their function, with a 10-20min frequency in the inner network while some outer parts see lower frequencies.

According to the statistics source given above the urban PT-system (bus + tram) offers 10.25 Mio vehicle-kms per year and gains about 30.6 Mio passengers / trips (2012). After a strong decrease during the construction phase of the tramway (26 Mio. in 2010!), patronage has been increasing since due to the new tramway offer. The input (vehicle-kms) has only increased slightly from about 9.8 Mio in 2010. Apparent is a rather high number of so-called free trips (“voyages gratuits”) which may be a result of a free city-centre shuttle. Taking this into account the results of the scheme seem less convincing.

Caen

Caen is a French city in the Normandy region. The city itself has a population of 107000 (2013). With an area size of 25.7km² the resulting average density is 4172 inhabitants / km².

As explained in the main report, French “political” cities are usually rather small compared to cities in other European countries which is a result of missing mergers of smaller villages or integration in bigger “neighbours”. Therefore the agglomeration of French cities is often more comparable with other cities in view of any benchmarkings. It is usually also identical with or near to the service area of the urban PT-network which is regularly organised on agglomeration level.

The agglomeration of Caen has a population of 236000 (2013). It consists of 35 municipalities which cover an area of 222km². The average density on agglomeration level is 1063 inhabitants / km².

French national PT-statistics (Annuaire statistique: transports collectifs urbains; by CERTU) give very detailed information on the results of all French PT-operators including population in the service area of the netwoks. These numbers may differ from the actual city or agglomeration numbers. For Caen the population for 2012 is given with 221878 based on 29 municipalities which in this case is identical with the population in the service area. To be consistent with other information from the same source this number has been used for the benchmarking.

Caen is linked to the main railway network and is located at the Paris – Cherbourg corridor. It has some node function for regional train services.

The urban bus network saw an upgrade in 2003 when one of the first, so-called rubber-tyre tramways has been introduced as line A and B (two lines overlapping in the centre; identical technology as in Nancy). As the vehicle technology is no more available for further extensions, one has decided to convert the scheme into a standard tramway.

The star shaped network sees almost all lines reaching the city centre with several corridors being used by several bus lines complimenting each other. Overlaps between the “tram” and standard buses are limited to some very central sections otherwise the bus network concentrates on other corridors.

The two tram lines operate with an 8min frequency each which results on a 4min frequency in the core section used by both lines. Maximum frequencies of other bus lines are 10min. Frequencies vary depending on the role of lines in the network.

According to the statistics source given above the urban PT-system (bus + tram) offers 9.13 Mio vehicle-kms per year and gains about 29.27 Mio passengers / trips (2012).

Use in the report: Benchmarking

Link: http://www.twisto.fr/

Douai

Douai is a French city in the Nord Pas de Calais Picardie region. The city itself has a population of 41200 (2013). With an area size of 16.9km² the resulting average density is 2437 inhabitants / km².

As explained in the main report, French "political" cities are usually rather small compared to cities in other European countries which is a result of missing mergers of smaller villages or integration in bigger "neighbours". Therefore the agglomeration of French cities is often more comparable with other cities in view of any benchmarkings. It is usually also identical with or near to the service area of the urban PT-network which is regularly organised on agglomeration level.

The agglomeration of Douai has a population of 152000 (2009?). It consists of 35 municipalities which cover an area of 236km². The average density on agglomeration level is 646 inhabitants / km².

French national PT-statistics (Annuaire statistique: transports collectifs urbains; by CERTU) give very detailed information on the results of all French PT-operators including population in the service area of the netwoks. These numbers may differ from the actual city or agglomeration numbers. For Douai the population for 2012 is given with 196060 based on 46 municipalities while for the same year the population in the service area is given with 193095 (45 municipalities). To be consistent with other information from the same source this number has been used for the benchmarking.

Douai is linked to the main railway network being located at the Paris-Lille corridor. It has direct connections with these cities and other cities in the region as Valenciennes, Arras, Cambrai etc.

Douai had progressed a busway system as an upgrade of the bus network since the mid-2000s. However, technology choice for the rolling stock led into huge homologation problems which delayed the opening for several years. Even when finally opened in 2010 the vehicles did never work as planned which has resulted to a complete replacement of rolling stock since 2014!

Network details are highlighted in the main report.

According to the statistics source given above the urban PT-system offers 3.69 Mio vehicle-kms per year and gains about 4.76 Mio passengers / trips (2012). After a strong decrease during the construction phase of the tramway (26 Mio. in 2010!), patronage has been increasing since due to the new tramway offer. The input (vehicle-kms) has only increased slightly from about 9.8 Mio in 2010. Apparent is a rather high number of so-called free trips ("voyages gratuits") which may be a result of a free city-centre shuttle. Taking this into account the results of the scheme seem less convincing.

Use in the report: Benchmarking, Best practice

Link: http://www.eveole.com/

Metz

Metz is a French city in the Lorraine region, located in the border region to Luxembourg and Germany. The city itself has a population of 118000 (2013). With an area size of 41.9 km² the resulting average density is 2829 inhabitants / km².

As explained in the main report, French "political" cities are usually rather small compared to cities in other European countries which is a result of missing mergers of smaller villages or integration in bigger "neighbours". Therefore the agglomeration of French cities is often more comparable with other cities in view of any benchmarkings. It is usually also identical with or near to the service area of the urban PT-network which is regularly organised on agglomeration level.

The agglomeration of Metz has a population of 221810 (2013). It consists of 44 municipalities which cover an area of 277 km². The average density on agglomeration level is 801 inhabitants / km².

French national PT-statistics (Annuaire statistique: transports collectifs urbains; by CERTU) give very detailed information on the results of all French PT-operators including population in the service area of the netwoks. These numbers may differ from the actual city or agglomeration numbers. For Metz the population for 2012 is given with 223719 based on 40 municipalities which in this case is identical with the population in the service area. To be consistent with other information from the same source this number has been used for the benchmarking.

Metz is linked to the main railway network and has direct connections with cities as Thionville, Luxembourg, Nancy, Forbach, Saarbrücken and certainly Paris. As Nancy (see below), Metz is not directly linked to the new high-speed corridor East which connects Paris with Strasbourg. The new station TGV Lorraine is located more or less in the middle between Metz and Nancy.

Metz has introduced in 2013 a new busway scheme consisting of two corridors overlapping in the centre. Network details are highlighted in the main report.

According to the statistics source given above the urban PT-system offers 8.1 Mio vehicle-kms per year and gains about 14.8 Mio passengers / trips (2012). Newer network data including the busway operation are not available yet from this source but there are indications that the planned target of 16.2 Mio passengers / trips for the whole network had been reached already in 10/2014, one year after the opening. The busway attracts currently about 32000 passengers / trips per day – it has been designed for 35000.

Use in the report: Benchmarking, Best Practice
Link: http://lemet.fr/

Nancy

Nancy is a French city in the Lorraine region, about 280km East of Paris and 120km West of Strasbourg. The city itself has a population of 104000 (2013). With an area size of 15km² (!) the resulting average density is 6934 inhabitants / km².

As explained in the main report, French “political” cities are usually rather small compared to cities in other European countries which is a result of missing mergers of smaller villages or integration in bigger “neighbours”. Nancy with its 15km² “city size” is a typical evidence for this.Therefore the agglomeration of French cities is often more comparable with other cities in view of any benchmarkings. It is usually also identical with or near to the service area of the urban PT-network which is regularly organised on agglomeration level.

The agglomeration of Nancy has a population of 256000 (2015). It consists of 20 municipalities which cover an area of 142.3km². The average density on agglomeration level is 1799 inhabitants / km².

French national PT-statistics (Annuaire statistique: transports collectifs urbains; by CERTU) give very detailed information on the results of all French PT-operators including population in the service area of the netwoks. These numbers may differ from the actual city or agglomeration numbers. For Nancy the population for 2012 is given with 262638 based on 20 municipalities which in this case is identical with the population in the service area. To be consistent with other information from the same source this number has been used for the benchmarking.

Nancy is linked to the main railway network and has a function as a railway node in Eastern France. It has direct connections with a variety of cities (Metz, Strasbourg, Luxembourg to name but a few) including Paris (90min by TGV high speed trains). As Metz (see above), Nancy is not directly linked to the new high-speed corridor East which connects Paris with Strasbourg. The new station TGV Lorraine is located more or less in the middle between Metz and Nancy.

The urban bus network saw an upgrade in 2001 when one of the first, so-called rubber-tyre tramways has been introduced as line 1 (identical technology as in Caen). As the vehicle technology is no more available for further extensions, one has decided for classic busway technology and for 2013 two lines have been converted to this standard (line 2-3). The "technology future" of line 1 is not decided (see also Caen discussion).

All HQ-lines but also the majority of other bus services are oriented towards the city centre offering connections to both the railway station and a central interchange node. Several central corridors are served by several bus lines complimenting each other.

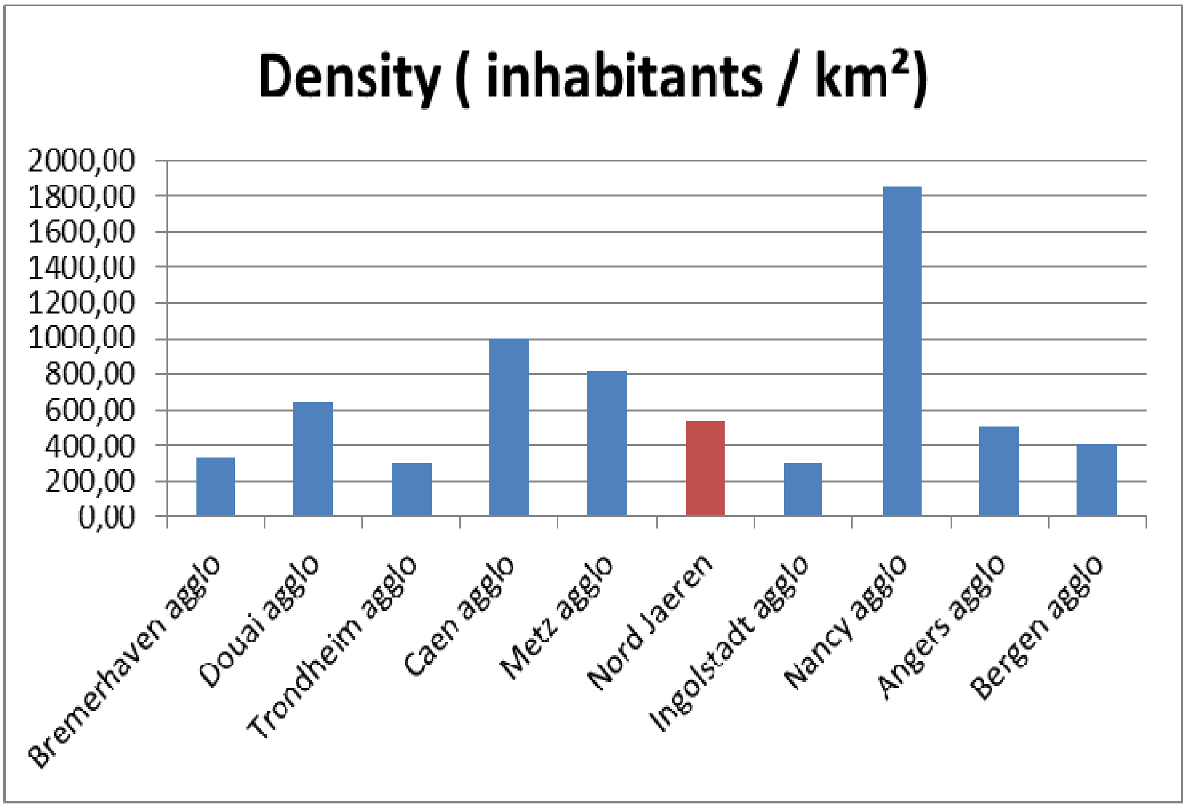
Line 1 operated with a 5min frequency, other HQ-lines in 8-10min frequency at least for peak hours.

According to the statistics source given above the urban PT-system (bus + tram) offers 10.25 Mio vehicle-kms per year and gains about 30.6 Mio passengers / trips (2012).

Use in the report: Benchmarking

Link: http://www.reseau-stan.com/

The following diagram highlights the densities of the cities / agglomerations used in the benchmarking. Besides Nancy which appears even on agglomeration level relatively dense, all other cases are in a range from about 300-1000 inhabitants / km².



Populations are given in the main report.

Annex 2

Short descriptions of case study cities (Sandnes focus)

Sandnes

Sandnes is a city in the Norwegian county of Rogaland and part of the Nord Jaeren region. It has a population of 72789 and is the second biggest city in Nord Jaeren. The area size is 285km² (land only) which results in an average density of 254 inhabitants / km².

For the built up area (“tettsteder”) SSB gives 58000 inhabitants.

Consistent with SSB, which also uses the complete population for calculating population related ratios, a population of 72789 has been used for Sandnes in the benchmarking.

Sandnes is connected with the main railway line from Stavanger to Egersund (“Jaerbanen”) which connects further to Kristiansand and Oslo. The Stavanger – Sandnes corridor has been extended to complete double track and is operated with a 15min frequency. The railway appears well used but with scope for better integration with the bus offer (and vice versa).

Some ferry services compliment the regional PT-offer.

Sandnes is part of the Nord Jaeren bus network which is currently in an upgrading process to see a busway concept replacing earlier tramway and tramtrain (Kombibane) plans.
The bus offer (as part of the Nord Jaeren network) appears as both regional and urban but with out any clear separation or branding. The Sandnes network is oriented towards the Ruten terminal which is connected to the Sandnes main railway station. The majority of bus lines terminate at Ruten – timetabling appears focusing on joint arrivals at the terminal.

The offer is calculated with 2.88 Mio vehicle-kms in 2014 (see chapter B.4.2.1); the resulting patronage is given with 3.73 Mio (calculated as 23.5% of the total Nord Jaeren patronage according the SSB-statistics; see also B.4.2.1).

Passenger numbers show a positive trend in recent years – a trend which is different to the Stavanger and Sola development within the Nord Jaeren region.

Use in the report: Benchmarking (focus city)
Link: https://www.kolumbus.no/

Grenland

Grenland is the name for a region in the Norwegian county of Telemark. It is usually describing the area of the cities Skien, Porsgrunn, Bamble and Siljan but sometimes also further municipalities are included or excluded (e.g. Kragerø and Drangedal included, Siljan excluded). For the purpose of the benchmarking study the SSB-definition, which includes Skien, Porsgrunn, Bamble and Siljan, has been used. The population of this region is about 106000. The total area (land only) is summing up to 1366km² which results in an average (very low!) density of 77 inhabitants / km².

For the built up areas (“tettsteder”) in the four cities SSB delivers 93000 inhabitants and 53km² area size which would result in an average density of 1737 inhabitants/km².

Consistent with SSB, which also uses the complete population for calculating population related ratios, a population of 106000 has been used for Grenland in the benchmarking.

The two main cities in Grenland, Skien and Porsgrunn, are both linked to the main railway line towards Vestfold and further to Oslo. A branch line from Skien to Notodden is connecting in Nordaguttu to/from another main line connecting Oslo with Kristiansand and further to Stavanger.

The urban bus network in Grenland consists of three metrobus lines and five “standard” bus lines (“Pendel”).The three metro bus lines operating in a 10min frequency are responsible for 83% of the total patronage.

There are two bus terminals in Skien (centre) and Porsgrunn (railway station) where all metrobus lines meet. The standard lines are with one exception connected either at Skien or Porsgrunn.

The offer was amounting to 4.94 Mio vehicle-kms in 2014; the resulting patronage is given with 3.37 Mio (both according SSB-statistics). Telemark Fylkeskommune sources indicate slightly different numbers (4.7 Mio vehicle-kms (per contract?) and about 3.6 Mio passengers / trips).

Passenger numbers show a positive trend in recent years but had shown a dramatic decrease in about 2010 (in SSB-statistics – not in Telemark Fylkeskommune statistics; likely resulting from different counting or calculating approaches?).

The modal split situation appears very weak with numbers from 2005 indicating only 4% PT-share vs a car share of 72% (driver + passenger)!

Use in the report: Benchmarking

Link: https://farte.no/

Kristiansand

Kristiansand is a harbour city in the county of Vest Agder in the South of Norway. It has a population of 87447. The area size is 261km² (land only) which results in an average density of 335 inhabitants / km². The SSB-definition applied for the "Kristiansand agglomeration" includes the municipalities of Kristiansand, Vennesla, Songdalen and Søgne. The total population of these muni-cipalities is 118000. With an (increased!) area size of 1027km² the average density goes down to 115 inhabitants / km ².

Consistent with SSB, which also uses the complete population for calculating population related ratios, a population of 118000 has been used for Kristiansand in the benchmarking.

Kristiansand is linked to the main railway line to Oslo in the East respectively Stavanger in the West.

The city has introduced in 2003 a reorganised bus network with the so-called Metrobus as the HQ-offer. The scheme showed quite some success in the first years and received quite some reputation for its innovative approach (at the time). However, it faced increasing problems towards the end of the last decade (delays, missing priority in increased car traffic volumes, technical problems with passenger information etc) which have led to a downward patronage trend. Decisions have been taken in 2010 to further upgrade and improve the system.

The metrobus services operate with a 10-15min frequency for core sections during peak periods, off peak and other corridors are operated with 20-30min frequencies. The "terminal structure" is given by the so-called "kvadraturen" formed by four streets around a block.

The offer was amounting to 7.6 Mio vehicle-kms in 2014; the resulting patronage is given with 7.86 Mio passengers / trips (both according SSB-statistics).

Passenger numbers show more or less stagnation in recent years after the decrease in the years 2009/10 (SSB-statistics).

Use in the report: Benchmarking
Link: http://www.akt.no/

Tønsberg

Tønsberg is a harbour city in the Norwegian county of Vestfold (South-west of Oslo). It has a population of 41920. The area size is 106km² (land only) which results in an average density of 395 inhabitants / km². The SSB-definition applied for the "Tönsberg agglomeration" includes the municipality of Nøtterøy. The total population of the two munipalities is 62420 – this number is used for the benchmarking (in line with the SSB approach).

Tønsberg is linked to the main railway line to Oslo in the East respectively Grenland (Skien, Porsgrunn) in the West.

The bus system is based on a variety of urban and regional bus lines oriented towards a central bus terminal where the majority of lines terminate. Frequencies are in a range from 15 to 120 min depending on time and section of a route.

The offer was amounting to 1.88 Mio vehicle-kms in 2014; the resulting patronage is given with 3.7 Mio passengers / trips (both according SSB-statistics). Also here, as mentioned for other Norwegian cases, it appears that SSB-data and other local information are differing. The latter is speaking about 3.27 Mio passengers in Tønsberg for 2014 and another 0.82 for Nøtterøy. Reasons for the differences are unclear; the SSB numbers are used to ensure comparibility with other cases.

Passenger numbers show more or less stagnation in recent years up to 2014 but also a rather significant increase in the years 2009/10 (SSB-statistics). Local sources speak of a significant increase in passenger numbers from 2014 to 2015 (+93000 for Tønsberg and Nøtterøy).

Use in the report: Benchmarking

Link: https://www.vkt.no/
https://www.vkt.no/Aktuelt/ID/431/230000-flere-busspassasjerer-i-2015

Bruchsal

Bruchsal in the German state of Baden-Wurttemberg is a city of 43000 population about 20km North of Karlsruhe. It is part of the Karlsruhe county and owns some centre function for the neighbouring villages. The city area is 93km² which results in an average density of 460 inhabitants/km².

The city is part of the KVV (Karlsruher VerkehrsVerbund, the local PTA) and linked to the Karlsruhe light rail network with connections to both Karlsruhe and other regional destinations. It is also served by the Rhein-Neckar S-Bahn system and shows a total of 8 railway stops within the city limits. It is also served by 3 regional bus lines but has introduced in 2000 also an additional urban “STADTBUS” scheme with 5 lines.

The scheme offers about 0.58 Mio vehicle-kms and gains about 1.3 Mio passengers / trips per year (year?).

Use in the report: Benchmarking

Link: http://www.stadtwerke-bruchsal.de/html/page.php?page_id=73

Friedrichshafen

Friedrichshafen is a German city of 58000 population in the state of Baden-Württemberg. It is located at Lake Constance and belonging to the county with the same name. The area size is about 70km² which results in an average density of 835 inhabitants / km².

The city is connected to the rail network in several directions, towards Ulm and Stuttgart respectively to Bregenz and Innsbruck (both in Austria) being main destinations. Six stops exist within the city limits of which the main station and the harbour station are the most important ones which are also locations for terminals of the urban and regional buses.

Furthermore there exists a ferry connection to Romanshorn in Switzerland and ship connections to a number of cities around Lake Constance (Konstanz, Meersburg, Überlingen, Bregenz, Lindau), the latter only in the summer time.

18 bus lines which overlap on certain sections operate during the day in a 30 or 60min frequency. The offer is 1.6 Mio vehicle-kms per year, the annual patronage is 3.6 Mio passengers / trips (2014).

Use in the report: Benchmarking
Link: http://www.stadtverkehr-fn.de/

Gütersloh

Gütersloh in the German state of Northrhine-Westphalia is a city of 96000 population. It is located 20km from Bielefeld and belongs to the county of Gütersloh. With an area size of 112km² the average density is 860 inhabitants per km².

The city is well connected to the railway network both in direction of Bielefeld (every 20min) and Hamm (every 30min).

The urban bus scheme consists of 11 lines operating in a 30min frequency. The rather star-formed network shows very little overlaps between lines which could give a higher frequency for the users. The network is oriented towards a bus terminal at the railway station which is working with a rendezvous principle. It is also the terminal for regional bus lines.

The network offers 1.6 Mio vehicle-kms and gains 3.36 Mio passengers / trips per year (2011 data).

Use in the report: Benchmarking
Link: https://www.stadtwerke-gt.de/privatkunden/stadtbus/
https://www.stadtwerke-gt.de/uploads/tx_itao_download/stadtwerke-guetersloh-stadtbus-jubilaeum.pdf

Hürth

Hürth is a German city of 58000 population and belonging to the Rhine-Erft county in Northrhine-Westphalia. With an area size of 51km² the average density is 1130 inhabitants / km². The city is directly neighbouring to Cologne in the South-West of it. The city has been for a long time a centre of brown-coal production and surface mining has touched about one third of the city area over the years.

Hürth is connected to the railway network with the Hürth-Kalscheueren station which is located at the Cologne-Bonn mainline and served by three regional railway services in an hourly frequency each. The city is also connected to the Cologne light rail network (line 18, formerly Köln-Bonner Eisenbahn (KBE)) with two stops, of which one is also serving as a terminal for some regional bus lines. The frequency is 10 minutes towards Cologne and 20 minutes towards Bonn.

The urban bus scheme was established under STADTBUS terms (see Lemgo, Dornbirn etc) in 1997 and consists of 8 lines. One of those connects to the railway station, several to the light rail stops.

The STADTBUS had in 2010 a yearly offer of 1,185 Mio vehicle-kms which resulted in 3.25 Mio passengers / trips (no updated information available). Buses operate in a 20min frequency and are oriented to a city centre terminal.

Use in the report: Benchmarking
Link: http://www.svh-direkt.de/nc/stadtbus-aktuelles/

Lemgo

Lemgo is a German city of 41000 population in the Northrhine-Westphalia state, belonging to the Lippe county and located 25km East of Bielefeld. The city area is 101km² which results in an average density of 404 inhabitants/m².

The city is connected to the railway network with a single track, non electrified line, served with an hourly frequency and shows three railway stops including the main station. The city is served by numerous regional bus lines which use the railway station as their hub.

In 1994 an urban STADTBUS-network with 5 lines was inaugurated, the first in Germany at the time which has found many followers in the meantime (e.g. Bruchsal, Hürth, see above). The scheme has received a lot of attention and is seen as one of the most successful systems of this genre in Germany. The urban bus scheme is based on a “rendezvous stop” in the city centre, two of the urban bus lines are also connecting to the railway station.

The system offers 845000 vehicle-kms per year and generates about 1.83 Mio passengers / trips (2014). Passenger numbers have been slightly decreasing in the last years.

Use in the report: Benchmarking
Link: http://www.stadtbus-lemgo.de/

Trier

Trier is a German city of 108000 population and belonging to the Rhineland-Palatinate state. It is in a border location to Luxembourg and France and owns world heritage status in view of its buildings respectively ruins from Roman times. The city area covers 117km² which results in an average density of 926 inhabitants per km². Two universities with 23000 students form an import share of the population and influence also the PT-offer.

The urban PT-network crosses the city limits and serves a few neighbouring municipalities. The population of this "service area agglomeration" is 130000 – this number has been used for the benchmarking.

Trier is connected to the railway network into 4 directions: Saarbrücken, Koblenz, Luxembourg and Perl of which the first two directions are to be seen as the main lines.

The bus terminal at the railway station and the "Porta Nigra" stop are the two main terminals in the city area. The network is rather complex and clearly influenced by the geographical and topographical conditions (river valley …). In the core parts bus lines overlap and offer a higher frequency to users (see also main report, chapter C.4).

According to information received from Trier the system offers 4.3 Mio vehicle-kms per year and gains about 16 Mio passengers / trips (2015). The offer appears relatively high for German bus cities.

Passenger numbers have stayed relatively stable in recent years but the cost coverage ratio has been strongly improved (see chapter C.1).

Use in the report: Benchmarking, Best practice
Link: http://www.stadtbus.info/

Tübingen

Tübingen is a German city of 86000 population and belonging to the state of Baden-Württemberg. It is located 30km South of Stuttgart and forms an own agglomeration of 330000 population together with the neighbouring city of Reutlingen (110000 population).
With an area of 108km² the resulting average density is 794 inhabitants / km².

With an average age of 39 years it is the "youngest" city in Germany – this being certainly connected to its university background.

Tübingen shows 6 railway stops within the city limits; the main railway station is a node station for regional railway services.

The urban bus scheme (see also main report) offered 3.5 Mio kms in 2014 and gained 20.6 Mio passengers / trips.

Use in the report: Benchmarking, Best practice
Link: http://www.swtue.de/stadtverkehr/liniennetz.html

Dornbirn

Dornbirn in the Austrian state of Vorarlberg has a population of 48000 and is the biggest city in this state (10th biggest in Austria). The city area is 120km² which results in an average density of 400 inhabitants/km².

The city is an economical centre and a regional traffic node. It is linked to the railway network being located at the mainline from Lindau (Germany) toBludenz (and further to Innsbruck). The city has four railway stops, one of which is the main railway station which has been developed into a mobility turntable.

According to information received from Dornbirn the system offers 1.1 Mio vehicle-kms per year and gains about 3.5 Mio passengers / trips (2015). This is a lower number than reported in earlier years; the reason is the introduction of a vehicle-based counting system while older numbers have been calculated from ticket sales.

Dornbirn is a hub for regional bus transport (called Landbus) but has also been introducing one of the very first STADTBUS schemes in 1991 which has gained model function for many other systems of this genre (see also main report).

Use in the report: Benchmarking, Best practice
Link: http://stadtbus.dornbirn.at/

Schaffhausen

Schaffhausen is a Swiss city of 38000 population and the capital of the canton of the same name. The city is located at the border to Germany. With an area of 41.8km² the resulting density is 860 inhabitants / km². The canton of Schaffhausen has a population of 79000.

The urban PT-network crosses the city limits and serves a few neighbouring municipalities. The population of this “service area agglomeration” is 46000 – this number has been used for the benchmarking.

Schaffhausen is connected to the railway network and has access to both Swiss and German destinations (e.g. Zurich, Basel (via Germany), Stuttgart etc). The railway station is owned 65% by SBB (Swiss State railway) and DB (Deutsche Bahn).

The urban network (see also main report) consists of one trolleybus line and six other bus lines which are operated with 10min frequency during the day. The system offers 2.7 Mio vehicle-kms to the citizens every year, the resulting patronage being 13.5 Mio passengers / trips (2014). The annual report (see link) offers very detailed input and output data also for single bus lines.

Use in the report: Benchmarking, Best practice

Link: http://www.vbsh.ch/
http://www.vbsh.ch/images/pdf/geschbericht/vbsh_geschaeftsbericht_2014.pdf

Winterthur

Winterthur is a Swiss city in the canton of Zurich own a population of 106000 and is the sixth biggest city in Switzerland. Despite of being only 20km away from Zurich, Winterhur and its neighbouring villages form a sparate agglomeration of 123000 inhabitants. With an area size of 68km² the average density is 1569 inhabitants / km².

Winterhur is a major railway node and its main station shows the fourth biggest frequency in Switzerland (122000 passengers per day!) – besides regional and long-distance services it is served by 10 S-Bahn lines of the Zurich network.

There is a regional bus offer which adds about 1 Mio vehicle-kms and 1.65 Mio passengers / trips to the urban results which have been used in the benchmarking (3.96 Mio vehicle-kms / 24.6 Mio passengers / trips (2014)). The bus network consists of trolley bus and standard bus lines and is strongly oriented towards the main railway station. It is based on through running lines for the 10 urban bus lines while regional bus lines terminate.

Use in the report: Benchmarking

Link: http://stadtbus.winterthur.ch/

Boulogne-sur-Mer

Boulogne-sur-Mer is a French city in the Nord Pas de Calais Picardie region, located at the English Channel. It is still the biggest fishing port in France. The city itself has a population of 42537 (2013). With an area size of 8.4km² (!) the resulting average density is 5050 inhabitants / km².

As explained in the main report, French "political" cities are usually rather small compared to cities in other European countries which is a result of missing mergers of smaller villages or integration in bigger “neighbours”. Boulogne with only a bit more than 8km2 “city size” is a typical evidence for this.Therefore the agglomeration of French cities is often more comparable with other cities in view of any benchmarkings. It is usually also identical with or near to the service area of the urban PT-network which is regularly organised on agglomeration level.

The agglomeration of Boulogne has a population of 117208 (2013). It consists of 22 municipalities which cover an area of 205.1km². The average density on agglomeration level is 571 inhabitants / km².

French national PT-statistics (Annuaire statistique: transports collectifs urbains; by CERTU) give very detailed information on the results of all French PT-operators including population in the service area of the netwoks. These numbers may differ from the actual city or agglomeration numbers. For Boulogne the population for 2012 is given with 120476 based on 22 municipalities which in this case is identical with the population in the service area. To be consistent with other information from the same source this number has been used for the benchmarking.

Boulogne is linked to the main railway network and has direct connections with cities as Amiens, Lille, Calais, Arras, but also to Paris.

The urban bus system is based on 21 lines (2012) which are oriented to two terminals at the railway station and in the centre (“Place de France”). The frequencies of the different lines range from 20 to 40 (!) min, frequencies are also differing within line as denser frequencies are regularly ending at certain stops and only some buses continue beyond. Several corridors are operated jointly by different bus lines resulting in somewhat denser frequencies; however, still not resulting in clear, easy to understand total frequencies.

According to the statistics source given above the urban bus system offers 2.06 Mio vehicle-kms per year and gains about 6.94 Mio passengers / trips (2012). Both input and output have decreased since 2007. Apparent is a rather high number of so-called free trips (“voyages gratuits”) which may be a result of a free city-centre shuttle. Taking this into account the results of the scheme seem less convincing.

A new operation contract has been issued from 2013. Any network changes resulting from such are not yet included to the statistics.

Use in the report: Benchmarking
Link: https://www.marineo.fr/

Colmar

Colmar is a French city in the Alsace region, located in the Rhine valley near the German border. The city itself has a population of 67956 (2013). With an area size of 66km² the resulting average density is 1020 inhabitants / km².

As explained in the main report, French "political" cities are usually rather small compared to cities in other European countries which is a result of missing mergers of smaller villages or integration in bigger "neighbours". Therefore the agglomeration of French cities is often more comparable with other cities in view of any benchmarkings. It is usually also identical with or near to the service area of the urban PT-network which is regularly organised on agglomeration level.

The agglomeration of Colmar has a population of 110978 (2013). It consists of 21 municipalities (7 added from 2016) which cover an area of 242.8km². The average density on agglomeration level is 457 inhabitants / km².

French national PT-statistics (Annuaire statistique: transports collectifs urbains; by CERTU) give very detailed information on the results of all French PT-operators including population in the service area of the netwoks. These numbers may differ from the actual city or agglomeration numbers. For Colmar the population for 2012 is given with 104537 based on 14 municipalities while for the same year the population in the service area is given with 113636 (22 municipalities). To be consistent with other information from the same source this number has been used for the benchmarking.

Colmar is linked to the main railway line from Strasbourg to Mulhouse; both these are node stations giving access to long distance trains into France, Germany and Switzerland.

The urban bus system is based on 20 lines which are oriented to two terminals at the railway station and in the centre ("Theatre"). The frequencies of the different lines range from 10min to 60min, frequencies are also differing within line as denser frequencies are regularly ending at certain stops and only some buses continue beyond.

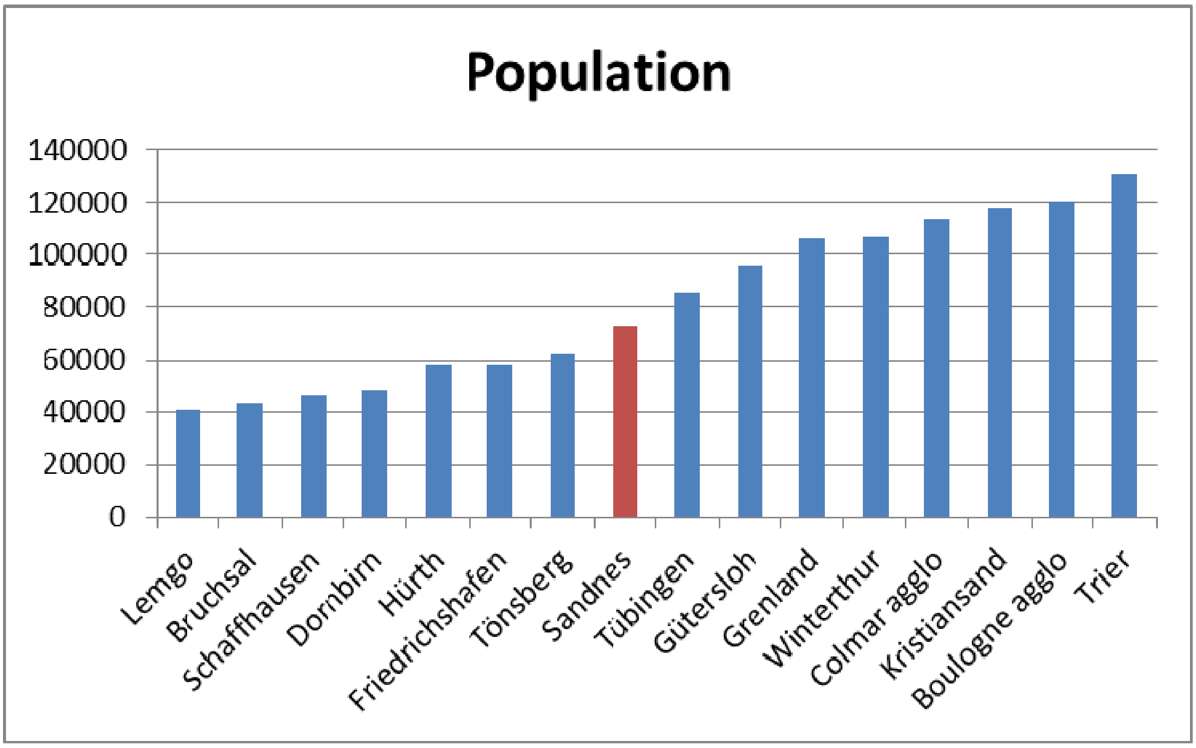
According to the statistics source given above the urban bus system offers 2.06 Mio vehicle-kms per year and gains about 6.94 Mio passengers / trips (2012). Both input and output have increased since 2007.

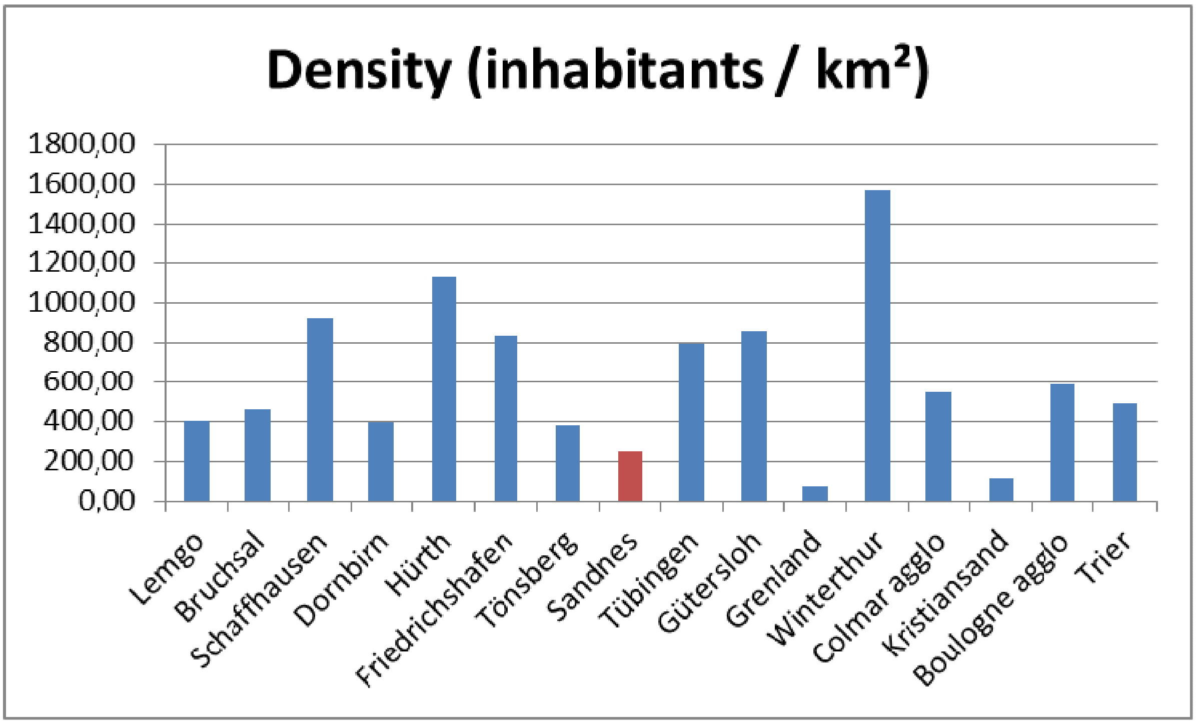
A new operation contract has been issued from 2013. Any network changes resulting from such are not yet included to the statistics.

Use in the report: Benchmarking

Link: http://www.agglo-colmar.fr/transports-urbains / http://www.trace-colmar.fr/

The following diagrams summarise the population and densities of the Sandnes related benchmarking cities.





Visible is the populatian range of the case study cities between 40000 and 130000 population. Even more important is the evidence that all cities respectively agglomerations are in a comparable density range. Only Winterthur and to some extent Hürth could be seen as “too dense” compared to the others. The very low density for Grenland and Kristiansand is a result of a huge hinterland which gives a slightly misleading touch to the situation.

Annex 3

Tabell over busslinjer som kjører delvis i Sandnes

Buss Linje	Beskrivelse	Avganger én retning	Tall	Total avgang: én retning	Total avgang: to retning	Antall km i Sandnes	Antall km pr år I Sandes
2	Sandnes-Kvadrat-Gausel-Hillevåg-Stavanger-Tasta-Vardeneset	man-fre lørdag søndag minus 'gul avganger	81 46 31 *m-f:18*	81x52x5=21060 46x52=2392 31x52=1612 *minus:* *18x51=918* **Total: 24146**	48292	6.0	**289752**
3	Sandnes-Lurahammaren-Gausel-Hillevåg-Stavanger-Kvernevik-Viste Hageby	man-fre lørdag søndag *minus 'gul avganger*	66 54 36 *m-f:28* *l:10*	66x52x5=17160 54x52=2808 36x52=1872 *minus:* *28x51=1428* *10x51=918* **Total: 19902**	39804	4.4	**175138**
9	Sandnes-Kvadrat-Forus-Sola-Flyplass-Tanager-Sunde-Madla-Stavanger	man-fre lørdag søndag *minus 'gul avganger*	57 17 13 *m-f:34* *l:12x13* *s:13x14*	57x52x5=14820 17x52=884 13x52=676 *34x51=1734* *12x13=156* *13x14=182* **Total: 14308**	28616	6.6	**188866**
X60	Sandnes-Kvadrat-Forus-UiS-SuS-Stavanger-(Hundvåg)	man-fre lørdag søndag minus 'gul avganger	51 0 0 *m-f:20*	51x52x5=13260 *minus:* *51X20=1020* **Total: 12240**	24480	6.5	**159120**
22	Sandnes-Ganddal-Orstad-Kvernaland	man-fre lørdag søndag minus 'gul avganger	23 16 4 *m-f:5*	23x52x5=5980 16x52=832 4x52=208 *minus:* *51x5=255* **Total: 6765**	13530	6.5	**87945**
23	Sandnes-Figgjo-Ålgård	man-fre lørdag søndag minus 'gul avganger	40 16 14 -10	40x52x5=10400 16x52=832 14x52=728 *minus:* *51x10=510* **Total: 11450**	22900	11.3	**258770**
52	Sandnes-Ganddal-Kleppe-Bryne	man-fre lørdag søndag minus 'gul avganger	24.5* 12 0 -7 *inkl. 1 skole avgang (50% vanlig avgang)	24.5x52x5=6370 12x52=624 0 *minus:* *51x7=357* **Total: 6637**	13274	6.2	**82299**
					TOTAL		**1241890**