1 Overview

1.1 Wimbledon station is to be found in London SW19. The station (*Figure* 1) is served by the London Underground (District Line), Croydon Tramlink and National Rail. The station has ten platforms; platforms 1-4 serve the District line, platforms 5-9 National Rail and platform 10 National Rail/Tramlink. The station is managed by South West Trains. There are a number of bus stops that serve Wimbledon station – both on Wimbledon Bridge and Alexander Road. Wimbledon station has a ticket hall that serves National Rail, Underground and Tramlink. There are stairs and lifts down from the ticket hall main concourse to all platforms. Wimbledon is marked on the London Underground map as having step free access from the platform to the street.

1.2 Wimbledon station is a transport gateway for the Wimbledon Olympic venue.

1.3 A key travel requirement for the London 2012 games is to deliver accessible journey plans to support the Games Network of Accessible Transport (GNAT). To support this Transport Direct is investigating the necessary changes to the data standards to support the modelling of stations.

1.4 This paper maps the use cases for accessible journey planning to the model for Wimbledon station, building on the paper from MDV "*Accessibility Information*" which uses Wimbledon as its model. It compares current concrete data elements of the UK NaPTAN stop model for Wimbledon with the same data in the new enhanced CEN IFOPT model in order to illustrate key additional concepts that could be captured to enable enhanced journey planning – including accessibility. The IFOPT model envisions a standardised, detailed representation of an interchange that can be used by many different applications to provide guidance and assistance to users.

1.5 Wimbledon has been chosen because it is sufficiently large to illustrate many of the key aspects of a complex interchange, but not so large – as say a major London terminal would be – to describe it in detail in a paper. In addition we provide a brief discussion of considerations raised by other types of station and also a comparison with Nottingham station to illustrate the issues associated with variable levels of accessibility.

1.6 This paper assumes an understanding of the NaPTAN data model and the IFOPT model. See '*NaPTAN & NPTG Schema Guide v2.4'* Transport Direct 2010 & 'IFOPT: *Identification of Fixed Objects in Public Transport'* CEN 2008.

1.7 Many of the concepts used to describe accessibility, stations and transport interchanges in detail are also relevant for describing venues and other points of interest in general – or direct relevance for describing the accessibility Olympic venues. In fact IFOPT proposes a common base model for any type

of public site: this is extended specifically for stations and interchanges with additional transport mode-specific details.

1.8 Although the paper is primarily about transport interchange and accessibility data as a distinct data layer, it also includes a short consideration of the relationship of such data to GIS data sets such as Ordnance Survey, NavTeq & Open Street Map since the integration of the two is essential for end-to-end journey planning.

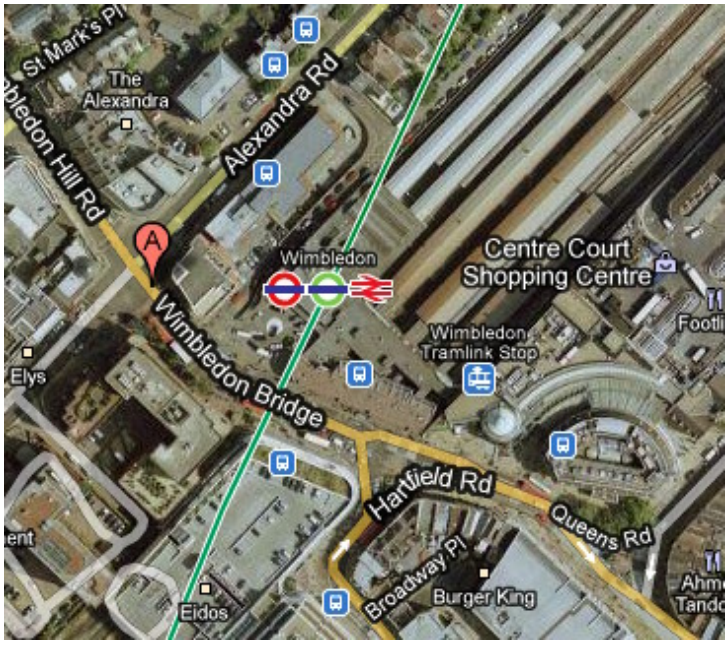


Figure 1 Wimbledon Station & surrounding stops (From Google)

1.9 A key theme that emerges from this paper is that while much work has been done to collect detailed accessibility data, in order to use it in journey planners a more joined up representation is needed of certain data elements. To understand why this representation is needed, it is important to distinguish between merely "**narrative**" presentations of the data, whereby the user has to use a browser and visualisation tools to visit each step of a journey to assess each feature of relevance to them, and "**computable**" use, in which the relevant details are in a structured, quantitative representation that can be used by a computer to provide accessibility-aware journey plans (and in real-time applications to show the user's progress against them).

1.10 To round out Wimbledon as an example of transport data and also to give some insight into how the identifiers of a station need to be integrated to make a "computable" application, we also outline how the interchange data can be related to timetable and real-time data. These considerations are not specific to accessibility. This ancillary discussion is in sections 11, 12 and13.

1.11 All graphics and maps are copyright of the indicated sources. We thank MDV gmbh for their "Accessibility Information" paper from which we include some diagrams and SELTA for images of the DIVA representation.

2 Wimbledon in NaPTAN

2.1 *Figure 2* from TfL shows Wimbledon as a rail and underground nexus within the context of London, with two connecting rail services as well as the District underground line. It is an important feeder interchange for commuters to reach the tube network.

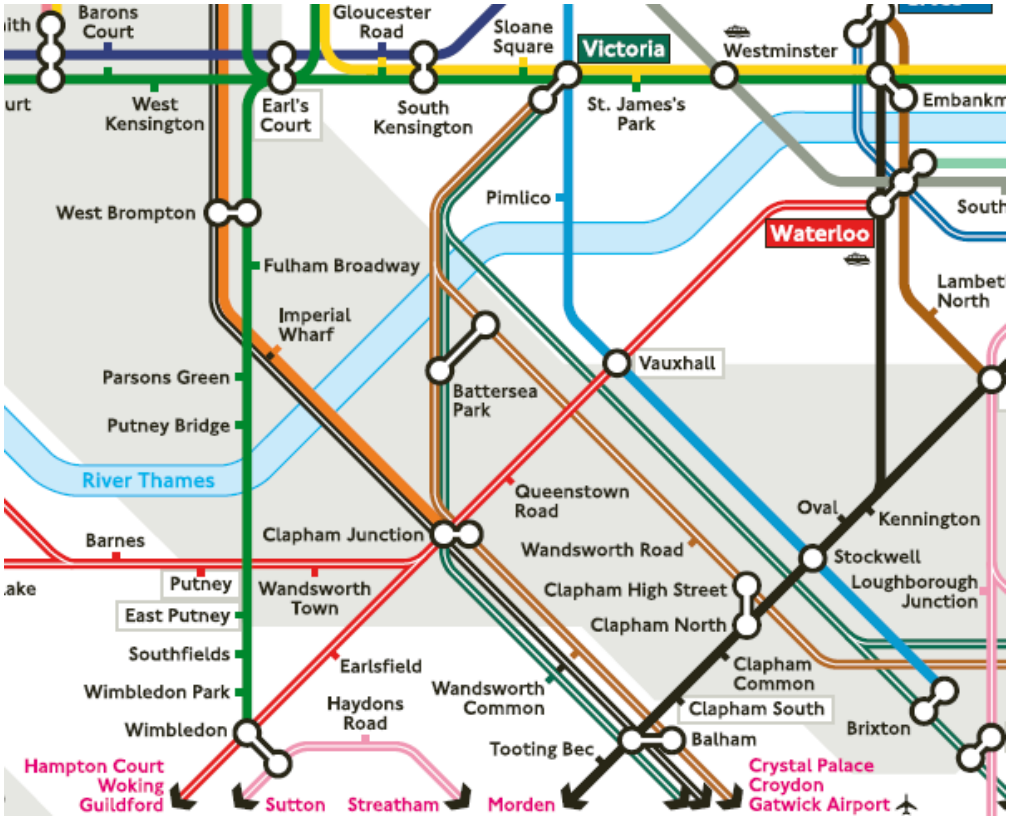


Figure 2 Wimbledon as a rail & underground station (TfL PDF map)

2.2 Wimbledon as an interchange is currently (April 2010) represented in NaPTAN by the following NaPTAN Stop points;

- Two station NaPTAN points of type RLY: 9100WIMBLDN[1] '*Wimbledon Rail Station'* and 9100WDON '*Wimbledon Rail Station'*, each with separate TIPLOCs (*WIMBLDN, WDON*), but a common CRS code ('*WIM'*). They both are associated with rail schedules. Other possible points for the station are not populated (although the NaPTAN model would support them); there are no RSE points for the station entrances, and no RLP points for the rail platforms.

[1] WIMBLDN is the code used for First Capital Connect Thameslink services. WDON is the code used for South West Trains services. There is in rail data an additional code - WDNLUL that is used for the District Line services that run on Network Rail track. As these District Line trains do not offer any journeys between Network Rail stations we exclude them from the data feed to TTIS and TTBO.

- A MET point 9400ZZCRWMB'*Wimbledon Tramlink Stop'* and a single PLT point for the Tramlink platform (9400ZZCRWMB1); these are grouped by a stop area for the Tramlink Station (940GZZCRWMB). There are no TMU points for the entrances.

- A MET and a single PLT for the underground platforms (9400ZZLUWIM) which are grouped by a stop area (940GZZLUWIM). The four District Line platforms are all contiguous with a concourse area i.e. comprise a single surface. For station level journey planning, this is either sufficient. If however one wishes to be able to reference each platform individually, then for a fully populated model there should be four PLT points). There is a TMU point (490000272003) for an entrance to the station.

- Four nearby BCT points for nearby on-street bus stops; 490000272P '*Wimbledon, Stop P'* (Wimbledon Bridge); 490014734N1 '*Wimbledon Stop'* (Alexandra Road); 490015472D '*Wimbledon Stop D'* (The Broadway); and 490015472L '*Wimbledon Stop L'* (Hartfield Road). The bus stops are associated with the station through the use of a NaPTAN stop area (490G00272P).

2.3 A TfL spider map (*Figure 3*) presents a more extended view of Wimbledon as an interchange compared to the current NaPTAN grouping and includes other nearby stops it considers as 'Wimbledon stops'. Additionally *E, F, G, H, J, K, N, M, R, S, X, & Y* are shown as part of the Wimbledon interchange.

Figure 3 Bus stops near Wimbledon station (TfL Spider map)

2.4 The TfL spider map illustrates that the scope of an interchange depends on the use case - here to show where one can catch a bus in the central Wimbledon area. Arguably, as long as there is at least one stop for each route & direction that passes the vicinity of the station, the subset of nearest stops

to the interchange suffices for the computation of journey plans – so the smaller NaPTAN set is enough for Wimbledon (the other stops are in NaPTAN but in distinct Stop Areas). But even, adopting this rule there is a minor inconsistency in NaPTAN, which groups *Stop A* on *Alexander Road* as part of the *Wimbledon* Stop Area but groups *Stop B* on *Alexander Road* as the only member of a different *St George's Road* Stop Area – it should probably be in both groups.

2.5 The Croydon Tramlink network map presents a view of Wimbledon as an interchange that indicates the lines and directions for connecting underground and rail services relative to Tramlink.

Figure 4 Wimbledon Tramlink Branch (Croydon Tramlink)

2.6 The NaPTAN stop areas which serve to group the stops are:

- 910GWDON '*Wimbledon'* (GRLS), which serves as an overall parent group and groups the 9100WIMBLDN rail stop.
- 910GWIMBLDN '*Wimbledon*' (GRLS), which groups the rail stops and is subsidiary to 910GWDON.
- 490G00272P '*Wimbledon' (*GCLS), which groups the bus stops with the station (its parent is 910GWIMBLDN). One might have additional on street areas (GBPS) to group the Alexandra Road & Wimbledon Bridge stops.
- 940GZZCRWMB '*Wimbledon Tramlink Stop'* (GTMU), which groups the Tramlink stops for Wimbledon.

- 940GZZLUWIM '*Wimbledon Underground*' (GTMU) which groups the tube stops (and should be but isn't tagged as part of to the 910GWDON).

2.7 The hierarchy of points and stop areas making up the Wimbledon interchange according to the NaPTAN model can thus be summarised as shown in Figure 5.

StopArea GRLS Rail: 910GWDON Wimbledon
StopPoint RLY Rail: 9100WDON Wimbledon
(StopPoint TXC Taxi: 4900WDONTXC Wimbledon Taxi Rank)
StopArea GRLS Rail: 910GWIMBLDN Wimbledon
StopPoint RLY Rail: 9100WIMBLDN Wimbledon Rail Station
(StopPoint RSE Rail: 9100WIMBLDN0 Wimbledon Rail Station, Main Entrance)
(StopPoint RSE Rail: 9100WIMBLDN1 Wimbledon Rail Station, Entrance from Shopping Centre)
(StopPoint RLP Rail: 9100WIMBLDN5 Wimbledon Rail Station, Platform 5)
(StopPoint RLP Rail: 9100WIMBLDN6 Wimbledon Rail Station, Platform 6)
(StopPoint RLP Rail: 9100WIMBLDN7 Wimbledon Rail Station, Platform 7)
(StopPoint RLP Rail: 9100WIMBLDN8 Wimbledon Rail Station, Platform 8)
(StopPoint RLP Rail: 9100WIMBLDN9 Wimbledon Rail Station, Platform 9)
(StopPoint RLP Rail: 9100WIMBLDN10 Wimbledon Rail Station, Platform 10) (StopPoint RLP Rail: 9100WIMBLDN9 Wimbledon Rail Station, Platform 9)
StopArea GTMU Tram: 940GZZCRWMB Wimbledon Tramlink Stop
StopPoint MET Tram: 9400ZZCRWMB Wimbledon Tramlink Entrance
StopPoint PLT Tram: 9400ZZCRWMB Wimbledon Tramlink, platform 10
StopArea GTMU Metro: 940GZZLUWIM Wimbledon Underground
StopPoint MET Metro: 9400ZZLUWIM Wimbledon Underground
StopPoint PLT Metro: 9400ZZLUWIM Wimbledon District Line
(StopPoint TMU Metro: 490000272003 Wimbledon Underground Station Entrance 1)
(StopPoint PLT Metro: *9400ZZLUWIM1 Wimbledon District Line, Platform 1)*
(StopPoint PLT Metro: *9400ZZLUWIM2 Wimbledon District Line, Platform 2)*
(StopPoint PLT Metro: *9400ZZLUWIM3 Wimbledon District Line, Platform 3)*
(StopPoint PLT Metro: *9400ZZLUWIM4 Wimbledon District Line, Platform 4*)
StopArea GCLS: 490G00272P Wimbledon (parent is 910GWIMBLDN)
StopPoint BCT Bus: 490000272C Wimbledon, Stop C (Wimbledon Bridge →E)
StopPoint BCT: Bus: 490000272P Wimbledon, Stop P (Wimbledon Bridge →W)
(StopArea GCLS: 490G00019043 St Georges Road (SW19) (parent would be 490G00272P)
StopPoint BCT: Bus: 490014734A Wimbledon Stop A (Alexandra Road →N
StopPoint BCT Bus: 490014734B Wimbledon Stop B (Alexandra Road →S
StopPoint BCT Bus: 490015472D Wimbledon Stop D (The Broadway →S)
StopPoint BCT Bus: 490015472L Wimbledon Stop L (Hartfield Road→*N*)

Figure 5 Hierarchy of NaPTAN points

2.8 Note: Figure 5 includes some points such as rail platforms that are (a) not currently (March 2010) populated in the NaPTAN data set – these are shown bracketed and in italics, or (b) present but not grouped in the NaPTAN stop areas (these are shown normal face but in brackets). In the Rail CIF timetable at least one rail service on Saturday is shown as leaving from platform 10, the platform shared with Tramlink – platform 10 should also be declared separately in NaPTAN as a tram as well as a rail platform.

2.9 The bus stops will soon be allocated a five digit SMS code of the form 1-9999.

2.10 NaPTAN itself doesn't hold data about which lines pass each stop, or in which direction. In practice, certain platforms will be reserved for trains in a particular direction and the permanent signage in the station will reflect this. For buses,

information about which lines serve which stops can be exchanged in TransXChange. There is no equivalent exchange format for rail and metro (though the new CEN NeTEx standard will support this).

3 Wimbledon in Direct Enquiries

3.1 Wimbledon station is described in the London Underground Direct Enquiries site (http://www.directenquiries.com) which provides narrative tools for examining the station

3.2 For TfL LU stations such as Wimbledon, Direct Enquiries provides users with information on the accessibility of routes from the station entrance to any of the platforms (including the rail platforms). A list of navigation paths is provided for every transition between every entrance and platform and for underground / underground and underground / rail transfers. These are grouped in three headings '*Entrances'*, '*Halls to Platform*' and '*Interchanges'* – *Figure 6* shows the names of the first few navigation paths in the list.

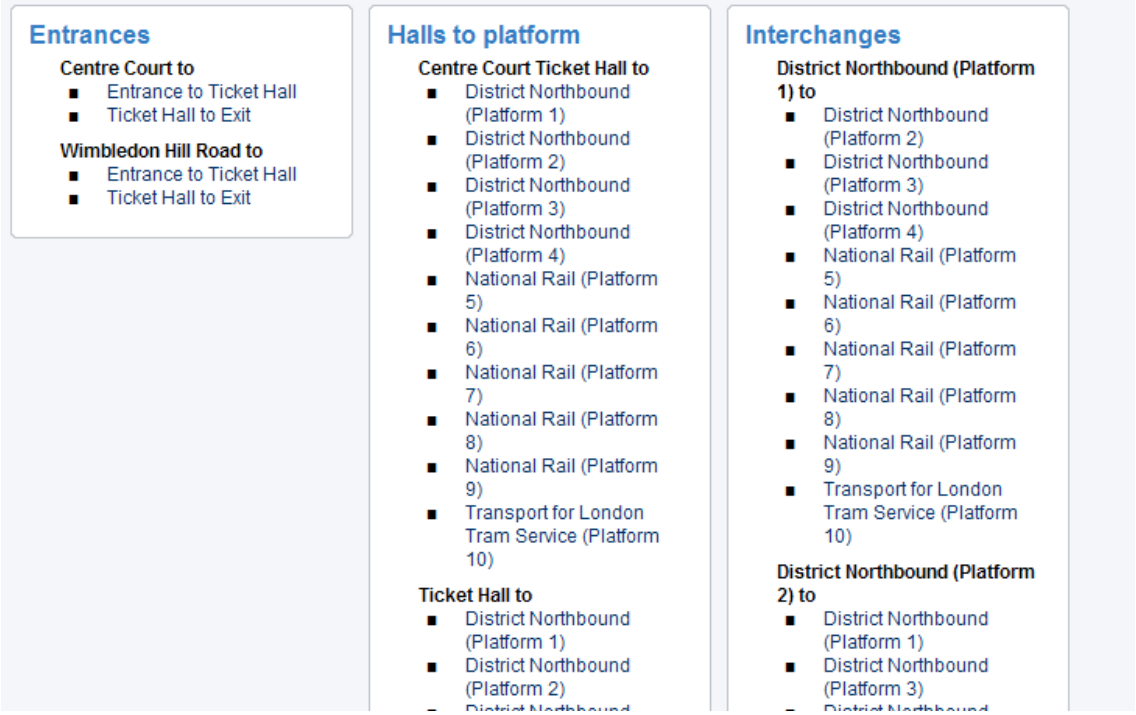


Figure 6 Partial list of Navigation Paths (DirectEnquiries.com – LU)

3.3 Each individual path can be displayed as a step by step description of path links; each step corresponding to use of stairs, level, ramp or lift/escalators (*Figure 7*).

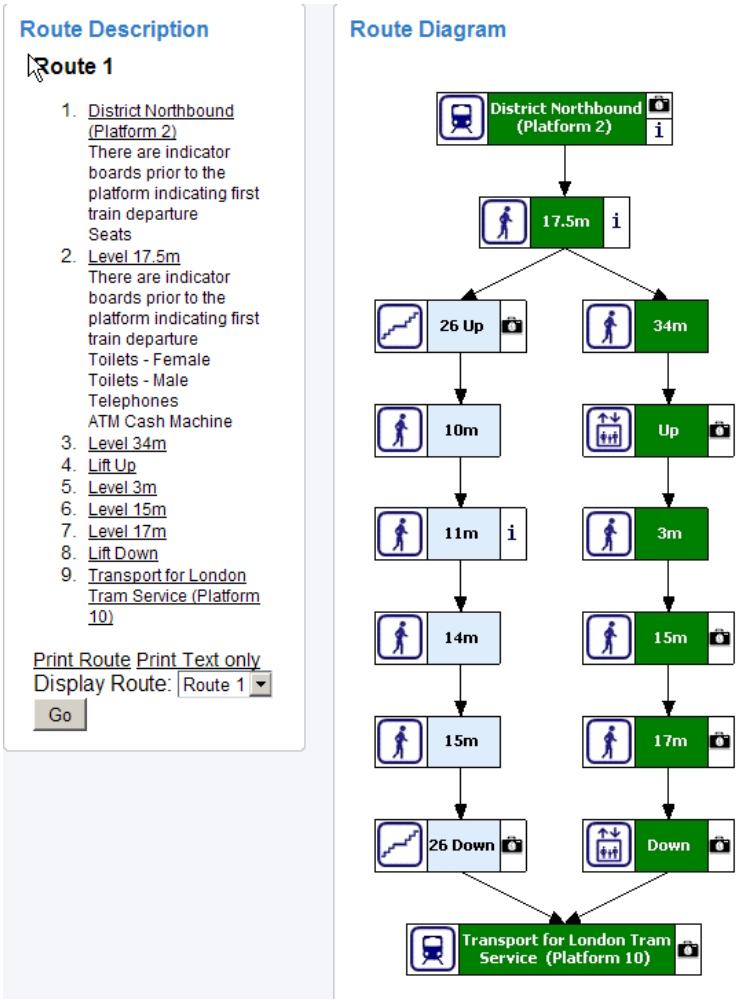


Figure 7 Example of Interchange Navigation Path (DirectEnquiries.com – LU)

3.4 Direct Enquiries includes a local area 'micro' Journey Planner that allows users to choose the best access route from platform to street or from street to platform (*Figure 8*). The user can choose the optimisation criteria to make their own judgement as to the key accessibility criteria for them. For example a wheelchair user can seek to avoid escalators whilst a claustrophobe can avoid lifts. This allows a "computable" use of the data for a local area, but without regard to the end to end journey options.

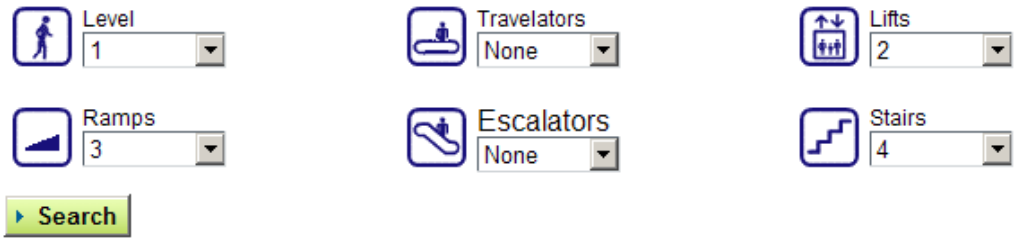


Figure 8 Input criteria for access plan (DirectEnquiries.com – LU)

3.5 The navigation paths returned by the local access planner may be made up of several stages and include alternatives. For example, to get from the entrance to District line northbound involves two stages (*Figure 9, Figure 10*)

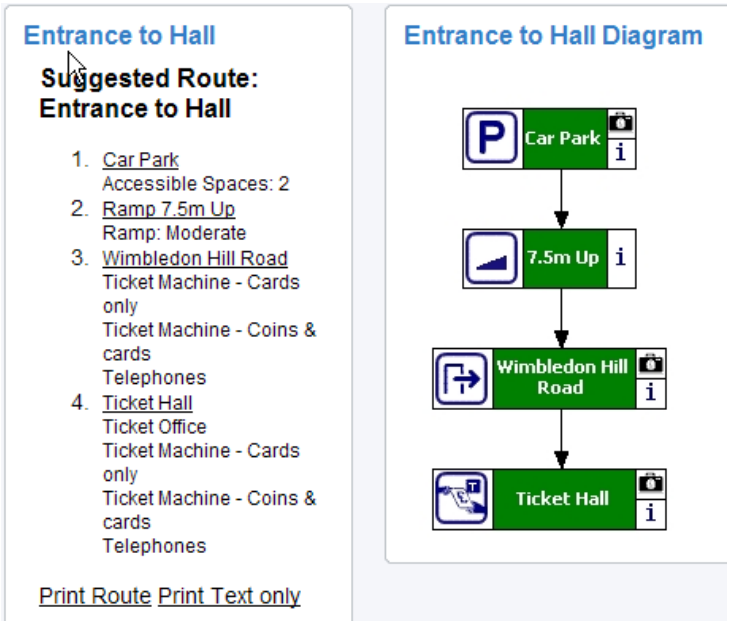


Figure 9 Access plan results - Navigation Path - Stage 1 (DirectEnquiries.com – LU)

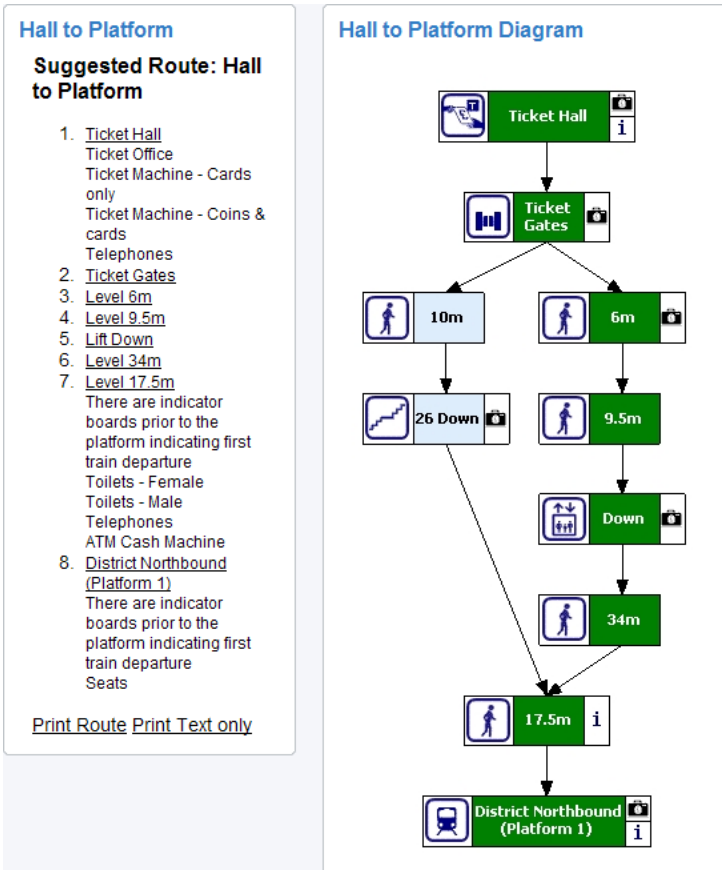


Figure 10 Access plan results - Navigation Path - Stage 2 (DirectEnquiries.com – LU)

3.6 If you look at the details of the route suggested by Direct Enquiries you can see that the micro journey planner results include not just the in-station links, but also preliminary steps from the accessible car park to the hall (*Car Park,*

Ramp). In addition the steps are annotated with information at each step relevant for a disabled user.

3.7 The navigation paths are directional – '*From Entrance to Platform'* is distinct from '*From Platform to Exit''*. Overall the interchange topology is represented to the user as a series of named navigation paths that can themselves be built up from smaller links. Having named paths for a particular purpose allows the user to understand the data and find the part they need. *Figure 12, Figure 13*, and *Figure 15* summarise the navigation paths through Wimbledon Station that have been explicitly created by the DE surveys.

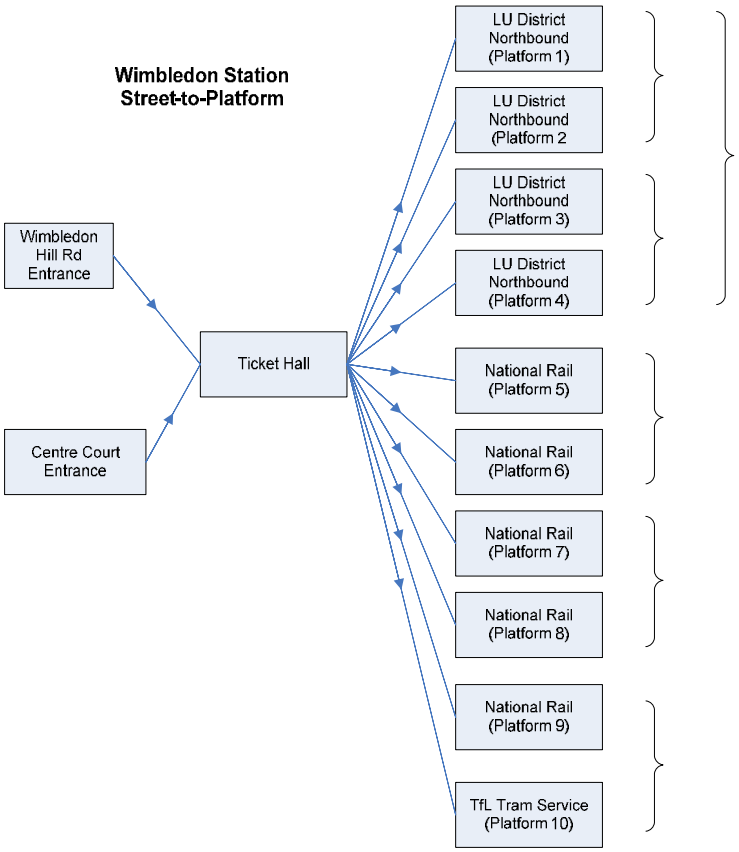


Figure 11 Street to Platform Navigation paths (DirectEnquiries.com – LU)

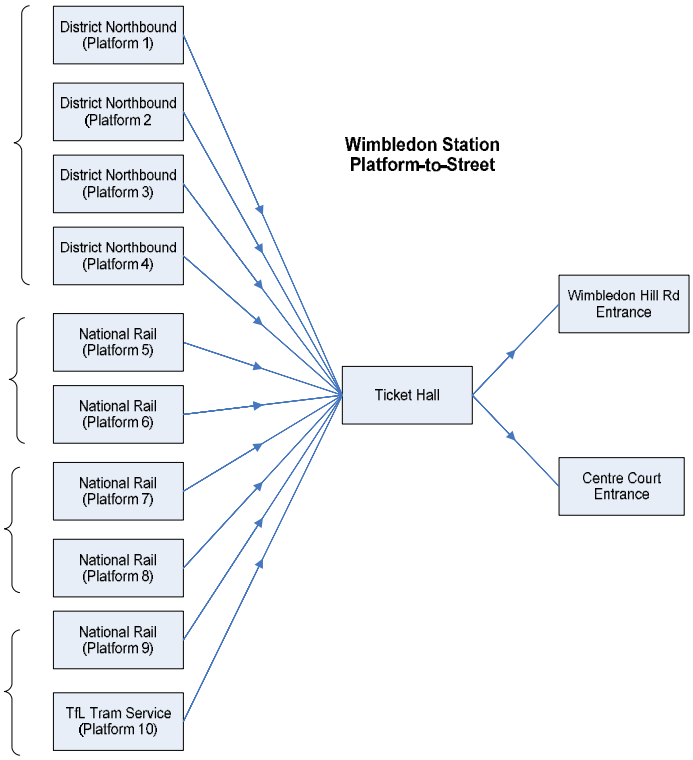


Figure 12 Platform to Street Navigation paths (DirectEnquiries.com – LU)

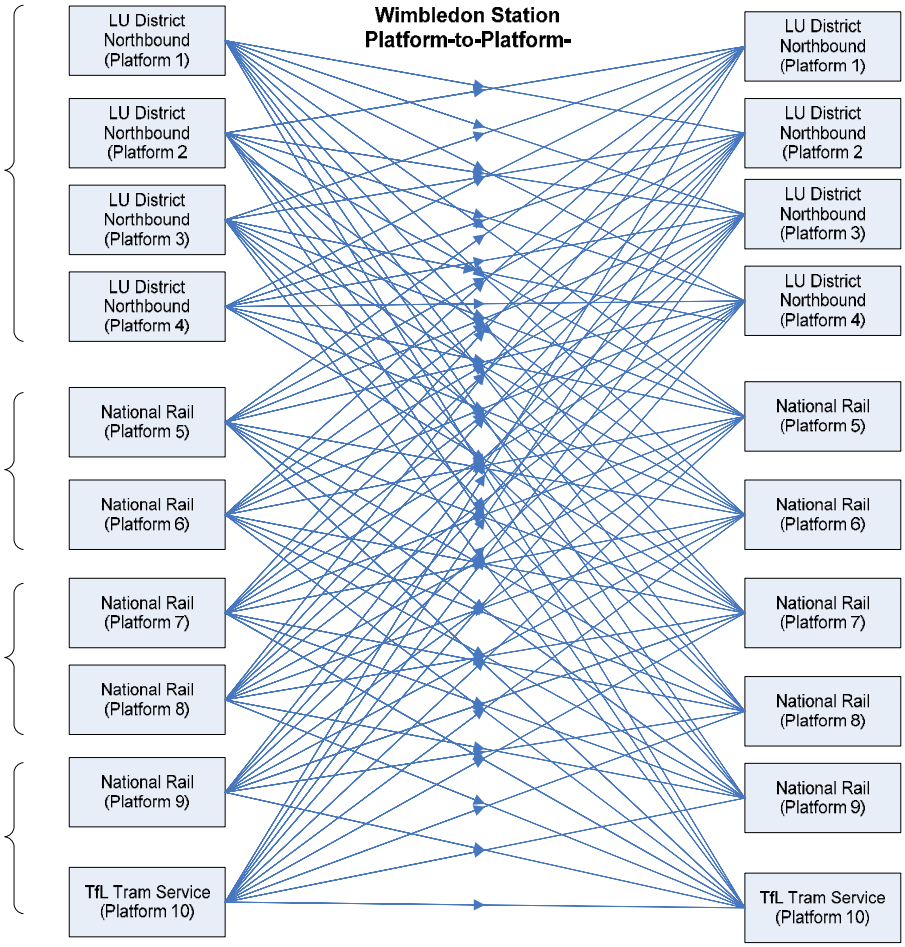


Figure 13 Platform to Platform Navigation paths (DirectEnquiries.com – LU)

3.8 The Direct Enquiries navigation site enumerates specific navigation paths that are easy for a user to understand as simple point to point transitions. However the real topology – connectivity between areas - is summarised in Figure 14 (dashed line indicate lift / stairs).

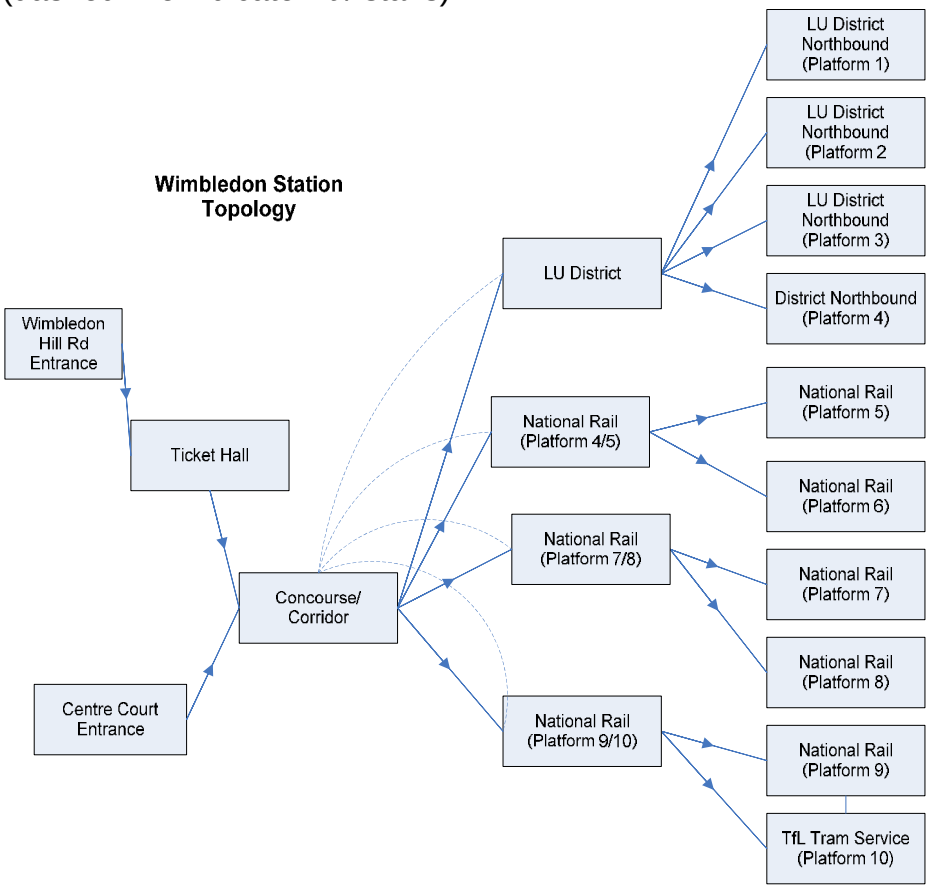


Figure 14 Route Topology of Wimbledon Station

4 Wimbledon in NRE Stations Made Easy

4.1 The National Rail Enquiries “Stations Made Easy” site includes a facility to show the whole station on an interactive plan that includes the lifts and stairs to all platforms, allowing a “narrative” exploration of the station. See http://www.nationalrail.co.uk/stations/sjp/WIM/plan.html.

4.2 The site was developed in 2009 as part of a £1.2 investment by ATOC, DfT and Transport Scotland to survey all GB rail stations.

4.3 The user can hover over points such as lifts to find out about their capabilities. Hovering over a point shows a photo and attributes for the element. It allows the user to visually plan a route to / from any one of platforms 1 to 4 and 5 to 9, the car park, entrance hall etc. Note that this is largely a graphical representation – although it very usefully collates many attributes of the station, it requires the user to interpret them one by one. One can’t make a journey plan say to find the wheelchair routes that are open after 10 pm.

Figure 15 Wimbledon Station plan – Ground floor (NRE Stations Made Easy) from National Rail Enquiries www.nationalrail.co.uk'.

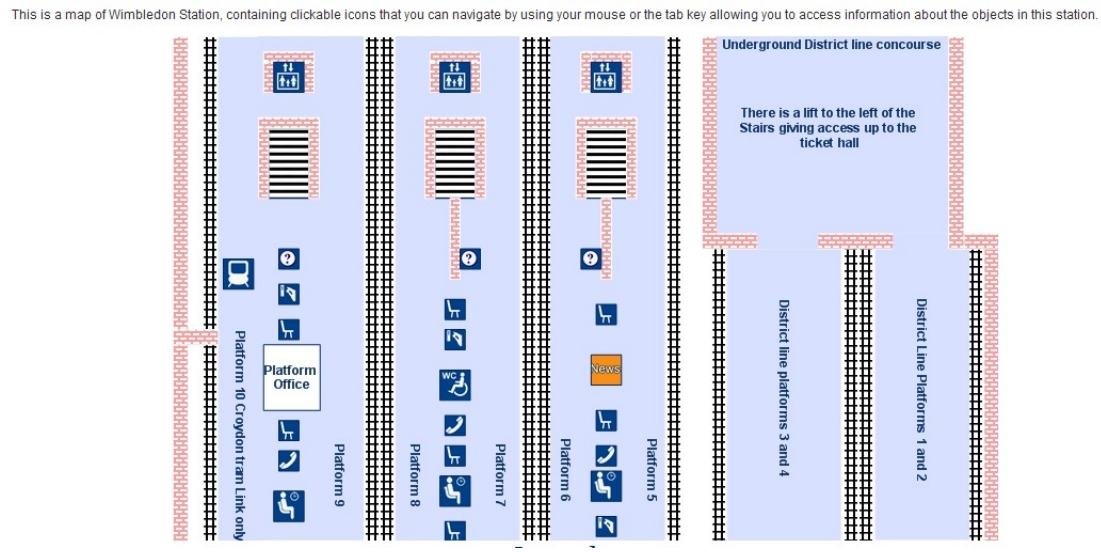


Figure 16 Wimbledon Station plan – Lower Ground floor (NRE Stations Made Easy) from National Rail Enquiries www.nationalrail.co.uk'.

4.4 Some of the hover buttons contents are shown in *Figure 17* below: Typically they include various structured or text properties associated with different types of node, along with an image. These can include information relevant for specific class of disabled user; for example, for the deaf, whether there are hearing loops; for the blind, whether there are audible announcements; or for wheelchair users, whether there are wheelchair-accessible lavatories.

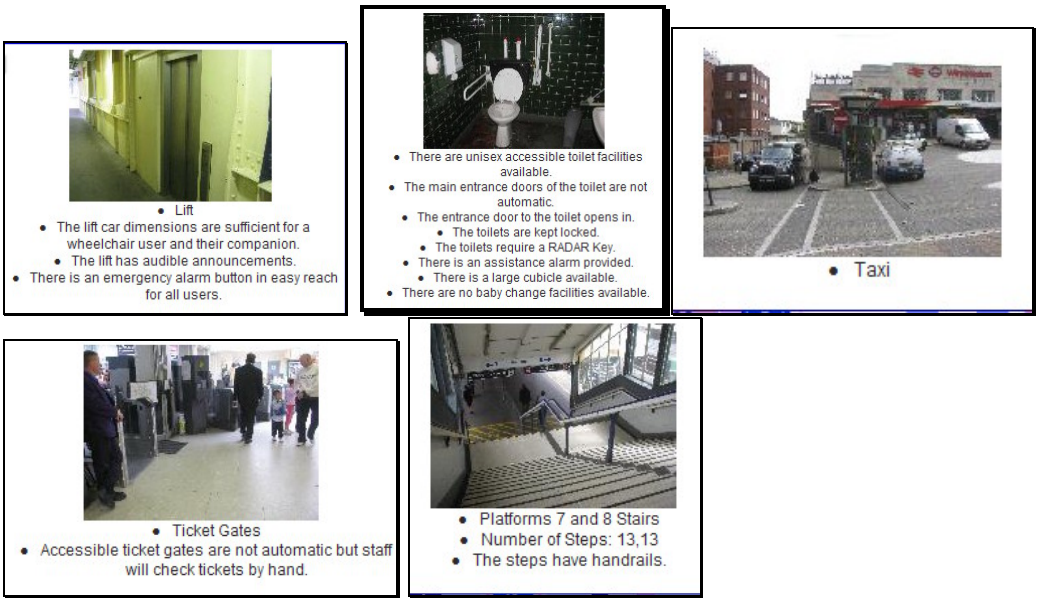


Figure 17 Hover windows for selected DE icons (NRE Stations Made Easy) from National Rail Enquiries www.nationalrail.co.uk'.

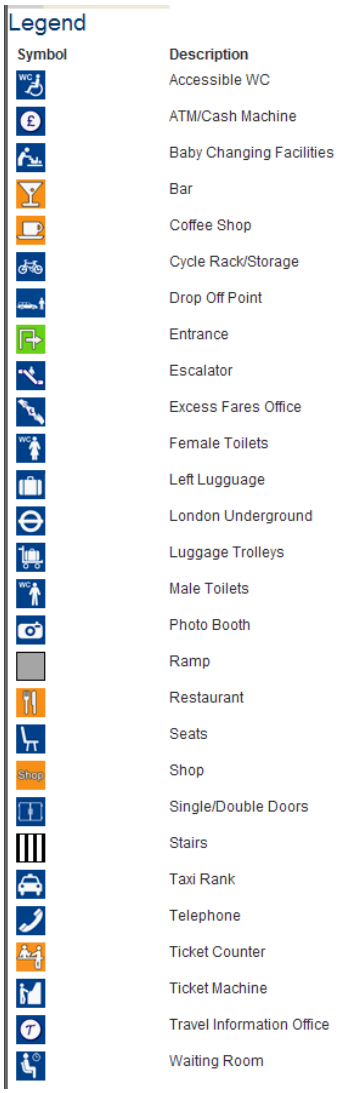
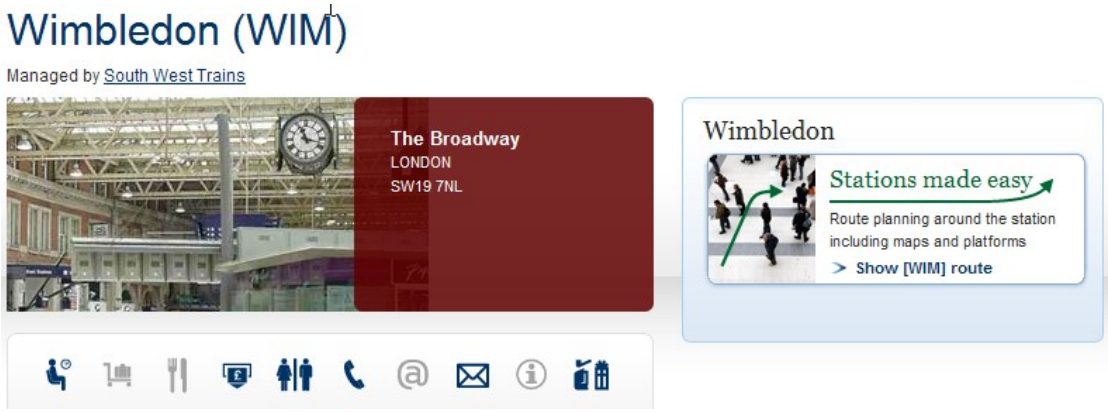


Figure 18 NRE Station Made Easy – Legend (From Euston Station)

4.5 The National Rail Enquiries site also includes a set of narrative pages that list accessibility related information about the site, covering opening hours, parking, toilets etc.



Accessibility and mobility access

Customer help points	Monday-Friday 24 hours Saturday 24 hours Sunday 24 hours
Staff help	Monday-Friday 24 hours Saturday 24 hours Sunday 24 hours
Accessible ticket machines	✓ Yes All South West Trains ticket machines are able to sell tickets with Disabled Persons Railcard discounts. All machines are accessible, however the station may not be so please check the station access note for further details
Accessible ticket office counter	✓ Yes
Induction loop	✓ Yes
Ramp for train access	✓ Yes
Accessible taxis	✓ Yes
Accessible public telephones	✗ No
Accessible toilets	✓ Yes A National Key Scheme toilet is available. Radar Key available from station staff. If you wish to buy a 'National Key Scheme' key, [RADAR]. Their address is 12 City Forum, 250 City Road, London EC1V 8AF, tel: 020 7250 3222, minicom: 020 7250 4119, fax: 020 7250 0212, email: radar@radar.org.uk, web www.radar.org.uk/ site:
Step free access coverage	✓ Whole station Wimbledon has level access to and between all platforms. There are lifts between the overbridge (access opposite the stairs to platforms 9 or 5) and the platforms. Please note that the lifts are located behind the stairs to the overbridge on platforms 5 to 9
Impaired mobility set down	✗ No
Disabled parking	✓ Yes - 2 spaces
Accessible car park equipment	✗ No
Wheelchairs	✓ Yes

Transport links	
Connection time	6 minutes (minimum)
Cycle storage	To be confirmed by station operator
Sheltered cycle storage	✓ Yes
Car park	✓ Station Car Park
Car park opening	Monday-Friday 24 hours Saturday 24 hours Sunday 24 hours
Car park spaces	40
Charges	£8.00 peak , After 1600 Mon-Sat £2.00 off peak , £8.00 daily
Notes	Pay & Display. Sat £8.00-Sun £2.00 Weekend tickets available from 1200 Fri £10.00.

Figure 19 Wimbledon Station Information - NRE Web site from National Rail Enquiries www.nationalrail.co.uk'.

5 Wimbledon in the TfL Journey Planner

5.1 TfL maps give an overall indication of accessibility at the station level. Wimbledon is flagged as a wheelchair-accessible station.

5.2 The TfL Journey planner is provided by MDV. MDV's product set supports interchange accessibility routing at two levels: (i) **journey planning through interchanges** and (ii) detailed **indoor routing**. The current TfL Journey Planner implements journey planning through interchanges, but not indoor routing. To supporting detailed indoor routing requires significant extra effort to survey and collect data at an additional level of detail– as shown in 'Stations Made Easy'. The discussion in this paper focuses mainly on journey planning through interchange, though the relevance of IFOPT to indoor routing can be seen in later sections.

5.3 For journey planning through interchanges, the MDV DIVA data tool used to prepare and populate the TfL journey planner (i.e. MDV's EFA product) can represent the transfers between modes at a detailed level, including transfer times. To do this it uses a logical model for Wimbledon (*Figure 20)* that

represents the key nodes of the interchange, including Stop Points, Entrances, Halls, Mezzanine floors, Park and Ride Places and Bike and Ride locations. In some cases it is sufficient to represent a transport mode as a single node (e.g. for routes where the platform can vary (e.g. Underground), and the platforms are interchangeable. In other cases, a detailed point is needed – e.g. Stop P versus Stop C

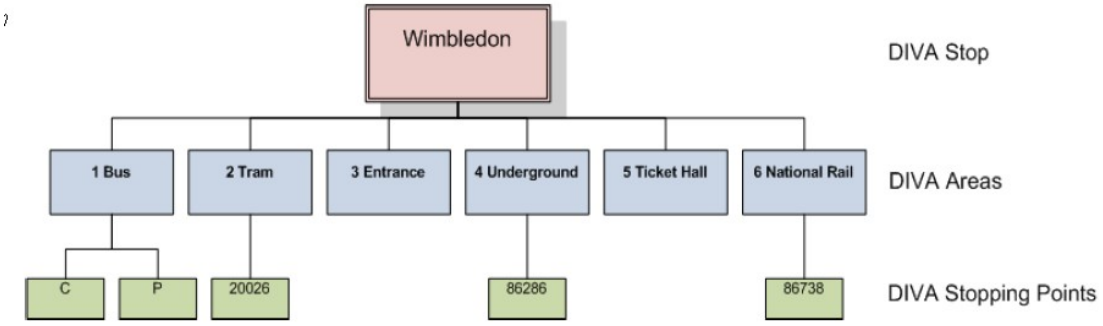


Figure 20 Logical Model of Wimbledon – (MDV)

5.4 Figure 21 shows the topological points and links for Wimbledon in the DIVA representation. The representation does not model all the individual platforms, but rather areas within the interchange between which it considers the transfer times to be equivalent. There is thus one node for the four District Line platforms (which are joined by a contiguous concourse). It does however distinguish between two groups of rail platforms.

Figure 21 Wimbledon in DIVA (from SELTA db)

5.5 Table 1 (Courtesy of SELTA) lists the nodes used to represent Wimbledon in DIVA. Table 2 shows a connection to the nearby but distinct stop pair on Alexandra Road. These nodes correspond to most of the NaPTAN points, with the addition of some additional nodes that allow the description of a basic topology of the station for making transfers. The table has a level and the relation to a TOID in a mapping system.

Type	Area	Point	Name1	Name2	Ext Name	Coord	(OSGR)	GeoRef		Usage	Lvl
Area	1		Bus	Bus	490G00272P	524830	170614	25421942	+31m	Entrance and PT	0
Point		->N	TEMPORARY STOP	490014734N1		524770	170759	759071277+	93m		
Point	C		WIMBLEDON STATION (SW19)	490000272C		524805	170643	25489596+	13m		
Point	D		WIMBLEDON STATION (SW19)	490015472D		524883	170618	25422046+	3m		
Point	L		WIMBLEDON STATION (SW19)	490015472L		524798	170556	25503472+	32m		

Point	P		WIMBLEDON STATION (SW19)	490000272P		524777	170609	25489596+	22m		
Area	2		Tram	Croydon Tramlink	9400ZZCRWMB1	524839	170650	2006005249	+82m	Only PT	-1
Point		20026		WMB SN	524837	170651		2006005249+	83m		
Area	3		MAIN	MAIN STATION ENTR	490000272003	524777	170639	25489596	+36m	Entrance and B+R	0
Area	4		Under	Underground	9400ZZLUWIM1	524793	170673	2006005082	+29m	Only PT	-1
Point		86386	Wimbledon			524793	170673	2006005082+	29m		
Area	5		BookH	Booking	Hall	524787	170649	1999503402	+18m	Mezzanine	0
Area	6		RPL-R	RPL >RaynesPark	9100WDON1	524825	170680	1999503402	+67m	Only PT	-1
Area	7		RPL-S	RPL->Sutton	9100WIMBLDN1	524836	170670	1999502965	+154m	Only PT	-1

Table 1 Wimbledon nodes in DIVA (SELTA database)

#	Type	Stop	Name	PlaceId	PlaceName				
1	connected	19043	Wimbledon,	St	Georges	Road	(SW19)	31117132	Wimbledon

Table 2 Wimbledon Related stops in DIVA (SELTA database)

5.6 The nodes are then connected with a “Footpath matrix” of point-to-point transfers between nodes, including transfer times that can be used when planning a journey. There can be separate transfers by Lift, Stairs, or that are Step free. These in effect define a set of topological links between nodes.

From	Stop	272	272	272	272	272	272	272	19043
To	Area	1	2	3	4	5	6	7	
Stop	Area	Name	Bus	Tram	MAIN	Under	BookH	RPL-R	RPL-S
272	1	Bus	2.0	4.0	1.0	4.0	2.0	5.0	5.0
272	2	Tram	4.0	2.0	3.0	4.0	2.0	5.0	5.0
272	3	MAIN	1.0	3.0	3.0	1.0	4.0	4.0	
272	4	Under	4.0	4.0	3.0	2.0	2.0	5.0	5.0
272	5	BookH	2.0	2.0	1.0	2.0	3.0	3.0	
272	6	RPL-R	5.0	5.0	4.0	5.0	3.0	6.0	6.0
272	7	RPL-S	5.0	5.0	4.0	5.0	3.0	6.0	6.0
19043	0	5.0	7.0	4.0	7.0	5.0	8.0	8.0	

5.7 When using the TfL Journey Planner, any or all of four accessibility limitations (*Step free, Escalator free, Lift Free, Wheelchair access)* may be specified as additional search arguments, along with a speed of movement (Figure 22). When making a point-to-point journey plan they will be used as computable attributes to avoid start, destination or interchange stations that do not meet the criteria.

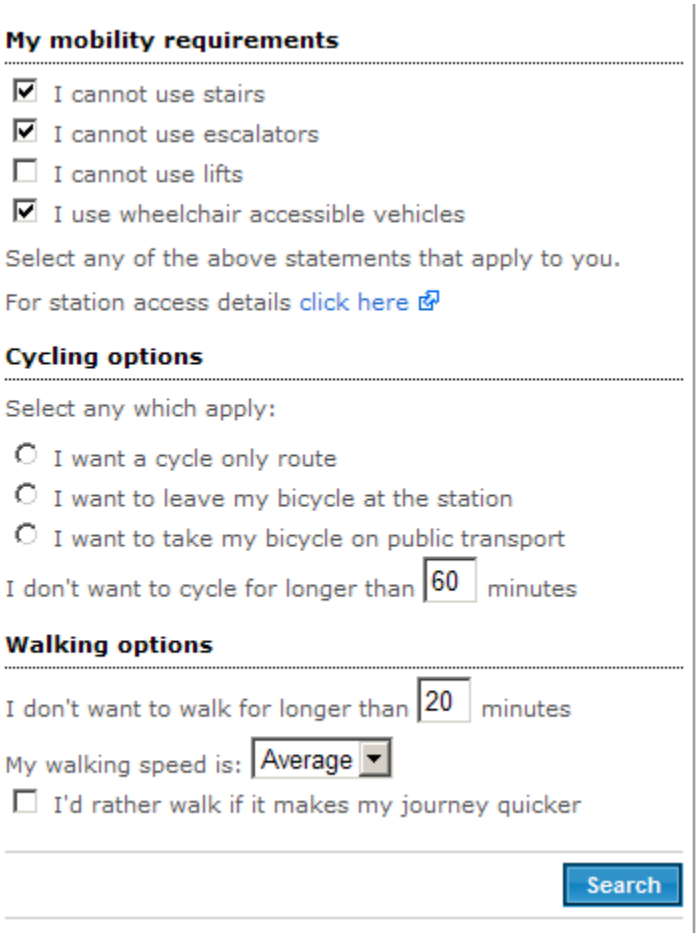


Figure 22 TfL Journey planner accessibility input criteria

5.8 Journey plans will be optimised for the given accessibility requirements, ignoring stations that are not considered accessible.

5.9 The entrances to the station buildings and other points of interest are used to provide routed directions for point-to-point planning both as instructions and on maps. For example, *Figure 23* shows a fragment of a map for an individual journey plan along a street and into the station. However these routes into stations are not accessibility limitation aware – they simply connect to the main entrance. Nor are there any instructions about the specific access path to use.

5.10 To do true indoor accessibility routing, MDV have an indoor routing product, which provides a detailed representation of paths similar to that discussed under NRE's "*Stations Made Easy".* This can be integrated both with schematic maps for a narrative view (as for "*Stations Made Easy*") and to support "computable" indoor journey planning, further integrating with journey data, GIS data and map views as discussed later.

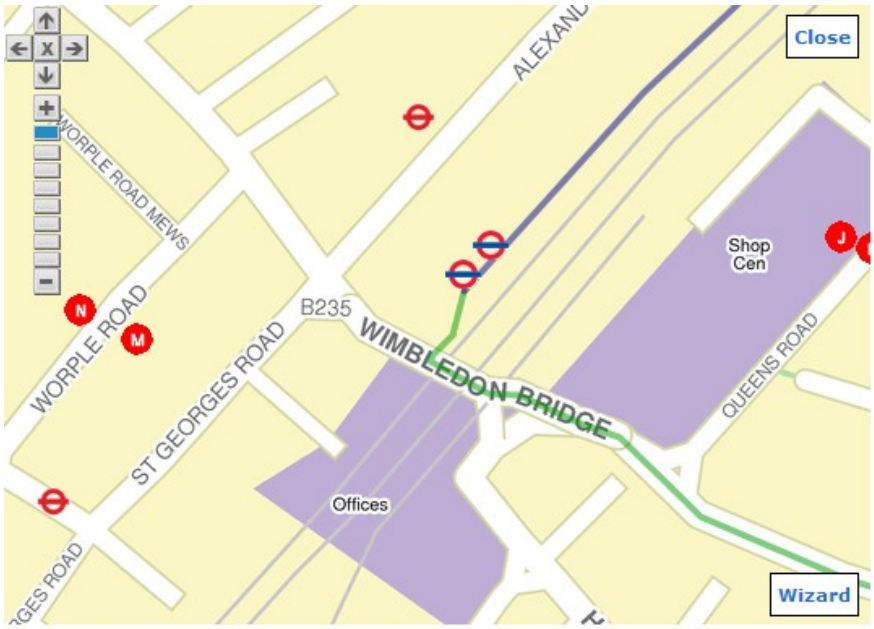


Figure 23 Fragment of a journey map showing routed path to entrance (TfL)

5.11 TfL has navigation path data in a semi structured representation for the Underground – as can be seen from the entrance data available from their interactive tube map. This lists navigation paths and includes the true platform to train step/gap distances that are need for the exact determination of the viability of wheelchair access.

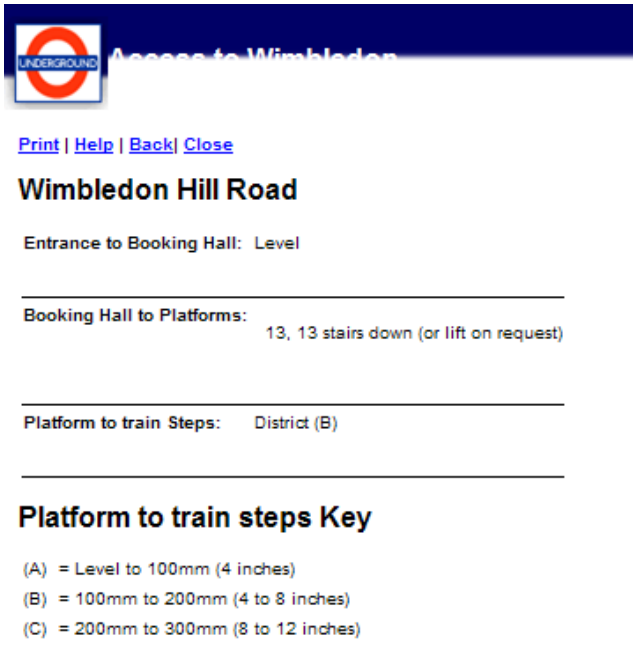


Figure 24 TfL Step Gap data (TfL Interactive Map)

6 Parking, taxi ranks, drop off points

6.1 In considering Wimbledon as an interchange, taxi, parking and drop off points are also important – especially for disabled users. NaPTAN currently allows only taxi ranks locations to be captured (though one is not populated for Wimbledon). NaPTAN does not capture drop off points or parking, although Transport Direct does hold car park data.

6.2 Wimbledon has a station forecourt with taxi rank – as can be seen in the satellite shot from Google (*Figure 25*).

Figure 25 Wimbledon Satellite picture

6.3 There are a number of car parks around Wimbledon station – as shown by *Figure 26* from a local council site. The National Rail '*Stations Made Easy'* site indicates there is a station car park and gives costs and opening times, but it doesn't locate it relative to the station. (Anyone planning to use it for a time critical journey would probably also need an indication of the likelihood of getting a place).

6.4 The TfL web site states there are 2 disabled parking bays.

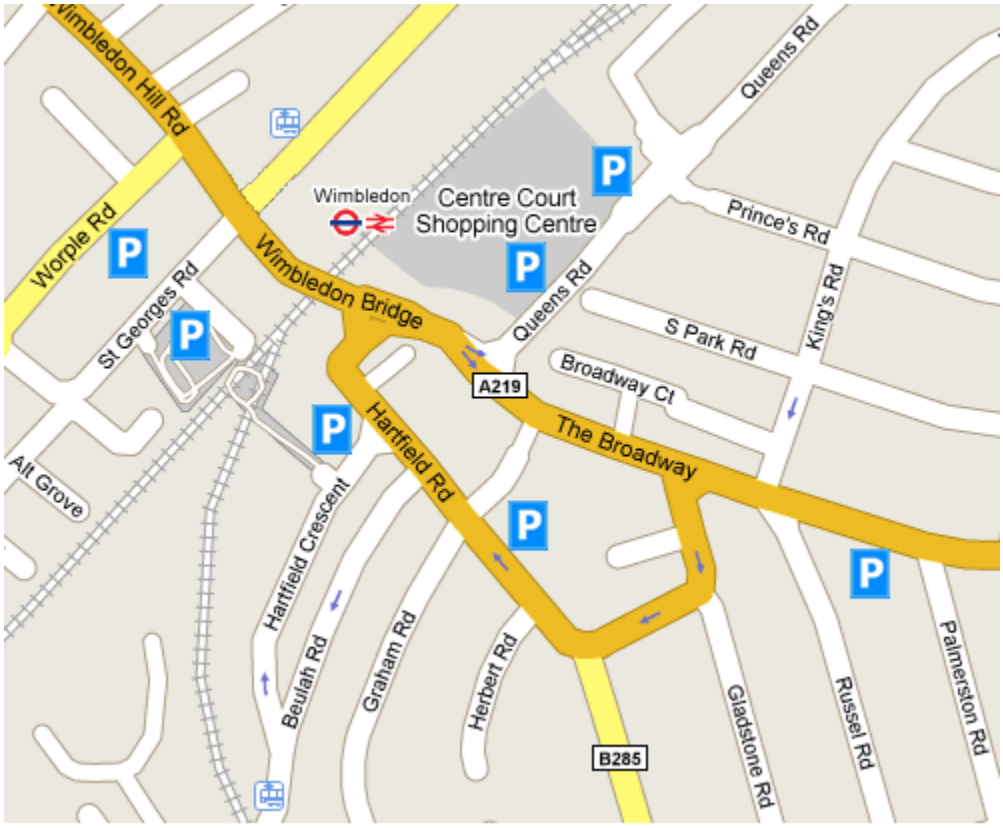


Figure 26 Parking near Wimbledon station

6.5 The Transport Direct site has more detailed information about the parking *Figure 27*, but it isn't linked to the TfL or NRE rail sites and pedestrian access points are not shown.

Car parks found for Wimbledon Rail Station

Select the Car park you wish to travel from or to below. Then click "Drive **from**" or "Drive **to**".

Option	Car park name	Total Spaces	Park Mark Approved	Disabled Spaces	Distance	Select
1	Wimbledon, Wimbledon Bridge	-			0.1 miles	◉
2	Wimbledon, St George's Road	113			0.1 miles	○
3	Wimbledon, Centre Court Shopping Centre	751	✔		0.1 miles	○
4	Wimbledon, Wimbledon Station	40			0.1 miles	○
5	Wimbledon, Hartfield Road	126	✔		0.2 miles	○
6	Wimbledon, Queens Road	159	✔		0.2 miles	○
7	Wimbledon, Broadway	126	✔		0.3 miles	○
8	Morden, Kenley Road	123	✔		1.2 miles	○

Show map | Drive from this car park | Drive to this car park

Figure 27 Parking sites for Wimbledon Station (TransportDirect.info)

6.6 Transport Direct has structured data on the car parks that can include capacities, disabled spaces and coordinates. (*Figure 27*, *Figure 28).* It does not look like the disability data for Wimbledon is populated.

Wimbledon Station

Car park

Address
The Broadway
Wimbledon
Surrey
SW19 7NL
08456000650
South West Trains

Minimum Cost of Parking:
£2.00

Total Number of Spaces:
40

Type of Car Park:
Surface Car Park

Figure 28 Example data for a car park (TransportDirect.info)

6.7 Wimbledon has been videoed as part of the Google Street View coverage. Since all Wimbledon's bus stops and main entrance are directly on the street, this means that Google Street View itself provides a useful accessibility tool for a "narrative" assessment of a journey. For example, one can visit every bus stop on street, look at steps and ramps and road crossings, and rehearse a possible route. *Figure 29* shows the front of Wimbledon and one can see a clear line of access.

Figure 29 Wimbledon Station, Google street view

6.8 *Figure 29* from Street View shows the bus stops E, F and G in Sir Cyril Black Way near Wimbledon station.

Figure 30 Sir Cyril Black Way stops, (Google Street View)

6.9 Other community-contributed surveys can also be helpful for a "narrative" assessment of accessibility. For example, for Wimbledon Centre Court shopping centre which is adjacent to the station, Google maps (*Figure 46*) reveals the availability of a "*Tour of the lifts at Wimbledon Centre*" a video of all of the individual lifts inside the shopping centre. These would be relevant for a wheelchair user assessing the car parks with a view to using the station.

7 Wimbledon as an interchange for cyclists

7.1 For cyclists, Wimbledon station is an interchange to which they might wish to cycle and park to catch a train or to take their cycle with them – cycles may be taken on the District Line outside peak hours. In the latter case suitable routes to the platform are of interest.

7.2 The TfL journey planner allows one to search for cycle routes and supports a powerful set of search criteria to find journey combinations using cycles.

Cycling options

Select any which apply:

- I want a cycle only route
- I want to leave my bicycle at the station
- I want to take my bicycle on public transport

I don't want to cycle for longer than 60 minutes

Figure 31 TfL journey planner cycling options

7.3 The results allow one to compare cycle and public travel times. This may be especially helpful for encouraging use of cycles to reach Olympic venues.

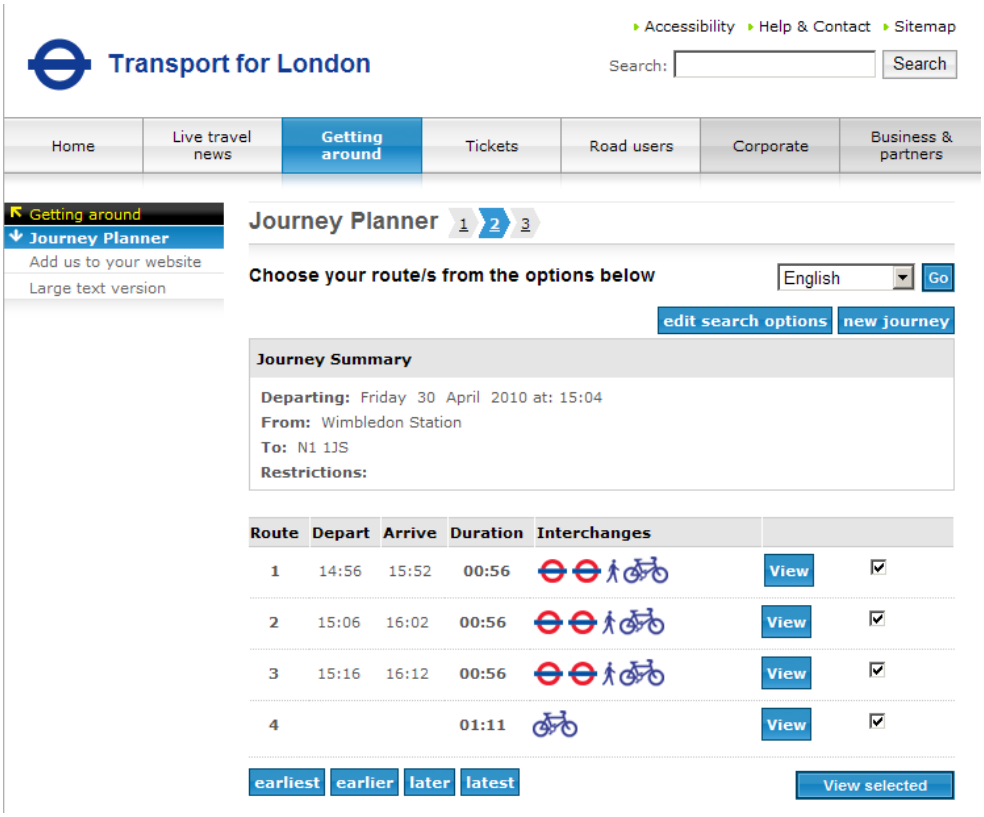


Figure 32 TfL Journey planner results for a cycle journey request

7.4 TfL has a basic tool to provide an indication of the availability of official cycle parking at stations.

Figure 33 TfL Cycle Parking

7.5 The NRE 'Stations Made Easy' tool shows where the station cycle parking facilities may be found.

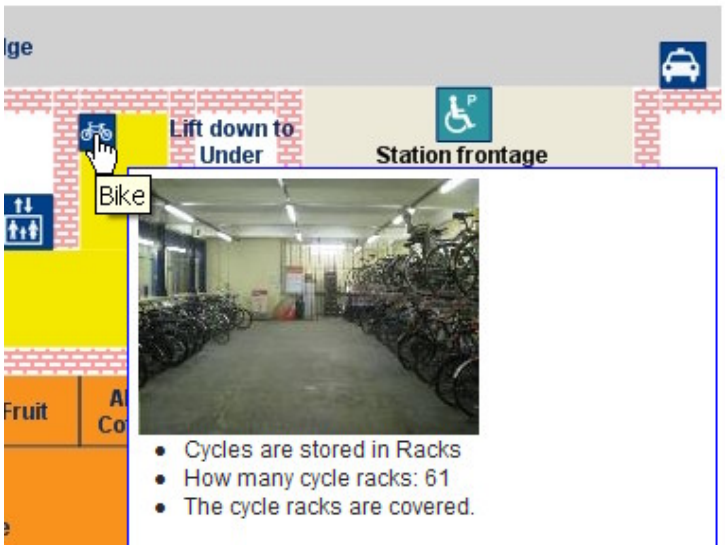


Figure 34 Stations Made Easy - cycle parking hover box from National Rail Enquiries www.nationalrail.co.uk'.

7.6 In the Olympic context, the TfL & NRE tools appear to already cover most requirements for cycle access to transport interchanges. If the public is to be encouraged to cycle to Olympic events, then similar considerations apply to providing cycling access information about venues, especially if cycle parking needs to be managed. For example, one may wish to recommend specific routes to get to a venue and to direct cyclists to designated cycle parks which may be some way from the actual Olympic event within the site.

7.7 A separate TfL tool exists (*Figure 35)* to allow the collaborative collection and sharing of named cycle routes. This might be used to create and publicise special recommended routes to venues and even individual Olympic events. The DfT CycleNetXChange standard (http://www.dft.gov.uk/cyclenetxchange/overview.htm), which is based on OS ITN – see below, in principle provides a format for exchanging such data.

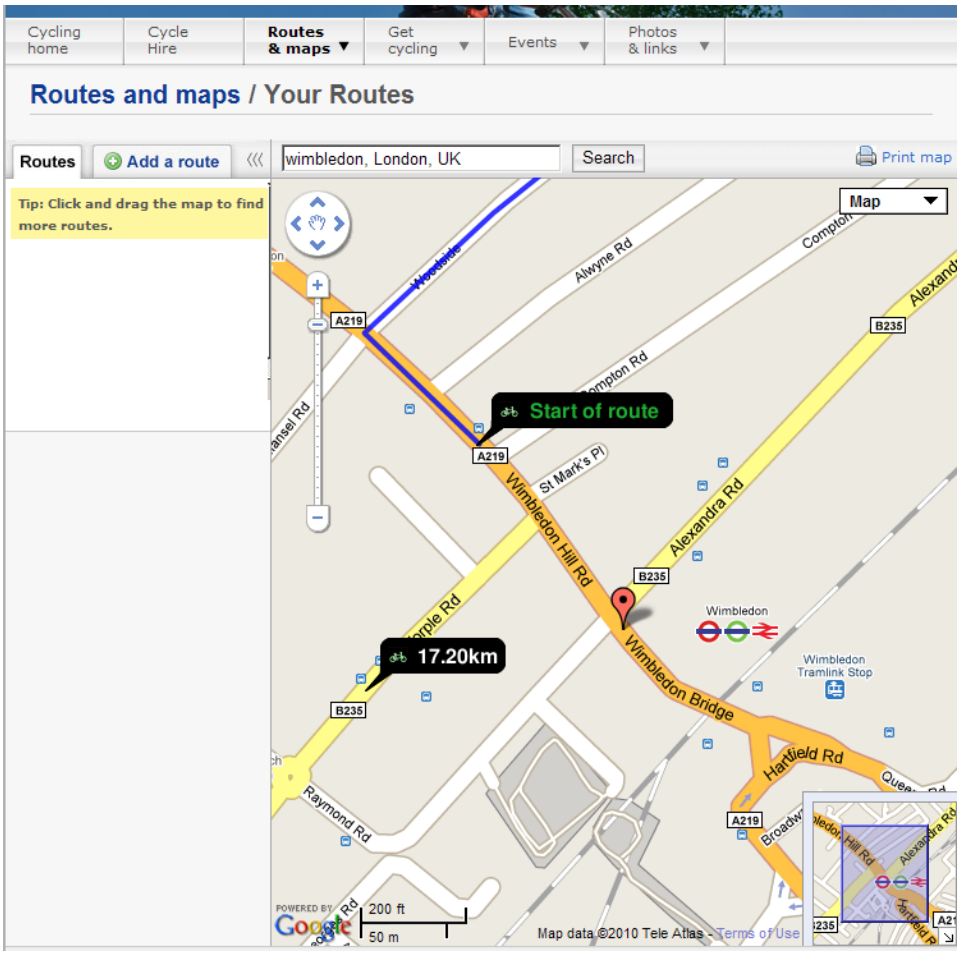


Figure 35 TfL Cycle Route Tool (TfL web site)

8 Wimbledon in Open Street Map

8.1 Intermodal journey planning engines need to integrate interchange data with an underlying GIS data set, both to present data in the context of a map, and to allow road and path routing to the interchange from other points.

8.2 Typically a journey planner will use the recorded location of entrances to automatically associate interchange buildings to the nodes of the GIS road and path data sets, allowing multi-modal routing that links the road network with the PT network. It is also possible to have explicit references to GIS features – as opposed to interpolating links from spatial co-referencing.

8.3 GIS vector data sets, such as OS ITN, NavTeq or Open Street Map use a node/link representation of the map features: nodes can be adorned with different attribute sets to describe their properties and appearance when rendered on a map at different scales. These attributes can include the types of vehicle or traffic which may use a path, whether turns can be made and other information necessary to provide full step-by-step routing.

8.4 Open Street Map (http://www.openstreetmap.org/) provides a useful illustration of such a GIS map set with the advantage, for our purposes here of exposition, that the actual stored objects can be examined (and edited) directly online and there is an open IPR licence. We therefore use it as an exemplar that is also relevant for other data sets such as OS & NavTeq.

8.5 In the OSM data for Wimbledon (e.g. Figure 36), many of the surface visible features such as platforms are already present and spatially located to a useful degree. OSM can also record hidden paths and many different map features such as cycle parks, pedestrian crossing etc

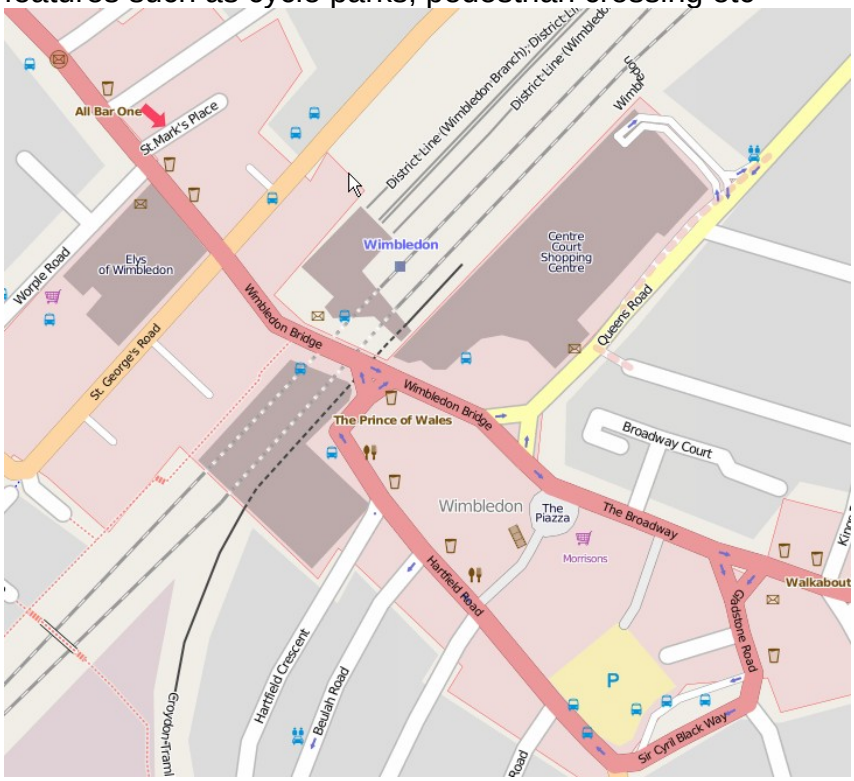


Figure 36 Wimbledon vicinity in OSM view

8.6 The OSM Edit tool (*Figure 37*) allows the Wimbledon data to be edited directly and new features to be added, opening up the possibility of "crowdsourcing" of some types of accessibility data.

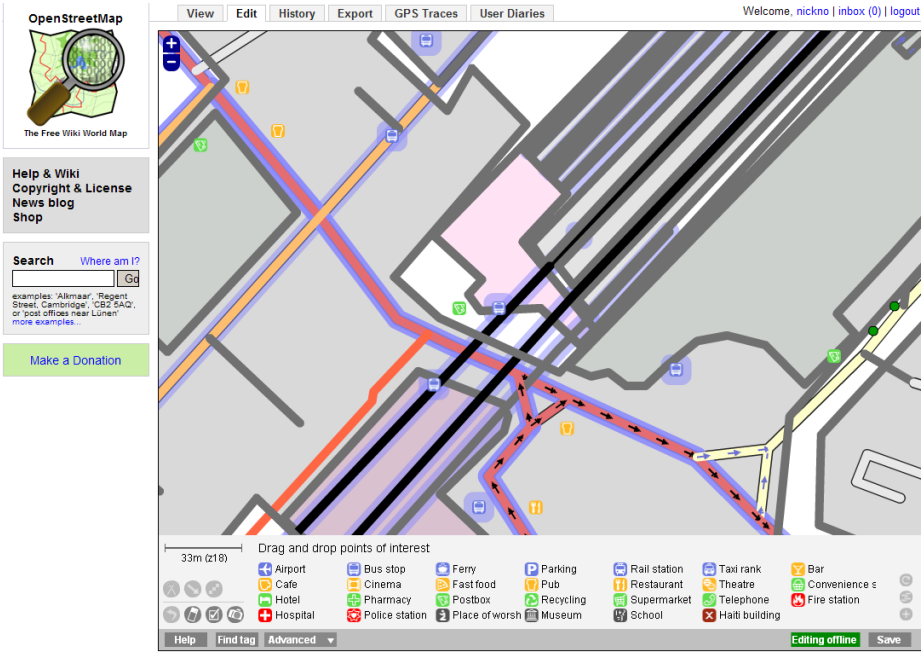


Figure 37 Wimbledon in OSM edit tool

8.7 *Figure 38* shows the OSM edit view for a selected bus stop – in OSM the bus stops (pale blue rectangles) and station entrances have been populated with NaPTAN data.

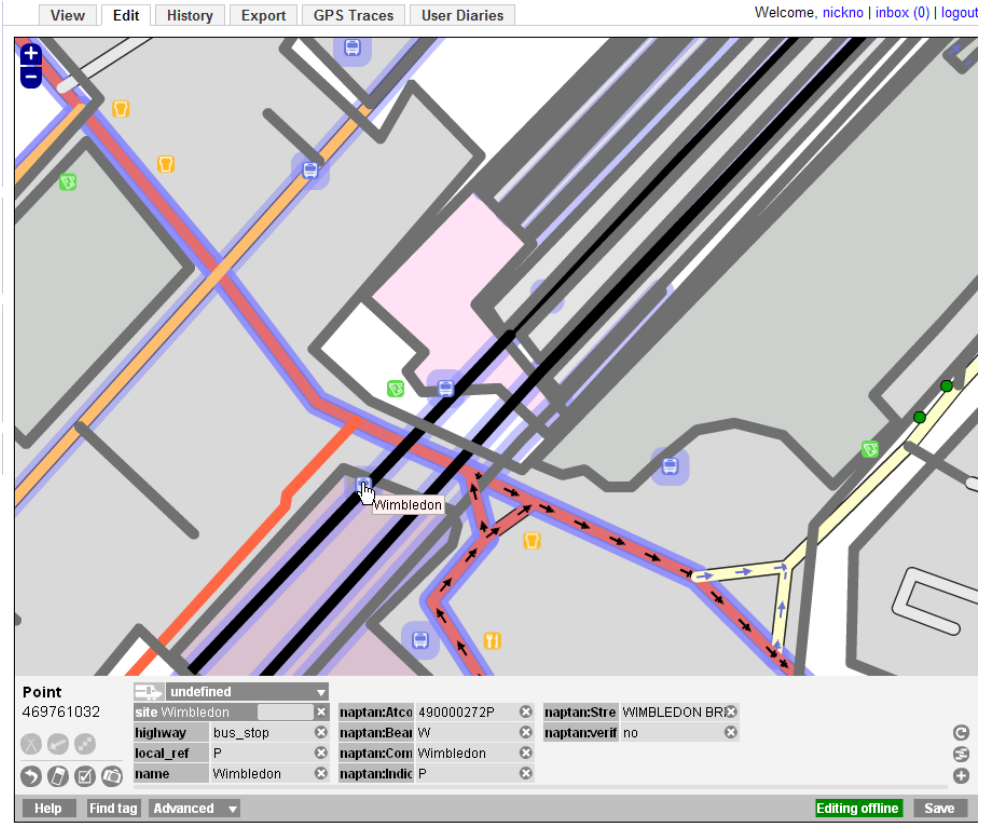


Figure 38 OSM edit view for a Wimbledon Bus stop P

8.8 *Figure 39* shows the edit view with a street section (Wimbledon Bridge) selected. The red dot shows the nodes. Some of the attributes that distinguish the elements as part of a road – as opposed to footpath, cycleway or other type of route - are shown below. OSM has a large set of standard attributes Additional paths can be added at will as visible or hidden layers.

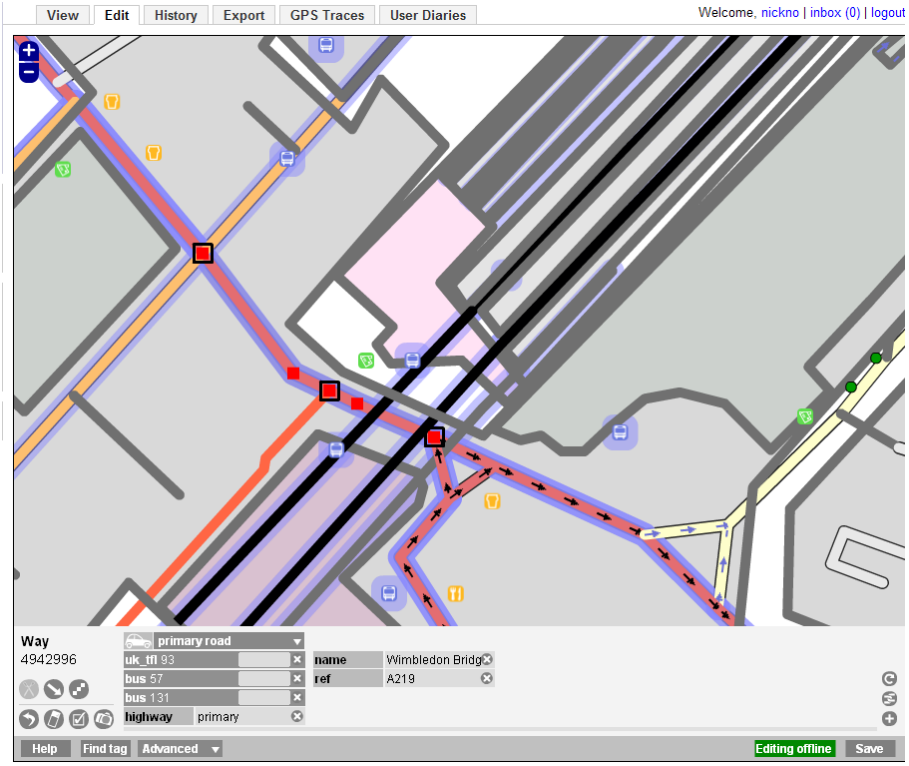


Figure 39 Wimbledon Bridge roadway in OSM editor

8.9 OSM includes station boundaries, delineated to a level of detail that allows the buildings and location of platforms to be quite precisely located. *Figure 40* shows a close up of an edit view of the Wimbledon Station buildings (using the CloudMade Mapzen tool http://mapzen.cloudmade.com/) on the same OSM data set). This provides sufficient context to place the entry points of a transport layer representation in a spatial frame of reference – and even some of the larger internal elements such as platforms.

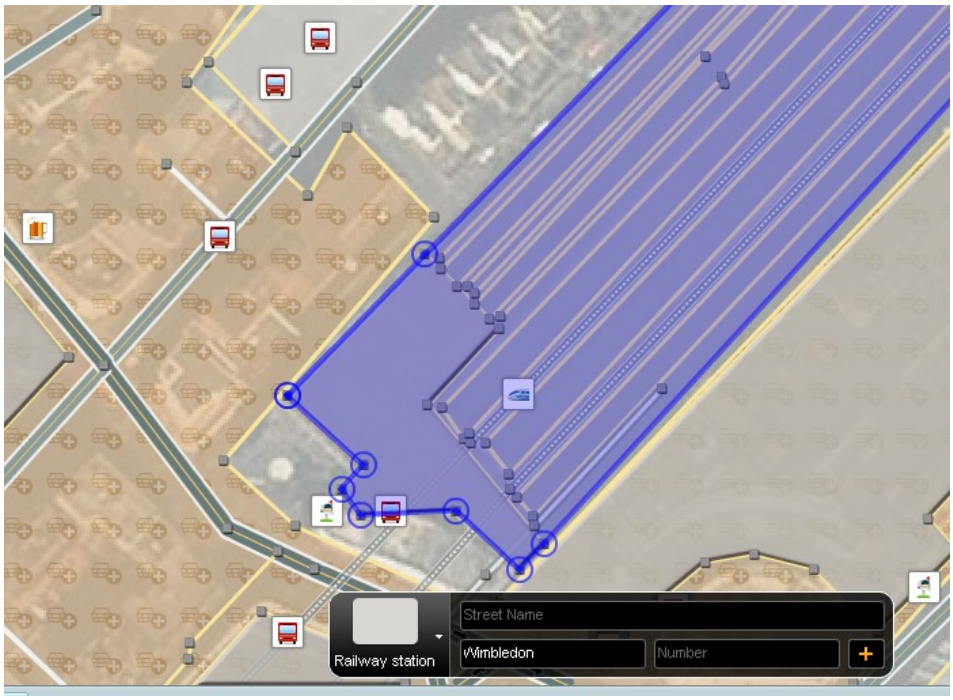


Figure 40 OSM Station boundaries for Wimbledon (CloudMade Mapzen)

8.10 OSM has each of the physical platform pair blocks delineated. *Figure 41* shows the edit view for platforms 5 & 6. OSM does not currently have paths through the station. It does allow for additional hidden layers of information so the same basic node/link mechanisms, with additional attribution could be used to build footpaths where the path network projects directly onto a map.

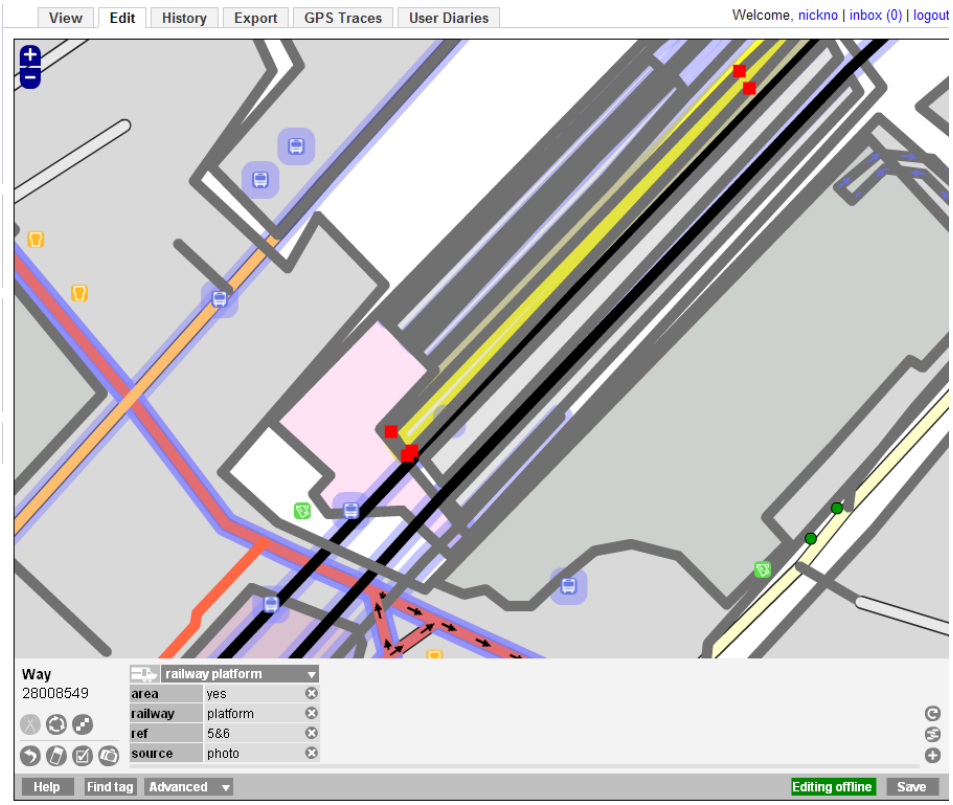


Figure 41 Platform 5 & 6 in OSM editor

8.11 OSM has a large number of simple key/value attributes that can be associated with features. These are described on the OSM wiki (http://wiki.openstreetmap.org/wiki/) and can be used to express basic properties of features. Most of them are to provide a classification of the feature that allows it to be rendered on a map according to a systematic taxonomy. Others describe other more general aspects of the feature. Table 3 shows a small subset of OSM attributes especially relevant for accessibility. There is a “wheelchair” attribute with three possible values that can be used to indicate if a place or link is accessible.

Key	Value	Comment
layer	-5 to 5	0: ground (default); -1..-5:under ground layer; 1..5 (not +1):above ground layer This is intended to indicate actual physical separation, shouldn't be used just to influence rendering order.
surface	paved / unpaved / asphalt / concrete / paving_stones / cobblestone / metal / wood / grass_paver / gravel / pebblestone / grass / ground / earth / dirt / mud / sand / ice_road	Apply to all types of highways. If the tag is not present, it is assumed surface=paved, excepted for highway=footway and highway=track. (sealed/unsealed outside UK).
smoothness	excellent / good / intermediate / bad / very_bad / horrible / very_horrible / impassable	Apply to all types of highways.
width	Number	Width of way in metres
est_width	Number	A rough guess of the width of way in metres

incline	Number%	Incline steepness as percents. Positive/negative values indicate movement upward/downwards in the direction of the way.
operator	User Defined	The operator tag can be used to name a company or corporation which is responsible for a certain object or which operates it.
opening_hours	24/7 **or** mo md hh:mm-hh:mm. (read described syntax)	opening_hours describes when something is open.
wheelchair	yes / no / limited	Indicate if a special place can be used with wheelchairs.
tactile_paving	yes / no	A paving in the ground to be followed with a blind man's stick.
narrow	yes	Relative indication that a way (waterway, highway, cycleway) gets narrower.
covered	yes	Used to denote that a node, way or area is covered by another entity (or in some cases the ground), when the use of layers is inappropriate, or additional clarification is needed.

Table 3 Some OSM attributes relevant for Accessibility (OSM wiki)

9 Wimbledon In Ordnance Survey & NavTeq

9.1 Although OSM data is used above to illustrate the GIS context, spatial data for Wimbledon is of course also available from the Ordnance Survey, which provides fundamental national GIS resources. OS Data is available directly as a product and also sources NavTeq and other products such as Bing and Street Map UK. The OS Integrated Transport Network (ITN) layer (an additional and separate product) includes distinct road and pedestrian path networks as vector data that can be used for routing, and including turn and other attributes. The road network coverage of the UK is comprehensive; the pedestrian network is work in progress, though many parts of London are covered. The availability of full pedestrian path level data is a key issue for detailed journey planning, especially to large venues as often there are footpaths that are better than the road network. NavTeq provides an alternative ready integrated route network with augmented attributes for road navigation.

9.2 Many of the Olympic venues involve extensive redevelopment and will require new surveys to bring them up to date in OS data sets such as ITN. Our understanding is that the Olympic venues will be prioritized within the OS survey process.

9.3 Ordnance Survey also has a collaborative route capturing tool, OS Explore, that in principle could be used to capture walk, cycle and path routes. However it only works at a fairly large scale suitable for driving

10 Wimbledon Station & IFOPT

10.1 The IFOPT standard enables the modelling of all the different elements of a station, including the component areas of the station, the levels, the paths through the station and the various types of equipment found in the station such as ticket machines and lifts, barriers, signs and seating. It also allows detailed accessibility attributes to be recorded at both the element and the station level.

10.2 In this section we will show how some of the IFOPT model can be used to provide a standardised representation of a complex interchange using the Wimbledon example and a simple transformation of the available NaPTAN data. This is not an exhaustive account of the IFOPT & Transmodel model capabilities, but focuses on aspects relevant to the transport data discussed above. The IFOPT model is described concisely – but quite technically - by a UML model which highlights the objects, attributes and relationships needed to represent an interchange. A summary extract is available as a separate paper. Here we focus on use of the model elements for Wimbledon but avoid the use of UML.

10.3 The core elements of the IFOPT model are the various spaces of which it is comprised, such as platforms (QUAYs), entrances (ENTRANCEs), concourses (ACCESS SPACEs), etc. The fundamental elements correspond to the various types of NaPTAN points (Entrances, Platforms, Areas). *Figure 42* and *Table 4* below show these key IFOPT structural elements for Wimbledon, including any equivalent NaPTAN point. Note that the NaPTAN points described earlier as missing in the current live data set have been added.

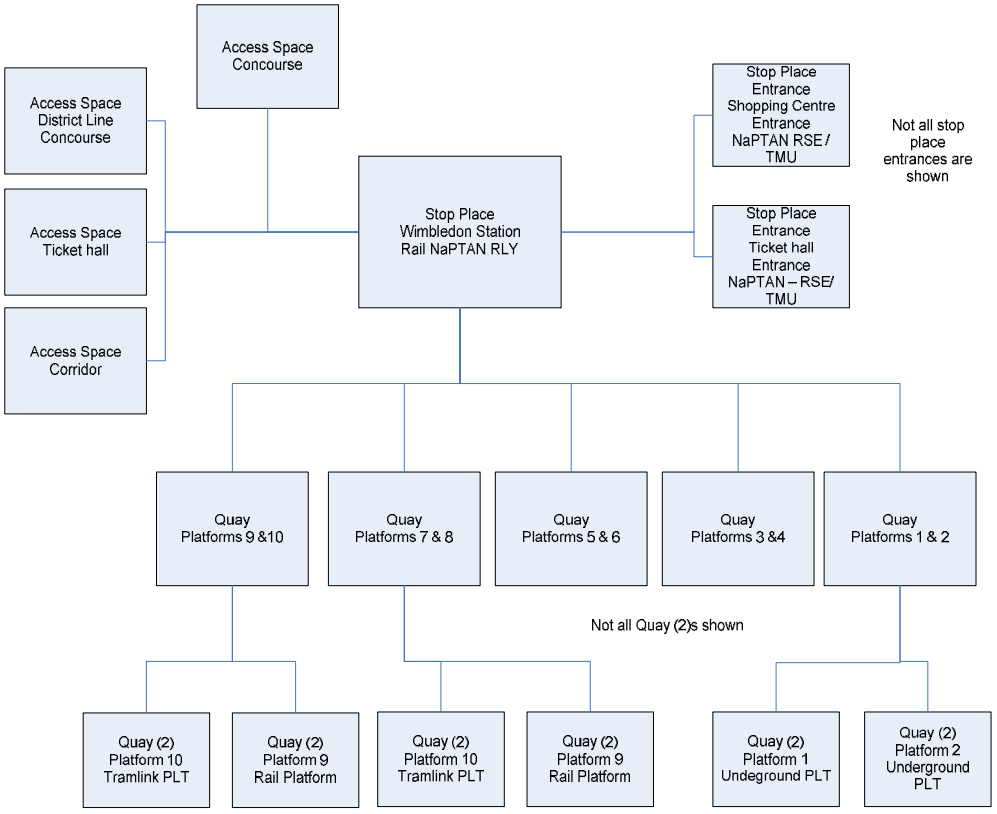


Figure 42 Wimbledon Station IFOPT nodes

10.4 As well as the familiar Quays for platforms and bus poles, *Table 4* includes Quays for car drop off points. Additional internal entrances are shown later in Table 5.

IFOPT Type	IFOPT component Description	Part of	Mode	NaPTAN Type	NaPTAN Point Name

STOP PLACE	*Wimbledon Station*		Rail, Metro	StopArea	*Wimbledon Rail Station*
ACCESS SPACE	*Ticket Hall*	*Wimbledon Station*	Rail, Metro	StopPoint RLE	*WIMBLDN*
ACCESS SPACE	*Ground Concourse*	*Wimbledon Station*	Rail, Metro	StopPoint RLE	*WIMBLDN*
ACCESS SPACE	*Ground Concourse Corridor*	*Ground Concourse*	Rail, Metro		
ENTRANCE	*Wimbledon Station Main Entrance to Ticket Hall*	*Wimbledon Station*	Rail, Metro	StopPoint RSE	*Wimbledon Station Entrance*
ACCESS SPACE	*Centre Court Entrance Area*	*Wimbledon Station*	Rail, Metro	--	--
ENTRANCE	*Centre Court Entrance from Shopping Centre*	*Wimbledon Station*	Rail, Metro	StopPoint RSE	*Wimbledon Station Entrance from Shopping Centre*
STOP PLACE	*Wimbledon Underground Station*	*Wimbledon Station*	Metro	StopArea	*Wimbledon Underground*
STOP PLACE	*Wimbledon Tramlink*	*Wimbledon Station*	Tram	StopPoint MET	*Wimbledon Tramlink*
QUAY (comp)	*Platform 9 & 10*	*Wimbledon Station*		--	--
QUAY [child]	*Platform 9*	*Platform 9 & 10*	Rail	StopPoint RLP	*(Platform 9)*
QUAY [child]	*Platform 10*	*Platform 9 & 10*	Tram	StopPoint PLT	*(Platform 10)*
QUAY (comp)	*Platform 7 & 8*	*Wimbledon Station*			
QUAY [child]	*Platform 7*	*Platform 7 & 8*	Rail	StopPoint RLP	*(Platform 7)*
QUAY [child]	*Platform 8*	*Platform 7 & 8*	Rail	StopPoint RLP	*(Platform 8)*
QUAY (comp)	*Platform 5 & 6*	*Wimbledon Station*		--	--
QUAY [child]	*Platform 5*	*Platform 5 & 6*	Rail	StopPoint RLP	*(Platform 5)*
QUAY [child]	*Platform 6*	*Platform 5 & 6*	Rail	StopPoint RLP	*(Platform 6)*
QUAY (comp)	*Underground District Line Concourse*	*Wimbledon Station*		StopPoint MET	*Wimbledon (LU)*
QUAY [child]	*Platform 3 & 4 (LU)*	*Underground District Line Concourse*		--	--
QUAY [child]	*Platform 3 (LU)*	*Platform 3 & 4 (LU)*	Metro	StopPoint PLT	*(Platform 3)*
QUAY [child]	*Platform 4 (LU)*	*Platform 3 & 4 (LU)*	Metro	StopPoint PLT	*(Platform 4)*
QUAY [child]	*Platform 1 & 2 (LU)*	*Underground District Line Concourse*	Metro	--	--
QUAY [child]	*Platform 1 (LU)*	*Platform 1 & 2 (LU)*	Metro	StopPoint PLT	*(Platform 1)*

QUAY [child]	*Platform 2 (LU)*	*Platform 1 & 2 (LU)*	Metro	StopPoint PLT	*(Platform 2)*
QUAY	*Taxi Rank*	*Wimbledon Station*	Taxi	StopPoint TXC	*Taxi Rank*
QUAY	*Set down point*	*Wimbledon Station*	Car	--	--
PARKING	*Station Forecourt*	*Wimbledon Station*	Car	--	--
PARKING AREA	*Station Forecourt Disabled Area*	*Station Forecourt*	Car	--	--
PARKING BAY	*Station Forecourt Disabled Bay 1*	*Station Forecourt Disabled Area*	Car	--	--
PARKING BAY	*Station Forecourt Disabled Bay 1*	*Station Forecourt Disabled Area*	Car	--	--
STOP PLACE[Child]	*Wimbledon Station Bus*	*Wimbledon Station*	Bus	--	--
STOP PLACE[Child]	*Alexandra Road*	*Wimbledon Station Bus*	Bus	Stop Area GBPS	*Alexandra Road*
QUAY	*Alexandra Road A*	*Alexandra Road*	Bus	StopPoint BCT	*Alexandra Road A*
QUAY	*Alexandra Road B*	*Alexandra Road*	Bus	StopPoint BCT	*Alexandra Road B*
STOP PLACE[Child]	*Wimbledon Bridge*	*Wimbledon Station Bus*	Bus	StopPoint BCT	*Wimbledon*
QUAY	*Wimbledon Bridge P*	*Wimbledon Bridge*	Bus	StopPoint BCT	*Wimbledon Bridge P*
QUAY	*Wimbledon Stop C*	*Wimbledon Bridge*	Bus	StopPoint BCT	*Wimbledon Stop C*
QUAY	*The Broadway D*	*Wimbledon Station Bus*	Bus	StopPoint BCT	*The Broadway D*
QUAY	*Hartfield Road L*	*Wimbledon Station Bus*	Bus	StopPoint BCT	*Hartfield Road L*

Table 4 IFOPT Nodes with NaPTAN equivalents

10.5 The IFOPT model then enables the creation of PATH LINKs between the elements; PATH LINKS connect QUAYs (platforms), ACCESS SPACEs either generally or at specified ENTRANCEs. Each PATH LINK also describes any change in LEVEL, for example between the concourse and lower ground platforms, as well as any EQUIPMENT (lift, steps etc) associated with that PATH LINK and the time taken for the PATH LINK. PATH LINKS state in which directions they can be used.

10.6 Sequences of PATH LINKs can be assembled into named NAVIGATION PATHs to guide the user through an interchange. In an implementation these NAVIGATION PATHS can either be predefined statically (as in the Direct Enquiries examples shown for NRE *Stations Made Easy*) or be computed dynamically by a micro journey planner, as for the TfL local access search engine on DirectEnquiries.com. Paths can be filtered according to the specific needs of the users, for example steps or escalators.

10.7 The model for NAVIGATION PATHs is thus two-level (*Figure 43*). Simple point to point PATH LINKs are used to link nodes: nodes may be QUAYs or ACCESS SPACEs or PATH JUNCTIONs – intermediate branch points. PATH JUNCTIONs make it possible to use the same links in many different NAVIGATION PATHS. A link may also indicate a specific ENTRANCE of the node – but it doesn't have to. For example a platform may well not have an entrance, but rather be accessible over a whole edge;

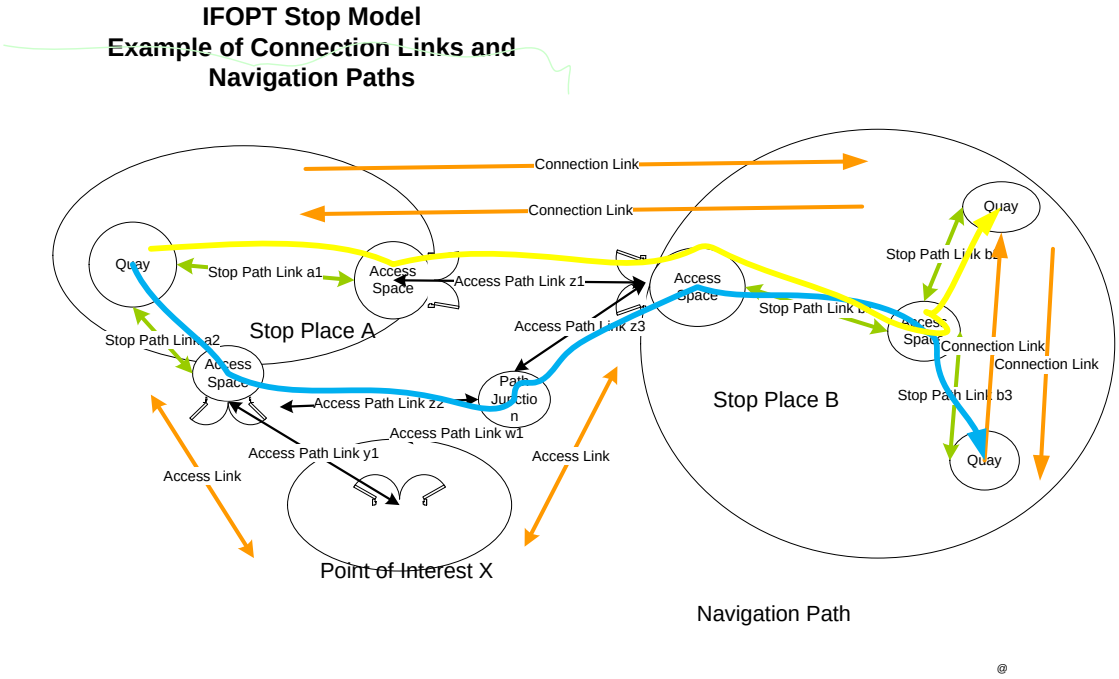


Figure 43 IFOPT Path Links & Navigation Paths

10.8 The LEVELs used in IFOPT are named components that correspond to the labels used to describe interchanges to users such as '*Mezzanine', 'Street'*, etc. Every Node and each end of a PATH LINK is associated with a LEVEL

10.9 QUAYs can be nested; this allows one to represent composite platforms with two or more sides or named sections. At Wimbledon there are pairs of rail platforms (5&6, 7&8, etc), each treated as a nested QUAY. In addition the District Line platforms (1, 2, 3 & 4) can also be grouped as a single QUAY since they are in effect a single accessible surface, serving a single direction. One can thus journey plan to any level of detail. Only if one is has specific departure data, say from real time, will the distinction between platforms on the same surface matter. Similarly ACCESS SPACEs can be nested - the corridor area of the Upper Ground Concourse is nested within the Upper Concourse, with internal entrances.

10.10 *Figure 44* shows Wimbledon as a set of nodes connected by PATH LINKS to create a topological model of the interchange. The PATH LINKS (arrowed lines) are shown as that connects the ACCESS SPACES and QUAYS: these can also indicate the use of specific ENTRANCES at either end, if relevant. This logical representation can be compared with the schematic maps *o*f Stations Made Easy, *Figure 15* and *Figure 16* and the topological diagram in

Figure 14. The precise choice of PATH LINKS will reflect the level of detail that one wishes to capture about the topology. Elements which fall within the gated area (light green), i.e. that require a ticket to access, can be distinguished from areas of unrestricted access.

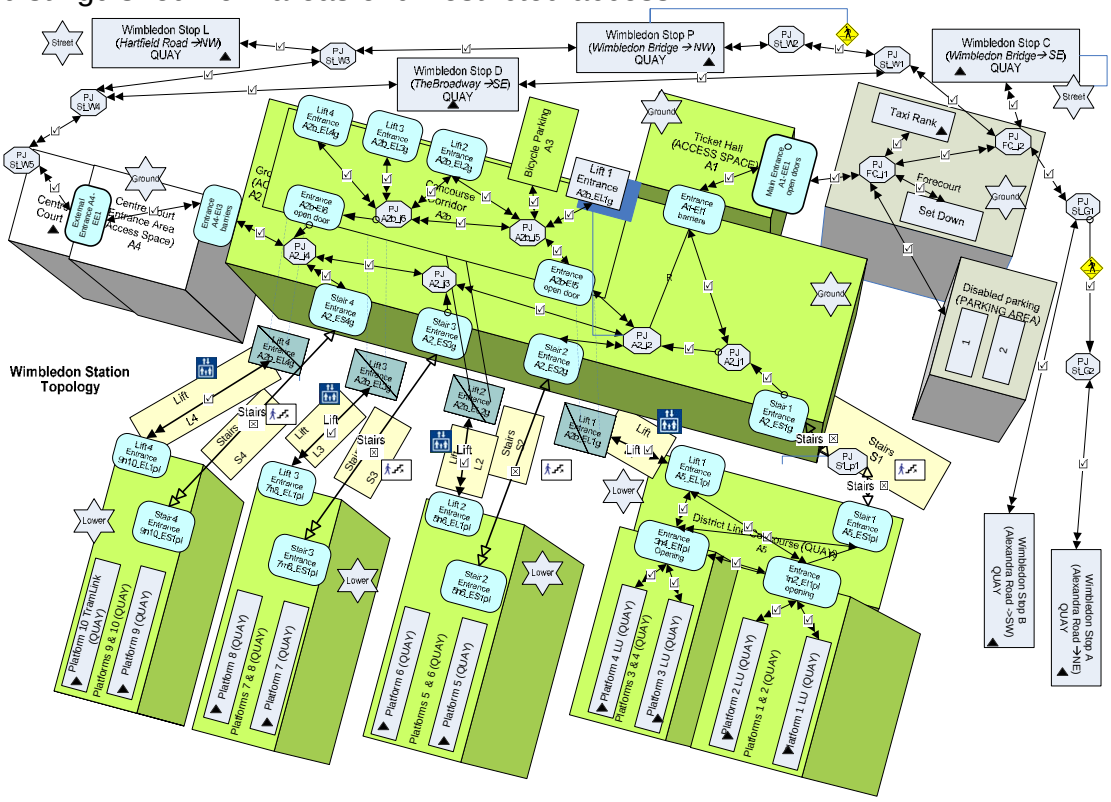


Figure 44 Wimbledon Nodes & Path links

10.11 The topological model can then be annotated with equipment, images and other elements that describe detailed properties of the interchange, for example, lifts, or stairs, ticket barriers, surfaces, and their detailed accessibility properties. IFOPT provides a systematic set of standardised EQUIPMENT objects, describing different types of equipment including ticket machines, doors, gates, ramps, seats, phones and information displays with standardised attributes. EQUIPMENT can be located within a space using EQUIPMENT PLACE using both relative (e.g. 6m along) or absolute (e.g. WGS coordinates).

10.12 Each of the icons in the Direct Enquiries applications corresponds to an EQUIPMENT object: the detailed properties, such as number of steps, accessibility of the barrier, etc can all be described in a way that a computer application can process.

10.13 One can also specify AVAILABILITY CONDITIONs in IFOPT that apply to specific components, for example if the Shopping Centre ENTRANCE to the Wimbledon station concourse is only open during shopping hours and not at night, this can be described with a structured elements that a journey planner can use when planning a journey at a given time of day.

10.14 PATH LINKs typically describe detailed connectivity between two components. To describe a route through a station a NAVIGATION PATH is used - a sequence of PATH LINKs that can be given a meaningful name to a user – for example “Platform 1 to Platform 5”. NAVIGATION PATHS may be given an overall accessibility. *Figure 45* shows a few of the possible paths for Wimbledon, corresponding to some of those shown in Direct Enquiries. The NAVIGATION PATHS may either be created manually, or be computed dynamically by an indoor routing engine.

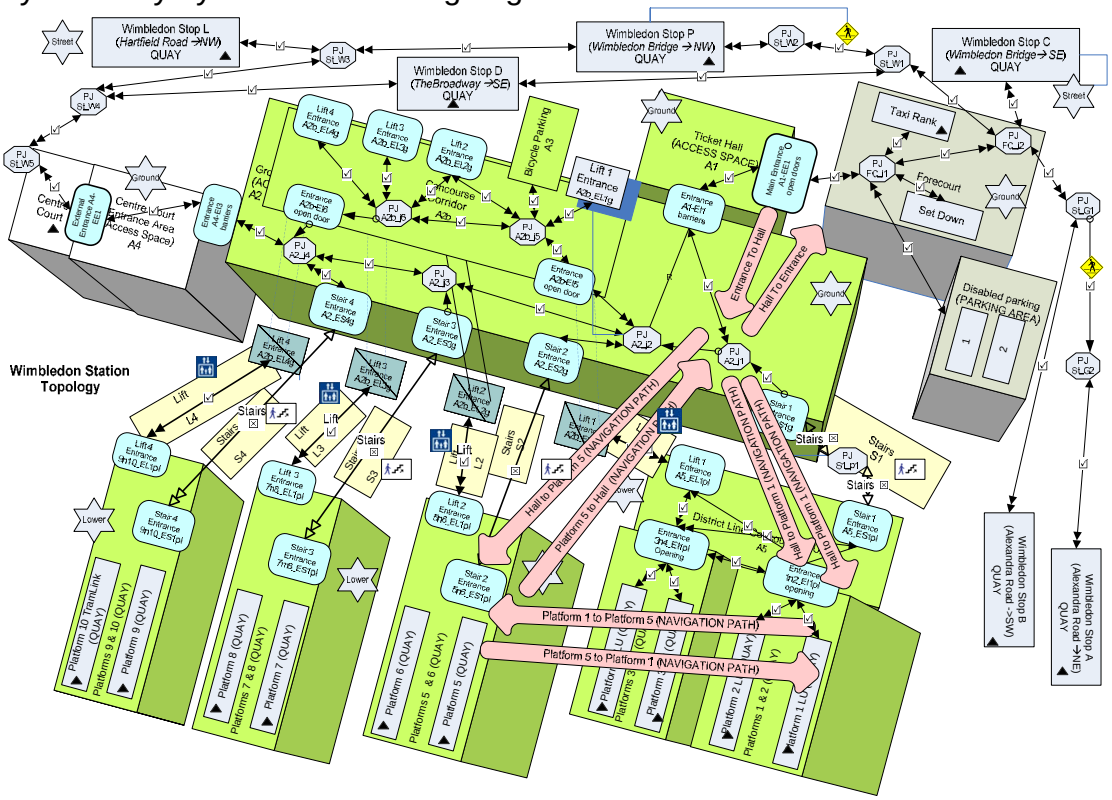


Figure 45 Some Navigation Paths for Wimbledon

10.15 There may be points in the station that incur delays either always or at certain times of day – for example, to buy a ticket, pass through a ticket barrier or security check, or immigration control. IFOPT allows one or more CHECKs to be associated with Stop Place components, each specifying a process delay and a VALIDITY CONDITION for when it applies (e.g. ticket machine delays 5-10 minutes, 8:30-9:30 am). These can be used to give more realistic journey times and to warn users of potential bottlenecks of which they might not be aware, (for example trying to by a TfL ticket at a major station in rush hour).

10.16 In reality there are many different types of accessibility need: for example impaired hearing, vision, mobility, or aversion to lifts or escalators, or just being encumbered with a pushchair or heavy baggage. The TfL Journey Planner discussed above uses a four category classification based on mobility categories - *Wheelchair, Step free, Escalator free, Lift free* – the last two also corresponding to some cognitive aversions (e.g. claustrophobia). The Direct Enquiries model holds more detailed attributes that can be used to derive the

high level categories, but which also allows a much more elaborate assessment of wheelchair local accessibility, for example, even looking at step gaps and access widths. This allows a more nuanced assessment of local access routes, for example to consider a short route that involves going up two steps as being preferable to a long detour on a cobbled surface. However, if one is aiming to journey plan across systems then one needs to use a uniform set of summary assessment criteria for the end-to-end journey planning to establish possible routes.

10.17 To describe accessibility, IFOPT models as distinct elements: (a) the description of the user's needs – for example *wheelchair*, *hearing impaired*, *vision impaired, lift-averse* etc; and (b) the description of the limitations of a component or site to support a specific need. The latter can be used to derive summary criteria for use by a journey planner when routing a journey, for example, both to choose stations that are accessible when planning a point-to-point journey and to direct a user to the entrances and exits most suitable according to their needs. The former can be used to describe inputs to a journey planner to identify what the user is seeking. IFOPT has a quite detailed user need model– however for journey planning it suffices to choose a subset of just values similar to that used by TfL in London.

10.18 The additional internal entrances shown in *Figure 44* are listed in Table 5

IFOPT Type	IFOPT Name	Level
ENTRANCE	*Ticket Hall to Ground Concourse*	Ground Floor
ENTRANCE	*Ground Concourse Entrance from Centre Court Entrance Area*	Ground Floor
ENTRANCE	*Ground Concourse to Lift to Platforms 9 & 10*	Ground Floor
ENTRANCE	*Ground Concourse to Lift to Platforms 7 & 8*	Ground Floor
ENTRANCE	*Ground Concourse to Lift to Platforms 5 & 6*	Ground Floor
ENTRANCE	*Ground Concourse to Lift to Platforms 1 -4 (LU)*	Ground Floor
ENTRANCE	*Platforms 9 & 10 to lift to Ground Concourse*	Lower Ground
ENTRANCE	*Platforms 7 & 8 to lift to Ground Concourse*	Lower Ground
ENTRANCE	*Platforms 5 & 6 to lift to Ground Concourse*	Lower Ground
ENTRANCE	*Platforms 1 -4 (LU)to lift to Ground Concourse*	Lower Ground
ENTRANCE	*Ground Concourse to Stairs to Platforms 9 & 10*	Ground Floor
ENTRANCE	*Ground Concourse to Stairs to Platforms 7 & 8*	Ground Floor
ENTRANCE	*Ground Concourse to Stairs to Platforms 5 & 6*	Ground Floor
ENTRANCE	*Ground Concourse to Stairs to Platforms 1 -4 (LU)*	Ground Floor
ENTRANCE	*Platforms 9 & 10 to Stairs to Ground Concourse*	Lower Ground

ENTRANCE	*Platforms 7 & 8 to Stairs to Ground Concourse*	Lower Ground
ENTRANCE	*Platforms 5 & 6 to Stairs to Ground Concourse*	Lower Ground
ENTRANCE	*Platforms 1 -4 (LU) to Stairs to Ground Concourse*	Lower Ground
ENTRANCE	*Ground Concourse to Stairs to Platforms 9 & 10*	Ground Floor

Table 5 Wimbledon - Additional Entrances in IFOPT

10.19 An aspect of station passenger information that is not described in any of the existing data sets discussed above is signage (though it is supported in the MDV indoor routing product). Stations typically have carefully designed signage located at critical decision points within the interchange – for example *'District Line Northbound'*, '*London Trains platform 3 & 4', 'Exit to Centre Court Shopping Centre'*, etc. References can be used in instructions to orient the user within the interchange a: e.g. 'F*ollow sign to Platform 3*', '*Turn left at sign to Ticket Hall, etc.*' The IFOPT model treats signs as a kind of EQUIPMENT whose contents and locations can be exactly specified. This makes it possible to create detailed journey plan instructions, augmented reality guides and other applications for the interchange that refer to what the user can see if they are positioned within it. TfL does have a detailed asset database that records the location of most station equipment including signs but this is not yet integrated with public-facing data sets.

10.20 Given the use of MDV EFA in the TfL journey planner, it is interesting to relate briefly the MDV representation to that of IFOPT. Although MDV use a proprietary internal model to represent interchange data – it is closely equivalent at a conceptual level to the IFOPT model.

1 The MDV accessibility limitation (lift free etc) corresponds to a core subset of those used in IFOPT relevant for end-to-end journey accessibility planning.

2 The MDV "Footpath" model corresponds to NAVIGATION PATHs between nodes. MDV often uses a two level node model, corresponding to nested QUAYs or ACCESS SPACEs in IFOPT. The ability to consider a nested space as part of a containing parent allows one to journey plan efficiently, only considering platforms where appropriate.

3 The MDV indoor routing model introduces detailed path links and path junctions that can be ascribed with equipment etc.

11 Relating the stop to the timetable

11.1 NaPTAN & IFOPT serve fundamentally to locate the physical stops in the real world so that they can be found by name, place, co-ordinates, relation to other elements, or other search strategy. To produce useful travel applications the physical STOP PLACES or QUAYS need to be related to the actual services

of each transport mode. The nature of this relationship needs to be understood at different levels of precision for different purposes – for example, to understand if a mode connects at all ("stop/ line level"); to find a stop for a specific destination ("line/ direction level"); or to provide a specific journey plan ("journey level")

11.2 At a stop/line level:

4 **Underground**: Wimbledon is on the *District Line*.

5 **Tram**: Wimbledon is a *Tramlink* station.

6 **Rail** has a large number of services that go through Wimbledon, including to *Waterloo, Guildford, Dorking, Sutton, Hampton Court*, etc.

7 **Bus**: The following buses go past Wimbledon Station stops,

- 57, 93, 156, 163, 164, 131, 200, 219, 493, N87

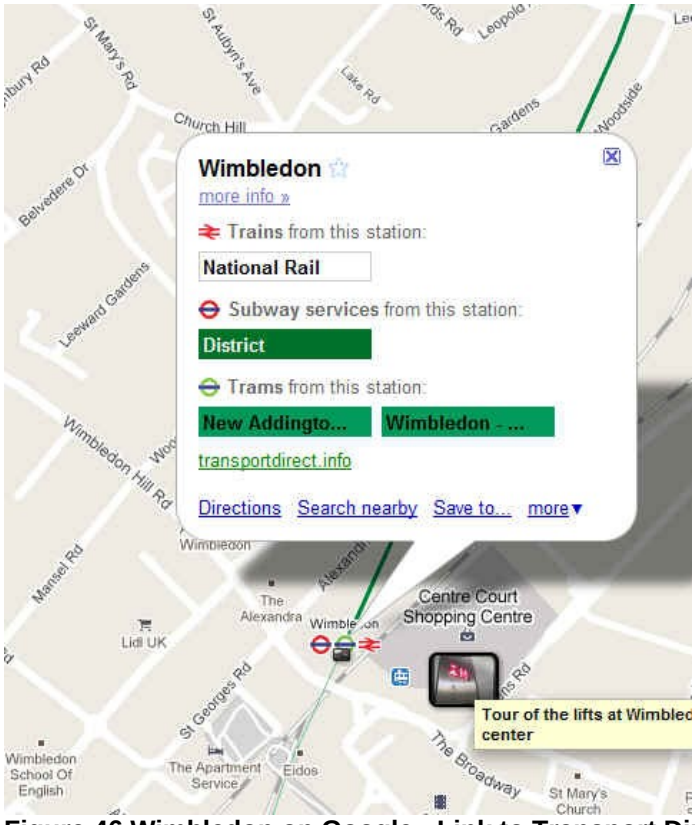


Figure 46 Wimbledon on Google - Link to Transport Direct

11.3 At a line & direction level:

1 **Underground**: Wimbledon is the southern terminus for the District Line (and so all platforms serve the same direction, rather than a particular direction).

2 **Tram**: Wimbledon is the northern terminus for the western branch of Tramlink.

3 **Rail**: National Rail has a large number of services that go through Wimbledon, including to *Waterloo, Guildford, Dorking, Sutton, Hampton Court*, etc. Particular services e.g. Southbound, City-bound etc normally go from particular platforms.

4 **Bus**: Wimbledon is the terminus for some routes and a waypoint on others. Table 6 shows the stop /route associations. (See spider map earlier)

- *57 Eden Street (Kingston upon Thames) to Atkins Road / New Park Road (Balham)* - Waypoint
- *93 Priory Road (Cheam) to Putney Bridge Station (Putney)* Waypoint
- *131 Fairfield Bus Station (Kingston upon Thames) to Tooting Broadway Way Station (Tooting))* - Waypoint
- *156 Sir Cyril Black Way (Wimbledon) to Vauxhall Bus Station* - Terminus
- *163 Francis Grove (Wimbledon) , Morden Station (Morden*) - Terminus
- *164 Francis Grove (Wimbledon) ,to Sutton Station / The Quadrant (Sutton)* - Terminus
- *N87 Aldwych / Southside (Aldwych)* | *Fairfield Bus Station (Kingston upon Thames)* - Terminus
- *200 Lambton Road (Raynes Park) to Raleigh Gardens (Mitcham)* Waypoint
- *219 Francis Grove (Wimbledon) , Falcon Lane(Wandsworth)* - Terminus
- *493 St Georges' /University of London (Lambeth) to Richmond / Manor Road (Richmond)* - Waypoint

NaPTAN	Road	Stop	NaPTAN Common Name	Routes	Bearing
490014734A	Alexandra Road	**A**	*St George's Road*	**156, 493, N87**	N
490014734B	Alexandra Road	***B***	*St George's Road*	**156, 493, N87**	S
490000272C	Wimbledon Bridge	***C***	*Wimbledon [Wimbledon Station]*	**156, 163, 164, N87**	*E*
490015472D	The Broadway	**D**	*Wimbledon Station*	**57, 93, 131, 200, 219,**	E
490014731E	Sir Cyril Black Way	**E**	*Sir Cyril Black Way (SE19)*	**57, 131, N87**	W
490014731F	Sir Cyril Black Way)	**F**	*Sir Cyril Black Way (SE19)*		W
490014731G	Sir Cyril Black Way	**G**	*Sir Cyril Black Way (SE19)*		W
490014731H	Sir Cyril Black Way	**H**	*Sir Cyril Black Way (SE19)*		W
490000272P	Wimbledon Bridge,	**P**	*Wimbledon [Wimbledon Station]*	**156, 163, 164, N87**	W

490015472L	Hartfield Road	**L**	*Wimbledon Station*	**57, 93, 131, 200, 219, N87**	*W*
490014738J	Queens Road	J	*Wimbledon Police Station*	200	*N*
490014738K	Queens Road	K	*Wimbledon Police Station*	200	S
490014734S	Wimbledon Hill Road	S	*Wimbledon Hill Road (SW19)*	93, 200, 493	W
490014734R	Wimbledon Hill Road,	R	*Wimbledon Hill Road (SW19)*	93, 200, 493	*E*

Table 6 Bus Stops and line/directions at Wimbledon

11.4 Detailed route information is available from the TfL Bus Route finder (*Figure 47*).

Figure 47 TfL Bus Route Finder for route 493

11.5 Because of the one way system at Wimbledon, the same route may follow different roads in different direction past the interchange, e.g. route 493. (See Figure 48 & Figure 49) In this case detailed route tracks are especially useful for conveying an understanding of which stop to take to travel in a particular direction.

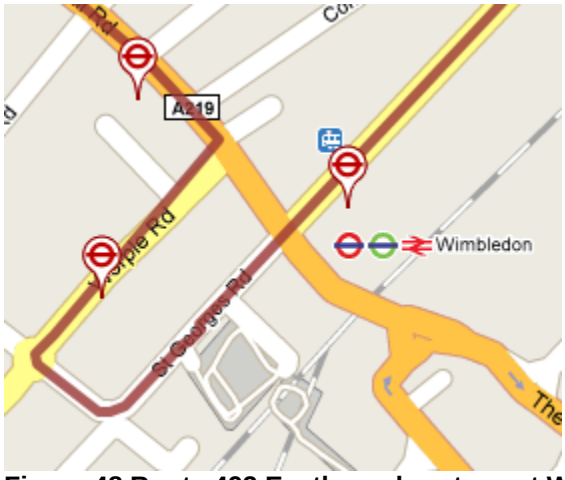


Figure 48 Route 493 Eastbound route past Wimbledon (TfL Route finder)

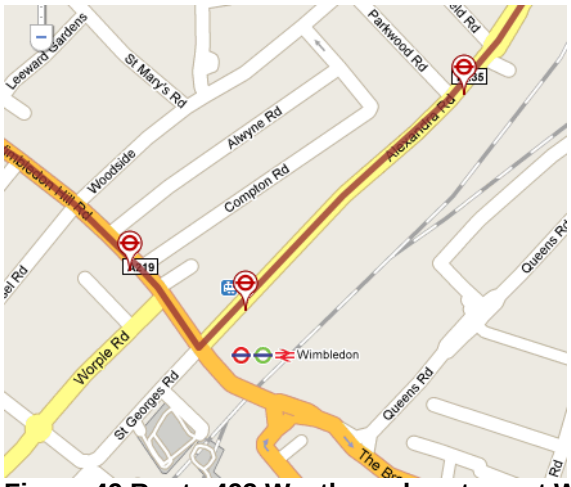


Figure 49 Route 493 Westbound route past Wimbledon (TfL Route finder)

11.6 Informationally, there is a distinction between the three levels discussed above, viz:

1 Associating a line with a stop regardless of direction (e.g. '*route 156 stops at Wimbledon station' or 'the tube map shows that the District Line ends at Wimbledon*'.). The station can be treated simply as a point; both directions of the line are represented as a single link. Pairs of bus NaPTAN stops points may be shown as a single named stop area.

2 Associating a route/direction of a line with a stop (e.g. '*route 156 towards Vauxhall stops at Hartfield Road'*, or '*Platforms 3 & 4 have trains towards Waterloo*'). There may be distinct stop points and links for each direction (as for buses), or multiple possible platforms for the same link (as for the underground at Wimbledon because it is a terminus).

3 Associating a scheduled stop point of a specific journey with a specific platform (e.g. '*the 10:22 stops at Wimbledon platform 3, not platform 4*'). The exact stop point for a specific direction is needed.

11.7 Historically there has been confusion between the stop as identified in the timetable and the stop as a physical point. IFOPT clarifies this relationship. To associate timetable and real-time data of a particular service with the physical stop, IFOPT uses the concept of a STOP ASSIGNMENT. An assignment can be just to the whole station, or to a specific platform within the station (thus allowing for platform changes). In the trivial case where the scheduled stop has the same identifier, the assignment can be implicit (i.e. they have the same codes). In other cases, where the code is different (as say for most of the Wimbledon modes) an explicit assignment can be used – currently described in the NaPTAN data set by the NaPTAN ***AnnotatedRailReference***, ***AnnotatedMetroReference***, etc. For example, one can infer that any WIM stop references in the real time rail data relate to Wimbledon by matching the

CRS code, but an explicit stop assignment would be needed to state more specifically that a train will stop at say *Platform 3* within it.

11.8 As a footnote, there is a tram enthusiast site for Tramlink (http://www.croydon-tramlink.co.uk) that that includes very detailed track and station maps for the line; these show a control room view of the network for operating it. Although such maps (which presumably come from the operating companies, but are also available as paper based publications for rail enthusiast) do inform one of important aspects of the station – such as the platform topology and which platforms access tracks in particular directions, they also illustrate another key point – most of the detail of a really accurate physical representation is irrelevant: Passenger information requires an abstraction and simplification of the network to present just the salient aspects.

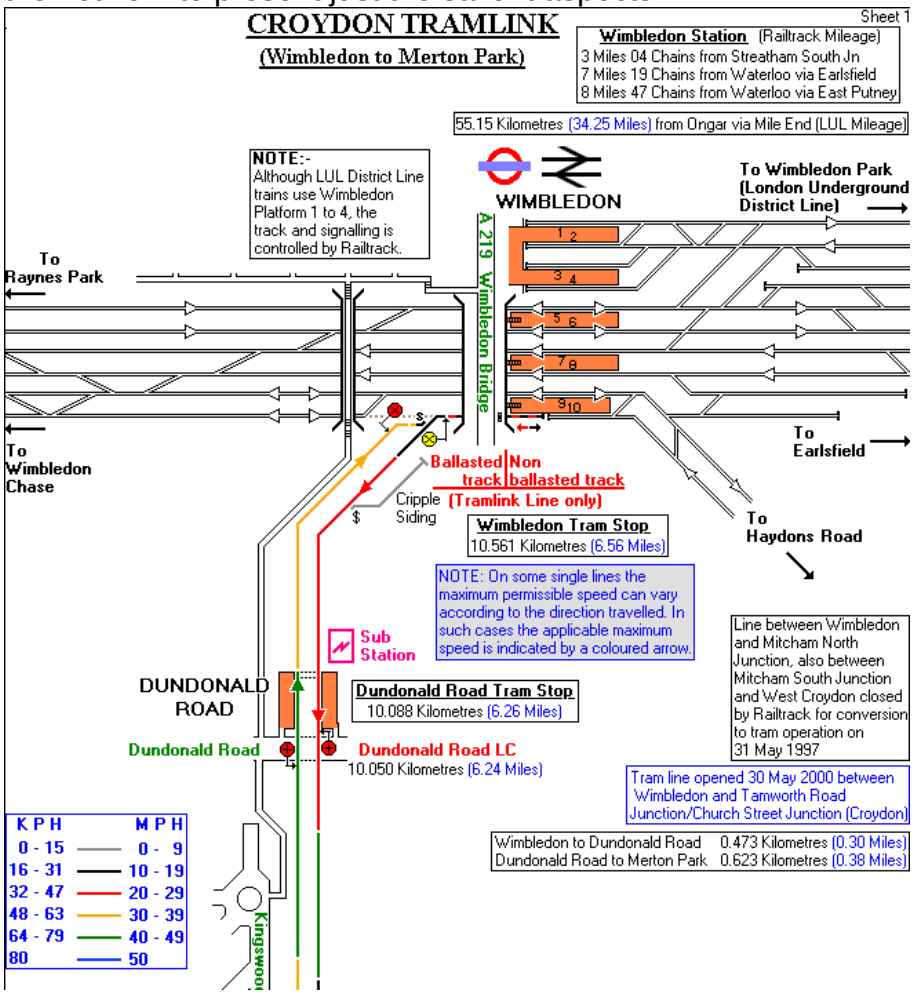


Figure 50 Track network map example

11.9 Most journey planners allow transfer times for an interchange to be specified to some degree. The new CEN NeTEx model allows general journey planning parameters to be exchanged with successive levels of precision:

1 ACCESS – a default time for any transfer at an interchange (of a given mode or all modes) regardless of the actual point (some journey planners support only this level of precision)

2 CONNECTION – a default time for a transfer between two points of the interchange, for example 'District Line Platform 1 to Tramlink Platform 10'.

3 INTERCHANGE – the transfer time between two specific services, for example 'T*o transfer from the 10:22 which arrives at platform 5 to the 10:30 which leaves from platform* 7'.

12 Real-time data and Wimbledon

12.1 Users often want to know when services leave, and from which platform or stop: such information can be presented on in-station and on-street displays, on-line, or on mobile devices. An application presenting data to a user - for example, to show a departure board from a stop - needs to be able relate the service data (timetabled or real-time) to the interchange or a part of the interchange, for example to show the trains in a certain direction or buses from a stop.

12.2 Journey planner data might be used to check the platform and the pre-trip. Real-time data might be used to get the actual platform, or to see how long the user has to get to the platform.

12.3 Changes would be needed in the RAIL CIF to include the default platform for each service in the rail timetable.

12.4 Here we discuss briefly the relationship of the identifiers used in the real-time data with the physical representation of the station.

12.5 Service real-time data is available for Wimbledon for all modes (though not yet available as a web service for bus and tram). Each mode is using a different set of identifiers for the stops & destinations in the real-time data, however using an interchange model it is possible to tie these together in passenger information applications.

12.6 NRE departure and arrival data is available as a public web site and as an online service (subject to a data licence). Data for all stations is keyed on CRS code. The destination and calling stations can be included in the results, and in some stations the platforms, so in principle direction-based views can be provided. Platform numbers may be included in the data, but there is no formal alignment of the numbers or identifier with other data sets.

LIVE DEPARTURES:
WIMBLEDON (WIM)

Last updated: Monday 19 April 2010 15:04:55 - automatically refresh this page

- View Wimbledon Arrivals
- Wimbledon Station Information
- Service Bulletins affecting Wimbledon
- Call TrainTracker™ on 0871 200 49 50 or text WIM to 84950 to use TrainTracker™ Text

Train Departures

DESTINATION	PLATFORM	TIMETABLE	EXPECTED	OPERATOR	TRAIN DETAILS
London Waterloo	5	15:05	On time	South West Trains	Details
Woking	8	15:06	On time	South West Trains	Details
London Waterloo	5	15:08	On time	South West Trains	Details
Dorking	8	15:10	On time	South West Trains	Details
London Waterloo via Kingston & Richmond	8	15:13	On time	South West Trains	Details
London Waterloo	5	15:14	On time	South West Trains	Details
London Waterloo	5	15:17	On time	South West Trains	Details
Sutton (Surrey)	9	15:17	On time	First Capital Connect	Details
Guildford via Cobham	8	15:19	On time	South West Trains	Details
London Waterloo	5	15:20	On time	South West Trains	Details
Hampton Court	8	15:22	On time	South West Trains	Details
London Waterloo	5	15:23	On time	South West Trains	Details

Figure 51 NRE Rail Real-time departures web page or Wimbledon from National Rail Enquiries www.nationalrail.co.uk'.

12.7 Data on Tube departures data is available from London Underground's *Trackernet*, which keys data by a Station, LU line/ and direction. Data is frequency-based, i.e. the interval to the next train to a specific destination will be shown. Since Wimbledon is a terminus for the District Line (i.e. all trains leave in the same direction) a station-level rather than a platform-level assignment works. However there is no ready way to match a service to a destination other than by name.

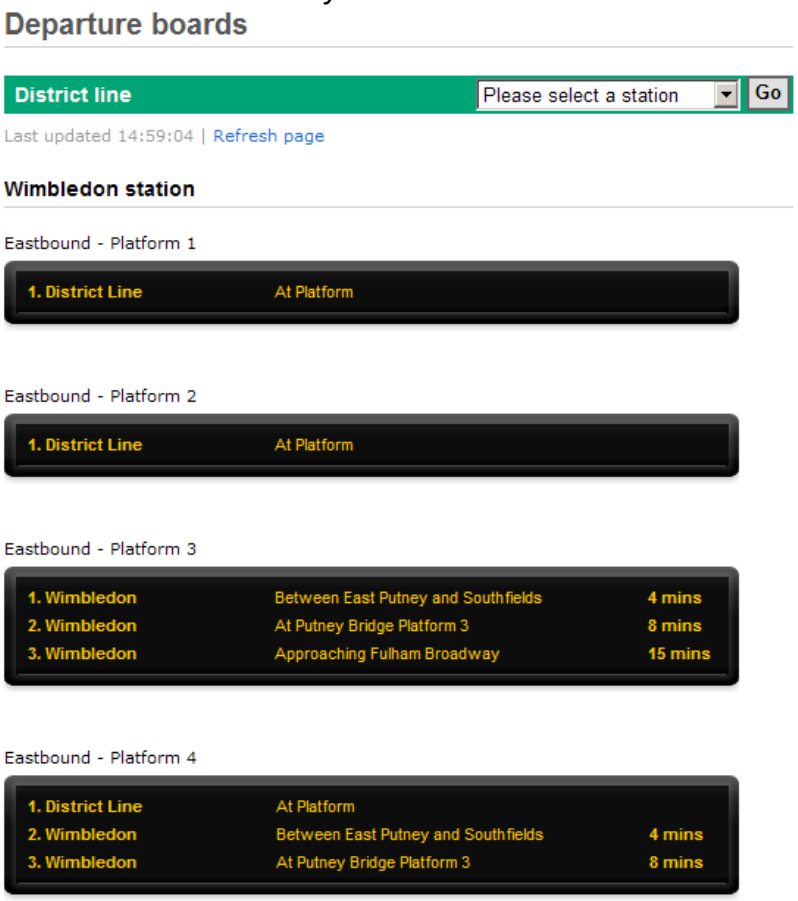


Figure 52 Wimbledon Tube departures TfL

12.8 Bus data arrival is available from LBSL's Countdown2 systems for signs (and will be available for other channels soon such as web and mobile). Internally it is keyed on LBSL stop identifier; each stop also has a NaPTAN alias that can be used to integrate it with other systems.

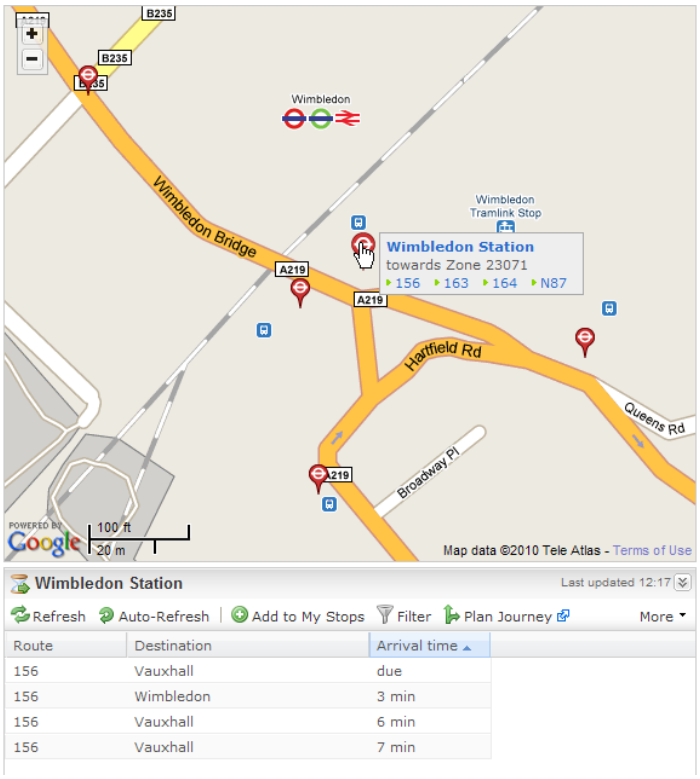


Figure 53 Real-time bus departures for Wimbledon Stop P (Tfl)

12.9 Disruption data on engineering works is also available from TfL. This can include both planned disruptions such as engineering works and real-time data such as route diversions due to a burst water main. Situation data is tagged by route and/or stop allowing it also to be associated with results in the journey planner and other tools (*Figure 54*).

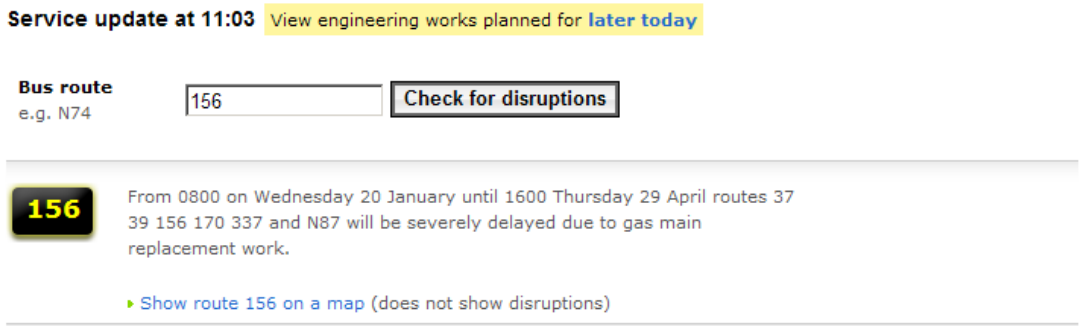


Figure 54 TfL Situation data for route 156 - 16/4.2010 (Tfl Web Site)

12.10 Another potential type of real-time data concerns equipment status. For a user in a heavy wheelchair, loss of a lift may render an interchange unusable. Many modern lifts and escalators have automated fault monitoring systems. In Paris RATP has been developing a real-time facilities management service. This has been standardised as a simple CEN SIRI service SIRI-FM which can be used to send the status of lifts, escalators, displays and other equipment to journey planners and information applications. The data requirements are very simple – a means of identifying the appropriate assets and of describing their status. In the Wimbledon context, this might be used to report the status

of the four lifts. It can also be used to report the unexpected unavailability of staff that can assist passengers.

13 Wimbledon in Google Earth

13.1 Route data typically stops at the entrance to the interchange building or venue. To journey plan within a complex interchange building or large venue, a 3D topological model that can be computed over is needed, yet this also needs to be related to the plan and to the environment and schematic presentations that a user can understand. Preparing such models requires sophisticated tools and a significant effort.

13.2 MDV's toolset for indoor routing data preparation includes advanced tools to capture and link building plans for both interchanges and venues as part of the transport network, using a proprietary but IFOPT-like format.

13.3 In the longer term it will be important to collect and exchange such data models easily and widely from many sources. The IFOPT model discussed above addresses the topological layer. What standards and tools might be relevant for the spatial layout of buildings themselves?

13.4 As a short "envisioning digression", we also mention here the Google Earth tools which offer some intriguing additional possibilities. Google Earth provides a powerful 3D visualisation tool for navigating a virtual model of the world and has collaborative modelling tools to build parts for the model using open standards. The Google Earth toolset includes a tool, *Sketch-up,* that can be used to create detailed architectural representations of buildings, both external and internal. These can include floors, plans, exits, furniture, surfaces and renderings, which can then be visualised in many different ways; both static plan, perspective views and dynamic walkthroughs using VRML, giving sometimes astonishing results. Sketch-up has many of the features of a CAD/CAM program, with additional features for locating the building model within a geospatial data set. Sketch-up has been used to create models of large numbers of buildings and venues around the world including existing and future Olympic facilities.

13.5 Google Earth has a Building Warehouse that includes a number of stations. Most of the building models that can be found on Google Earth have concentrated on the external appearance of well known buildings. For example, *St Pancras (Figure 55), Wembley (Figure 56), London Olympic Stadium (Figure 57), Mornington Crescent (Figure 58).* As such they are attractive but not especially helpful for understanding accessibility or journey planning, other than making clear the front door, and giving a recognisable image of the building.

Figure 55 Google Earth Data Warehouse entry for a St Pancras model

Figure 56 Wembley Stadium in Google warehouse

Figure 57 Olympic Stadium London

Figure 58 Google Earth data warehouse entry for Mornington Crescent

13.6 However where a building is externally visible as, for example, *Prince Regent DLR station (Figure 59)*, the model provides an immediate indication of accessibility that could immediately be overlaid with a set of topological links.

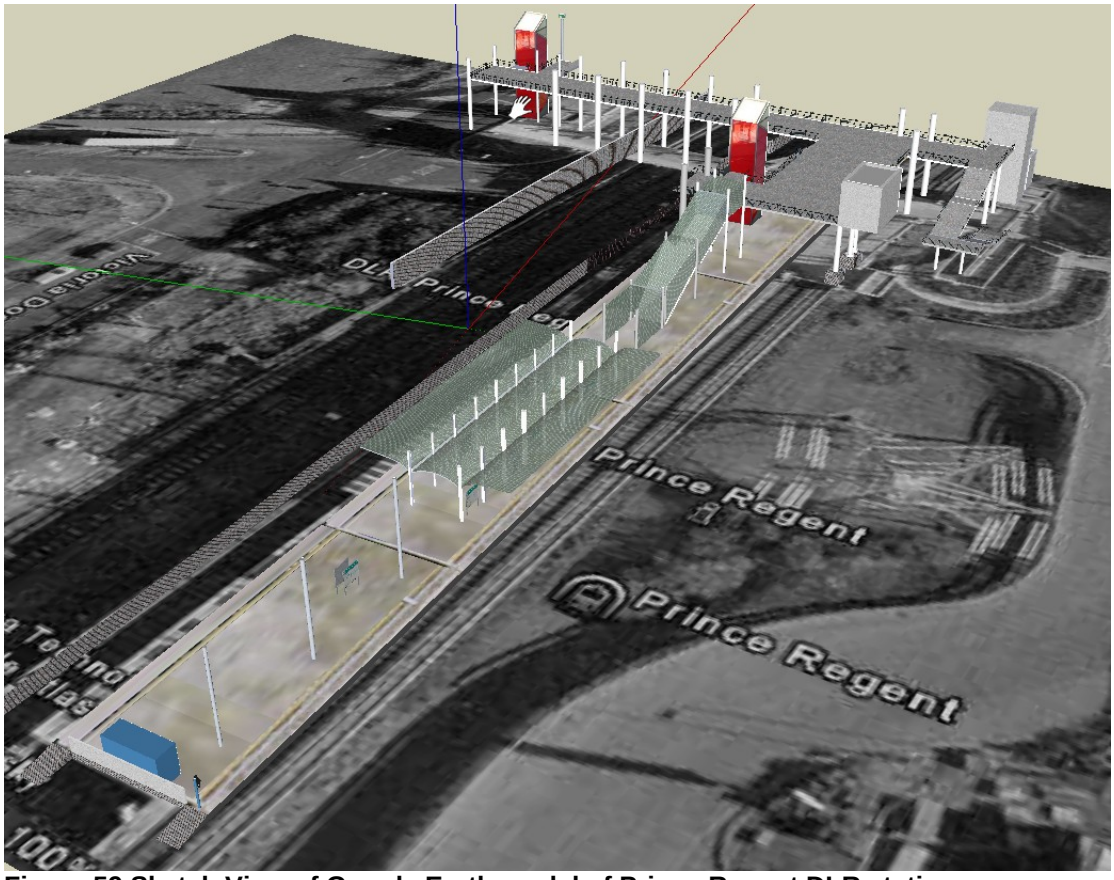


Figure 59 Sketch View of Google Earth model of Prince Regent DLR station

In a few cases examples can be found where Sketch up has been used to model the internals of a station, with some very powerful results, including walk paths, for example, Tokyo *Shibuyu* station *Figure 61*.Some proof of concept models (e.g. *Figure 62*) show how the detailed internals can be captured and presented dynamically,

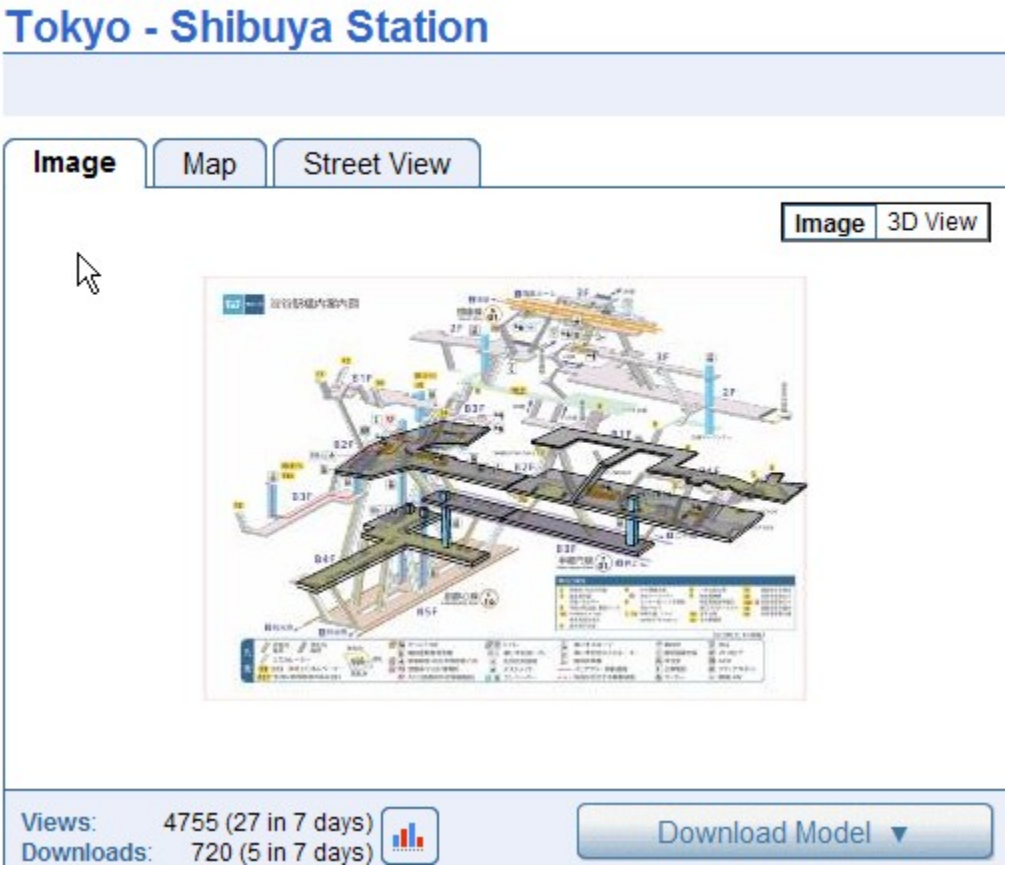


Figure 60 Shibuyu station

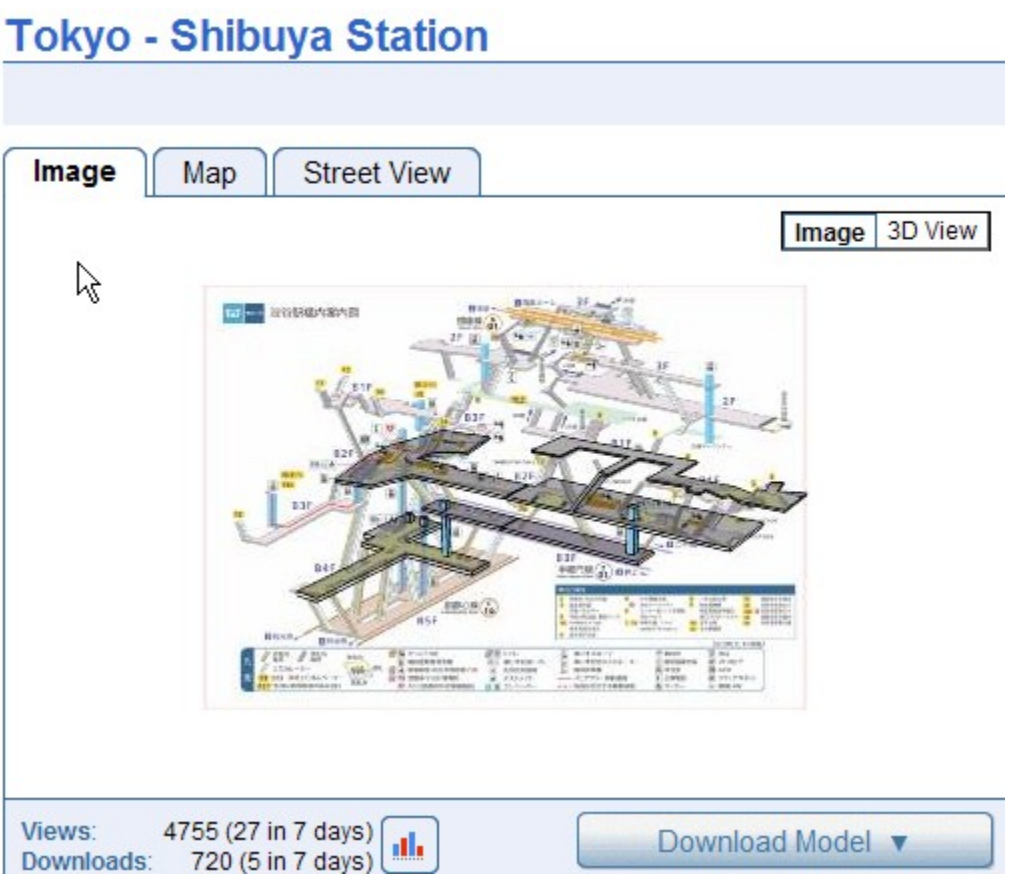


Figure 61 Shibuyu station

Figure 62 Hypothetical Subway station

13.7 There isn't yet a Google Earth model for Wimbledon station. To understand Sketch-up's capabilities I spent a couple of hours attempting to build one with Sketch-up , starting with the Google Satellite view *(Figure 63*) – which shows the platforms very precisely, and a picture of the station façade from Street View.

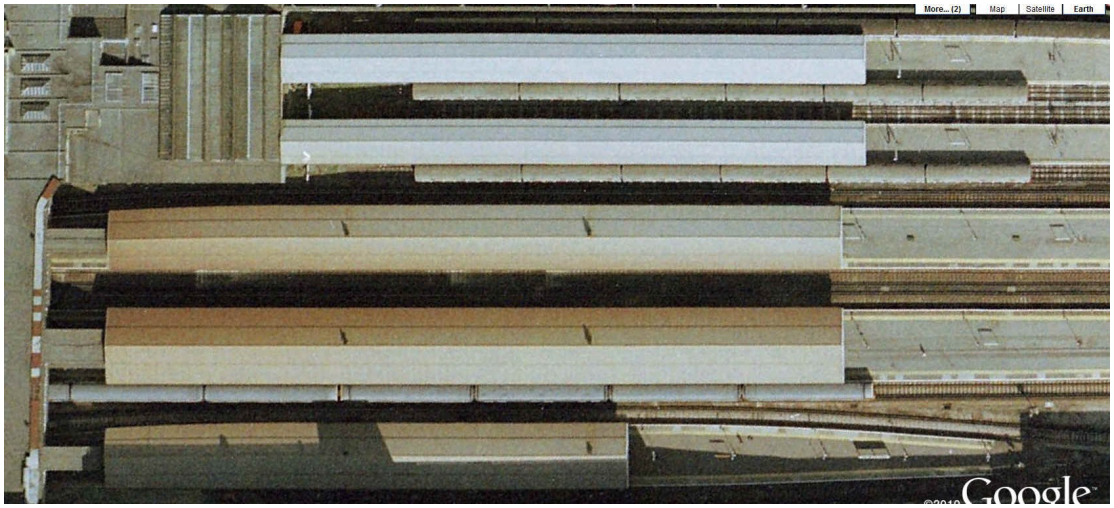


Figure 63 Google Earth Satellite view of Wimbledon

13.8 A fair degree of skill in CAD/Cam concepts is needed to use the Sketch-up tool properly but even as a beginner one can quite rapidly get useful results. What is remarkable is that it provides a fully articulated 3d model from which sections, walk-throughs and plans can be created. Figure 59 shows a view of part of the building. Photographs can be pasted onto the surfaces to create a realistic rendering. One interesting further feature is the ability to design ready made "Dynamic components" and share them with other users. One could envisage a set of standard components (NaPTAN entrance, lift, ticket barrier, stairs, toilet etc) with exact IFOPT attributes that could be used to very rapidly populate a station so that it could be linked to other tools.

Figure 64 Start of a sketch up model for Wimbledon

13.9 A really visionary approach for the Olympics might entail creating detailed virtual representations of all the Olympic sites and stations - perhaps recruiting UK design and architecture students through a competition to build momentum – and then adding selected accessibility components.

14 How general is Wimbledon as an example?

14.1 Wimbledon illustrates many of the key aspects of a complex interchange and the considerations for accessibility. We note here some additional aspects and considerations that are not brought out by the Wimbledon example.

14.2 Wimbledon is quite small compared to a major terminus such as Paddington, Kings Cross, Victoria and its Rail and Underground platforms reside within the same gated area. At other stations there are often distinct areas with separate barriers. Large stations may be broken into smaller areas (partly in order to describe the station to passengers) and there may be significant transfer times in crossing between areas.

14.3 Use of Wimbledon station does not involve processes or choke points that may incur delays such as check-in or security – potential bottlenecks are ticket barriers, ticket machines and lifts (for impaired users). As a commuter station there will be a big difference in peak and off-peak passenger traffic.

14.4 Although it is small, Wimbledon is extremely busy since it is on one of the UK's densest rail commuting routes. According to the Rail.CIF timetable (Analysis by JSC) its two primary platforms, 5 and 8, are among the top 10 platforms in the UK in terms of rail traffic. *Table 7* shows the timetabled frequencies of service. (It appears that at least one service uses the Tramlink Platform).

Tiploc	Platform	Average	Average Weekday	Average Saturday	Average Sunday
WDON	5	271	287	278	187
WDON	6	7	1	0	48
WDON	7	10	3	2	54
WDON	8	239	253	247	163
WIMBLDN	8	31	34	34	17
WIMBLDN	9	76	84	67	47
WIMBLDN	10	0	0	1	0

Table 7 Wimbledon Station Trains by Platform (data from RSP ATCO.cif)

Table 8 shows Station usage data for Wimbledon 2008 & 2009 based on ticket sales (http://www.rail-reg.gov.uk/server/show/nav.1529), indicating there are on average roughly 45,000 passengers journeys through the station a day.

Entries Full	Entries Reduced	Entries Season	Entries Total	Entries & Exits	Interchanges

1,138,306	1,586,931	4,860,638	7,585,875	15,171,750	1,333,795

Table 8 Station Usage Data 2008-2009 for Wimbledon (ORR)

14.5 Two different organisations (TfL & NRE) have data describing details of the station in different formats, each with some unique features. This means that some reconciliation is likely to be necessary.

14.6 Wimbledon is a terminus for the Underground. This means that all platforms service trains in just one direction. It is only a single line and does not have a complex Underground topology, so describing a path through it is easier than in a multi-line, multi-direction, multi-level station such as *Bank* or *Kings Cross*, which also have one way pedestrian routes.

14.7 Wimbledon station platforms don't have designated boarding points as say Eurostar or the Jubilee line enclosed platforms do. Some services do split, so passenger information may include instructions such as "*Front four coaches for Dorking*" so that a direction is relevant.

14.8 As an urban station, there are a number of car parking options, not just in the official station car park. At some stations the availability of car park is critical for being able to use the station, so for a time critical journey would probably also need an indication of the likelihood of getting a place would be useful.

14.9 Wimbledon is in an urban area that has been extensively mapped by Google Street View and its station entrances and all of its bus stops are on the street. This means they can be explored with Street View. Not all areas of the country are covered by Street View, nor all stops on-street.

15 Nottingham Station

15.1 Nottingham Station is to be found in Nottingham NG1. The station is served by the Net tram and National Rail. The station has six mainline platforms, with an additional two that serve the tram. There are a number of bus stops that serve Nottingham station – both on Carrington Street and on Station Street. Nottingham station has a ticket hall that serves rail. Tram tickets are currently sold on the tram. There are stairs and lifts down from the ticket hall main concourse to all rail platforms. Access from the car park is by ramp to platform six. Access from the station's street entrance is only via steps. Access to the tram platforms from Station Street is via a lift as well as steps. Access between the station platforms and the tram platforms is via a link from the station centre bridge. There are steps to the centre bridge for all rail platforms and to the tram platforms.

15.2 The diagram below shows the main elements of Nottingham station as would be created within the IFOPT standard.

15.3 All National Rail platforms are accessible for wheelchairs and passengers with pushchairs from the main entrance and from the car park entrance – but not from the Station Street entrance. The Tram platforms are accessible from

Station Street, but not from the any of the National Rail platforms without leaving the station via the main entrance and using the road outside the station.

15.4 This is an example of where, looked at separately, the rail station and tram stops when can be considered accessible, and indeed both are accessible for starting and ending a journey. However a change of mode between rail and tram at Nottingham station is a much less convenient change for wheelchairs and passengers with pushchairs.

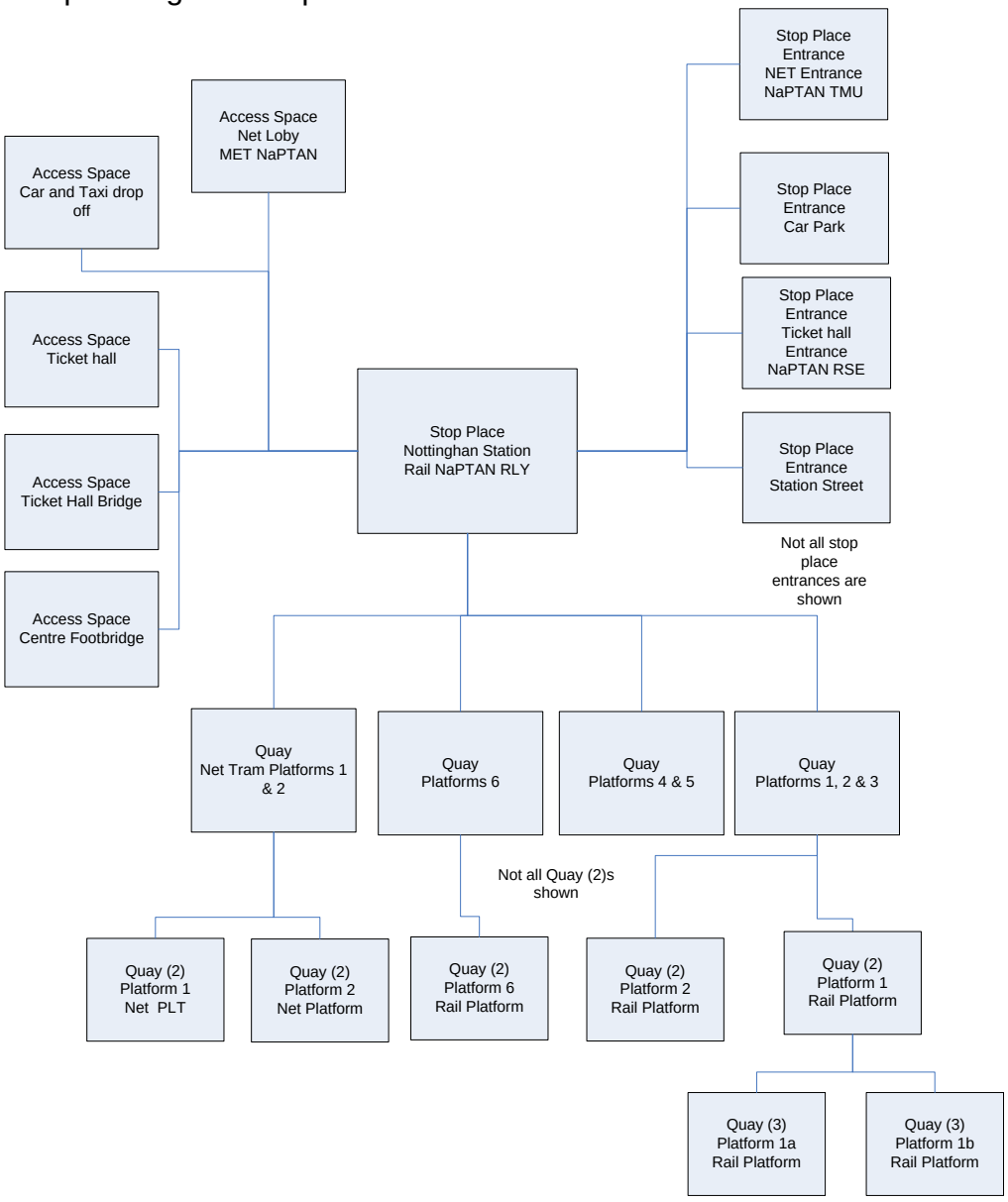


Figure 65 Nottingham Station NaPTAN components

16 Wimbledon Station & accessible travel use cases

16.1 Wimbledon station is a good example of a station that has more than one type of rail service. It is also good example of an accessible station.

16.2 If the data for Wimbledon is modelled as described then it would supply the stop data to support the following Olympic use cases.

- OLY#01: Accessible stops and stations: Identify potential GNAT route limitations.
- OLY#02 Accessible transfer between stop points.
- OLY#03 Allow time for accessible interchange.
- OLY#04 Display routes within interchanges showing accessibility features and barriers.
- OLY#05 Display routes between stops and venues showing accessibility features and barriers.
- OLY#06 Plan a route that meets a user's accessibility preferences.
- OLY#07 Identify to a user the start and end points for a journey that meets their accessibility preferences.
- OLY#09 Plan a multi-legged journey that meets the accessibility requirements of the user.

17 Summary

17.1 Both accessibility support and improved journey planning require a richer data model of interchanges - and a number of different initiatives are working towards this. There is already much valuable data assembled, especially in the Direct Enquiries models - and their imaginative applications demonstrate how powerful some of this can be when inspecting a site to visualise it in a "narrative" interaction. However data is not available in a standard form that would allow it be integrated with other systems, for example as part of a larger journey planning systems in a "computable" mode, or indeed in personalised applications for disabled users and others that would encode the data into a personal device.

17.2 Joined-up interchange standards could help both draw greater value from existing data and facilitate providing similar capabilities for other cities and for other large interchanges such as airports and ferry ports.

17.3 An important property of the IFOPT model is that it allows for incremental population. One may start with a minimal subset and over time fill in other elements to enrich the data set to support additional application capabilities.

17.4 Some expertise is needed to judge the simplest representation of a model that will capture the salient topology and features. As for NaPTAN, guidelines can help to codify this process, but some subjectivity will remain.

17.5 Signage content is currently neglected in the current data sets but is important for orienting travellers within a complex interchange.

17.6 An open standardised model, including an OSM representation would open the possibility of the “crowdsourcing” of accessibility data – the collaborative community based collection and maintenance of detailed data using free local expertise.