A CASE OF GOOD PRACTICE: 
THE SWISS ‘NETWORK’ APPROACH 
TO SEMI-RURAL PUBLIC TRANSPORT

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BACKGROUND

This paper examines the ‘network’ approach to providing public transport in semi-rural areas, through case studies of semi-rural parts of the Swiss Cantons of Zürich and Graubünden. The importance of this issue is increasing in most developed nations, as the share of the population living in dense cities declines. Suburban areas are growing, but so also are ex-urban and semi-rural regions.

Semi-rural areas pose particular problems for public transport providers. Low densities and dispersed travel patterns lead to low occupancy rates, high subsidy levels and infrequent services. These combine with the absence of traffic congestion and parking difficulties to produce a low mode share, with patronage largely confined to ‘transit captives’. The typical pattern is infrequent, low-quality, welfare-style services with poor utilisation rates.

As the populations of semi-rural areas grow, the limitations of this marginal public transport are becoming increasingly apparent. High rates of car use mean that semi-rural areas often contribute disproportionately to problems like climate change and oil depletion, even if congestion and local air pollution levels remain low. Many semi-rural areas have significant numbers of low-income residents attracted by cheaper housing, who find that automobile running and ownership costs consume high proportions of household income. Rising oil prices in recent years have exacerbated this problem. Although car ownership rates tend to be high, there remain significant numbers of car-less households, whose residents frequently experience isolation and disadvantage.

As a result, the provision of public transport to semi-rural regions is receiving increasing attention from policy-makers, after decades of neglect. For example, in 2008 the UK Commission for Integrated Transport called for ‘a new approach to rural public transport’, pointing out that a fifth of the English population, or 9.5 million
people, live in rural areas that are currently poorly served (CfIT, 2008). The Commission called for a greater emphasis on flexible, demand-responsive ‘TaxiPlus’ services, which it argues can provide better service than conventional bus operations with lower subsidies.

The Commission for Integrated Transport’s approach reflects the dominant school of thought in the area of rural and semi-rural public transport. Demand-responsive transport systems are commonly suggested as a way to solve rural transport problems, the usual rationale being similar to that offered by OECD (1979, pp. 20-21): ‘existing traffic demand would not justify any scheduled service, and that a demand-responsive system is likely to produce more favourable economic results than a scheduled service of comparable standard.’ However, the OECD also notes that ‘except for some corridor services, demand responsive systems are expensive and in all cases need heavy subsidisation’ (Ibid., p. 29).

Many experiments were conducted with demand-responsive services in the 1970s, but high costs and poor patronage led to most being withdrawn. The CfIT recently investigated five UK examples of 'taxi-based' demand-responsive schemes and found the best performer had a cost recovery of 36%, followed by 25%, 16%, 8% and 7% (Mott Macdonald, 2008a, pp. 39-40). However, the CfIT’s research pointed to a number of European schemes that have apparently been more successful. One of the most successful— at least in terms of passenger numbers— is the Swiss PubliCar service. No cost recovery figures were available for PubliCar services, although the costs per passenger journey were estimated as falling between CHF 20 and CHF 60 (converting to USD 19-57 as of January 28, 2010) (Mott Macdonald, 2008b, p. 23).

PubliCar is operated by PostAuto, the bus subsidiary of the Swiss Post Office, mainly in the French-speaking Cantons of Vaud, Jura and Valais (Mott Macdonald, 2008b; PostAuto, n.d.). The service was introduced in the 1990s to replace low-performing fixed-route, fixed-timetable bus routes, and has more recently been extended to provide late-evening services in regions served at other times by regular routes. PubliCar has attracted considerable attention, particularly in the United Kingdom.

This attention is understandable, as Switzerland has been more successful than most other developed countries at encouraging the use of public transport, walking and cycling. At the most recent census in 2000, 43 per cent of Swiss workers used these ‘sustainable’ modes, with 57 per cent using private motorised transport (mainly cars, plus a few motorcyclists). The share of students, from primary through to tertiary, travelling by car/private transport was only 8 per cent. However, the pattern varied across the different cantons, with higher car use in the French-speaking areas that are the heartland of PubliCar, and lower rates in German-speaking cantons like Zürich and Graubünden (see Table 1).
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Table 1. Mode choice for trips to work and education, 2000

<table>
<thead>
<tr>
<th>Canton</th>
<th>Work trips (%)</th>
<th>Education trips (%)</th>
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<tr>
<td></td>
<td>Car</td>
<td>PT</td>
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<tr>
<td>Vaud</td>
<td>65</td>
<td>24</td>
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<tr>
<td>Valais</td>
<td>67</td>
<td>13</td>
</tr>
<tr>
<td>Jura</td>
<td>73</td>
<td>12</td>
</tr>
<tr>
<td>Zürich</td>
<td>47</td>
<td>41</td>
</tr>
<tr>
<td>Graubünden</td>
<td>50</td>
<td>19</td>
</tr>
<tr>
<td>All Switzerland</td>
<td>57</td>
<td>27</td>
</tr>
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</table>

Note: excludes those making no journey to work (‘kein arbeitsweg’) or school (‘kein schulweg’).

PubliCar services are much less developed in German-speaking Switzerland, despite these regions being served by the same bus operator (PostAuto). There are no services in the Canton of Zürich, and only a single one in Canton Graubünden (an evening service supplementing fixed bus routes that operate during daylight hours). The approach employed in these areas relies on integrated network planning, rather than flexible, demand-responsive services.

The ‘network’ approach to semi-rural public transport employed in German-speaking Switzerland may be more successful, at least in reducing car use, than the demand-responsive model. But it has received considerably less attention from transport analysts and policy-makers, who have focussed on inputs (innovative service types) rather than outputs (patronage and mode share). This paper begins the task of rectifying the deficiency, by outlining the main features of the network model and assessing its performance and the reasons for its success. This will be explored through case studies of public transport provision in a semi-rural region of Canton Zürich and a rural region of Canton Graubünden.

THE NETWORK PLANNING CONCEPT

The ‘network’ approach was discussed by Mees (2000), who analysed Toronto’s experience in confronting the challenge of providing transport to low density suburban areas. The Toronto Transit Commission achieves a ‘network effect’, by operating high-frequency bus services to extend its rail network, providing the kind of service offered on a system like the Paris Metro. But the high frequency model is not an option for rural areas, because demand is too sparse.

Cullinane and Stokes (1998) propose a 'blueprint for rural transport' in the UK. They argue for a coarse-grained national public transport network, which they say ‘does not need to reach every village, hamlet, or suburb, but it does need to allow travel between all centres of population of more than a defined number (maybe say 5,000 people)' (Ibid., p. 309). Both rail and road-based public transport would form a
network ‘integrated through a common system of timetabling.’ Services would run regularly along every major road and arrive and depart from major towns at ‘standard times such as “on the hour” or “half hour”,’ and ‘frequencies between neighbouring towns of larger than say 20,000 people, would be at least half-hourly, preferably every 15 minutes or more’. Bus services would be given priority in congested areas and services would be ‘fast and direct’. Services between towns ‘would not deviate off major roads to serve minor settlements but would have feeder services to the major roads’. This national network would be supported by local connections to stops on the national network ‘every 5 miles or so’, and would include regular high-frequency services serving smaller towns and linking from one national network route to another. The network would also include demand responsive transport services, and more informal community transport (Ibid., p. 310).

The authors cite Switzerland’s policy as an example of timetable synchronisation at the national and local level, with trains leaving major cities on the hour or half hour and reaching their destinations in 25 or 55 minutes depending on distance, ‘thus enabling interchange to be made reliably without the use of timetables’ (Ibid., pp. 316-317). Their observation parallels that of Apel & Pharoah (1995, p. 143), who give an example of timetable synchronisation and network integration within the Canton of Zürich. They describe the operation at the suburban railway station at Wetzikon, where S-Bahn (suburban and regional trains) and local bus services depart every half hour throughout the day. While the Canton does cover rural areas and dispersed urban settlements, Apel & Pharoah do not explicitly promote the system as a model for rural transport, even though the system achieves a significant modal share in rural areas as well as the city and suburbs.

Similar to the approach taken in Switzerland, Nielsen et al. (2005) recommend pulse timetables for regional public transport outside small-to-medium sized cities, in a section entitled ‘Finding Strategies for Weaker Markets’. Even if a full ‘forget the timetable’, high-frequency service cannot be achieved, a pulse timetable can offer ‘significant improvements over traditional low quality networks’ (Ibid., p. 116). Nielsen et al. al. give the example of the success of small cities of 40,000-80,000 people in Nordrhein-Westfalen in Germany, which restructured their bus networks along ‘pulse timetable’ lines to increase patronage and cost recovery.

Vuchic (2005, p. 224) notes that the basic concept of ‘pulsing’ is also used by airlines at hubs, where planes arrive at a central point simultaneously to allow passengers to transfer in all directions, and that a similar ‘timed transfer’ system is often used on transport systems that keep precise schedules. He cites as examples the intercity and regional rail systems of Germany, the Netherlands and Switzerland, which often ‘pulse’ at 15, 30 or 60 minute intervals. The same approach is also commonly used for ‘night owl’ services in the early hours of the morning, and it is also used in North American cities including Edmonton, Sacramento and Portland, where it provides a transit service in automobile-oriented suburban areas where long headways would otherwise discourage passengers from making trips that require a transfer. Vuchic
emphasises the importance of detailed planning of the network and interchange layout, plus the need for reliable schedules.

Clever (1997) summarises the main principles of a pulse or integrated timed-transfer (ITT) system, and also draws attention to the importance of the coordinated network: 'With ITT, passengers do not get on board only a single line, but a whole system' (Ibid., p. 110).

While the basic concept of a pulse or integrated timed transfer system is recognised in the field of transport planning, timed transfer systems do not seem to be widely or regularly applied outside those cities and regions that have been initiated into the practice. In English-speaking countries in particular, most examples are found in North America and appear to be applied to suburban rather than rural areas.

DEVELOPMENT OF NETWORK PLANNING IN SWITZERLAND

The Swiss network planning approach did not evolve to serve the needs of semi-rural communities; rather, it emerged as the response to a crisis on the national rail system. After having achieved its best business result in 1961, the national rail operator, the Swiss Federal Railways (Schweizerische Bundesbahnen or SBB) went into deficit in 1966. Thanks to increasing use of the private car, the share of rail trips fell from 28% in 1960 to 16% in 1970 (Hürlimann 2005, p. 5). With the SBB’s revenue not keeping pace with expenses, its internal capital reserves were exhausted by 1971 (Ibid., p. 11). There was a growing recognition within the SBB that the services it offered would have to change to increase competitiveness.

Measures discussed within the SBB included significant reduction of travel times, more frequent connections, the introduction of a ‘rhythmic’ or cyclic timetable for commuter and longer distance services, modernisation of stations, connections to the airports and increased cooperation with other public transport enterprises (Ibid.). However, the examples provided by high speed trains in Japan and Germany were highly influential, and most SBB officers seemed to agree that ‘far reaching measures’ to increase rail service speed up to 250 km/h were necessary, such as constructing new, straighter high-speed lines and using pendulum trains (Ibid., pp. 6-7, 11-12).

However, the engineer-in-chief of the construction division was sceptical of the view that introducing high speed services were the most effective way of improving overall travel speed. He argued that trip time was influenced mainly by the time taken to make connections between trains, and that therefore it was only for the longer distance, intercity passenger traffic that improved running speeds would have much effect (Ibid., p. 11).
At around the same time, three young SBB officers produced an internal brochure, ‘Taktfahrplan [Pulse Timetable] Switzerland: A New Passenger Rail Concept’, intending to challenge thinking within the organisation. The authors wanted rail to offer a more comprehensive timetable so that it could compete with the car (Foster & Stähli, 1982, p. 219). They proposed instead a regular interval timetable (i.e. services repeating at the same time past the hour), with timed connections at major interchange points on the hour or half hour, which was based on the example of services in the Netherlands. The idea seems to have entered the SBB bureaucracy at this point: it was recognised by the technical sections that total travel times on most trips were influenced mainly by the time taken to make connections between trains, rather than time on vehicles, and the timed connections of the Taktfahrplan promised to cut those waiting times (Hürlimann, 2005, p. 11).

The first version of the Taktfahrplan was introduced on some of the main railway lines in 1982; and set the foundations for the development of 'Rail 2000' (Bahn 2000), which later became 'Rail + Bus 2000'. Rail 2000 promised a new service concept with hourly services on all major lines throughout Switzerland, based around services that would leave major nodal stations on the hour or half hour. SBB staff emphasised timetable innovation and 'electronics instead of concrete'. Infrastructure upgrades were justified less on the basis of a general desire to speed up trains, but as a way of achieving the service plan and getting trains to the next node on the hour, as reflected in the Rail 2000 slogan: 'not as fast as possible, but as quick as necessary' (Hürlimann, 2005, p. 22).

The Rail 2000 concept was approved by referendum in December 1987 (Ibid., p. 20). The success of Rail 2000's focus on high service standards (within the framework of the Taktfahrplan's timed connections) in winning public support, seems to have energised the planners and supporters of public transport in Switzerland, and provided a blueprint for further improvements on a regional or cantonal level. The integrated services offered in rural parts of Canton Zürich and in the Canton of Graubünden were inspired by the national model, and operate as smaller-scale extensions of it.

NETWORK PLANNING IN THE ZURICH WEINLAND REGION

The Zurich Weinland region is located at the northern tip of the Canton of Zürich. The canton, with a population of 1.3 million and an area of 1,728 square kilometres, includes Switzerland’s largest urban area, as well as the network of surrounding towns which have grown to essentially become Zurich’s suburbs (Canton Zürich Statistical Office, 2009).
Figure 1. The Zurich Weinland (Canton Zürich) and the Lower Engadine and Val Müstair (Canton Graubünden)

Source: SFSO (2001). Map altered to circle the cantons of Zürich (ZH) and Graubünden (GR); and outline the districts of Andelfingen (approximating the Zurich Weinland) and Inn (the Lower Engadine and Val Müstair).

The Weinland region is located between the cities of Winterthur and Schaffhausen (which is in its own Canton of Schaffhausen). Compared to much of northern Switzerland, the climate is relatively mild and sunny: the region’s name originated from its suitability for growing wine, and grapevines still dot the Weinland’s hillsides. Agriculture is still relatively important in the region, with its landscape dominated by woods, fields and vineyards spread amongst the rolling hills, although the closely spaced villages are expanding steadily and much of the working population commutes to neighbouring urban centres. The Weinland planning region is also almost identical to the administrative district (Bezirk) of Andelfingen, named after the region’s largest central town, which has a population of about 3500.

Most settlements in the Weinland have fewer than 1000 people, and are scattered across a flat landscape by Swiss standards. The urban form of the townships and villages is varied, although they usually include a compact and historic centre. Some of the larger settlements (such as Andelfingen) include small areas of American-style single family housing as well as occasional two or three storey apartments. The visitor’s impression is one of quiet small towns and villages in a closely-settled rural area.

Most travel in the Weinland region is in a north-south direction between Schaffhausen and Winterthur (and on to Zurich), which is reflected in the provision of
transport infrastructure and also in journey to work patterns (SFSO, n.d., based on 2000 census). About a third of the commuting workers living in the Weinland region also work there; the major destinations outside the region are (in order of importance) Winterthur and surroundings, Schaffhausen, the City of Zurich and Zurich's Glattal region (just north of the City).

The Weinland is served by two north-south railway lines: the easternmost one follows a winding route from Winterthur to the town of Stein am Rhein, while the western line runs more directly from Winterthur to Schaffhausen. Both are single track lines with limited passing loops. For historical reasons, they run remarkably closely together for a rural area: at one point, the tracks are only two kilometres apart. Most of the Weinland’s villages receive a base hourly or twice-hourly public transport service during the day, using coordinated bus and S-Bahn services. A majority of villages have services running until midnight, plus additional night services in the early hours of Saturday and Sunday mornings which are popular with young, late night revellers.

These public transport services help to achieve a journey to work mode share of between 13 and 26 percent of commuters travelling to work by public transport in each municipality; overall, the Weinland’s average is 21.7% (SFSO, n.d., based on 2000 census). Individual motorised transport (mainly cars) accounts for 64.7% of journeys, and walking and cycling make up the remaining 13.6%.

**Administrative arrangements**

Rail services have been operated by the SBB for many decades, but the region had no equivalent of the large municipal public transport enterprises that operated in many Swiss cities. In rural areas like the Weinland, public transport services were operated either by PostAuto or small private operators. Before the radical restructuring of the public transport network by the canton’s new public transport authority in 1990, services had developed largely by historical accident and were of poor quality. Towns such as Trüllikon, with 600 residents, had only three buses a day, while smaller settlements had none (F. Feurer, Interview, October 2, 2008).

The **Zürcher Verkehrsverbund** (Zürich Transport Federation or ZVV) is the Canton of Zürich’s regional transport agency. It is responsible for overall strategic planning of transport services, system finances, and marketing in the canton (ZVV, n.d.). It delegates some of its lower level ‘tactical’ planning tasks to 8 ‘market responsible enterprises’, which are responsible for their assigned regions, where they are usually the largest operator of local services; any smaller remaining operators also deal with them. The SBB is also a ‘market responsible enterprise’, responsible for rail services throughout the canton. The ZVV is overseen by a transport board, made up of representatives from major operators, and federal, cantonal and local governments.

The ZVV was modelled on the examples of the German **Verkehrsverbünden** (transport federations) which first developed in Hamburg (Vuchic, 2005; Mees, 2010).
The legislation to establish the ZVV, along with accompanying regulations, was passed in 1988 following a cantonal referendum. The new regional transport agency was to be supported by new funding arrangements that shared costs between the Canton, its municipalities and the Federal Government. In order to win widespread public and local government support, the proposal included service standards that would eventually connect the main town within each of the 171 communes (Gemeinden) to the public transport system. The ZVV was established as a small dedicated planning group in 1988 to make preparations for the launch of the S-Bahn suburban services in 1990, works for which had been approved by Canton Zürich voters in 1981.

**How the ZVV plans the network and services**

The ZVV redesigned the regional bus network and train timetables for the launch of the S-Bahn system in 1990. Changes since then have been incremental or evolutionary.

The transport network in Zurich’s Weinland is designed according to the principles of the integrated Taktfahrplan (see above), in which services are designed to ‘pulse’ or connect at designated transport hubs. The establishment of the ZVV allowed a service standard to be applied across the cantonal rail network: as happens elsewhere in the canton, the S-Bahn services in the Weinland run at times that repeat every hour. Some of the other elements of the Taktfahrplan concept also apply, even though the region does not contain any of the major city pulse points in the national network where services ‘pulse’ around either the minutes :00 and :30, or :15 and :45 past the hour. The closest national pulse point is at Zurich’s main station.

Despite this, the region is still able to take advantage of the other network efficiency opportunities provided by regular interval timetables: ‘crossing points’. These are locations where services in different directions meet regularly as they pass each other. Crossing points maximise the efficiency of transfers by allowing other connecting feeder services (such as buses) to arrive at the station just before the trains arrive, and leave just afterwards. They therefore work like pulse points in allowing travellers to change to any other service.

For services in a strict hourly pulse timetable, crossing points will occur every 30 minutes travel time from the pulse point; similarly, for a half hourly pulse timetable, crossing points occur every 15 minutes travel time. The major rail interchange for Weinland passengers, Winterthur, is 26 minutes via the airport from the pulse point of Zurich, and is almost a crossing point for intercity services to St Gallen and other cantons. Weinland passengers going to Zurich can change at Winterthur to either S-Bahn or InterCity services, whichever arrive first.

However, crossing points can also occur with services that are unevenly spaced within the hour, but still run at times that repeat every hour. For example, S33 line
services through the Weinland run twice every hour during the day, but do not run at exact half hourly intervals due to the limitations of a single track line with limited passing loops. Instead, services have headways of approximately 25 and 35 minutes: from Marthalen station, for example, trains to Winterthur depart from Marthalen at :34 and :59 minutes past the hour, and to Schaffhausen at :25 and :01 (2008 timetable). Marthalen station is therefore a once-an-hour crossing point for S33 services to Winterthur (departing at :59) and Schaffhausen (departing at :01). The ZVV has made good use of this crossing point by scheduling four different hourly bus services to connect to these two services every hour.

Unlike the rail system, which had a legacy of extensive fixed infrastructure, the regional bus system could be redesigned relatively freely when the ZVV was being established. As such, the Canton's service planning regulations from 1988 (enacted with the legislation setting up the transport body) set out detailed principles for the bus network. Under the sub-heading ‘Taktsystem’, the regulations state that all bus lines should strive for regular services so that they can be coordinated with the S-Bahn system (Regulation 740.3, section 7). The ‘service offer’ regulations also outline detailed service standards, with hours of operation the same across the system, in order to allow transfers to continue to function until the last services.

Under the regulations, the general operating hours for ZVV services are from 6am until midnight, although services can be shortened or extended depending on demand, or to make a connection, or for operational reasons (ibid., s. 8). Outside this time, it is expected that services will cover their own costs: for example, a CHF 5 surcharge applies to fares for after-midnight services on Saturday and Sunday mornings. The regulations also set out a three-tiered hierarchy of service frequencies or headways for the region. Basic or minimum services are to be supplied to the more rural or remote areas of the canton in ‘Supply Zone 1’, which covers most villages of the Weinland. In Zone 1, an hourly pulse timetable (stundentakt) is standard, although it can be altered in accordance with principles outlined in the regulations (ibid., s. 11). If demand is too low outside peak times, services can be reduced to 12 runs per day in each direction, or other forms of operation can be examined.

The regulations also state that all settlement areas with a combination of at least 300 inhabitants, jobs and educational places are to be covered by at least one public transport stop (ibid., s. 2). A settlement area is considered to be served if its properties are within either a 400 metre radius of a bus stop or within a 750 metre radius of a railway station (ibid., s. 4). Service can be extended to a smaller settlement if it can be done at minimal cost, or services can be provided to a number of smaller settlements if the additional service costs can be justified.

Requests for new or altered services are considered through a process that involves ‘regional transport conferences’. These conferences are organised for each of the devolved sub-regional service planning areas that are assigned to each of the ZVV's
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‘market responsible transport enterprises’. One advantage of the transport conference structure is that it allows devolved local level consultation and decision making with the 171 (often very small) municipalities of the canton, which also have to pay a significant part of the costs of service provision. The president of the Weinland Transport Conference, for example, is a volunteer and local resident from the village of Rudolfingen (F. Feurer, Interview, October 2, 2008).

The main aims of setting up the ZVV were to not only plan the system’s services more effectively, but also to integrate fares between different modes and operators, and improve the provision of information so that the system could be presented as a single network. Information about ZVV services is widely available and of a high standard. The quality of information is helped by the simplicity of service design, including a generally stable route structure and repeating timetables. Every station or stop is clearly named and has a timetable (and usually a map of the local area), while extensive information is available online. Signage at railway stations follows the Swiss national standard, and bus interchanges are clearly signposted with bus destinations.

The ZVV fare system has a zonal structure that covers all transport modes running in each zone, with about 5 zones covering the Weinland. Passengers pay for the number of zones they intend to travel through, and can buy either single, daily, monthly or yearly tickets.

How standards are applied in the Zurich Weinland

The Weinland’s network of nine regional bus routes is designed to feed passengers to the faster rail system where possible. Most regional bus lines in Zurich’s Weinland run every hour, providing basic, once an hour connections with rail services, even if rail services are provided every half hour during the day. The trains without bus connections are used by through-travellers and the significant number of Weinland residents who live within walking or cycling distance of the stations. However, the failure to match the additional trains with bus services must reduce the attractiveness of bus-train travel in relation to station access by car, even though parking charges apply.

Most of the routes were designed in about 1988 as the ZVV was being established, with some input from the local communes. Since that time, the basic structure appears to have been kept intact, with incremental alterations and improvements to original services, along with the occasional new line. The network of bus routes and stations serves fifty of the fifty-five villages in the Weinland; the other five have less than 300 people or jobs.

The route structure is generally simple: a typical bus route will start at a station (timed to connect to a particular train) and travel outward from the line. It will follow the main roads through towns and villages, and then terminate at another railway
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station, where the connection to the train is also timed so that it acts as a rail feeder. Only three of the nine bus routes in the Weinland terminate in a village without a railway station. One of these is Rheinau, which is isolated on a ‘peninsula’ created by a bend in the Rhine River. The other two terminate in villages served by other bus lines, which pass through the villages in different directions. The terminating buses do not make timed connections with the through-routed buses, as the planners have ascertained that there is little demand for east-west travel across the region, but the routes do allow the small number of people who might be interested in changing services to do so, if they are prepared to wait. It also gives people in the terminus villages the opportunity to travel in different directions.

Figure 2. Transport Network in the Zurich Weinland

![Transport Network in the Zurich Weinland](source: ZVV 2008 network map)

After around 9pm, bus routes on some of the quieter routes to smaller villages change, with coverage reduced to save costs. A special network of up-to-hourly 'after midnight' services operate throughout the canton early on Saturday and
Sunday mornings (between 1am and 5am). Less populated areas, including most of the Weinland, may receive one or two such services per night.

Although most bus routes are direct, they may not always take the shortest route from the origin station to the final terminus. This is usually to make efficient use of the bus route by serving the closest villages along the way. Nevertheless, routes rarely ‘double back’ on each other, and those that are less direct tend to act as feeders to stations in different directions, meaning that few passengers are likely to ride the entire length of the line. Routes rarely divert into side streets to serve more of a township: most of the built-up area of the small villages can be brought within a 400m radius of the one or two bus stops on the main street through the village, which conveniently tend to be located near a local shop or post office. Rheinau, which is drawn out along its long ‘peninsula’, has 5 internal stops.

A number of smaller villages, such as Rudolfingen (population 250) have access to services by virtue of being located ‘along the way’ between the larger villages and the stations. Within the core of semi-rural Weinland, no areas of 300 people or jobs were identified as being unserved in the ZVV’s most recent service review.

How services are financed

Providing a comprehensive network across the Canton to compete with car use, based on service standards that are set in the political process, means that cross subsidies are inherent to the nature of the service provided. With a zone-based, fully multi-modal fare system and limited information from a simple and flexible ticketing system, there is no natural distinction between revenues sourced from different modes of transport: all are mutually supporting parts of the network. The ZVV is a 'whole' network, and its cost recovery is worked out accordingly. However, figures on the patronage of each of the component services can be at least used to consider if the services are 'useful', and give some idea of what their nominal contribution to cost recovery might be.

Despite —or perhaps because of— the provision of attractive, high-quality public transport services, cost recovery across the ZVV’s network is relatively high. In 2008 the total cost of running services was CHF 817 million a year, partly offset by revenue of CHF 479 million a year, which gives an overall cost recovery of 59% (ZVV 2009, p. 23). This is a significant improvement over 2003, when cost recovery was 53%. An additional sum is provided by the Canton for expenditure on new railway infrastructure, such as double tracking and station modernisation. The Federal Government also makes contributions for rail infrastructure (major projects): this is not specified in the ZVV report, although the figure was CHF 215 million in 2000/01 (Brühwiler 2003).

The operational deficit is covered mainly by the Canton and municipalities: in 2008 the Federal government put in CHF 22m (around 3%) and the Canton and
municipalities paid the balance (CHF 314m) (ZVV 2009, p. 23). This balance is split 50:50 between the Canton and municipalities. The municipalities then split their overall contribution into two components: a share depending on each municipality's tax revenue accounts for 20% of the contribution, and a share depending on service levels to each municipality accounts for the other 80% (Brühwiler 2003).

Interestingly, it is not the job of the transport conferences to assess the cost recovery of any new services they propose or consider. Instead, they concentrate on applying the system standards, balanced against competing priorities, within the budget they are allocated by the ZVV. They also make sure that the system is working cheaply and efficiently. In particular, their job is to ensure that good use is being made of the buses and drivers, so that they are not standing idle unnecessarily. For a very approximate figure on cost recovery, however, Professor Ulrich Weidmann of ETH Zürich estimates the cost recovery on most Swiss bus routes to be less than 30% for rural services, and around 40% for suburban services (Interview, September 12, 2008).

Usage of Services in the Zurich Weinland

While cost recovery figures for the Weinland region are not readily available, the ZVV monitors patronage on services, and vehicles in the Weinland are generally well-loaded. In 2007/08, an average of 8266 people used the S16/S33/S11 services to cross into the City of Winterthur every workday from the Andelfingen corridor (although this includes 2600 passengers on the S16 and S11 express services from Schaffhausen that stop only at limited stations within the Zurich Weinland) (Canton Zürich Statistical Office 2009, p. 157). 2906 passengers also used the S29 services to cross into the City of Winterthur from the corridor beginning at Stein am Rhein.

Earlier ZVV internal figures show the average number of passengers on each S33 and S29 train through the Weinland was around 80 (at the City of Winterthur's boundaries, across Monday to Friday for the first five months of 2008). This is just short of the 90 second-class seats in the smaller two-car Thurbo train sets which run on the lines. Off peak services appear to carry far fewer passengers (sometimes as low as 30); while in the peak, services can carry more than 250 passengers and a small number have to stand, despite extra train units being added.

More detailed figures on passenger numbers are available for local bus routes, thanks to automatic passenger counters located at bus doorways, which are rotated around the buses throughout the year. We were given figures for services in route sections closest to the Weinland’s railway stations. According to the ZVV’s internal 2006 patronage figures, the busiest hourly bus services in Weinland (such as the 605 between Andelfingen and Oberstammheim, and the 620 between Martha and Rheinau) are generally well loaded during peak hours in the peak direction, with the busiest services (eg at 6pm in the evening) carrying 40-60 passengers, and the most
lightly loaded services carrying an average of 1 passenger (in the early morning counter-peak). The average throughout the day was around 14 passengers.

On bus routes through smaller settlements, such as the 621 (see Figure 2), the average number of passengers on buses throughout the day between 6am and 8pm was just under 10, although the busiest peak service carried 40-50 passengers. Having reasonably large capacity vehicles also allows services to cope with intermittent fluctuations in passenger numbers.

**Conclusion: The Zurich Weinland**

Network planning has produced a viable public transport service in the seemingly hostile environment of Zurich's Weinland. The network has been created despite low service frequencies, through the setting of strong service standards and the rigorous coordination of services. This 'Zurich' approach consists of a number of important features, many of which may be applicable to other peri-urban areas.

Firstly, high standards for service frequency and operational hours were agreed through the political process, and they continue to guide the provision of services. Minimum hourly services from early morning to the late evening provide a repeating pattern that is easy for passengers to remember and provides them with some level of convenience. Without such 'supply-led' service standards, there is little chance for demand to manifest itself: a network with irregular and limited services is unlikely to be convenient for a large cross section of potential users (Laube 1998, pp. 307-308). Similarly, minimum hourly services help planners to ensure that regular connections are made with other services in the network; by contrast, service provision that is fine-tuned to demand is unlikely to harmonise headways and make connections. On the other hand, service standards must be set with some idea of potential patronage to ensure acceptable levels of cost recovery and vehicle occupancy across the day.

With service standards in place, a multimodal central planning body (the ZVV) plans the transport network to deliver services efficiently to its geographic area. It aims to ensure that connections between services are coordinated, that all parts of an area are served, and that unnecessary duplication does not occur. The central body also ensures that fare revenue is shared: cross subsidies support less profitable services, including feeder buses, which are a necessary part of a comprehensive network. Central planning at a cantonal and national level also ensures wide availability of products to encourage public transport loyalty, such as periodical travel passes and half-price fare cards. However, there are also mechanisms for substantial local involvement in decision-making, such as through the ZVV's sub-regional transport planning conferences.

All local public transport services including regional buses are planned around the rail system, which has less timetabling flexibility but also forms the faster, high-capacity backbone of the public transport network. Across Switzerland, thanks to
strong leadership from the SBB and wide acceptance of the *Taktfahrplan*, trains are always timetabled to depart stations at the same minutes past the hour: any additional peak services are simply slotted in-between. This not only makes rail timetables easily memorable, but importantly makes the planning of bus feeder services much simpler. Regular timetables allow pulse or crossing points to be easily identified and planned as preferred interchanges for feeder buses from the surrounding area. Regular timetables also give buses a consistent amount of time to complete their route, which allows them to follow the same route and timetable throughout the day for easy passenger recall. The bus routes themselves are planned to serve an area as efficiently as possible—with the layout of settlements in the Weinland, direct routes tend to follow through-roads and feed stations at both ends of the route.

While no detailed figures are available, services in the Weinland, like other semi-rural areas of the Canton of Zürich, are subsidised by the more profitable central parts of the ZVV network. These include the core rail network (which the Weinland helps to feed) and the local systems in the core urban areas of Zurich and Winterthur. Some of the benefits for central areas are that high quality transport in semi-rural regions results in less commuter traffic in the cities, a wider pool of labour and easier access to recreational areas for city residents without cars. However, there may be a limit to how far such subsidies could be spread in a province or canton where major urban areas do not dominate as in the Canton of Zürich. Nevertheless, the reasonably high patronage figures for the Weinland suggest that semi-rural services do not drain resources to the extent that might be expected.

**NETWORK PLANNING IN GRAUBÜNDEN’S LOWER ENGADINE REGION**

The Zurich Weinland is a semi-rural or ex-urban area, but the Lower Engadine, in Canton Graubünden, is completely rural. With an area of 1196 square kilometres (these figures are for the District of Inn, which includes the Lower Engadine and the adjacent Val Müstair), the district occupies a similar area to New York City, but houses fewer than 9000 people (see Figure 1). With a sparse population located well beyond commuting distance from any large centre, the region presents an extremely difficult environment for public transport.

Graubünden is Switzerland’s largest and most sparsely-populated Canton, with more than 40 per cent of its area occupied by uninhabited mountainous areas. Major towns are the capital, Chur, with 33,000 residents and the famous tourist resorts of St Moritz and Davos. The Inn District is the most easterly part of the Canton, bordering Austria and Italy, and the main town of Scuol, population 2122, is just under two hours by train from Chur. Other settlements all have fewer than 1000 residents.
The Lower Engadine and Val Müstair are largely rural, and it is not surprising that travel by car is the most popular mode for journeys to work. However, at 49.8% of journeys, it makes up just under half of all journeys to work, a figure that is actually significantly lower than the equivalent for Zurich’s Weinland (64.7%) (SFSO, n.d., based on 2000 census). Journeys to work by foot or bicycle account for a remarkable 39.7% of trips, with walking making up the vast majority of that category, reflecting the localised nature of much travel to work. However, the figures for journeys to work by public transport are also significant: an average 10.5% of journeys are by public transport, including 3.8% by rail (see Table 3). While lower than the public transport mode share recorded for the Zurich Weinland, this figure is higher than those recorded at the most recent census for all US metropolitan areas other than New York and Chicago, as well as Australian cities like Adelaide, Canberra and Hobart; it is also higher than the shares for UK municipalities such as Milton Keynes, Basingstoke and Aylesbury (Mees, 2010, pp. 60-61, 64).

Sustainable transport mode share for student travel to educational institutions is also very high: only 3.7% travel by car; 62.9% walk or cycle (most of those walk); and 33.4% use public transport, mainly regular buses or school buses rather than rail (SFSO, n.d., based on 2000 census).

**Planning public transport in Graubünden**

The current planning arrangements for Graubünden's public transport services were introduced following the example of Canton Zürich's regional transport restructuring. The Canton of Graubünden invited the consultant responsible for the Zürich regional network to help replan Graubünden's public transport system. In 1993, it enacted new legislation and associated regulations which set service standards and established a cantonal public transport planning office to specify the services for which the Canton was willing to pay. While PostAuto services in particular had evolved from irregular historic service patterns, the new network aimed for hourly services through Graubünden’s main valleys, connecting to hourly rail services operated by the mainly Canton-owned Rhaetian Railway (Rhätische Bahn, or RhB) (R. Bergmaier, Interview, October 3, 2008). The public transport section of the Office for Energy and Transport (Amt für Energie und Verkehr or ‘AEV’) in Graubünden’s Building, Transport and Forest Department is ultimately responsible for coordinating network and service planning for all public transport in the canton.

Public transport planning in Graubünden is centralised in the cantonal public transport office, which makes it easy to plan a canton-wide network with good connections between services. Connections over longer distances are particularly important to Graubünden, given its dependence on tourism and the large numbers of tourists from central Switzerland (including from Zurich Airport) who reach the canton by rail. Around half of RhB users are foreigners and a significant proportion of the Swiss passengers do not live in Graubünden (M. Leuthold, interview, September 29, 2008). However, the canton’s public transport must serve three quite distinct
markets: commuter travel, especially around Chur; tourist travel to, from and within each region; and local travel by residents within each region.

Despite the different travel markets, the service concept used in Graubünden is essentially the same as that applied to Zurich’s Weinland. Where possible, planners aim to provide at least hourly services repeating at the same minutes past the hour between shared operating hours. This gives passengers a simple and easily memorable service pattern, and also helps to create a network by allowing connections to be made with other hourly services. At stations served by buses, all bus routes are timed to connect with hourly trains in (at least) the main direction of travel, to ensure convenient connections for longer distance trips. At the most important stations, buses on main routes meet together or ‘pulse’ every hour between the arrival and departure of trains. This means most inbound tourists or longer distance travellers do not need to consult the local bus timetable before arriving at a station by train: there will be connecting buses to almost all destinations. On the return journey, they may need to look up the timetable to find the ‘minutes past the hour’ at which a bus departs their local bus stop, but they will always find a connecting train at the station.

Like their counterparts at the ZVV, Graubünden’s public transport planners are very conscious of the importance of making connections, and told us that while missed connections did happen on rare occasions, planners knew they had to avoid them in all but exceptional circumstances to retain the confidence of users. They are even prepared to delay the departure of trains so that late buses can make their connections.

The rigid and hierarchical timetabling process which planners have employed to provide connections across Graubünden also works for local travellers. Main route local buses run at least every hour at the same minutes past the hour, meaning that even if services are fairly infrequent, they are evenly spaced throughout the day and depart at the easily memorable times. On busy routes, extra ‘shadow’ buses may be deployed to cope with overcrowding, and services may also be upgraded to every half-hour during the busiest periods of the day (in which case every second bus meets the train).

The regular service pattern on main routes actually works to the system’s advantage when dealing with different travel needs. Travel by residents helps to balance flows in the network: their travel often peaks at different times of the day and in different directions to tourist travel, and the combined demand helps to support a comprehensive timetable of services.

Cantonal regulations and service standards

The canton’s 1993 law on public transport and its associated regulations provide standards for regional services throughout the canton (Law 872.100, Regulation
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872.150). The number of services provided to an area depends on the potential demand in its catchment; each area is classified as either sparsely populated, rural or densely populated (Regulation 872.150, s. 10). The boundaries of each area are defined by an appendix to the regulations, which groups the canton’s municipalities in zones (Ibid., appendix 2). Each zone is classified according to its number of residents and jobs: ‘sparsely populated’ zones have up to 500 people or jobs, rural zones have between 501 and 2000, and densely populated zones have 2001 or more (Ibid., appendix 1). In the Lower Engadine and Val Müstair, no zone is classified as ‘sparsely populated’, as even the smallest municipalities are grouped together to form zones of sufficient size.

The service standards vary according to the zone’s classification. For sparsely populated area zones with fewer than 501 people, this can be as few as 4-5 return trips per day, but even the sparsely populated zones may eligible for an increase in services up to a total of 10 return trips per day. In rural zones, with 501-2000 inhabitants or jobs, the basic services standard is 6-10 return trips per day, with auxiliary services increasing the number up to 18 services a day (which would cover hourly services from 6am to midnight). Finally, in densely populated zones (with more than 2000 residents or jobs), basic services are 11-18 return trips a day, with auxiliary services up to 36 (the equivalent of half hourly services between 6am and midnight).

Graubünden’s public transport network is supported by policies and practices that go beyond the integration of service planning. Across the canton, the fare structure is consistent for both rail and bus services; and timetable information is available for combined rail and bus journeys. User information about fares and routes, however, is less developed than in the major cities of Switzerland.

How standards are applied in the Lower Engadine

Since they are part of the RhB network, rail services in the Lower Engadine run hourly. The rail system’s position at the core of the cantonal public transport network means that the service standards are largely irrelevant: at least hourly services must run so that the trains can link all parts of the canton and provide for multidirectional travel, even though some smaller zones may receive a better level of service than their population entitles them to. As part of the network core, rail services also tend to operate for the longest hours.

The two train services to the Scuol-Tarasp terminus, one from Chur and the other from St. Moritz, operate hourly until midnight. The railway line terminates at Scuol-Tarasp station, leaving bus services to perform the main line function further down the valley. Most of the towns and villages in the Lower Engadine along the main bus routes receive at least an hourly takt service between 6am and 7-8pm.
According to the regulatory standards, Ftan, Tarasp, Scuol and Sent are in the same zone, which entitles them, with a combined population that exceeds 2000 people and jobs, to a minimum of 11-18 services a day in each municipality. They do all receive at least this basic standard, with most getting hourly services over 18 hours. After 8pm, services to the closest towns around Scuol are replaced by hourly demand-responsive ‘bus-taxis’. These always await passengers arriving by train at Scuol-Tarasp station, but otherwise must be booked (by calling the driver’s mobile phone) no less than 30 minutes before travel.

In terms of geographic coverage, almost every village in the Lower Engadine has access to some public transport service. The railway in the Lower Engadine valley runs close by many of the major towns, and is therefore able to serve most of them.
without the need for a supplementary bus service. More distant villages are connected to the nearest station by shuttle-bus. There are no strict rules on walking distance standards in the regulations, with municipalities merely being entitled to a service. A 300-400m radius is used as a general rule when planning bus routes (K. Willi, interview, September 23, 2008). Most bus services tend to follow the central main roads through the villages. Sometimes, this will mean that houses on the outskirts of towns will be left outside this walking radius.

Only one service in the region uses a permanent demand responsive bus – to connect the small settlement of Brail, which is next to the border with the Upper Engadine region, to Zernez. It has the smallest usage of all regular bus routes: 8600 passengers a year, or less than 24 a day.

The public transport network in the Lower Engadine and Val Müstair offers most of the region’s residents a Zurich Weinland-style service, even if significant numbers of (less populous) small villages outside the region’s core have lower quality services. Within the core, passengers are provided with at least hourly services from 6am to midnight (over 18 hours), 7 days a week, although the core sections of the main line bus routes are replaced by demand responsive services after 8:30pm. On some routes, services are provided every half hour during the day. Services in the core area serve the travel of residents and tourists who make relatively frequent trips between the outlying villages and the centre of Scuol.

Services to more remote areas, without large towns or distant from the rail system, stop earlier: they usually have a 10-14 hour span of service with the last buses departing between 6-8pm. These include services to villages further down the valley beyond Sent, the bus line to the Val Müstair, as well as shuttles to townships from the main rail or bus lines. Additional seasonal links to uninhabited skiing or walking locations run according to special timetables.

The generally high standard of service on the regular public transport routes means that passengers are still able to arrive at Scuol-Tarasp station at any hourly pulse during the main service hours (8am to 6pm) on any day of the week and be able to catch any of the most popular bus routes. The main service hours are suitable for many of the residents going about the bulk of their daily activities, as well as for most tourists, as the region of small towns and villages is known for its daylight activities rather than its nightlife, while cold nights in the mountains may further discourage discretionary leisure travel after dark.

How services are financed

The RhB collects boarding and alighting figures over a year for each station, which indicate how many passengers use stations, but do not identify the service that they used (where two or more lines service a station) or in which direction people were travelling. Scuol-Tarasp was the seventh busiest station in the RhB network with
284,919 boardings or alightings at the station over 2007, which works out to 780 trips per day when averaged over the 365 days (RhB internal figures).

PostAuto services which depart Scuol-Tarasp station attract significantly more passenger trips than the station’s 780 trips per day: the five bus routes serving Scuol-Tarasp attract a combined average of 3360 trips per day (PostAuto internal figures, 2007). The busiest route, to the village of Sent and the nearby camping ground of Sur-En, attracts an average of 989 trips. The rail service therefore attracts the equivalent patronage of only one of the more highly used local bus routes, indicating that most public transport trips undertaken in the region by both residents and tourists are local. However, the rail connection to long distance services is still important to provide access to the national network, and to allow the buses to serve a wider range of travel needs (especially later in the evenings).

The average bus occupancy also appears to be high. The 989 trips for the busiest route to Sent-Sur-En can be divided by the 30 regularly scheduled buses (or 42 with additional seasonal services) to give an approximate occupancy figure of either 33 or 23 passenger trips per scheduled bus per day. Actual vehicle occupancies are likely to be lower: some passengers will get on and off along the route; shadow buses follow some of the busier services to cater for passenger overflows; and passengers on the demand responsive night bus-taxi services may also be included in the total patronage figures.

The RhB produces an annual report listing its revenue and expenses: in 2008 the average payment or subsidy per passenger was CHF 5.42, while average income per ticket was CHF 15.80, meaning passengers pay 74% of costs (RhB 2008, p. ii). However, these figures include premium-fare trains and carriages marketed to tourists. RhB planners we interviewed gave an average cost-recovery figure for regular services of 62%, while good lines manage about 80% (M. Leuthold, Interview, September 29, 2008). PostAuto Graubünden is a section of PostAuto Switzerland, and does not publicly report its cost recovery figures. However, the canton’s Office for Energy and Transport gives the average overall figure of about 35% cost recovery for PostAuto Graubünden (W. Glünkin, e-mail, January 28, 2010).

**Conclusion: The Lower Engadine**

The provision of public transport in the Lower Engadine is a challenging task, but a Zurich Weinland-level of service is still able to be provided to the canton-wide rail system and to the core of the regional networks, whilst all services make timed connections to the long distance trains travelling to the rest of the canton and the country.

Planners have been able to achieve this level of coordination by centrally planning timetables at a cantonal level using a strict hierarchy: starting from the SBB services, then planning RhB lines, and then local bus services. With clock-face RhB services
following the SBB lead, bus routes throughout the network can be easily planned to make consistent timed connections to longer distance services on every hour that they run. Buses are also able to consistently depart stops at the same minutes past the hour. Just as in the Weinland, this provides an easy, memorable pattern to make catching infrequent services as simple as possible.

The fact that some buses to villages surrounding Scuol run more frequently than the trains and attract more passengers, shows that there is also a greater proportion of local compared to long-distance travel, and it is likely that the same applies in other Graubünden regions. Despite this, planners insist that services are centred on the rail system’s timetable and stations. Not only does mean close connections between services, it also it also allows both buses and trains to become 'catch all' services catering for both local and longer distance trips. The use of short-distance shuttles to feed both rail and main line bus services also minimises the parallel running or duplication of bus and rail services to maximise the efficiency of the network.

Even though the system in the Lower Engadine and Val Müstair cannot provide a uniform standard of service to the tiniest villages in the entire region, it does provide a basic and high-quality public transport service to the majority of its residents and visitors.

**DISCUSSION AND CONCLUSIONS**

The Swiss ‘network’ approach to rural and semi-rural public transport presents a viable alternative to the flexible, demand-responsive approaches that currently dominate discussion in English-speaking countries. Although more work is required to confirm this, it appears to produce mode share and cost-recovery outcomes superior to those obtained to date with demand-responsive approaches. The cost recovery of Graubünden's PostAuto network is about the same (35%) as the CfIT’s best-performing UK example (36%) and much higher than the average; while PubliCar appears to be heavily subsidised given its estimated cost per passenger journey of between CHF 20-60. Of course, it must be stressed that the network and demand-responsive approaches are not simple alternatives: PublicCar routes in French-speaking Switzerland connect with regular services, while some regular routes in cantons Zürich and Graubünden revert to demand-responsive services for evening or late-night passengers.

Nevertheless, the basic approach that has been successful in semi-rural Zürich and rural Graubünden is the polar opposite of the demand-responsive philosophy. Fixed route structures and timetables repeating every hour seem ‘inflexible’ at first glance, but are employed to provide an all-purpose service that caters for commuters, local travel and tourists.
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Why has this approach received so little attention in English-speaking countries, especially the UK, where it would appear to offer so much potential? One key reason is that the Swiss network approach relies on strong central planning by a government monopoly agency: the ZVV in Zürich and the Cantonal Office for Energy and Transport in Graubünden. This runs counter to the UK approach, which for more than two decades has been based on deregulated private-sector-led services, supplemented by ‘gap-filling’ services funded by public agencies. Surprisingly, even the Commission for Integrated Transport, which is charged with “blue-sky thinking” on future strategic issues, seems unable or unwilling to reconsider the basic approach of deregulation, despite ample evidence that it has failed (Mees, 2010).

An additional reason for the lack of interest in network planning may lie in the tendency of many transport analysts to focus on service inputs rather than outputs. Demand-responsive services like PubliCar seem like the answer to competing with the car because they so resemble cars; rigidly-structured fixed networks of regular trains and buses seem so different from the car that it can be difficult to see how they might successfully compete with it. The relative success of the network approach shows that in rural transport, as in so many other areas of policy, appearances can be deceiving.

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