Are Melbourne's trams really the slowest in the world?

By Jan Scheurer, August 2024

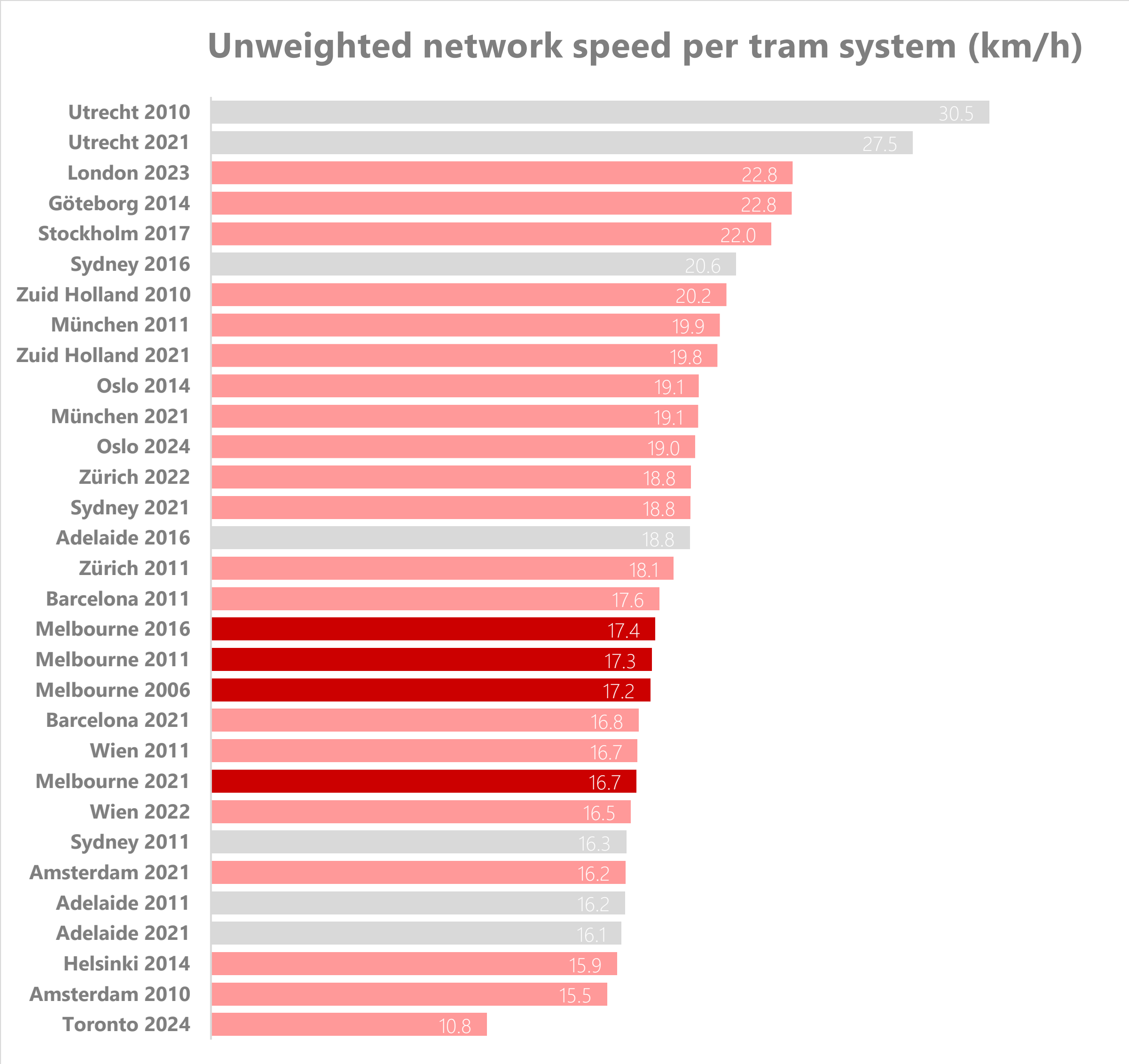
This is a claim one hears regularly[1]. Melbourne has the longest tram network run by a unitary operator in the world, it has the largest length of route-kilometres in mixed traffic, and it trails pretty much everywhere else in terms of commercial speeds.

But is it true?

We can't speak for each of the several hundred tram systems in the world, of course, but what we can do is run this question though the sample of SNAMUTS cities that operate tram or light rail systems. Across Australia and Europe, that's a total of fifteen: Adelaide, Melbourne, Sydney, Amsterdam, Barcelona, Göteborg, Helsinki, London, München, Oslo, Stockholm, Utrecht, Wien, Zuid Holland (Rotterdam/Den Haag) and Zürich. We'll also have a preliminary look at Toronto, where we're still in the process of completing the SNAMUTS analysis. In the Australian, and in about half the European cities, we can further compare the results across two or more points in time and thus point to recent trends about tram system performance. In total, we're compiling 31 data points.

Let's start with a relatively crude indicator: total running time (sum of all route segments, in both directions) divided by total track kilometres in revenue service. We could call it the unweighted network speed:

[1] https://www.theguardian.com/australia-news/2023/jan/22/snail-rail-why-are-trams-in-australian-cities-running-slower-than-they-were-100-years-ago



This initial analysis shows that Melbourne's trams are clearly not the fastest among its SNAMUTS peer cities – but nor are they the slowest. Moreover, Melbourne's experience of average tram speeds declining over time (if not dramatically) is far from unique – only Amsterdam and Zürich buck this trend, as well as Sydney whose tram network more than doubled in size in 2020. (We have marked the smallest tram systems, consisting of only a single trunk line, with grey bars in the graph).

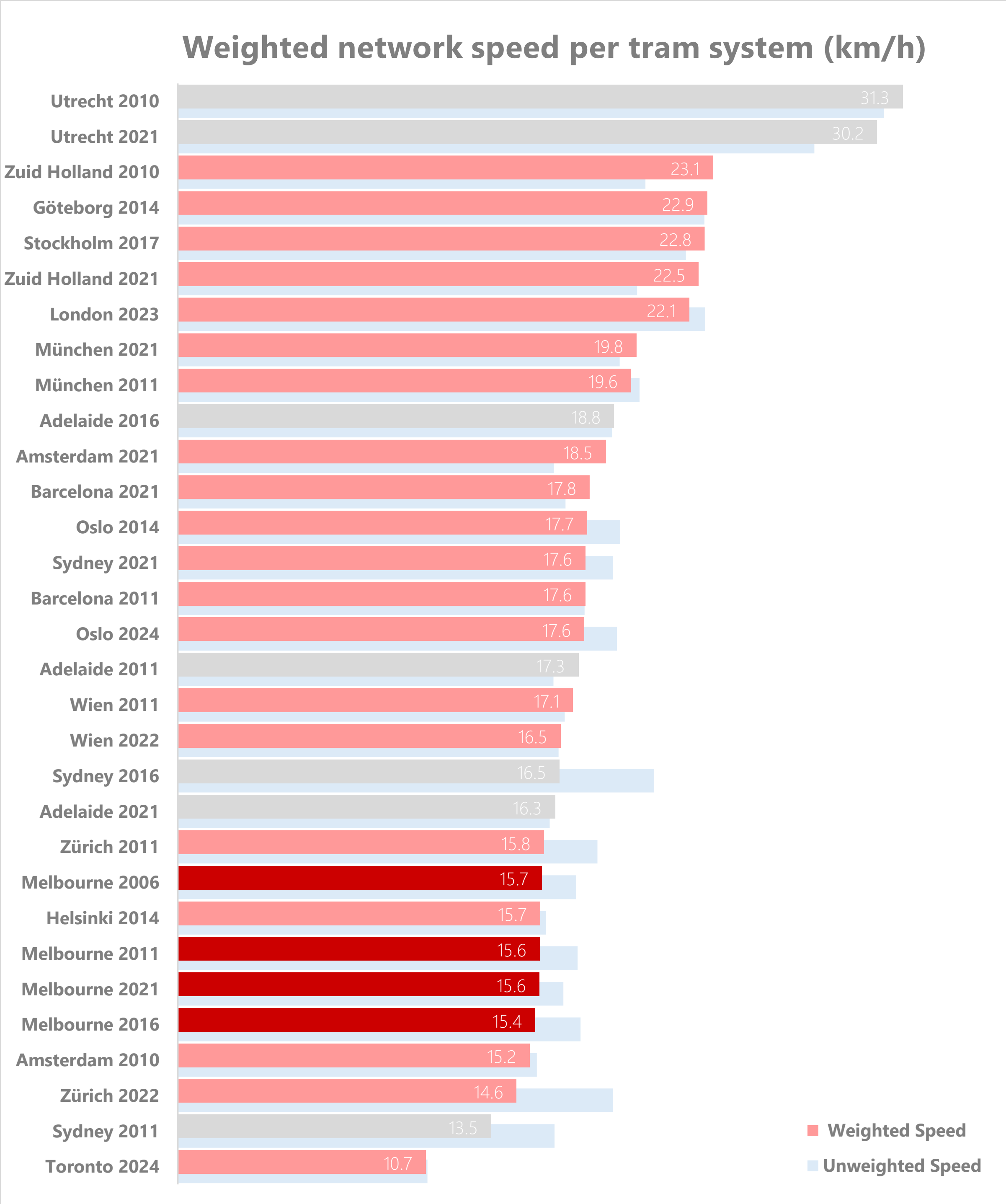
Some of the differences in unweighted network speed between the sample cities have quite straightforward explanations. Utrecht, London, Sydney, Barcelona and two of Stockholm's four disparate lines are second-generation tram systems, opened during the past 40 years and designed from the outset around priority over traffic and largely with exclusive rights-of-way, in some cases converted from former heavy rail lines. In such conditions, speeds comparable to metro operations can be achieved, and we could aptly speak of light rail systems rather than traditional trams. Göteborg and Zuid Holland (particularly Den Haag) also contain significant track mileage that conforms to light rail standards.

On the other hand, the tram systems in Amsterdam, Helsinki, Melbourne, Toronto, Wien and Zürich, and to a lesser extent München and Oslo, are dominated by inner urban operations that trace their origins back to the pre-1945 period and often share multifunctional, constrained street spaces. Among the European cities in this group, average tram speeds are roughly similar to those in Melbourne, while Toronto stands out as a laggard.

Refining the analysis: Measuring speed where it matters most

It could be argued that the comparison of unweighted average speeds contains a methodological bias that limits this indicator's meaningfulness. This is because higher speeds are often easier to achieve on route segments near the outer edges to the network, where there is less interference from road traffic or pedestrians and space for segregated rights-of-way more easily found, but where passenger numbers are generally lower. Conversely, in many networks the slowest route segments are located in the most central parts of the city where demand is inherently higher. But this is not a universal rule: in certain cities (within this sample, Den Haag and Wien), some inner-city tram lines have been relocated underground to increase their speed. In other cities, network reconfigurations within the tram system and/or in combination with other public transport modes have deliberately sought to shift passenger demand away from slower and towards faster route segments.

Let's have a look at how these patterns play out by introducing a weighting procedure to our tram network speed comparison. The weighting factor in this case is the SNAMUTS segmental betweenness index, which measures the concentration of metropolitan-wide travel opportunities that each route segment is able to attract. Thus network elements positioned at the crossroads of movement, channelling a high number of journey paths to and from nearby destinations as well as merely passing through the area on their way to places in other parts of the city, are weighted more highly than those positioned at the periphery where they generally only channel local access journeys. Here is what our comparison looks like after introducing this step:



By counting the speed of trams more where it matters most, the ranking of the cities in our sample experiences some changes. On the whole, Melbourne drops a little down the list but it is still not the poorest performer: that dubious honour continues to go to Toronto (whose numbers are not yet final but won't change dramatically enough to improve the Canadian city's rank here). More surprisingly, Melbourne is also underperformed by Zürich, whose tram network slowed markedly on this index during the 2010s (though speed improved on the unweighted measure, as shown above). Tangible drops in speed over time on this index are also apparent for Adelaide, Utrecht, Wien and Zuid Holland; conversely, Sydney and particularly Amsterdam improved quite sharply. Melbourne, alongside Barcelona, München and Oslo, had relatively stable weighted tram speeds over time. Zürich and to a lesser extent Melbourne, Oslo and

Sydney have significantly lower weighted than unweighted tram speeds, meaning that the networks are configured to channel a disproportionate share of travel opportunities onto slower-moving route segments. In Zuid Holland and (in 2021) Amsterdam and Utrecht the opposite is the case: faster route segments have greater relative significance than slower ones. In the remaining cities, weighted and unweighted tram speeds are broadly similar.

What makes a tram system become slower – or faster – over time?

These findings begin to illuminate some policy narratives. In Amsterdam, a comprehensive tram network configuration was implemented in 2017 when a new inner urban metro line was opened: the measures aimed at reducing tram capacity parallel to the new metro while enhancing it particularly for perpendicular and orbital metro-tram transfer connections. As a result, many travel opportunities shifted from some of Amsterdam's slowest tram lines through the historic centre towards the metro and towards faster tram lines elsewhere.

In Sydney, the relatively short single tram line's dominant task in 2011 was to facilitate journeys between Central Station and the western side of Darling Harbour, where the line's only on-street section made for particularly slow running. After an outer extension in 2014 to Dulwich Hill along a faster-moving converted heavy rail alignment, travel opportunities distributed more evenly along the length of the line. The 2020 addition of the CBD and inner south-east lines between Circular Quay and Randwick/Kingsford, which greatly outperform the Dulwich Hill line in terms of network significance, run through dense central city and inner urban neighbourhoods but enjoy greater priority over road traffic than almost any Melbourne equivalent, improving the network-wide performance further.

But what exactly happened in Zürich? The Swiss city is renowned as a pioneer, and a shining global example, for effective tram priority measures in mixed traffic[2] which should, in theory, increase or at least stabilise tram speeds. On the previously discussed unweighted measure, this holds true: the network average improved from 18.1 to 18.8 km/h between 2011 and 2022. But on the weighted measure, it dropped by twice that rate (from 15.6 to 14.2 km/h). Clearly, slower parts of the network already attracted substantially more movement opportunities than faster ones in 2011, and this trend has accelerated since.

Perhaps the answer can be found in the specific modal mix of Zürich. Besides trams (and buses), the city operates an effective heavy rail system allowing for fast movement throughout the metropolitan region (the Swiss *canton* of Zürich). Several inner-city tunnels were built during the last several decades to increase the capacity of this regional rail system but its role in facilitating intra-city journeys remains limited. Only two rail stations are located within the CBD area (or rather, at opposite ends of it), allocating a critical role for the tram system to distribute the growing number of rail passengers arriving there towards other, finer-grained destinations in inner Zürich which are also steadily increasing in residential population and employment.

Urban buzz up, tram speeds down

This hypothesis suggests another important aspect in our inquiry about tram speeds: how are these actually influenced by urban intensification? In principle, more residents and jobs per hectare translate into busier streets – busier with private vehicles (unless these are restricted) but also busier with pedestrians, cyclists and other micromobility users. For trams negotiating

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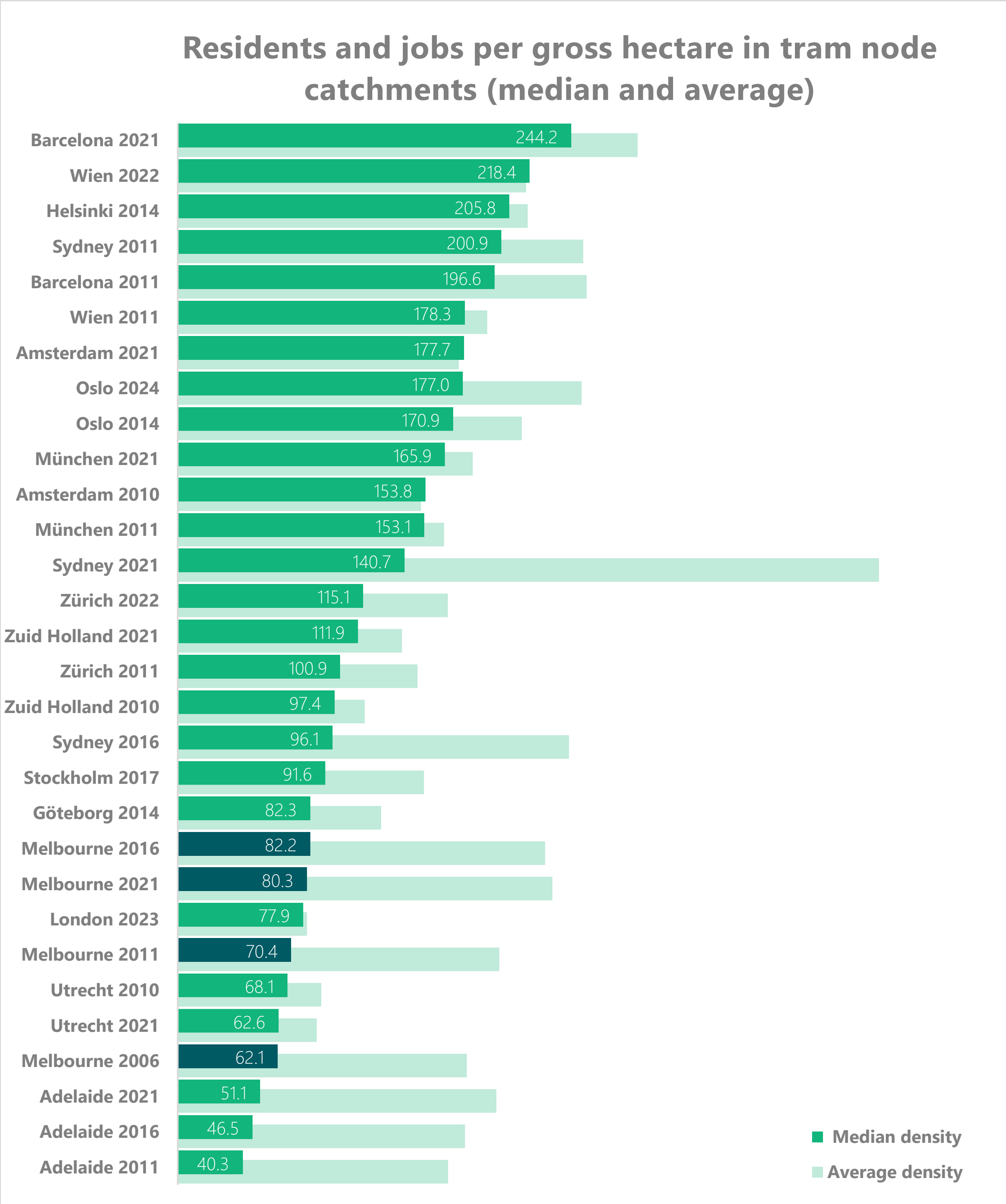
[2] https://www.ssatp.org/sites/ssatp/files/publications/Toolkits/ITS%20Toolkit%20content/case-studies/zurich-switzerland.html

these spaces, we can expect speeds to drop as street life increases, unless measures are taken to limit the interaction of people and vehicles on tram operations. We can also expect speeds to drop as passenger numbers increase, extending the time it takes passengers to board and alight, and sometimes leading to crowding conditions at stops and in vehicles. Lastly, increasing tram frequencies in response to growing demand may have a further detrimental effect on speeds particularly on surface networks with many at-grade junctions (as is the case in central Zürich, and also in Melbourne) where trams crossing each other's paths may suffer delays more often.

Let's take a look at the urban density of tram catchments in our sample of cities:



Extensive tram networks generally operate in a range of urban environments, and hence of urban densities, within the same city. We are distinguishing two measures here for urban density:

- To indicate the density of a 'typical' urban neighbourhood served by trams, we have highlighted the *median density value* (out of the total number of each city's SNAMUTS activity nodes where trams are present). This figure is lowest in Adelaide and Melbourne, Utrecht, Göteborg and London (where trams only operate in the southern suburbs). However, like in most European cities it has largely gone up over time.
- In addition, we are also showing the *average density value* of the same set of activity nodes as a comparison in the background. The discrepancy between these two values can be understood as a proxy measure of the heterogeneity of urban form around tram nodes and corridors.

In Australian cities, the CBD areas (dominated by skyscrapers) are generally more dense than those of their European peers while the non-CBD areas (traditionally dominated by low-rise, garden-oriented housing) are generally less dense. As a result, the density gradient from centre to periphery tends to be steeper in Australian than in European cities. Conversely in Amsterdam and to a lesser extent Helsinki, München and Wien, as well as around London's suburban tram system, there is not much variation at all between median and average tram node density. This suggests that the different neighbourhoods trams operate in in each of those cities are more alike one another (in terms of the spatial concentration of people) than in cities where median and average density diverge more.

Overall, urban densities around trams have been increasing over the past decade in every city where we have this data, with the exception of Utrecht where this is likely associated with the opening of a new line into (currently) lower-density areas. Melbourne's slight drop in average tram corridor density in 2021 may be an artefact of COVID movement restrictions on the day of the census, when more than one third of the working population was working from home and counted there rather than at their employment location.

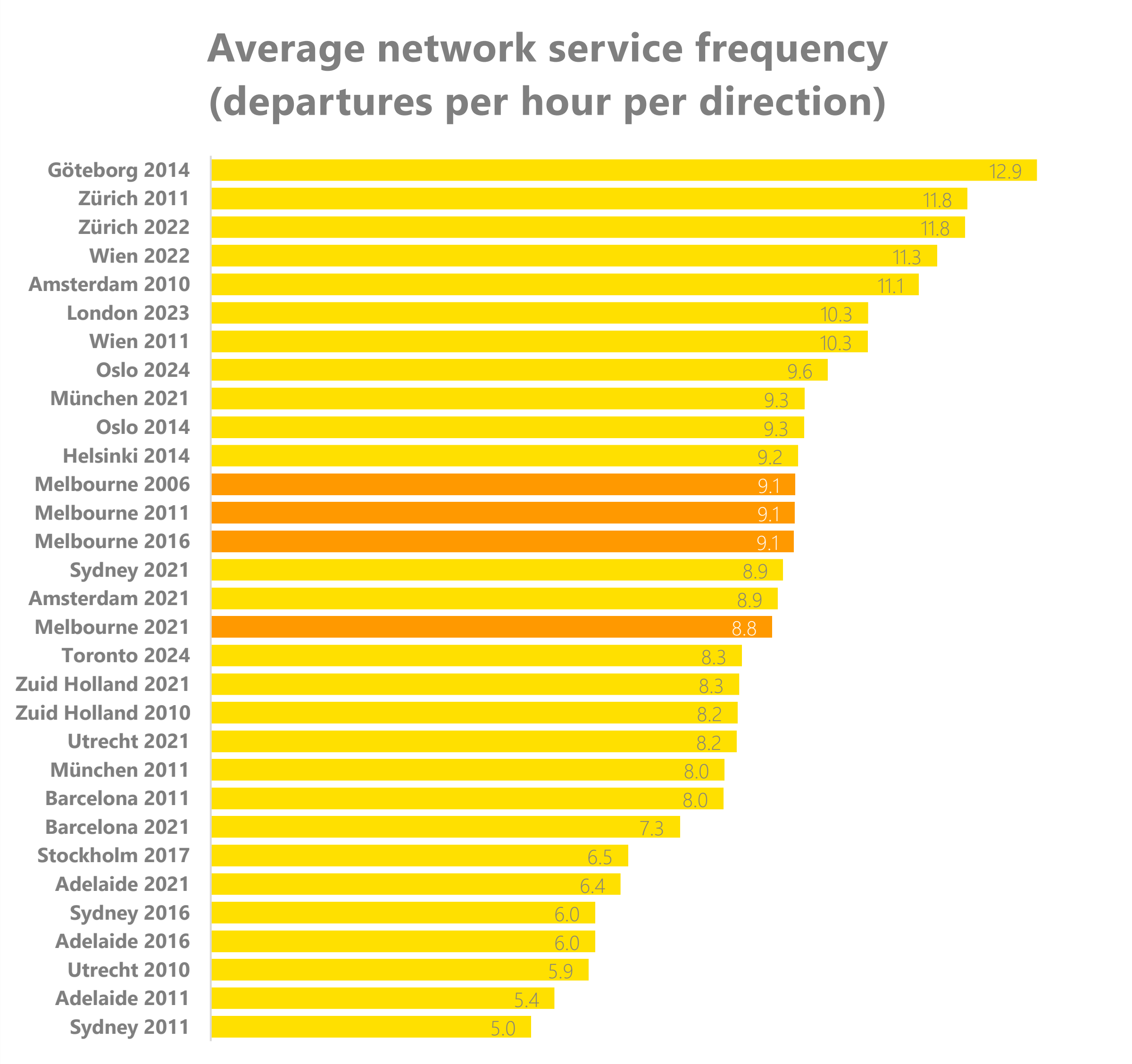
In typical (median) tram corridor densities, Adelaide, Melbourne, Utrecht, London (southern suburbs only) and the Swedish cities occupy the bottom end of the scale while Sydney (after its tram network became more complex in 2020) is more aligned with the Dutch cities, München and Zürich. The highest median densities around trams are found in Barcelona, Wien, Helsinki and Oslo.

But what might this mean for tram speeds?

Higher frequencies, slower operations?

Higher densities around trams translate into (potentially) greater travel demand, which in turn may require higher service frequencies which, as mentioned above, tend to negatively impact commercial speeds if operational conflicts at junctions or stops increase. Of the cities where longitudinal data is available, average tram frequencies increased notably in München, Utrecht, Wien and Sydney, and more modestly in Adelaide and Oslo. Average frequencies declined slightly in Barcelona and more dramatically in Amsterdam, though starting from a high level – this is attributable to the redeployment of trams from oversaturated inner urban radial routes to orbital and metro feeder routes. In Zuid Holland, Zürich and Melbourne, tram frequencies changed little though there is a small downward trend in Melbourne, a mid-fielder on this index within the 16-city sample, between 2016 and 2021. During this period, route 58 was improved from operating every 12 to every 10 minutes (and its predecessor route 8 taken out of the Swanston Street-St Kilda Road corridor), while routes 11, 12 and 109 declined from every 8 to every 10 minutes, producing a net negative effect.

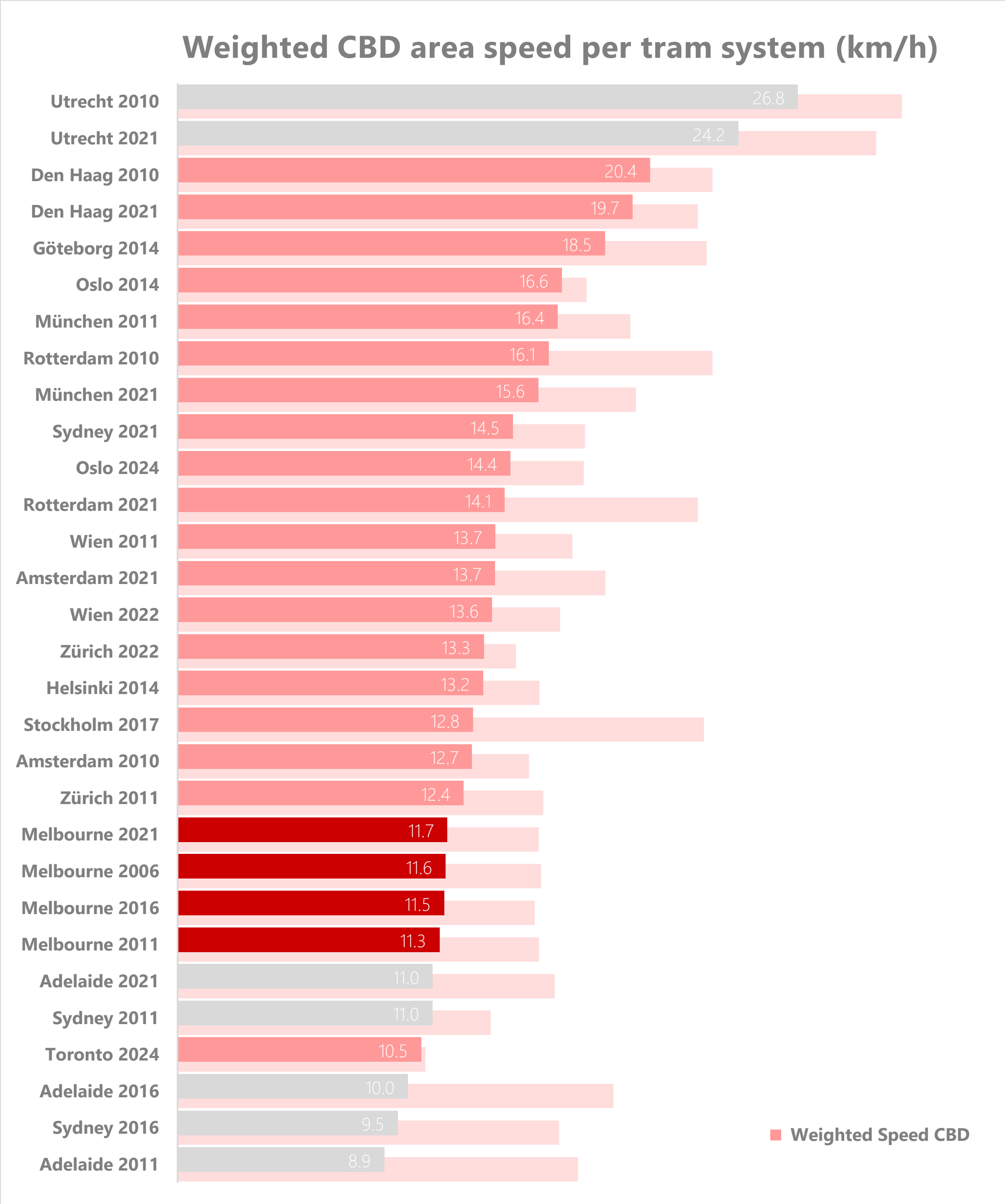
Notably Zürich has the second highest average tram frequencies in the sample after Göteborg, but unlike in Göteborg with its generous exclusive rights-of-way even in the CBD and surrounding inner areas, Zürich's high number of tram movements negotiate busier, narrower and also hillier streetscapes.



This index refers to the weekday interpeak period and weighs each route segment, including those were several tram routes overlap and their frequencies combine, according to its scheduled travel time. Bus or heavy rail movements that share lanes or tracks with tram lines are not counted.

The specific situation in city centres

Lastly, we will have a look at tram speeds in those parts of a city where urban density, streetlife intensity and potential operational conflicts between surface public transport modes tend to peak – the CBD areas. Mostly, tram speeds in city centres are tangibly lower than on average across the network, with the exception of Toronto (where CBD-typical speeds seem to extend across the entire city). Yet, they are lower in Melbourne than in any European city and also lower than in Sydney after the 2020 network expansion there (suggesting that the comprehensive remodelling of George Street as the tram was built has created operational conditions superior to those found across Melbourne's CBD). Adelaide, which also saw an expansion of its CBD tram route length between 2016 and 2021, is catching up to Melbourne levels of performance. In Europe, CBD tram speeds increased in Amsterdam and Zürich and remained stable in Wien, but declined in Den Haag, Rotterdam, München, Oslo and Utrecht (in the latter case from a very high base). Melbourne's CBD tram speeds remained stable between 2006 and 2021 despite the unmistakable increase in urban density and street activity throughout the central city; improvements in traffic light priority and the replacement of space-constrained safety zone stops with a smaller number of platform stops (reducing delays with boarding and alighting passengers) may play a role here.



It should be noted that Melbourne, like most other cities in this sample (Toronto is a conspicuous exception) and unlike on many of its inner and middle suburban routes, largely segregates tram lanes from those of private vehicles in the CBD area. Trams are thus generally not held up by traffic jams there, but they are affected by traffic lights (whose number in parts of the CBD can be considered excessive) as well as by priority conflicts between different tram lines (there are 15 four-way intersections and 5 three-way junctions between tram routes within the Hoddle Grid).

So are Melbourne's trams too slow?

In comparison with Melbourne's tram-operating peer cities in this very limited sample, it is clear that there is room for improvement in speed performance for our trams in both central city and suburban areas. Higher speeds may be achieved through measures such as better priority at traffic lights, tram-friendly traffic management (more right-turn bans and less parallel parking next to tram tracks), a greater share of protected rights-of-way, the deployment of larger vehicles and the provision of more spacious stop environments to reduce dwell times and absorb passenger growth. Melbourne has made some progress in some of these areas in recent years but clearly needs to continue along this path, even step up its game, if tram speeds are to improve sustainably across the network.

Another trend, which good public transport is in fact designed to facilitate, works against speeding up trams (or any mode of transport at street level): the increase of people using the public realm resulting from higher densities of residents, jobs and other activities along tram corridors. In this context, even keeping tram travel times stable can be considered a marker of success, and the scope for substantial travel time reductions on trams remains limited unless a greater extent of physical segregation between trams and other traffic, including pedestrians, is pursued. From an urban amenity perspective however, there is a trade-off involved here. While such segregation measures can and do result in faster public transport, they may reduce a street's capacity for vehicle traffic (which is often desirable from a sustainability viewpoint) and also act as barriers to pedestrian movement and thus inhibit the walkability of the urban realm (which is generally not desirable from a sustainability viewpoint). There is no one-size-fits-all solution to this dilemma: in each location, the most appropriate approach needs to be deliberated between stakeholders. In the meantime, we should expect trams (and their rubber-tyred counterparts in public transport) to record their slowest operating speeds in areas where the highest numbers of street users congregate.