# Executive Summary

Infrastructure Australia, in its 2019 report, paints a dire picture of the level of congestion in Adelaide and its continued worsening in the coming years in line with both an increasing population, and a significantly increasing reliance on public transport compared to cars. The report estimated the annualised cost of road congestion for Greater Adelaide to be approximately **$1.4 billion** in **2016** and is projected to rise to **$2.6 billion** in **2031** ([source](https://www.infrastructureaustralia.gov.au/sites/default/files/2019-08/Urban%20Transport%20Crowding%20and%20Congestion%20-%209.%20Greater%20Adelaide.pdf)).

With this backdrop in mind, the South Australia Department for Infrastructure and Transport (DIT) has in its possession a wealth of data relating to traffic information collected by way of bluetooth probes, which take count of motor vehicle numbers in a particular area and time, therefore producing a metric for congestion. This data can be analysed in conjunction with historical real time bus trip updates collected by GTFS-R which provide the actual arrival times for each stop on a bus’s trip.

The aim of the proposed analysis is to identify road segments where bus travel times are highly correlated with congestion and are therefore less robust to the upcoming increasing levels of demand, thereby providing a pre-emptive opportunity to mitigate increasingly lengthier and costlier bus travel times.

# Objective

We aim to find the extent of the relationship between road congestion and bus delays for segments of interest.

# Metrics to be Analysed

* Congestion – measurement options are:
  1. Primary – using links data, the road congestion provided for a direction of traffic measured according to bluetooth equiped vehicles
  2. Secondary – using sites data, the number of unique vehicles identified over a given period per bluetooth probe site, and the average duration spent by a vehicle in that site during that period
* Bus Delay – measurement options are:
  1. Primary – the travel time taken between stops and across a segment. This removes the possibility that we are measuring how accurately the schedule predicts and/or buffers for congestion
  2. Secondary –a stop’s actual arrival time in excess of its scheduled arrival time. Idle time and accumulated delays outside the bounds of the area examined will be disregarded

# Scope

The proposed analysis can be performed through several possible time and location dimensions:

* Time Dimensions
  + Per the morning peak (6am to 10am) and evening peak (3pm to 7pm)
  + Aggregation level(s). For example, 15-minute aggregates, hourly aggregates, …
  + By day of the week
* Location Dimensions
  + Segment of a road
  + A link
  + Bus stop or pair of stops
  + Intersection
  + Towards or away from the city, or both
  + With or without bus lanes
  + North-South/East-West

The time and location dimensions lists are not exhaustive, and we are happy to examine any other perspectives of interest you may identify.

# Road Segment Candidates

The selection criteria we identified for potential road segments to be analysed consist of primarily spatial overlap of bus delay and traffic congestion information, as well as segments with historically high levels of congestions. Possible candidates are:

* South Road
* Main North Road
* Port Wakefield Road
* Glen Osmond Road
* North East Road

We are happy to re-prioritise or expand the list of examined sections to include other areas of interest.

# Data Sources

DIT Transport Analytics AWS datalake. Databases needed:

* **addinsight\_prod**: to obtain sites and links, and their stats
* **gtfsr\_prod**: to obtain real-time trip updates that provide stop delay information
* **gtfs\_history\_prod**: to obtain routes, trips, and stops information

# Proposed Methodology

* Limit analysis to a time period. For example, March 2022, or quarter ending June 2022
  + Disregard weekends and public holidays within that period
* Analysis to be conducted on time-aggregated statistics applied equally to both congestion and bus travel time. For example, 15-minute aggregation resulting in 7am to 7:15am as one aggregate slice, followed by 7:15 to 7:30, 7:30 to 7:45, …
* Limit analysis to segment(s) identified

## Calculating Bus Travel Time of a Segment

Data obtained from the **gtfs\_history\_prod.trip\_updates** data set

1. Identify start and end bus stops on the segment to measure travel time on
2. Calculate the average travel time between selected bus stops on the segment per time aggregate across the entire time period. For example, the average bus travel time from the start to the end of the segment between 7am and 7:15am across March 2022
3. Calculate average travel time between pairs of stops on the segment to identify bottlenecks

# Calculating Congestion Using Links

Data obtained from the **addinsight\_prod**.**btlinkcongestionstats** data set

1. Identify sequence of non-overlapping links that compose the segment
2. Calculate the average congestion per link per aggregated time across the entire time period to identify traffic bottlenecks within a segment
3. Calculate the average congestion of all the links within a segment per aggregated time across the entire time period, to produce the average congestion across the entire segment

## Calculating Congestion Using Sites

Data obtained from the **addinsight\_prod**.**btsitestats** data set

Same calculation steps as when using links, however the resulting congestion is measured as the number of vehicles and average time spent by a vehicle in the sites contained within a segment and time aggregate across the time period under analysis.

## Comparison Between Delay and Congestion

The relationship between congestion and delays will be determined by analysing the variation in bus trip times compared with the variation in congestion levels. Visualisation will be used to examine the relationship per time aggregate. Specific aspects may be highlighted according to the dimensions desired, for example separate visualisations can be constructed according to the direction towards or away from the city, as well the relationship during morning and evening peak hours.

If a relationship is established for a segment, further analysis could be initiated such as:

* Narrowing the time or area scopes to produce outcomes of higher granularity. This can establish a prioritization of where resources should be allocated
* Performing the analysis on the same time period from previous years to highlight possible trends. This can identify areas where the congestion effect on bus delays is accelerating
* Examining specific portions of road or bus stops with consistently occurring bottlenecks. This allows for early proactive action on pinchpoints that can save resources when the bottlenecks get exacerbated through time
* Examining days that exhibit bigger than usual congestions and delays and the possible causes (such as a sporting event). Can the delays be reduced by taking specific actions such as the use of an express bus service to and from events? Simulations can be performed to determine the effects of such measures

# Example

As an example, the proposed analysis will be implemented on South Road between Ayliffes Road and Richmond Road for the month of March 2022

Map

Description automatically generated

Figure . Segment of South Rd to be analysed highlighted in blue

Below is the comparison between delays and congestion using link stats, separated by direction of travel. The highlighted areas are the morning and evening peaks. The data were aggregated using 15-minute intervals

Chart, bar chart, histogram

Description automatically generated

Figure . Delays vs congestion using link stats to/from the city with peaks highlighted

Below is the comparison using sites stats

Chart, line chart

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Figure . Delays vs congestion using site stats with peaks highlighted

The figures show that delays increase along with congestion during the evening peak when leaving the city. Delays also increase in the evening towards the city.

# Estimated Completion Date

October 7, 2022