

PROJECT OVERVIEW

PROBLEM DEFINITION

Currently, remote bussing operations account for a significant number of flights in Changi Airport during peak hours.

As the total air passenger traffic demand is expected to outgrow the current design capacity of all the existing terminals (T1 to T4) by 2030, CAG is planning the development of T5 to support the surge in air traffic.

To cater for various future scenarios and safeguard the operation flexibility, a sufficient remote bussing capability should be planned for T5 from an early stage. This project aims to find the different configurations of remote bussing services to support remote flight operations in T5.

KEY OBJECTIVES

- Plan for quality remote bussing service and customer satisfaction with least number of resources.
- Performance Indicators
 - Customer Satisfaction
 - Travelling Time
 - Number of Transfers
 - Resources
 - Number of Buses
 - Effective Utilisation
 - Number of Personnel
- Service Level Constraints
 - No bus arriving at the bus bays or planes will be late for more than 2 minutes

KEY SKILLSETS

- Simulation**
 - Model Building and Validation
 - Solution Analysis
- Systems Thinking**
 - Examine the interactions of the components in the system
- Optimisation**
 - Find an optimal resource allocation

METHODOLOGY

PROPOSED APPROACH

While establishing different configurations of remote bussing services, the route that the buses will travel and the resources needed under each configuration has to be considered when building the simulation models.

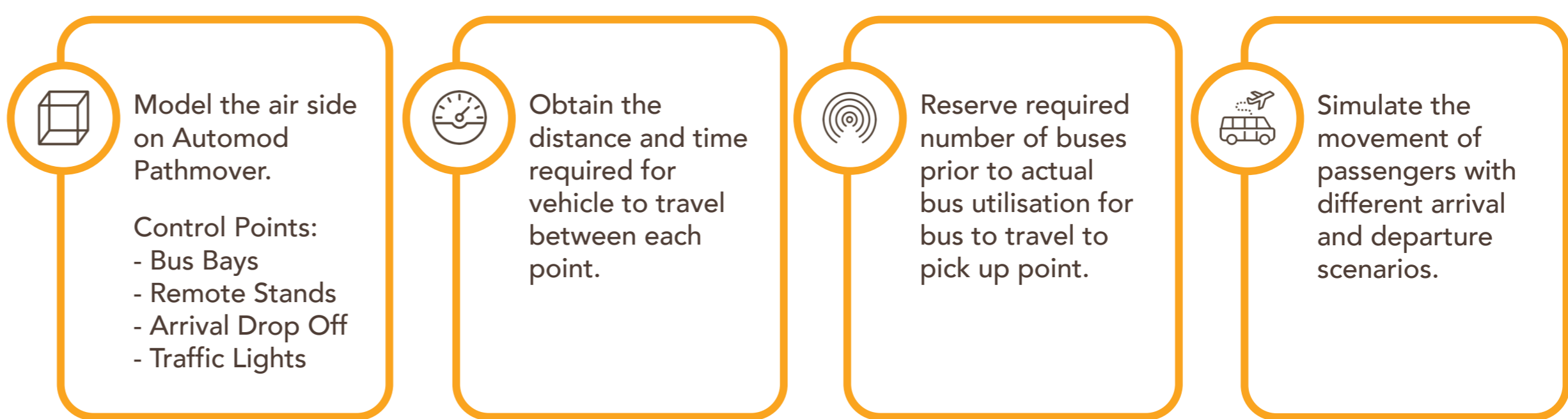
Arrival Model Scenarios

- Bus all passengers to arrival dropoff
- Bus all passengers to nearest bus bays

Departure Model Scenarios

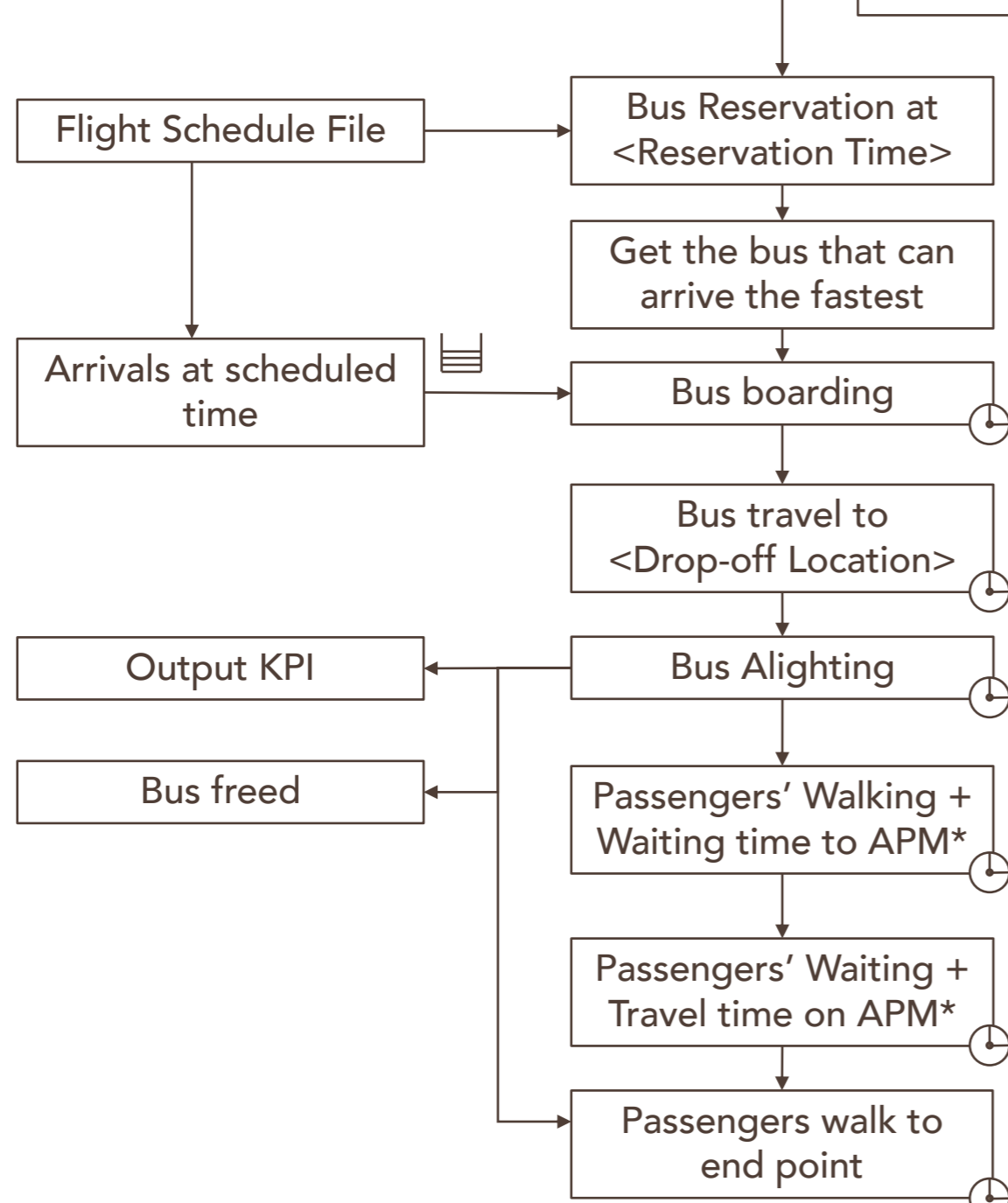
- Bus all passengers from headhouse
- Bus all passengers from nearest bus bays

SIMULATION METHOD IN 4 STEPS



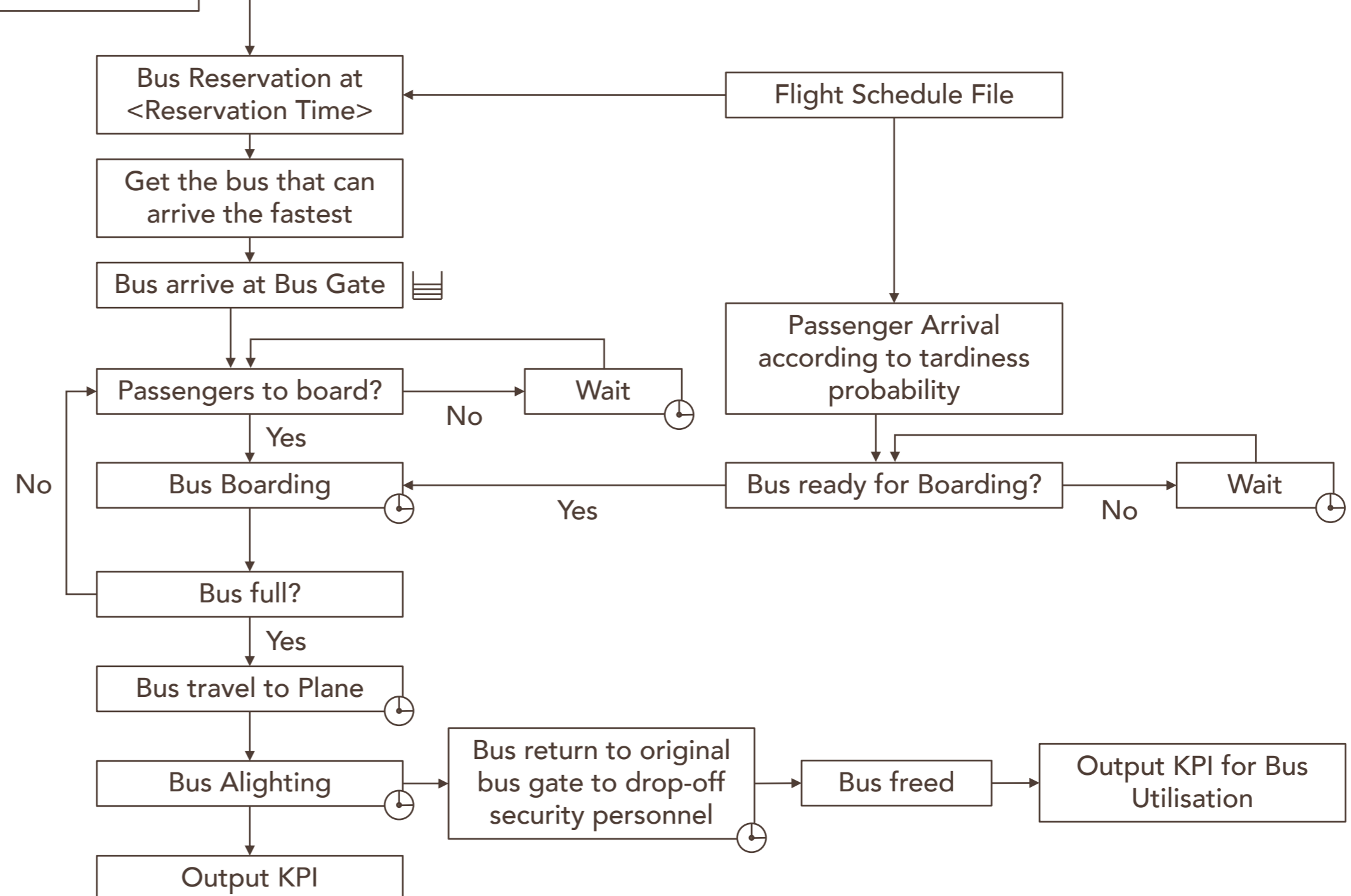
IMPLEMENTATION

ARRIVAL SIMULATION MODEL



*APM is Changi T5 airside Airport People Mover system

DEPARTURE SIMULATION MODEL

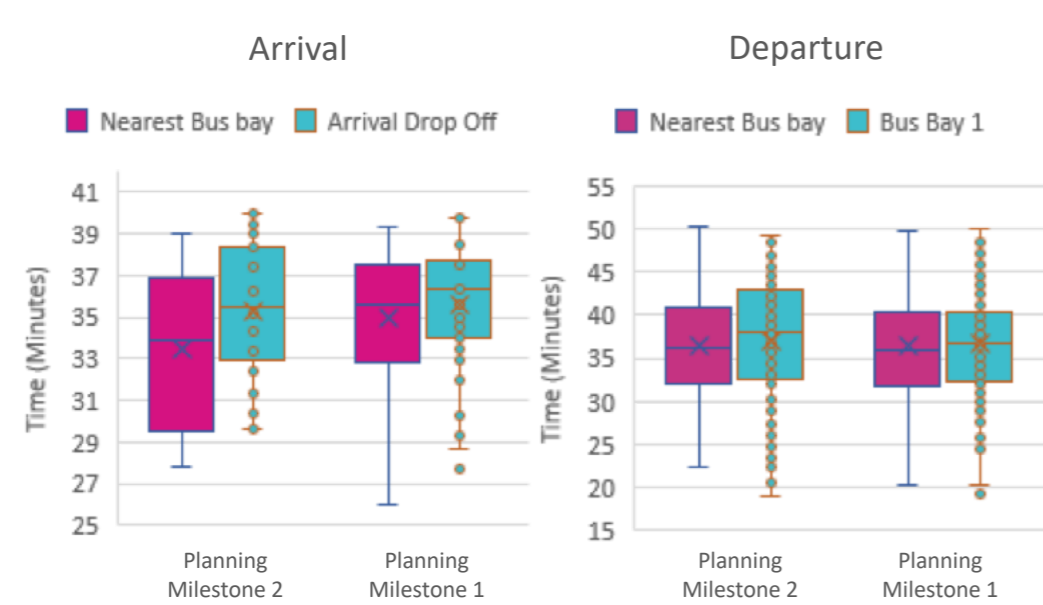


RESULTS

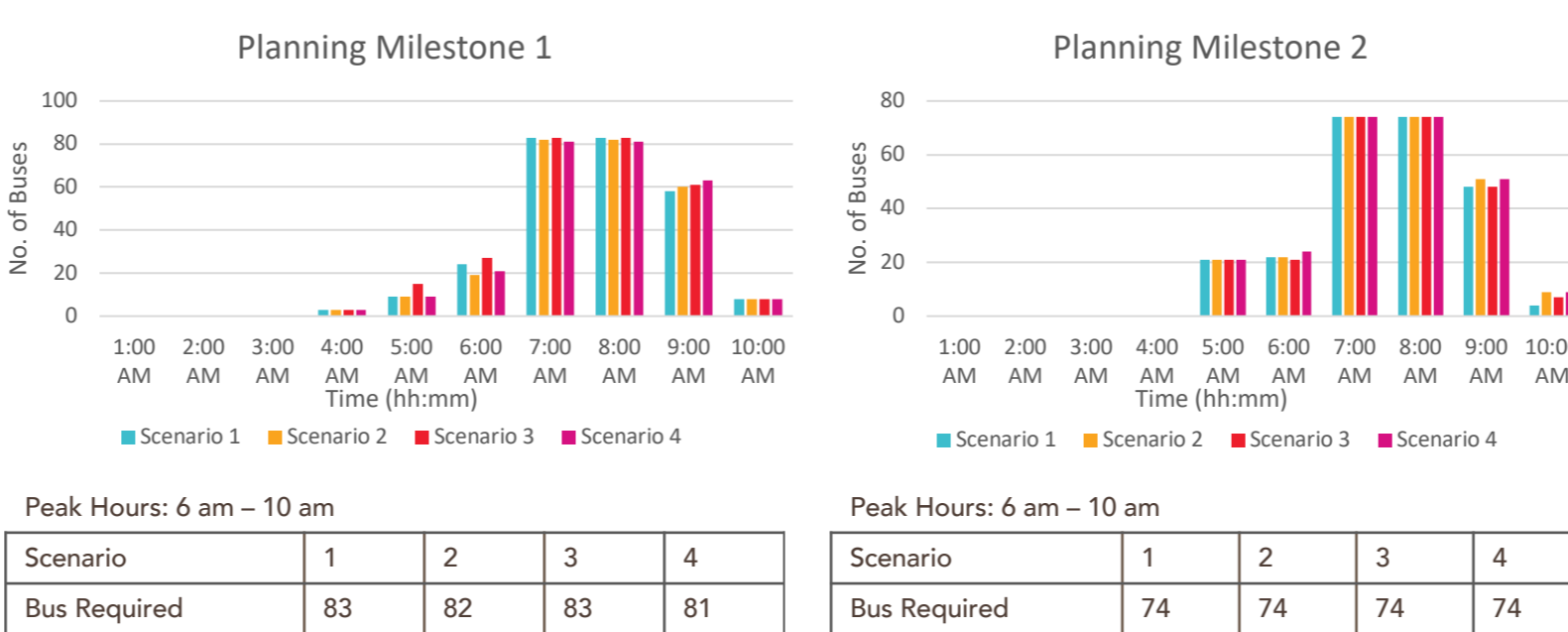
Using the projected flight schedule files for Planning Milestone 1 and 2, given to us by CAG, we ran the arrival and departure simulation models and obtained the following results:

Scenario 1: Arrival to nearest bus bays, departure from nearest bus bays
Scenario 2: Arrival to nearest bus bays, departure from headhouse only
Scenario 3: Arrival to arrival drop off, departure from nearest bus bays
Scenario 4: Arrival to arrival drop off, departure from headhouse only

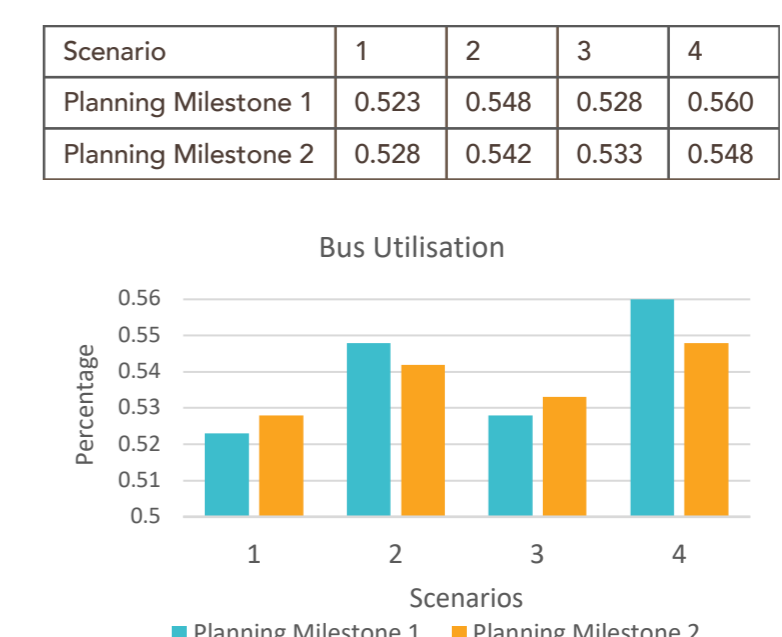
TOTAL TRAVELING TIME



BUSES IN USE (HOURLY)



BUS UTILISATION



RESULTS SUMMARY

| Scenario | 1 | 2 | 3 | 4 |
|--------------------------------|-------|-------|-------|-------|
| Number of Transfers | 2 | 1 | 1 | 0 |
| Bus Required | 83 | 82 | 83 | 81 |
| Total TT* Arrival (avg mins) | 34.9 | 34.9 | 35.6 | 35.6 |
| Total TT* Departure (avg mins) | 36.4 | 36.8 | 36.4 | 36.8 |
| Bus Utilisation | 0.523 | 0.548 | 0.528 | 0.560 |

| Scenario | 1 | 2 | 3 | 4 |
|--------------------------------|-------|-------|-------|-------|
| Number of Transfers | 2 | 1 | 1 | 0 |
| Bus Required | 74 | 74 | 74 | 74 |
| Total TT* Arrival (avg mins) | 33.5 | 33.5 | 35.3 | 35.3 |
| Total TT* Departure (avg mins) | 36.5 | 37.1 | 36.5 | 37.1 |
| Bus Utilisation | 0.528 | 0.542 | 0.533 | 0.548 |

*TT is the travelling time

CONCLUSION

KEY FINDINGS

Based on the results generated, our simulation model gives CAG the support needed to make planning decisions that will impact Changi T5's future operations. Our model findings are in line with the massive scale of T5, where a large pool of buses will be required for their remote bussing operations as well.



Our project meets the objectives of providing CAG the remote bussing operation simulation model and the hard data that will aid them in decision making.



General number of buses needed is around 80 buses.



Scenario 4 is a better cost minimising option but more analysis should be done to carefully weigh the different travel bussing experiences in all 4 scenarios.