2015

Evidence for Orbital Public Transport Corridors in the Greater Dublin Area

David O'Connor
Technological University Dublin, dave.oconnor@tudublin.ie

EVIDENCE FOR ORBITAL PUBLIC TRANSPORT CORRIDORS IN THE GREATER DUBLIN AREA

Mr David O'Connor
Lecturer
Dublin Institute of Technology

Abstract

Previous studies have looked at the absence and need for orbital public transport corridors in the Greater Dublin Area [1]. This current paper outlines recent evidence which demonstrates that demand for such orbital services exists.

Recent travel survey data indicates that demand exists in Dublin for both orbital and "networked" trips. In surveys of public transport users on two public transport corridors in the Greater Dublin Area, 27% of people transferred either from or to another public transport service as part of their journey.

Overall this appears a very significant level of passenger transfer within an urban transport market where traditionally transferability is thought of as being low or negligible. This suggests that there is an existing demand for orbital and directional trips (those which involve a transfer) within the Greater Dublin Area. Both surveys were taken across contrasting areas of the city.

The evidence for transfer demand is corroborated by the census and by household travel data collected by the NTA, both of which indicate a clear and significant demand for orbital trips. No matching or supporting high level of service corridors currently exist to support these. The Dublin City Council Core Strategy also suggests the implementation of an orbital network and this should, in a normal planning framework, lead transport strategy. Orbital High Quality Bus Corridors have been proposed for Dublin in the past but never implemented.

Orbital routes are often considered a costly idea that is unpopular with transport users. Yet many cities provide them in a successful, often revenue-generating context. Cities that support successful orbital services take a Network Effect approach to service design where high quality transferability is paramount.

Local and international evidence suggests that orbital QBCs can be a success if implemented with a high level of service. The benefits of implementing orbital high quality corridors goes beyond serving immediate trip demand and can help to create an effective city-wide transport network.

THE HISTORY AND BACKGROUND TO ORBITAL PUBLIC TRANSPORT CORRIDORS IN DUBLIN

The idea of orbital routes within Dublin has been around for some time, referenced for example in the 2002 DTO "Platform for Change" Strategy [2], the 2006 MVA "Dublin Bus Network Review" study [3] and more recently the NTA Greater Dublin Area Draft Transport Strategy 2011-2030 [4], where two notional orbital QBCs are referred to. To date, however, the physical implementation of public transport services serving orbital trip demand centres has been limited and levels of services low. Routes that do exist, tend to be meandering and serving limited sectors of the city. The conventional wisdom has been that orbital services have low patronage thresholds and, moreover, that propensity to transfer within the Dublin urban transport market is limited. Current research, to which this study refers, appears to contradict such assumptions [5, 6].

The QBC Network

Dublin has deservedly won high praise for delivery of its Quality Bus Corridor network [7]. This mostly happened from 1997 – 2010 and included the reallocation of road space on 16 corridors. The establishment of a (now disbanded) Quality Bus Network Project Office was instrumental in this regard, constituting an agency with cross-boundary authority and

planning & design capabilities. Resulting from this programme of implementation, approximately 20% of bus routes, which are dedicated QBCs, carry 50% of daily traffic and 90% of peak hour traffic [7]. But the network was never fully delivered as outlined in the relevant strategy document, "Platform for Change" [2]. The document, strategic in nature, indicated a web-based network of services within which orbital services lacked coherence (see Figure 1). The strategy, although based on extensive traffic modelling, didn't appear to follow immediate land use and transportation planning principles. Few or none of the orbital segments were considered for implementation. Neither, in fact, was the city centre quality bus network implemented.

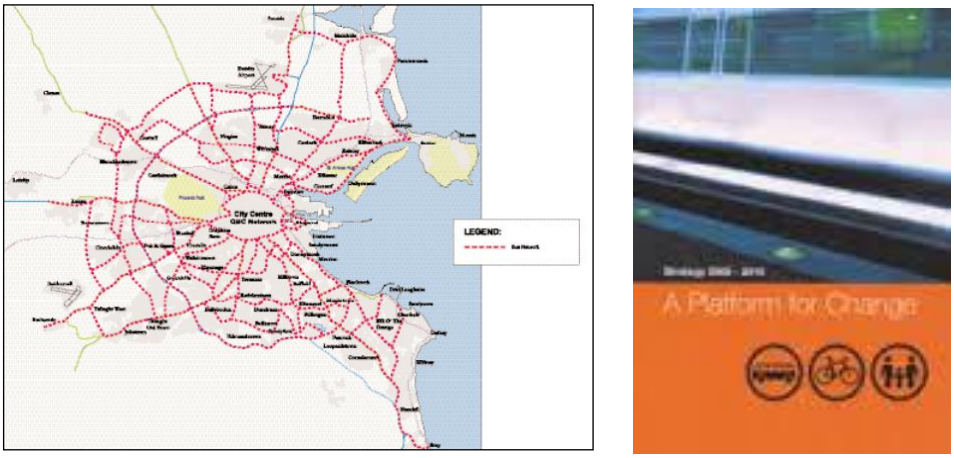

Figure 1: DTO Platform for Change Quality Bus Network Strategy (Source: DTO, 2002)

MVA Proposed Orbital Strategy, 2006

A considered case for orbital routes was made by the 2006 MVA study, commissioned by Dublin Bus [3]. The study proposed four quality service loops to complement the network of 16 arterial routes and provide a reorientation of the bus network away from a city-centre-focussed arterial model. The orbital loops also set out to connect key urban centres and major employment and educational centres.

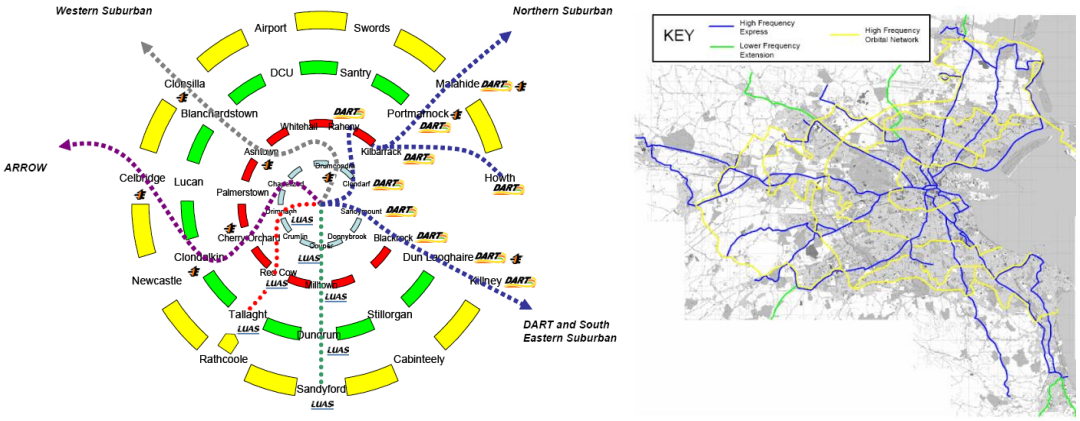

Figure 2: 2006 MVA Dublin Bus Network Review Orbital Network Proposals – schematic (left) and planned (right) (Source: MVA, 2006)

These proposals were part of a commissioned study which acted as a precursor to the "Network Direct" review of Dublin Bus services [8]. Network Direct was implemented between 2009 and 2013 and comprised a large-scale reorganisation of routes. The number of buses in service reduced from 1300 to fewer than 800. The overall number of routes was reduced from over 200 to 110. 27 of these routes now carry an estimated 70% or all Dublin Bus trips [9]. However, while major operational efficiencies were achieved, the proposal to implement quality orbital services was not included in the Network Direct implementation.

The Greater Dublin Area Draft Transport Strategy

The first draft Transport Strategy prepared in 2011 by the NTA [4] refers to Priority 1 QBCs, Priority 2 QBCs and two "indicative" Key Orbital Bus Corridors (see Figure 3). Unlike its predecessor, Platform for Change, no travel mode share targets were set out in this strategy. It will be clear, when discussing forecasted trip patterns below, that the strategy could not meet forecasted demand without a substantial orbital component for which only vague commitments were made within the Strategy.

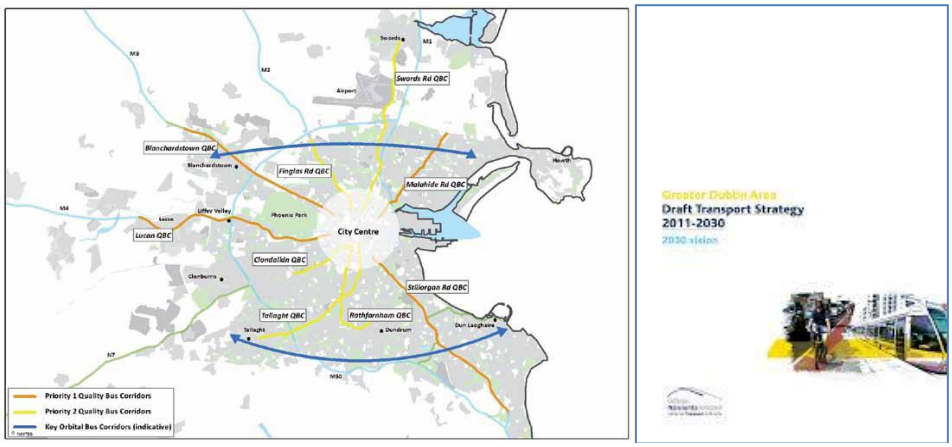

Figure 3: NTA Greater Dublin Area Draft Transport Strategy Bus Strategy Diagram (source: NTA 2011)

2014 Direct Award Contract to Dublin Bus

A new direct contract for the operation of all services in the Dublin area was awarded to Dublin Bus on 1st December 2014 for the operation of its existing bus services. The duration of the Direct Award contract was for a period of five years until 30th November 2019, except for certain identified local and orbital services.

The local and orbital services have been re-tendered on the market, with the objective of commencement of operation by the winning tenderer in autumn 2016. The services are being retendered in their current state. As illustrated in Figure 4 below, these tend to be meandering, incoherent and sectoral in nature [10].

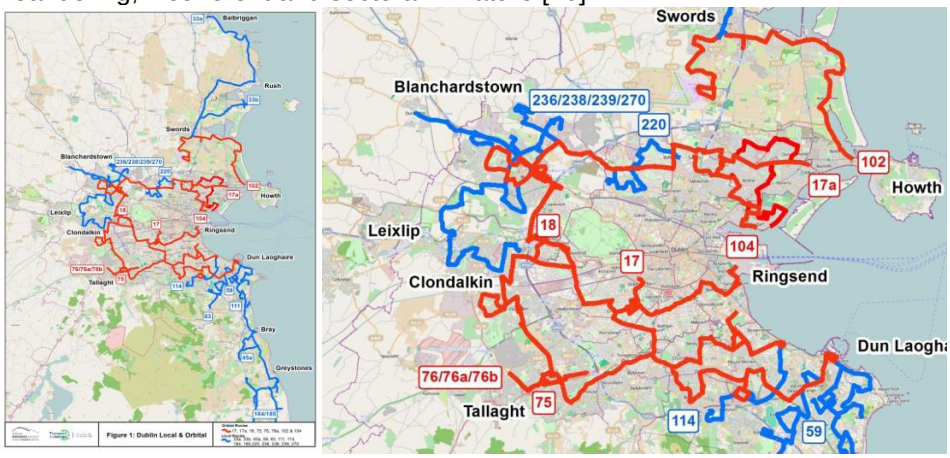

Figure 4: 2014 Bus Tender Route Map (inset: detail of orbital routes) (Source: NTA)

An Taisce Proposals

In the summer 2015 issue of the Annual Magazine of an Taisce – the National Trust for Ireland, in an article entitled "The Network Effect – the Potential for an Integrated Transport Network", James Leahy proposed a series of options where the current public transport services could be upgraded to form an integrated network [11]. Each option implies the

development or strengthening of orbital transport routes. The proposals have been submitted to various statutory consultations, including that for the forthcoming Transport Strategy for the Greater Dublin Area [12].

The proposals also follow and reflect a previous, imaginary proposal for an integrated transport network, prepared by Aris Venitikidis and James Leahy in 2010, referred to as an "Integrated Map for a Visionary Public Transport System for Dublin" [13]. While conceptual and highly visionary in nature, the proposal went viral on the popular international website for scientific discourse, www.ted.com, though it never received any official or formal recognition [14].

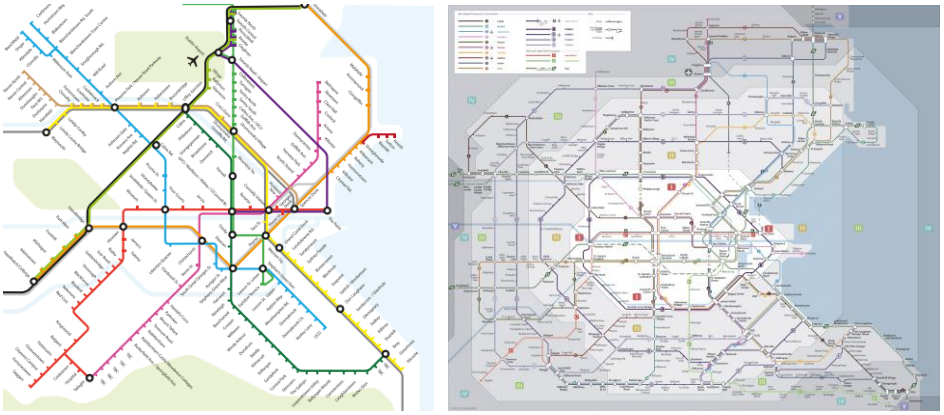

Figure 5: an Taisce proposal for a Network Effect for Dublin (left) and the Aris / Leahy Visionary Public Transport Map for Dublin (right)

Current Policy Direction

The NTA has announced a forthcoming, updated draft Transport Strategy for Dublin [15]. The publication of this paper predates the impending release of this draft Strategy. Therefore, it is not known whether and to what extent the development of orbital routes are proposed in the formation of new strategy.

The recently published draft Dublin City Centre Transportation Strategy Consultation Document [16] makes limited reference to orbital services. In Section 6.3.1 Quality Bus Corridors (QBC), the strategy states: "Orbital bus route movements will also be reviewed and strengthened to cater for the anticipated increase in demand". The document commits that it must be consistent with the forthcoming NTA Strategy for the Greater Dublin Area.

EVIDENCE FOR ORBITAL DEMAND

A number of studies [5, 6] were carried out during 2014 examining public transport passenger behaviour, specifically the distance users were prepared to travel to public transport under varying conditions. These studies demonstrate a high existing demand for transfer onto orbital services across a representative sample of the Dublin urban transport market.

The studies focussed on two corridors in the Greater Dublin Area, the Malahide QBC on the northside and the Stillorgan QBC on the southside of the city. As part of the surveys, bus users were asked about their mode of arrival and also what mode they would use to complete their journey. A total of nine stops, from city centre to outer urban locations, and 333 boarding passengers were surveyed [5, 6].

At each stop, waiting passengers were queried as to which mode they arrived by and, also, how they planned to complete their onward journey at the other end of the service. Across both surveys, the following patterns were recorded: -

- 82% of passengers walked to their bus stop;
- 11% of passengers drove to their bus stop (mostly *"kiss & ride"*);
- 7% of passengers arrived at their stop by bus;
- 78% completed their journey on foot or by bike;
- 21% transfer onto another public transport service;
- Out of 333 passengers surveyed a total of 27% (more than 1 in 4) bus users transferred as part of their journey.

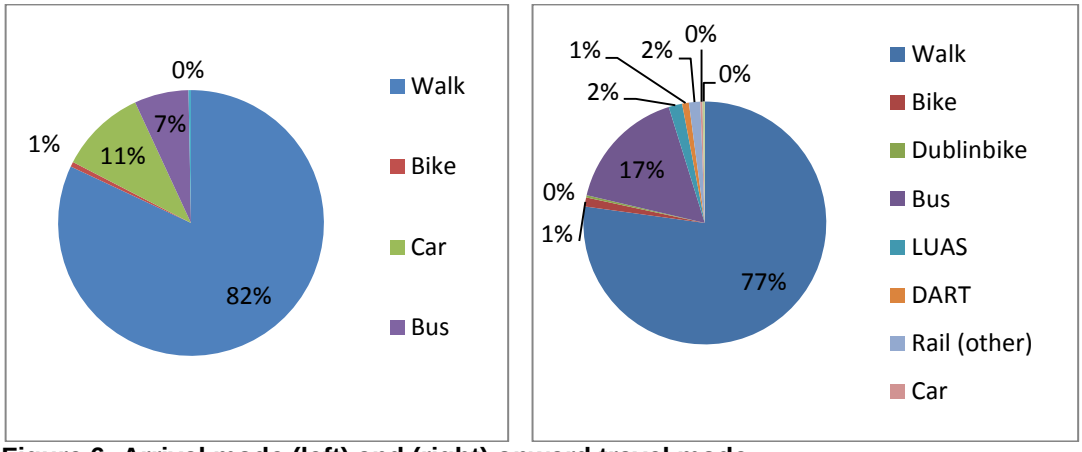

Figure 6: Arrival mode (left) and (right) onward travel mode

This survey was undertaken at 9 stops in differing parts of the city. 333 passengers were interviewed while waiting for their bus. Of these public transport users 27% (or more than one in four) transferred either from or to another public transport service as part of their journey. Overall this appears a very significant level of passenger transfer within an urban transport market where traditionally transferability is thought of as being low or negligible.

On the Malahide Quality Bus Corridor, approximately 1 in 3 (35.5%) of all passengers surveyed transferred either from or to another public transport service. On the Stillorgan QBC, a corresponding QBC serving higher socio-economically stratified suburbs on the southside of the city, revealed lower but still significant (14%) levels of transfer.

The results point towards a number of potentially relevant and new understandings about public transport user behaviour within the Greater Dublin Area. These are discussed in greater detail in the respective papers [5, 6]. But principally, for the purposes of this paper, the studies indicate clearly that there is a material demand for transfer within the Dublin transport market, even where it may be poorly provided for.

Evidence from the Greater Dublin Area Household Travel Survey

Data from the Greater Dublin Area Household Travel Survey, contained in the 2011 NTA draft Transport Strategy, also provides compelling evidence for the demand for orbital and "networked" trips, as suggested above. The Greater Dublin Area Household Travel Survey is a wide sample of all travel behaviour across the GDA and prefaces the development of the statutory transport strategy for the city. In particular, the survey informs the transport modelling processes which underpin the strategy formation [17].

Figure 4.6 of the 2011 NTA draft Transport Strategy (reproduced in Figure 7 below) takes data from the Travel Survey and indicates that 56% of morning peak trips in the GDA are orbital, while 39% of trips are arterial, or inbound [17]. Many, possibly even a majority of these arterial trips are likely to be "networked" trips, i.e. requiring a transfer to reach their end-destination. If a conservative assumption is made that this is the case for 1 in 3 such trips, then 69% of potential public transport trips are not provided for without orbital services.

In 2030 the percentage of orbital trips is forecasted in the draft strategy to reduce to 46%. But if it is assumed that a similar share of arterial trips are "directional", i.e. that they require some transfer, close to two-thirds of all trips will remain un-served by the Strategy. That is unless a high level of orbital service is provided, in turn with a high level of transferability.

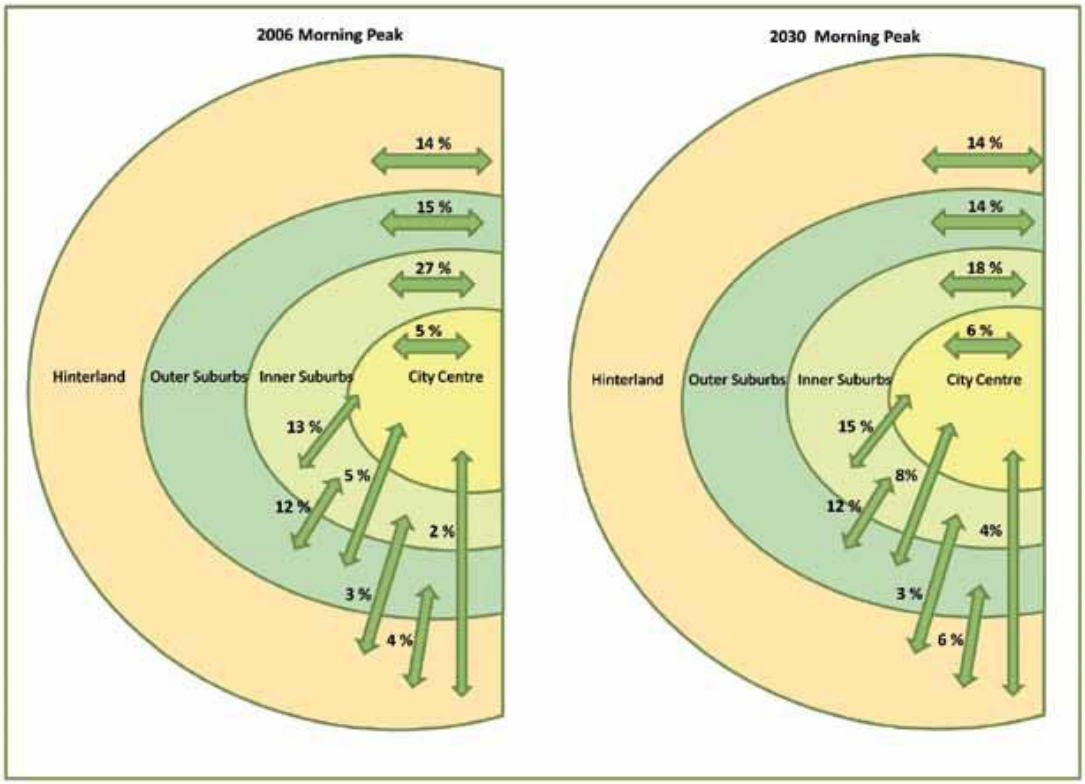

Figure 7: Current and Forecasted Travel Patterns for the Greater Dublin Area (Source: NTA, 2011)

Evidence from CSO POWSCAR Data

Analysis by Gleeson et al (and reproduced in Borscheid et al) [18, 19], also demonstrates the imperative for orbital transport services, particularly in disadvantaged, suburban locations. This study compared travel to work data from the CSO 2006 POWSCAR dataset for two electoral districts on the northside of Dublin. The POWSCAR ("Place of Work and School Census Anonymised Records") dataset contains individual household travel data records collected as part of the Census.

Figure 8 (below) shows the trip destinations of both residential neighbourhoods, highlighted in red. One affluent, inner suburb had mostly arterial trip demands, with most people

employed in service jobs, centrally located. The disadvantaged, suburban location had dispersed travel to work patterns, predominantly in outer sectors of the city which could only be accessed via orbital services. Given the absence of such services, the study highlighted the disparities in service levels for contrasting communities within the same city. While this is a sample of only two neighbourhoods, the wider socio-economic evidence suggests that this pattern is repeated persistently, particularly across the northern sectors of the city where manufacturing industry is in decline. The study represents further evidence for orbital trip demand, often in disadvantaged areas, where no orbital provision exists.

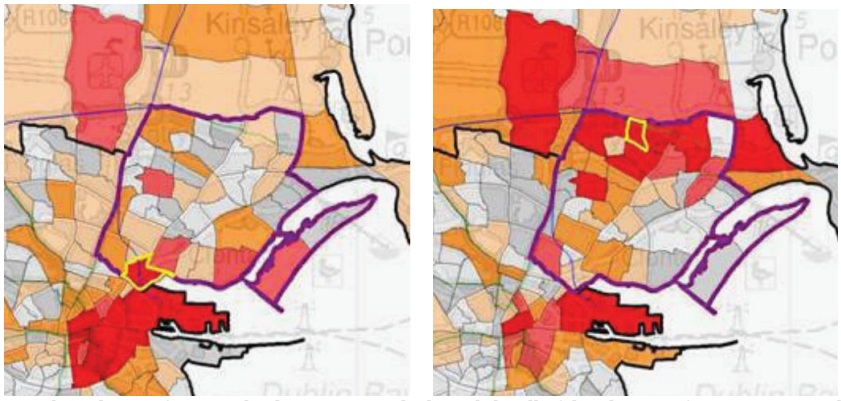

Figure 8: Destination of population at work (15+) in (left) Clontarf West D and (right) Priorswood B (Source: Gleeson et al (2009), New Ways of Mapping Social Inclusion in Dublin City, NIRSA, Maynooth)

North-east Dublin Study

Research was undertaken as part of an undergraduate dissertation by Colin Broderick to identify the potential for and barriers to implementing an orbital rapid transit network in north-east Dublin [1, 20]. The study looked at key trip demand centres in a sector of the city and assessed how well or otherwise they were served by orbital services. The study found that, even where demand for travel existed, these are, often inexplicably, omitted from transport models and strategies. The analysis suggested that both the population and employment forecasts informing the development of the strategy were based on an assumption of significant development at rail hubs. There does not appear to be an alternative scenario to deal with locations that will not be served by rail or otherwise reliant on any other mode of transport.

Figure 9: Orbital Strategy overlaid onto Population (left) and Employment (right)

DISCUSSION

The main argument for orbital QBCs is the Network Effect benefit they would deliver. Many cities provide them in a successful, often revenue-generating context. Those that do take a network approach to service design.

In particular, many northern and central European urban transport systems aspire to provide comprehensive mobility, serving anywhere-to-anywhere trips in a relatively timely and efficient manner. The most oft-cited reason for such optimality in urban transport is density. It is contended here that density and land use planning has an important though much overstated role to play. Even at low-medium densities, a population of 10,000 or more - the equivalent of a medium-sized Irish town - can live within walking distance of a transport hub [21].

The Network Effect

Paul Mees, in particular, argues that the density-patronage relationship is less clearcut than often claimed and that the most important determinant of ridership is service quality [22]. A central requirement in this regard is an idea called the "network effect". Very little has been written on this subject although esteemed authors such as Thomson seminally acknowledge its importance [23]. The most authoritative understanding of the concept has been given by Mees and his model is worth recounting here.

To explain it at its most basic, a theoretical city - "Squaresville" - is imagined which has 10 un-networked (in this case north-south) routes serving a grid of evenly populated districts (see Figure 10, below left) with similarly even trip distributions. In this model, using conventional transport planning assumptions, a total of 6% of trips are likely to be served by public transport [24].

Doubling the frequency of those routes, at standard elasticity of demand rates, would lead to a potential 9% of trips by public transport. In this case costs have doubled but patronage has only risen by 50%.

However, if instead of doubling frequencies 10 new networked (i.e. east-west) routes are added a different picture emerges (see Figure 10, below right). In this model, again using conventional assumptions, a total of 40% of trips are likely to be served by public transport. Now, for the same cost outlay, both patronage and revenue have risen more than 6-fold.

No real city is as evenly distributed as "Squaresville". Yet in every case, while many of the routes could be loss-making or feeder routes, the overall network stands to gain the most by being networked. Most businesses understand that such cross-subsidy is often essential to develop a viable market. This, according to Mees, is nearly always a feature of successful transit cities. Fundamental to the network effect, in turn, is the ability to transfer effectively between services.

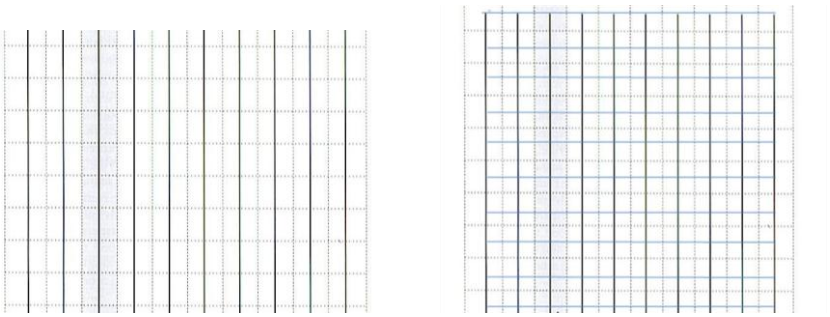

Figure 10: "Squaresville": the *Network Effect* illustrated (Source: Mees, 2002)

"The Geometric Shape of Transit's success"

Mees' theory demonstrates the need for networks with high levels of transferability. Being networked is clearly important, but so, also, is another factor: directness. Jarrett Walker outlines this in his discussion on the "Geometric Shape of Transit's Success" [25]. Each year, the TransLink Transit Network Management Group in Vancouver analyses all the bus

routes in the system and publishes its Bus Service Performance Review. This review helps identify trends and opportunities for improvement by looking at the performance of the whole bus system, as well as for each route. The review identifies those services that appear in the top and bottom of its patronage ranking. Services that appear in the top rankings possess common characteristics: direct, simple and consistent routing; serve areas of strong demand; key destinations at both ends and along the route; and, designed to maximize ridership.

Services that appear at the bottom also possess common characteristics: circuitous, indirect routing; serve lower-density, vehicle-oriented areas; limited destinations along the route; and, provide only basic access to the transit network. Figure 11 graphically illustrates many of these key properties. It is clear that the most successful routes are direct, legible and well planned.

Figure 11: Unsuccessful vs Successful routes in Vancouver Translink network (Source: Walker, J., 2013)

Joining up Dublin's Neighbourhoods

The question is prompted whether the principle of the network effect is appropriate for Dublin's urban structure. The Dublin City Council Development Plan 2011-2017 has a Core Strategy (see Figure 3 below right) [26]. A critical element of the strategy is the designation of Key District Centres and Key Developing Areas. Another vital component of the Core Strategy is three arterial Economic Corridors along with a Strategic Green Network. This vision suggests an orbital network of well connected district centres with strong connections to the centre. Any passenger transport services, if they are to be effective, should by necessity support and be consistent with the land use model in the Dublin City Council Core Strategy referred to above.

Moreover, Section 12 (5) of the DTA Act requires that the Strategy "must have regard to" the relevant City / County Development Plans [27]. Notwithstanding two "indicative" orbital QBCs published in a 2011 draft Strategy, the Dublin City Council Development Plan Core Strategy does not appear to be reflected by the current Strategy.

Figure 10: Dublin City Council Development Plan 2011 – 2017 Core Strategy

BEST PRACTICE EXAMPLES OF ORBITAL NETWORKS

Evidence, both local and international, suggests that where high priority is proffered that successful orbital services are feasible in their own right.

Transferability: the Zürich Model

Zürich is an example of such a networked city and its success is based on a very high level of transferability [28]. In Zürich public transport has sometimes been criticised for being slow, not because of congestion but because of dense stopping patterns. Yet patronage remains very high because of good schedule adherence and transferability. Services run on 4 – 8 minute headways in all directions.

According to local transport experts *"…It is important that the frequency of services remains under 10 minutes. If it is over 10 minutes, changing from one line to another is not attractive. With a 10 minutes frequency you have a network effect; with a 20 minutes frequency people don't change from one line to another" [29].*

Zürich also has a highly legible network, which a visitor can interpret easily and quickly, all of which has contributed to maintaining public transport mode shares of 50% and higher.

Figure 10: Integrated transport and good placemaking at Paradeplatz, Zürich

Nantes' High Quality Transit Network

The city of Nantes in France, finding it could not afford investment in LRT, realised it could get much higher return on investment from a BRT solution [30]. The BRT services integrate seamlessly with the LRT creating a well-patronised urban transport network. Buses get absolute priority through urban cores and run on high headways (3 mins peak, 6 mins off peak). A tram-like modal shift (25% away from cars) was recorded and some services achieving up to 28,500 ppd. Nantes is now adding 10 "Chronobus" (between BRT and tram) routes planned to increase its orbital network. An additional 100,000 passengers is forecast.

Figure 12: Nantes (BRT) Line 4 interchanges with (LRT) Line 1

Amsterdam Zuidtangent Orbital

The Zuidtangent is a network of orbital routes south of Amsterdam linking Schiphol airport with new business districts and residential areas. The routes are a response to changing land use patterns. The dispersed nature of the centres being serviced meant a bus-based solution was called for [31].

Even though it is an outer orbital route, the service operates on a high (10bph) weekday frequency. It maintains high average running speeds of >35kmph. The adaptable service copes with long distances between stops (1.9km on average) as well as constrained town centre environments, e.g. Haarlem. Operators refer to an uncompromising commitment to high level of service priority and branding which has led to highly successful revenue-generating schemes. Patronage in the first year of service was 99% higher than forecasted. 35,000 passengers per day are recorded on the service and the network of orbital services is being expanded on foot of this.

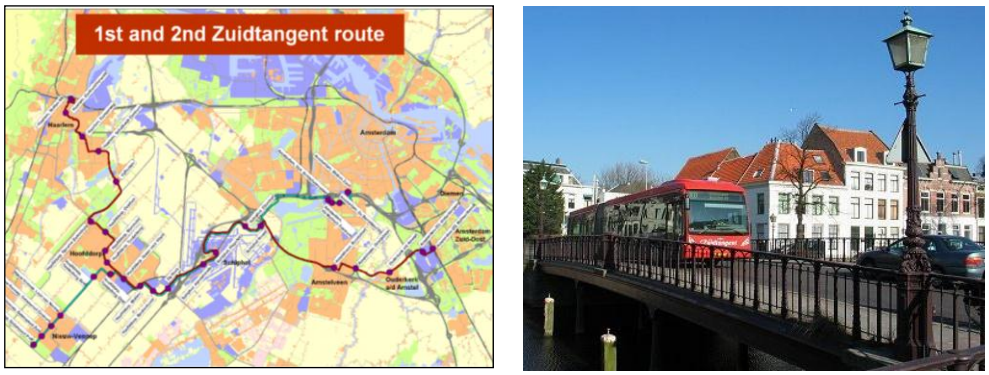

Figure 11: Amsterdam Zuidtangent Outer Orbital Service (Source: www.bhls.eu)

CONCLUSIONS

Recent travel survey data indicates that demand exists in Dublin for both orbital services and trips which involve a transfer. Surveys of users on both the Malahide and Stillorgan QBCs demonstrate that one in four bus users currently transfer as part of their journey. This is in spite of at best poor and often absent orbital services. Such demand for orbital services is corroborated by other sources, including the NTA Household Travel Survey and the CSO POWSCAR database. The Dublin City Council Core Strategy also suggests the implementation of an orbital network would be beneficial for economic and social development.

The evidence put forward in this paper is strongly supportive of the need for an integrated core transport network for Dublin, integrated with and connecting its urban structure. This should incorporate high quality orbital bus corridors. To be effective these would need to have equivalent running priority to arterial High Quality Bus Corridors, including high schedule adherence and headway reliability. Routes must be direct and pass directly through key district centres. A very high level of transferability is required, along with high quality interchange design.

Introducing high quality orbital QBCs would be an evolutionary step building on existing progressive measures and would require a framework of inputs involving planning authorities, transport agencies, communities and government. Most important it would tie transport strategy properly in with Dublin City Council land use policy, something not currently achieved by earlier strategic proposals. This in turn can lead to a fully mobile city with connected, healthy neighbourhoods. Local and international evidence suggests that such orbital QBCs can be a success if implemented with a high level of service in an urban environment such as Dublin's..

References

[1] Broderick, C. & O'Connor, D. Identifying barriers to implementation of the orbital elements of a rapid transit network for Dublin, Proceedings of the Irish Transport Research Network 2012, www.itrn.ie

[2] DTO, Platform for Change Strategy, www.nationaltransport.ie, 2002.
[3] MVA, Dublin Bus Network Review, available on request from Dublin Bus, 2006, p79
[4] National Transport Authority, Draft Transport Strategy for the Greater Dublin Area 2012 - 2030, Chapter 1, Page 9, www.nationaltransport.ie
[5] O'Connor, D. Stillorgan QBC Public Transport Level of Service Analysis, Proceedings of the Irish Transport Research Network 2014
[6] O'Connor, D. Malahide QBC Public Transport Level of Service Analysis, Proceedings of the Irish Transport Research Network 2014
[7] UITP Case Study on the Malahide QBC, UITP, 2002
[8] Network Direct, www.dublinbus.ie, extracted May 2012
[9] Presentation by Paddy Doherty, Chief Executive of Dublin Bus to Engineers Ireland, October 2014, www.engineersireland.ie/cpdseminars (accessed 15 November 2014).
[10] National Transport Authority, https://www.nationaltransport.ie/consultations/consultation-on-proposals-to-directly-award-contracts-from-december-2014-for-public-bus-services/ accessed on 21/7/2015
[11] Leahy, J., Annual Magazine of an Taisce – the National Trust for Ireland, summer 2015 issue, The Network Effect – the Potential for an Integrated Transport Network, an Taisce
[12] www.antaisce.org/node/1018 accessed on 22/7/2015
[13] Venetikidis, A., Designing an Integrated Map for a Visionary Public Transport System for Dublin, http://www.venetikidis.com/ArisV/DUBLIN_TRANSPORT_MAP.html accessed on 22/7/2015
[14] Venetikidis, A., Making Sense of Maps, http://www.ted.com/talks/aris_venetikidis_making_sense_of_maps, accessed on 22/7/2015
[15] National Transport Authority, "Public Consultation on the preparation of a new Transport Strategy for the Greater Dublin Area", https://www.nationaltransport.ie/news/fingal-north-dublin-transport-study/ accessed on 22/7/2015
[16] Dublin City Council, 2015 Dublin City Centre Traffic Study, http://www.dublincity.ie/TransportStudy, accessed on 22/7/2015
[17] National Transport Authority, Draft Transport Strategy for the Greater Dublin Area 2012 - 2030, Chapter 4, pp8-9, www.nationaltransport.ie
[18] Gleeson et al (2009), New Ways of Mapping Social Inclusion in Dublin City, NIRSA, Maynooth; reproduced in [20]
[19] Borscheid, Matthias & Reid, Odran (2012) 'New skills for new jobs? Accessibility of the labour market for marginalised communities in north Dublin'. The Irish Review of Community Economic Development, Law and Policy 3(1)
[20] "Identifying barriers to implementation of the orbital elements of a rapid transit network for Dublin: a land use and transportation study of the North Eastern Quadrant." Dissertation Thesis for BSc Spatial Planning by Colin Broderick, DIT, 2011
[21] Barton, Grant and Guise, Shaping Neighbourhoods - a guide for health, sustainability and vitality, Spon Press, 2010, p97
[22] Mees, Paul. Transport for Suburbia: Beyond the Automobile Age, 2010, pp55-58
[23] J. M. Thomson, "Great Cities and their Traffic", Peregrine Books, 1977, p96-97
[24] Mees, Paul. Transport for Suburbia: Beyond the Automobile Age, 2010, pp148-154
[25] Walker, J., The Geometric Shape of Transit's Success, www.humantransit.org, 2013, http://www.humantransit.org/2013/08/translink-high-and-low-performing-routes.html accessed on 22/7/2015
[26] Dublin City Council Development Plan 2011-2017, p10
[27] http://www.irishstatutebook.ie/2008/en/act/pub/0015/ accessed on 22/7/2015
[28]Butler Nash, A. and Sylvia, R., Imlpementation of Z|urich's Transit Priority Programme, Mineta Transpotration Institute,San Jose State University, 1991.
[29]Mees, P. A Very Oublic Solution, Melbourne University Press, 2002, pp138-139
[30] Rabuel, Sebastien. BusWay and Chronobus: how to develop the BHLS concept in Nantes, Polis Conference 2011, www.polisnetwork.eu
[31] ESF / COST, (Euopean Cooperation on Science and Technology), Buses with High Level of Service, www.bhls.eu, 2011