Traffic Control in Greater Manchester; Where We Are and Where We Go Next

1. Abstract

This paper gives an overview of the traffic control systems in Greater Manchester, how they are managed and how Transport for Greater Manchester (TfGM) are working to improve their operation. It explores Greater Manchester's ambitions, future plans and how the traffic control systems will develop in line with changing policies. The paper will look at traffic control on a network level, not focusing on individual junctions, and will present a long-term vision of the future of traffic control in Greater Manchester.

2. Greater Manchester Overview and Governance Structure

Greater Manchester is composed of ten local authorities, with a combined population of over 2.8 million people. It is predominantly urban and has a large regional centre at its core which is surrounded by suburbs and a number of smaller towns and villages. Figure 1 shows the Key Route Network, Greater Manchester's busiest roads, and the positions of the major town and city centres (Transport for Greater Manchester [TfGM], n.d).

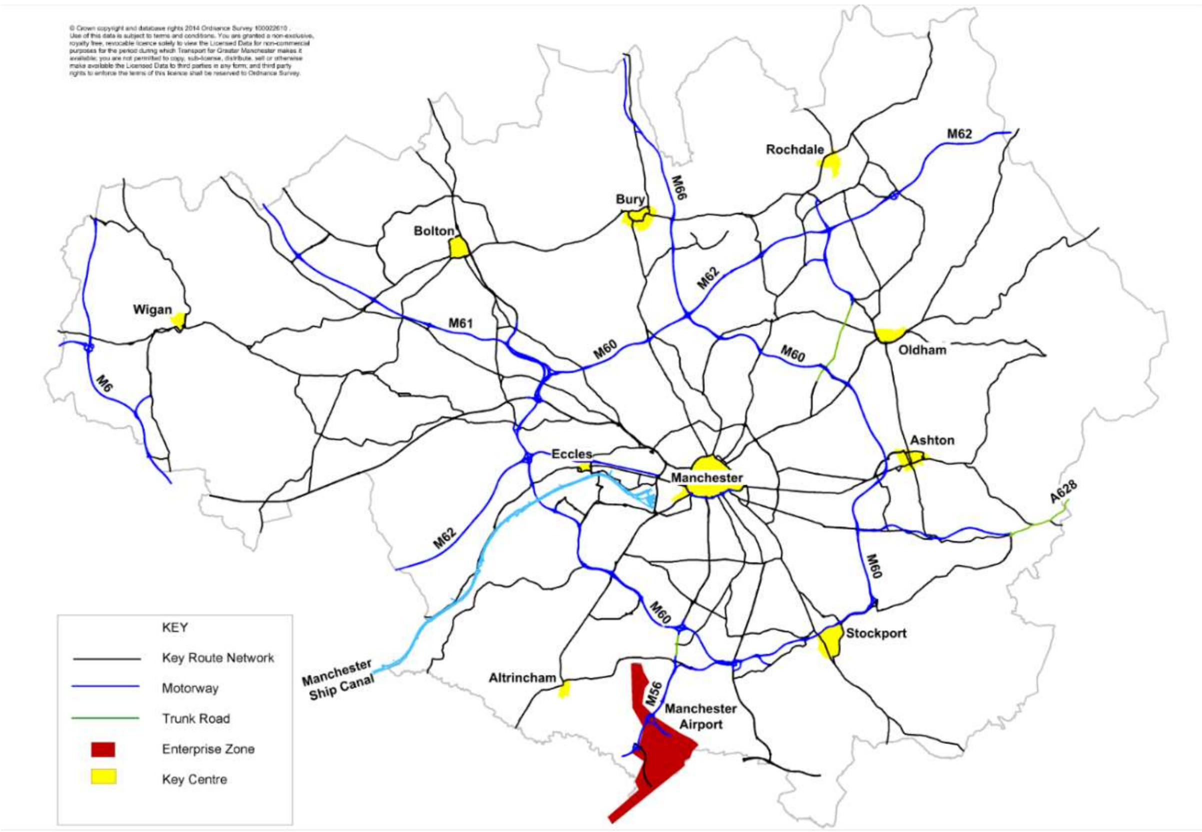

Figure 1: Map of Greater Manchester showing Key Route Network, Regional Centre and Surrounding Towns (Source: Transport for Greater Manchester [TfGM], n.d.)

The Greater Manchester Combined Authority (GMCA), made up of the ten local authorities and the elected mayor, was established in 2011 and is responsible for a range of functions, including transport. GMCA, alongside the Greater Manchester Transport Committee (GMTC), set Greater Manchester's transport policies which are then implemented by TfGM.

It is estimated, by TfGM, that approximately 6.1 million trips are made by Greater Manchester residents every day, with around 2.4 million of these being made by public transport or active travel (TfGM, 2021, p.8). Once commercial trips and trips by non-Greater Manchester residents are included the figure rises to around 7.4 million.

3. The Future of Greater Manchester

This is a time of change in Greater Manchester. There is a growing economy and a growing population and both are most evident in the regional centre, comprising central Manchester and the adjacent areas (see Figure 2 (TfGM, 2021)). The structures that govern the region are also changing, with powers and funding being devolved from central government.

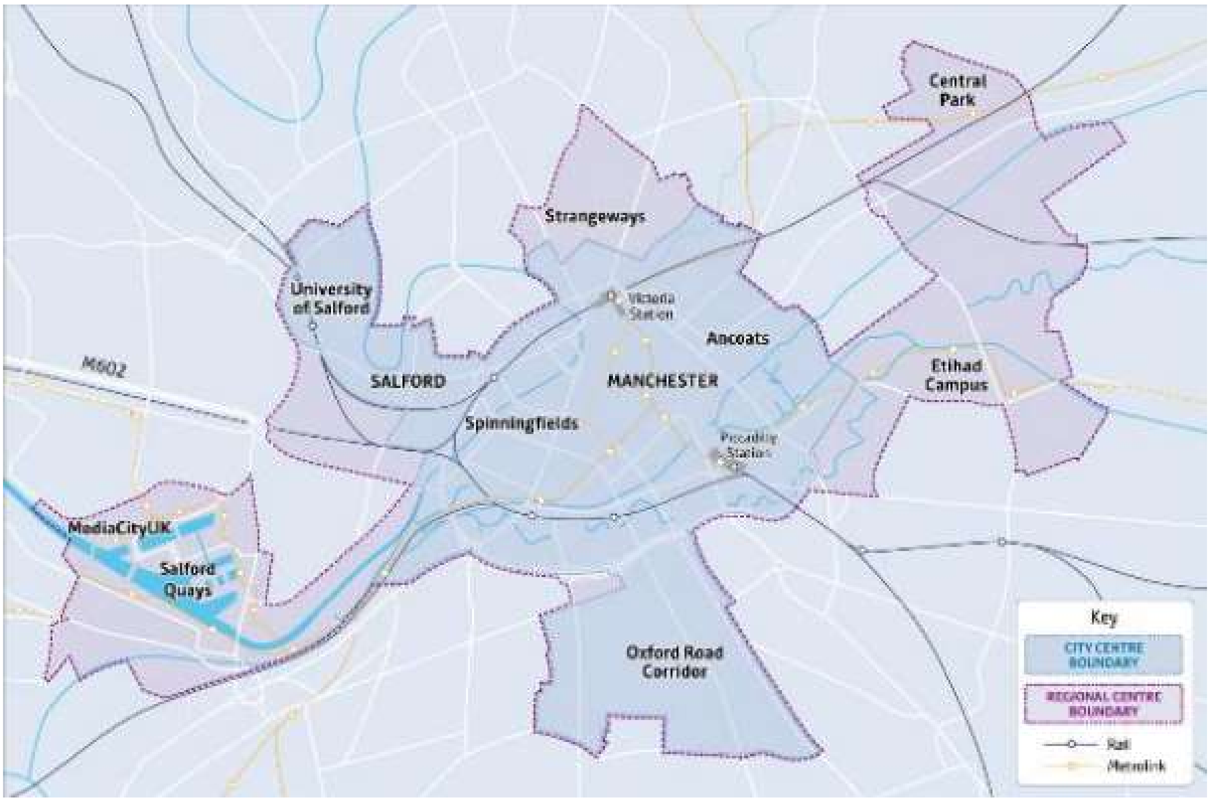

Figure 2: Map of the Regional Centre (Source: TfGM, 2021)

The Greater Manchester Transport Strategy 2040 (TfGM, 2021, p.4) sets out the long-term aspirations for transport. It identifies an 'evidence-based, long-term vision for the 'right mix' of transport modes on our network'. This 'right mix' vision sees 50% of trips being made by public transport or active travel, with no net increase in motor vehicle traffic, by 2040.

The Greater Manchester Transport Strategy 2040 (TfGM, 2021, p.44) also incorporates 'Streets for All', a 'people-centred approach to street design and road network management' that aims 'To make our streets welcoming and safe spaces for all people, enabling more travel on foot, bike and public transport while creating better places that support local communities and businesses.'

The ‘City Centre Transport Strategy’, a sub-strategy to the main 2040 strategy, takes the ‘right mix’ vision further and by 2040 aims to see 90% of morning peak trips into the city centre by walking, cycling or public transport (TfGM, 2021, p.94).

Key to the 2040 strategy is the creation of the Greater Manchester Bee Network, which aspires to create a word-class integrated transport network that combines tram, bus and rail with the UK’s largest cycling and walking network.

Perhaps the most high-profile element of the Bee Network is the re-regulation of bus services, which will see services being planned and overseen by the local transport authority for the first time since 1986. ‘Tranche 1’ will see TfGM running services in Bolton and Wigan and parts of Manchester, Salford and Bury from September 2023. By January 2025, tranches 2 and 3 will see TfGM running buses across the whole of Greater Manchester.

The changes to where people live and work, alongside changes to policies and the operation of transport services, will fundamentally alter how journeys are made across Greater Manchester. The management of the traffic signal network will have to support these changes and challenges.

4. Traffic Signal History

The Greater Manchester traffic signal network has grown and developed over time, adapting to changing travel patterns, policies and technologies.

The first automatic traffic signals, the first in the North West, were switched on in 1928, at the junction of Cross Street and Market Street in Manchester city centre. By the mid-1970s there were over 1,150 sets of traffic signals and the then Greater Manchester Council (GMC) proposed that over 700 of them should be added to a new Urban Traffic Control (UTC) system, to improve traffic flows and the reporting of faults. It also proposed the remaining traffic signals be connected to a Remote Monitoring System (RMS) and the purchase of 20 CCTV cameras. This system would then allow real time monitoring of traffic conditions and, when required, live updates to the traffic signal timings.

Due to central government reforms, the GMC ceased to exist in 1986 and its powers were transferred to the ten local authorities under the Association of Greater Manchester Authorities (AGMA), with Manchester City Council as the lead authority. This cooperation kept all the expertise in one body and it maintained a joined-up approach to both the design and build of new junctions and to the operation of the signals, preserving cross border co-ordination of traffic control.

The 1990s saw Greater Manchester introducing adaptive traffic control, with the first MOVA junctions being installed along the East Lancashire Road in Wigan in 1993. Three years later, 1996 saw the establishment of the first SCOOT region, this time in Wigan town centre. This was quickly followed by further SCOOT regions in Hazel Grove and Farnworth.

Since its earliest days, the way the traffic signal network has been managed has changed to reflect the policies and priorities of that time, whilst making use of the latest technologies. These priorities have shifted from the movement of motorised vehicles to an approach which considers all road users and better allows for, and in some instances prioritises, public transport and pedestrians.

5. The Present Day

5.1. Traffic Signals

A set of protocols delegates responsibility for traffic signals from the ten local authorities to GMCA. The work to install, maintain and manage the traffic signals is then discharged to TfGM, taking account of GMCA's and the local authorities' strategies and objectives.

The numbers below give an idea of the scale of today's traffic signal network in Greater Manchester and the systems that the signals are connected to:

- There are just under 2,500 sets of traffic signals in Greater Manchester, 1,400 junctions and 1,100 pedestrian crossings.

- All traffic signals are monitored remotely, connected to either the UTC system, RMS or Stratos (similar to RMS but using 4G communication – see section 5.2).

- Around 60 sets of traffic signals are owned by National Highways, but are managed on their behalf by TfGM.

- There are almost 1,200 junctions connected to the UTC system (this number includes sites with more than one stream) and over 400 pedestrian crossings.

- Almost 1,100 sites run SCOOT.

- Over 300 sites run MOVA.
  - The majority are connected to the RMS or Stratos systems, with a small number connected to the UTC system.

- 118 sites include control of Metrolink trams, providing them with full priority.
  - Full priority benefits travellers by reducing journey times and improving reliability. Operational efficiency is also improved by minimising the number of trams and drivers that are required for a given frequency of service.

- 117 SCOOT controlled traffic signals have late running bus priority installed.
  - Analysis of TfGM's late running SCOOT bus priority showed that buses which received priority benefitted from journey time savings of around 31 seconds per junction. Over just one corridor the journey time benefits to passengers were estimated at over £640,000 annually (2019 prices). The impact on general traffic was shown to be broadly neutral, with queuing on minor arms worsening only slightly during the evening peak.

5.2. Communications

Reliable communications (comms.) to sites are an integral part of any traffic control system, but they are a large on-going revenue cost.

Whether a site is connected to the UTC system or RMS/Stratos is largely dependent on whether the signals need to coordinate with adjacent sites. If they do then they will be added to the UTC system, but this incurs a far greater cost due to the requirement for an uninterrupted connection.

The majority of UTC sites, 747, are connected by an ADSL line, 62 by 4G, 57 by 10Mb fibre (where the fibre has been provided to facilitate CCTV) and 134 by 'shared' fibre (where fibre has already been provided for Metrolink and/or TfGM Stations and Interchanges). To reduce costs, wherever possible TfGM shares comms. connections, by installing cables between sites or by utilising wireless devices.

Sites that are connected to the Stratos or RMS systems are generally isolated sites with no adjacent signals, therefore not requiring any co-ordination. As the RMS/Stratos systems monitor for faults, and do not control the sites, they can utilise dial up communications. 261 sites are connected to Stratos using 'standard' 4G and 832 sites are connected to RMS via GSM (382) or PTSN (450). RMS, and the comms. it utilises, will be decommissioned in the coming years and alternatives are being put in place to ensure that the sites stay connected to one of the systems.

6. Operation and Management of Traffic Control Systems

6.1. Day-to-Day Operation

This section gives an overview of some of the ways that the day-to-day operation of the traffic signals is carried out in accordance with current policies:

- UTC engineers work with TfGM's Operational Control Centre (OCC), using hundreds of CCTV cameras and other data sources, to continually monitor the network in real time, making changes to the signal timings when necessary.

- A range of signal timing strategies have been created for common issues that occur on a regular basis, when needed these can then be quickly implemented by the OCC.

    - In addition, engineers have created a number of automated strategies, which trigger on reaching a pre-defined threshold.

- Engineers also work with the local authorities to prepare signal timing changes in advance of roadworks. Once the works begin, they then monitor and amend these changes to minimise queues and delays.

- A series of strategies have been developed to cater for regular events, such as football matches and concerts. The network is then monitored before and after these events and the strategies, which are timetabled in advance, are amended when necessary. This means that they have evolved over the years to reflect changing travel patterns and priorities.

- As well as proactively monitoring the network, UTC engineers respond to complaints from members of the public, visiting the sites and, if required, amending the timings.

6.2. How the Management of Traffic Control Systems is Adapting to Change

Engineers also undertake pre-emptive work, to manage the network and adapt to changes. A few examples of this work are listed below:

- Reviews have been carried out of SCOOT region maximum cycle times, to ensure they are appropriate for their location. In areas with high pedestrian volumes this has generally meant decreasing the maximum cycle times, whilst considering the needs of other road users.

- Reviews are also being carried out of the timings at standalone pedestrian crossings. Where appropriate engineers are decreasing pedestrian wait times, and setting up SCOOT gap-out plans.

- Much of Manchester city centre operates on fixed time plans, due to predictable traffic flows. As the way people travel around the city centre is changing, with fewer motorised vehicles and more active travel, assessments have been completed of these fixed time plans. This has led to a reduction in cycle times at many sites and the removal of morning and evening peak time plans, meaning they now run 'off-peak' plans throughout the day.
    - Reductions in traffic volumes has allowed the signals along Deansgate, a mile long road running north-south through the heart of the city centre, to be ran at a reduced 60 second cycle at all times. The offsets between the signals have also been amended to create better linking for cyclists.

- Signal timing reviews have been completed at 251 sites across Greater Manchester. Whilst changes were made at some sites, the relatively small number suggested a well understood and managed network.

- In collaboration with Manchester City Council, TfGM won funding from a Department for Transport (DfT) competition to make better use of data and technology to improve network efficiency. The funding is being used to trial TRL's Pedestrian SCOOT at three SCOOT regions across Manchester.
    - Pedestrian SCOOT will use above ground detectors to count pedestrians in waiting areas. It will then increase the green man time in line with pedestrian numbers.

- The TRL Pedestrian SCOOT project is just one of a number where TfGM have worked with third parties to trial new concepts and technologies, with the aim of encouraging innovation. Other projects include:
    - Vivacity Smart Junctions
    - GLOSA trials
    - HGV priority using RTEM detection
    - Simplifai AI control

- SCOOT late running bus priority is already operational at 117 sites and funding has been secured to install it at a further 143 sites, in readiness for TfGM beginning to run bus services in September 2023. This funding will also allow bus priority to be set up at MOVA sites which are connected to the UTC system.
    - Business cases are also being prepared to fund the role out of further bus priority between now and 2025, when all Greater Manchester bus services will be run by TfGM.
    - In addition to installing bus priority at traffic signals, multidisciplinary teams from across TfGM are working with colleagues at local authorities to identify all the causes of bus delays along their routes. Once the causes are fully understood measures will then be able to be put in place to improve bus reliability.

- Traffic signals can only operate effectively if they are well maintained and if faults are rectified in a timely manner. To ensure this happens, a team of operations technicians work with site engineers, Yunex (who currently hold TfGM's maintenance contract) and slot cutters to ensure the swift identification and fixing of faults.

- Proactive maintenance work is also carried out by TfGM.
    - Between March 2012 and April 2014, the LED Replacement Programme replaced approximately 55,000 halogen bulbs with low energy and low maintenance LED optics. The programme cost £6.75 million and over a ten-year period was predicted to save in excess of £9 million, due to reduced maintenance and energy costs.
    - Furthermore, between April 2016 and October 2016 over 4,000 pedestrian WAIT lamps were replaced with LED equivalents. This was forecast to deliver annual maintenance savings of £30,000 and annual energy savings of £23,000.
    - As a result of these LED replacement programmes, the number of faults passed to Yunex fell from around 1,000 per month to around 550.

- On behalf of National Highways, Emergency Diversion Route (EDR) strategies have been developed by UTC engineers, which amend signal timings following the closure of motorways. Analysis of their implementation has shown reductions in vehicle delays of between 14% and 31%. The average benefit, in journey time saving, of deploying a strategy has been calculated at over £14,000.
    - Funding has now been secured to work with National Highways to develop further EDR strategies.

7. Future Developments in Traffic Control

This section will discuss how TfGM will look forward and adapt to the changing needs of Greater Manchester and of the policies that govern it.

7.1. Existing Adaptive Control

Existing SCOOT regions need reviewing to ensure they are operating efficiently and are optimised in line with current travel patterns and policies.

Some SCOOT regions have been in operation for almost thirty years and during this period significant changes will have been made to the road network. For example, there may have been changes to road speeds, the addition of bus/cycling facilities or the construction of new developments. There will also have been changes to the way that people use the road network. The review would ensure that all these changes are incorporated into the SCOOT model. Additionally, it would also assess requirements for modifications to the physical infrastructure, such as the position of SCOOT loops. Finally, there may also be improved SCOOT software capabilities, not available when the regions were first validated, that can now be incorporated into the SCOOT model.

The benefits of SCOOT regions being reviewed and amended needs quantifying and funding sought to ensure all regions are fully optimised.

Most sites that would benefit from adaptive control are now controlled by SCOOT or MOVA, but there are still a few that would benefit from it. Upgrading these remaining sites to adaptive control would also mean that they could benefit from late running bus priority. Where it can be, a case will be made for upgrading these sites.

7.2. Future Adaptive Control

TfGM will continue to make use of the latest technology and software to ensure that it can cost effectively manage the traffic signal network. However, it recognises that there are limits to the improvements that can be made to SCOOT models and that Greater Manchester will require improved methods of traffic control.

A study has been carried out with Google Green Light, utilising their data, to assess stops and delay at traffic signals along Upper Brook Street, a radial route running into Manchester city centre. Data was gathered whilst the traffic signals ran both fixed time plans and SCOOT and analysis showed that, overall, fixed time plans resulted in fewer stops and delays to vehicles. The fixed time plans also ran cycle times that were equal to or lower than those used by SCOOT. The results are largely due to tidal flows, along Upper Brook Street, that benefit from rigid linking and they back up the observations of engineers on site. Even after amending the SCOOT model to improve the linking, the Google data still showed, overall, better performance when running fixed time plans.

Upper Brook Street may not be typical of other SCOOT regions, it is a straight road with predictable and tidal traffic flows. However, the project did demonstrate a weakness of SCOOT control, that it only sees traffic when it reaches an upstream loop and that it can sometimes struggle to produce effective linking.

The project not only demonstrated the value of utilising a data-led approach to decision making. It also showed the value of engineers spending time and effort observing and then understanding traffic networks and their control systems. Both these elements are important factors in producing a desirable outcome and both will need to be utilised in the future.

7.3. UTMC Common Database/ITS Platform

TfGM currently uses a UTMC Common Database to facilitate strategies and to assist in wider network operations. However, it plans to improve network management by implementing an ITS platform which will:

- Provide better information by integrating bus, tram, active travel and highway data.
- Embrace new and future multi-modal data sources, enhancing integration beyond UTMC.
- Make use of real-time modelling to deliver network improvements and drive predictive capabilities.

The ITS platform will be an important step forward in moving towards a data-led approach to network management.

7.4. Local Full Fibre Network (LFFN)

As discussed previously, reliable comms. are integral to effectively managing a network of traffic signals, but they are also a major expense. However, over the next two years, TfGM will extend its high-speed fibre connectivity (the Local Full Fibre Network (LFFN)) to 772 sets of traffic signals.

The LFFN is a shared fibre rollout alongside other public sector assets, such as schools, fire stations, libraries etc. It will significantly bolster the resilience of traffic signal comms. and future-proof sites ahead of the introduction of new technologies.

7.5. Existing Asset Maintenance/Fault Control

Current assets need to continue to be maintained effectively and efficiently, a task just as important as installing new assets and one which provides value for money.

7.6. Future Developments

TfGM will continue to keep abreast of developments in traffic signal control, trial new concepts/technology and encourage innovation.

7.7. Recruitment

It is recognised that there is a skills shortage within the industry, with too few engineers with the necessary skills available. TfGM's approach to recruitment has, therefore, moved to one which seeks to employ graduates and apprentices, who can then receive training which will allow both them and TfGM to meet the challenges outlined in this paper.

8. Improvements to Signalised Junctions and Crossings

This paper is primarily concerned with traffic control systems. For completeness, however, it is worth summarising some of the work that is being done to ensure that the physical traffic signal infrastructure, both new sites and existing, meets Greater Manchester's changing needs and ambitions:

- Engineers have been involved in the design, modelling, and development of innovative traffic signal schemes, funded as part of the City Regional Sustainable Transport Settlement (CRSTS). These schemes will contribute to the building of the Bee Network by prioritising public transport and active travel.
  - To facilitate the development of traffic signal schemes engineers have used innovative design and modelling methodologies. One example is the use of a probabilistic approach to modelling the appearance of new all-red pedestrian and/or cycle stages within standard Linsig modelling software. The technique involves using observed pedestrian demand data to better approximate the likely appearance frequencies of these stages.

- CYCLOPS (CYCLe Optimised Protected Signals) junctions, which protect cyclists by providing an external orbital cycle route that separates them from pedestrian and general traffic in space or time, have been developed by engineers at TfGM. Construction has already finished at fourteen CYCLOPS junctions and there are designs being developed for many more which will be built across Greater Manchester.

- SPARROW crossings have also been developed, to allow the creation of the joined up safe cycling routes that are a key part of the Bee Network. Using near-side signalling to control segregated, unidirectional cycle lanes, and an adjacent pedestrian crossing, SPARROWs allow cyclists and pedestrians to cross without conflict. Several have already been constructed across Greater Manchester and more are being designed.

- It has been identified that there are 282 signalised junctions across Greater Manchester with substandard crossing facilities and a further 185 with no controlled crossing facilities. Seven of the junctions, in the latter category, have recently received funding to rectify this situation.
  - Further work has also been undertaken to estimate the costs of upgrading all the remaining junctions and this will allow a business case to be made for funding.

9. The Effectiveness of Traffic Control

9.1. UTC System Outage

On Tuesday 4th April 2023 IT problems caused the UTC system to lose comms. to all sites during both the morning and evening peaks, meaning all signals were left running local timings and that none were running SCOOT.

Whilst not ideal, the loss of comms. did give TfGM an opportunity to analyse journey time data to see if there was any appreciable difference compared to days with no comms. issues. The analysis found that the average time to travel a mile increased by up to 13% in the AM peak and by up to 12% in the PM peak (see Figure 3).

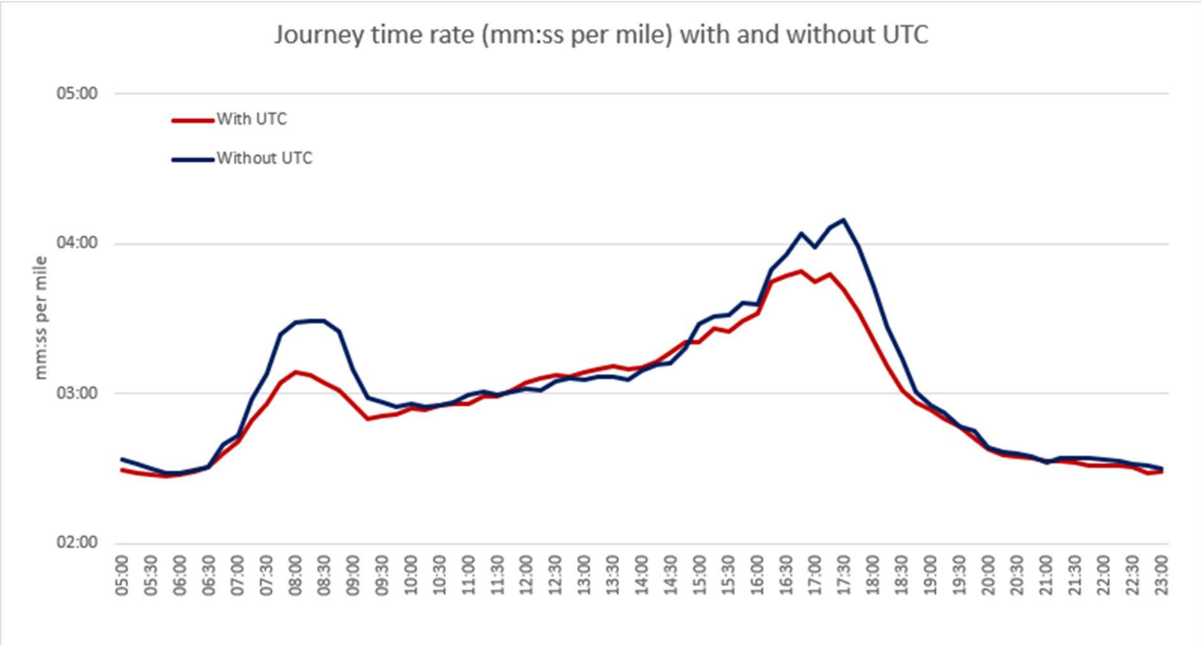

Figure 3: Journey Time Rate with and without UTC

When average trip lengths and estimates of the number of vehicles using the network were analysed it was calculated that the cost of the lost time to travellers was approximately £150,000.

It should be noted that the loss of connectivity took place during the school holiday period, when traffic flows were lower, and that the analysis only considers vehicle delay. It does not take account of the loss of benefit to bus operators and their passengers of SCOOT late running bus priority not being active. Additionally, signal timings could not be amended for events happening that day, interventions could not be made by engineers working with the Operational Control Centre and there was no reporting of traffic signal faults. None of this was captured by the analysis.

The loss of UTC comms. provides evidence of some of the benefits that well managed, and funded, traffic control systems provide to cities. Amongst other things, they have a role in reducing congestion, improving journey times for public transport and contributing to improvements in air quality. Whilst benchmarking cities is difficult, this analysis shows the value of traffic control systems in ensuring they run as effectively as possible. It demonstrates that they are an important part of the infrastructure that can contribute to Greater Manchester's future.

10. Conclusions

As Greater Manchester has developed and as technology has advanced, there has been an increase in the number of traffic signals and in the complexity of the signal network. There has also been an evolution in policies, from those which aimed to expedite the movement of traffic to those which consider the needs of all road users.

We have seen that effective traffic control systems have allowed Greater Manchester to meet these challenges, benefiting the region. However, these systems must continue to adapt to the changing world, alongside the organisations using them, to ensure they contribute to a future in which Greater Manchester achieves its ambitions.

11. References

Transport for Greater Manchester. (2021). *Greater Manchester Transport Strategy 2040*. Retrieved from https://assets.ctfassets.net/nv7y93idf4jq/01xbKQQNW0ZYLzYvcj1z7c/4b6804acd572f00d8d728194ef62bb89/Greater_Manchester_Transport_Strategy_2040_final.pdf

Transport for Greater Manchester. (n.d). *Map of Greater Manchester showing Key Route Network, Regional Centre and Surrounding Towns*. [Map] Retrieved from https://images.ctfassets.net/nv7y93idf4jq/3BvLFImGfKgQmRLolOHZ3e/06fb54c856bef6393b15fa48c0a77424/KRN_map.png

Transport for Greater Manchester. (2021). *Map of the Regional Centre*. [Map] Retrieved from https://assets.ctfassets.net/nv7y93idf4jq/01xbKQQNW0ZYLzYvcj1z7c/4b6804acd572f00d8d728194ef62bb89/Greater_Manchester_Transport_Strategy_2040_final.pdf