Comparison between Demand Responsive Feeder Transit Networks with Door-to-Door and with Temporary Stops

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Why automated demand responsive feeder bus operation?

- Improving urban mobility
- Reducing crashes
- Environmental benefits
- Economic profitability
- Energy saving
- Promoting equity

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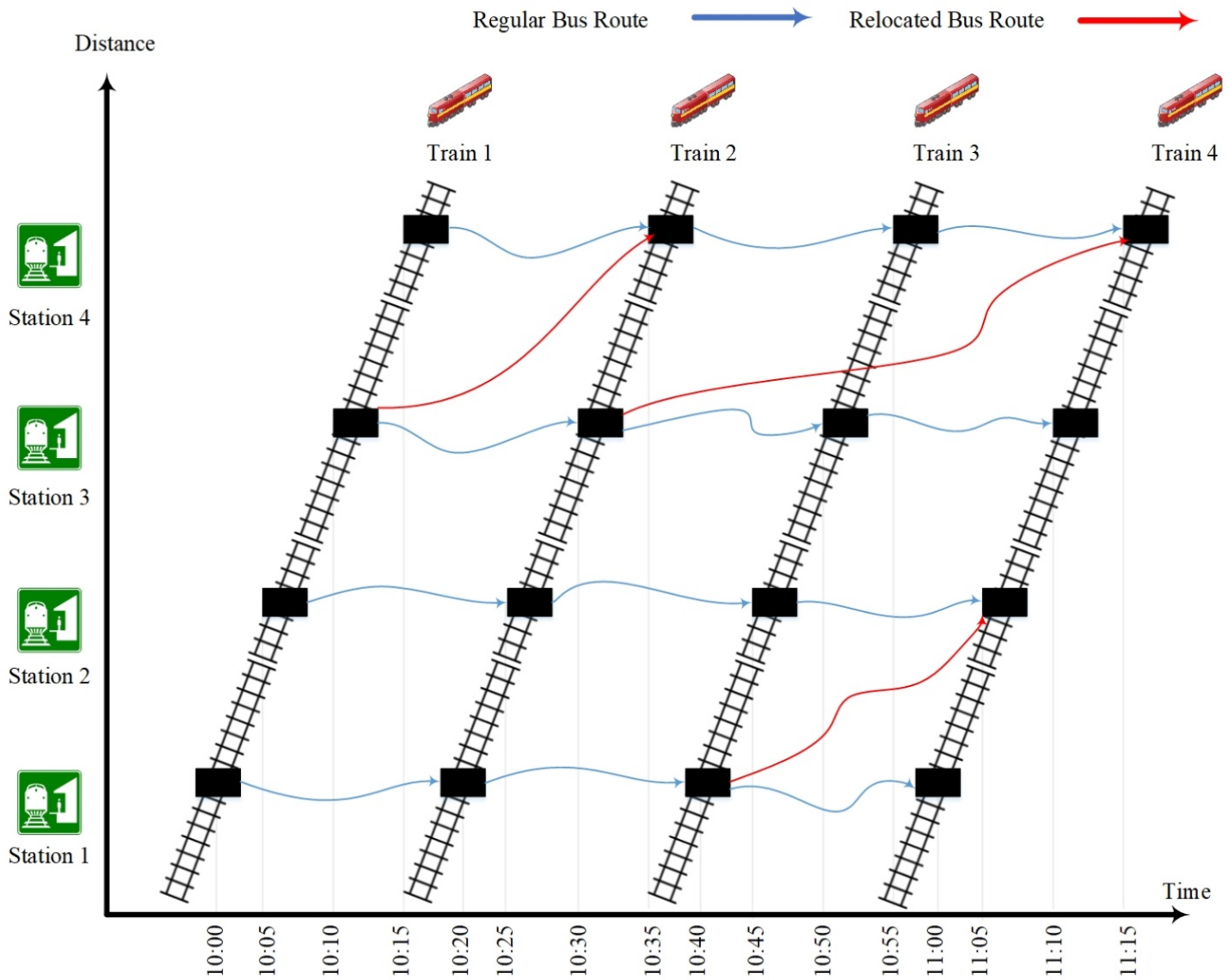
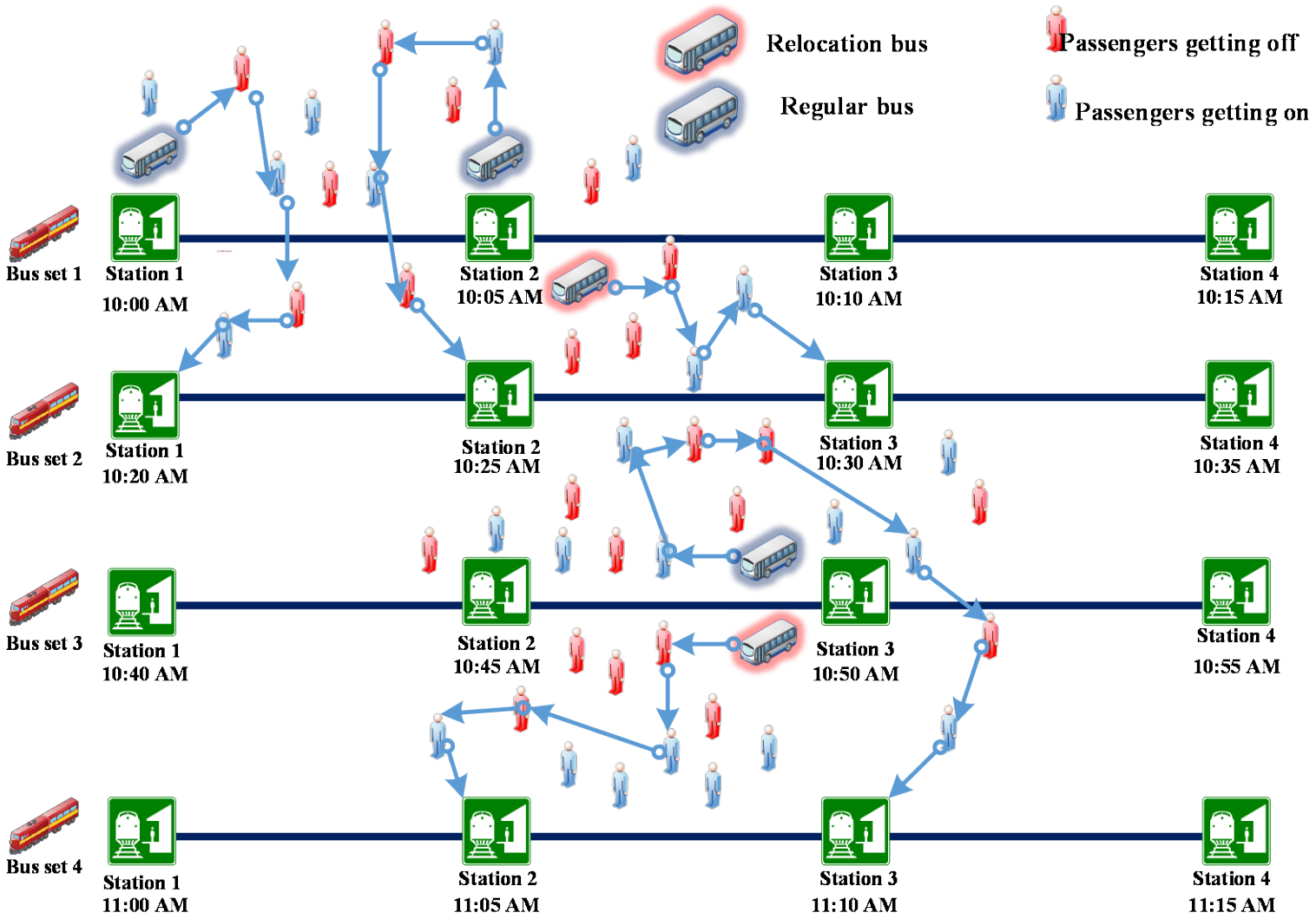


Innovations

- Relocation of vehicles
- Multi-train
- Multi-stop
- Multi-riders
- Individual passenger travel time



Assumptions

- Headway of train: 20 mins
- All passengers will be served
- Distance between stations is 2km
- Average speed for feeder buses is 30 km/h and for trains is 60 km/h

Objective function

- Minimizing total travel cost
  - *Total vehicle travel cost (operator's cost)*
  - *Total passenger travel cost (user's cost)*
- Constraints
  - *Additional travel time ratio*
  - *Time windows*
  - *Serving all passengers*
  - *Bus capacity and availability*

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Two different scenarios

Individual passenger pick up/delivery stopping point (IPD)

10:05 AM

10:08 AM

10:00 AM

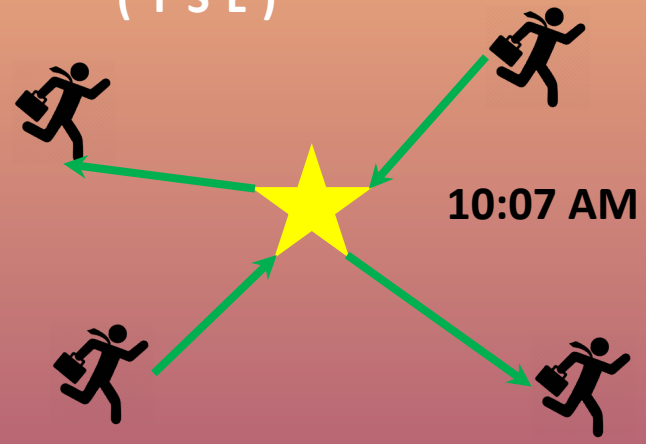
10:12 AM

10:20 AM

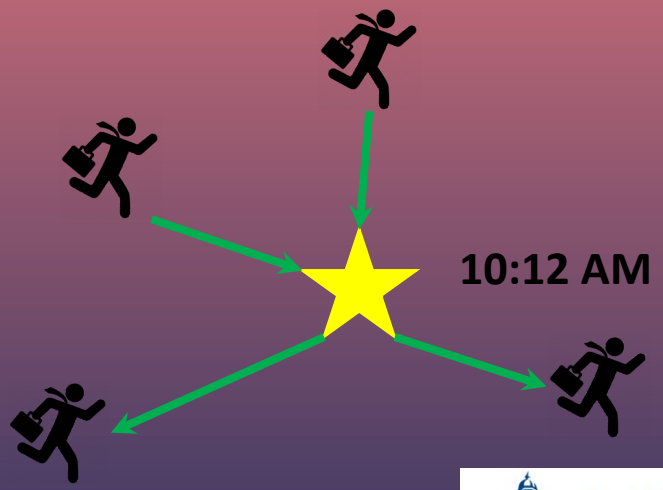
10:15 AM

Temporary/Flexible stopping points (TSL)

10:00 AM



10:07 AM



10:12 AM

10:20 AM

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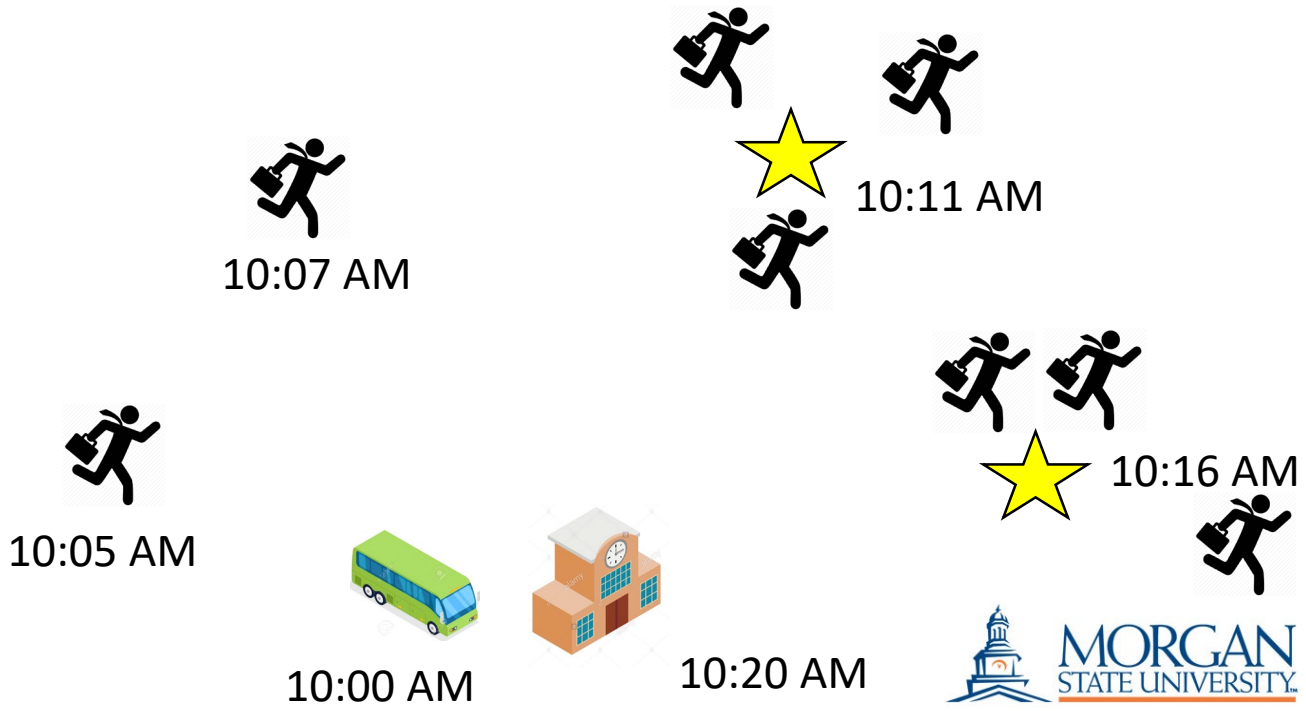
Temporary/Flexible stopping points (TSL)

- The algorithm starts with grouping of passengers and finding optimal location of stopping point



Scenarios

Passengers near one another (in close proximity)

- Individual passenger pick up/delivery stopping point (IPD)
- Temporary/Flexible stopping points (TSL)

Passengers farther apart (more scattered)

- Individual passenger pick up/delivery stopping point (IPD)
- Temporary/Flexible stopping points (TSL)

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Distribution of Passengers

Passengers farther apart

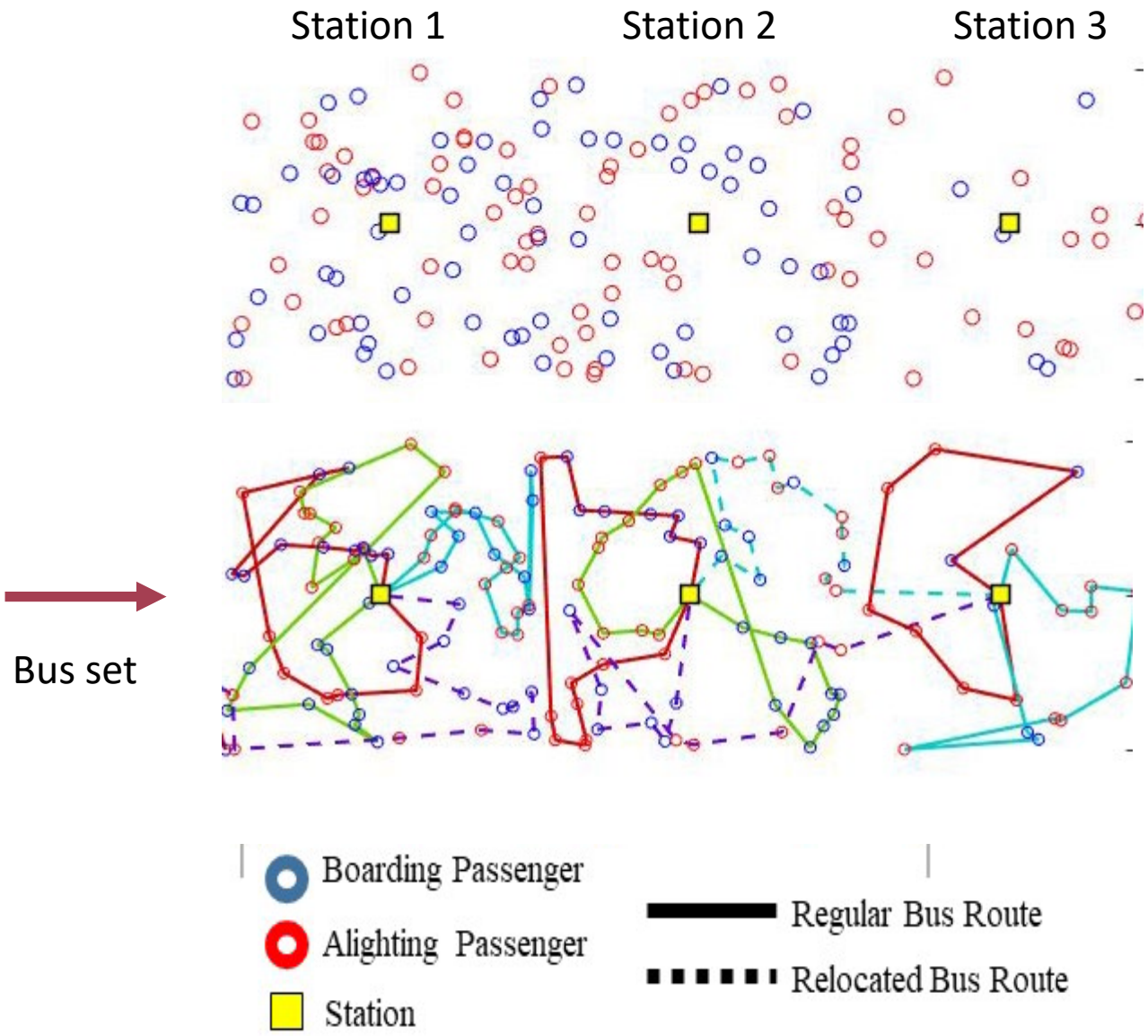
Passengers near one another

Passenger Information for Each Station and Each Train

	Station 1		Station 2		Station 3		Station 4	
	BP	AP	BP	AP	BP	AP	BP	AP
Bus set 1	16	24	21	19	19	21	25	15
Bus set 2	8	12	24	36	26	24	16	14
Bus set 3	16	29	12	13	26	29	15	20
Bus set 4	19	21	23	17	21	19	20	20

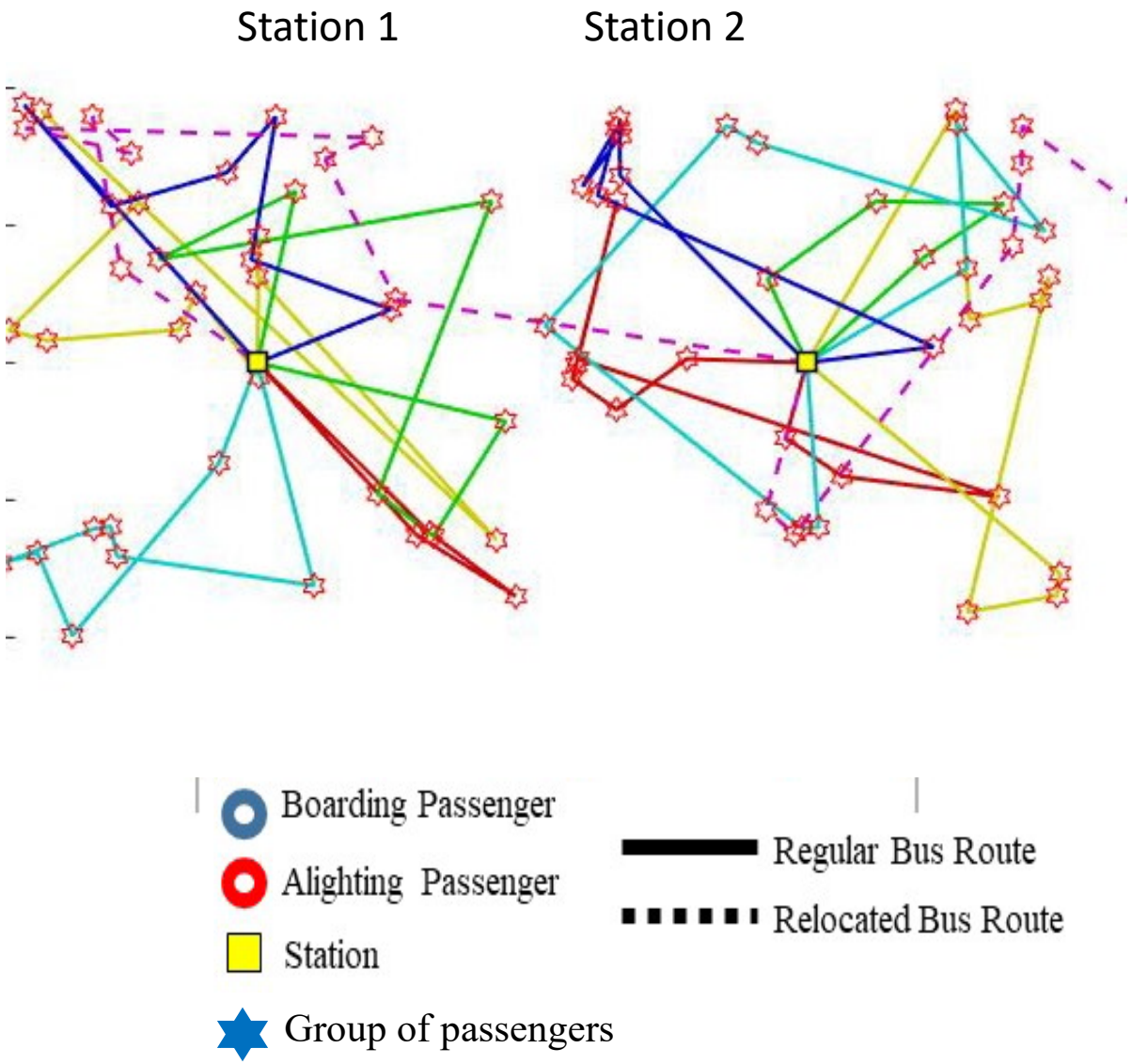
Passenger Data

- AP: Alighting passengers (prs)
- BP: Boarding passengers (prs)
- A bus set carries arrival passengers from the first train and departure passengers for the next train.



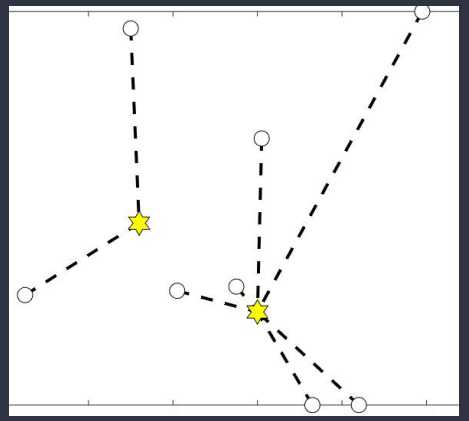
Passengers near one another (IPD)

- Vehicle will pick up/deliver passengers at the location of passengers
- All passengers will be served by feeder buses
- Relocation of vehicles between stations 1 and 2 and stations 2 and 3



Passengers near one another (TSL)

- Vehicle pick up/deliver passengers at temporary stops according to grouping of passengers in an optimal location
- Some passengers may not assign to any group due to their locations
- Relocation of vehicle between stations 1 and 2



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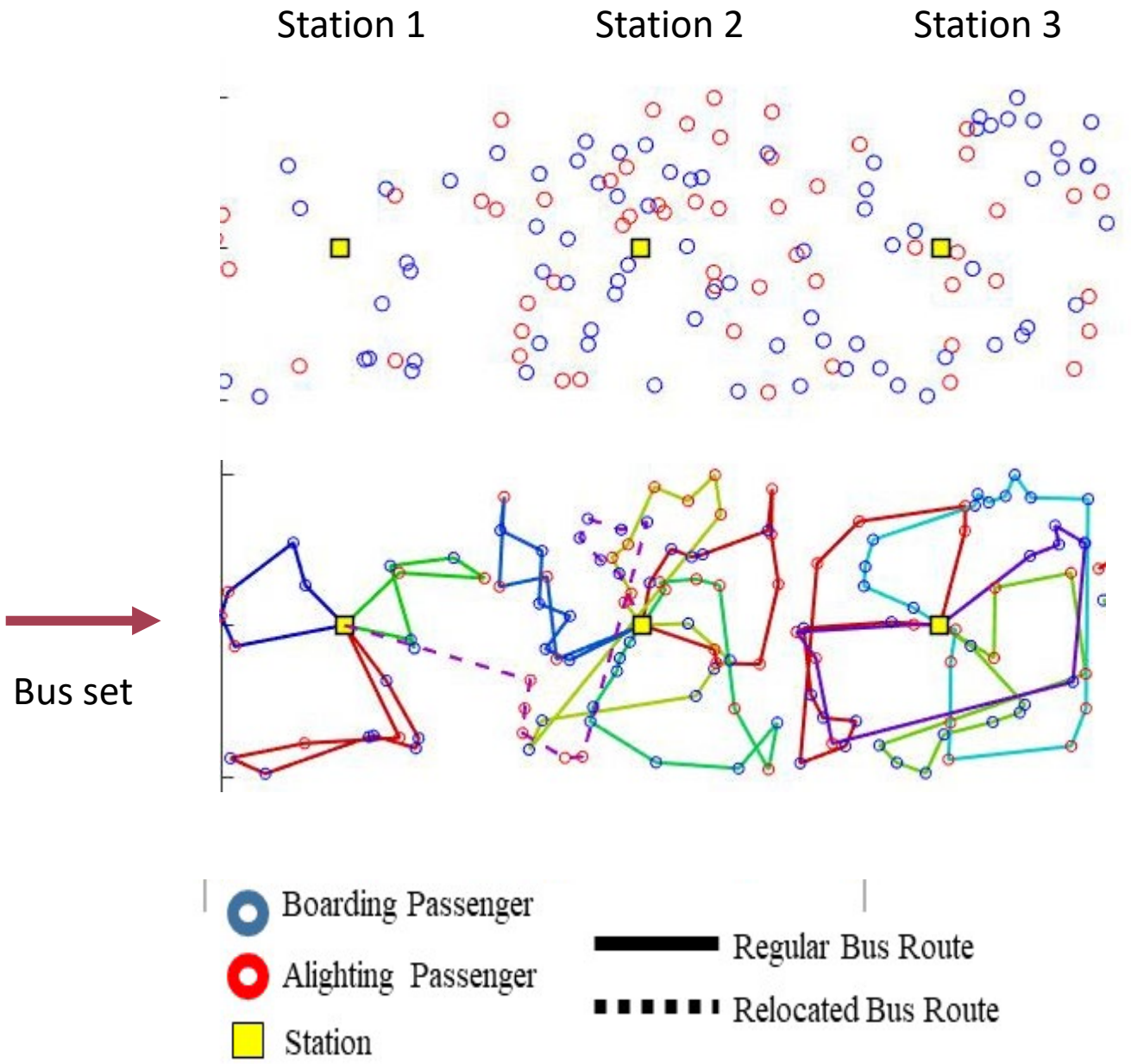
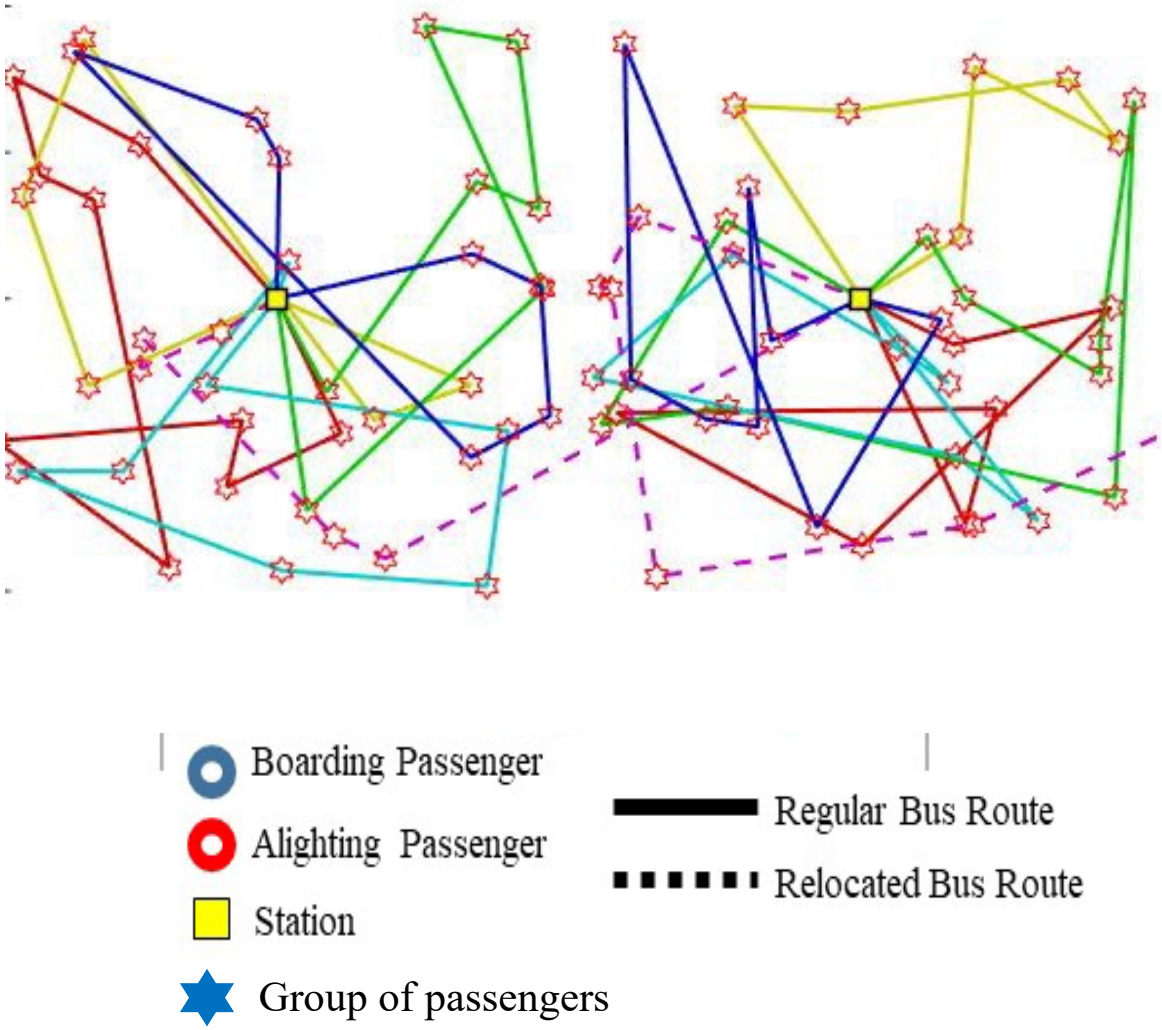


Passengers farther apart (IPD)

- The travel time monetary value for each passenger has been placed at $20 per hour, and $0.3 per kilometers for vehicles
- Vehicles pick up/deliver passengers at their locations
- Relocation of vehicle between stations 1 and 2

Station 1 Station 2



Passengers farther apart (IPD)

- Vehicle will pick up/deliver passengers at the location of passengers
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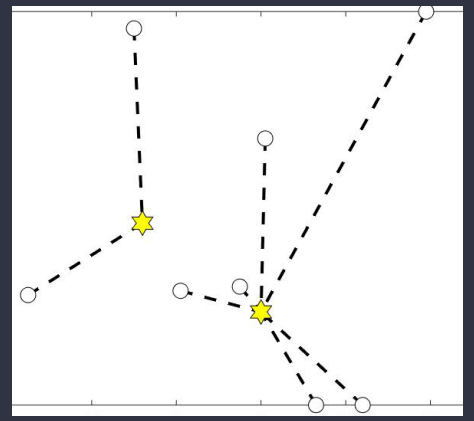

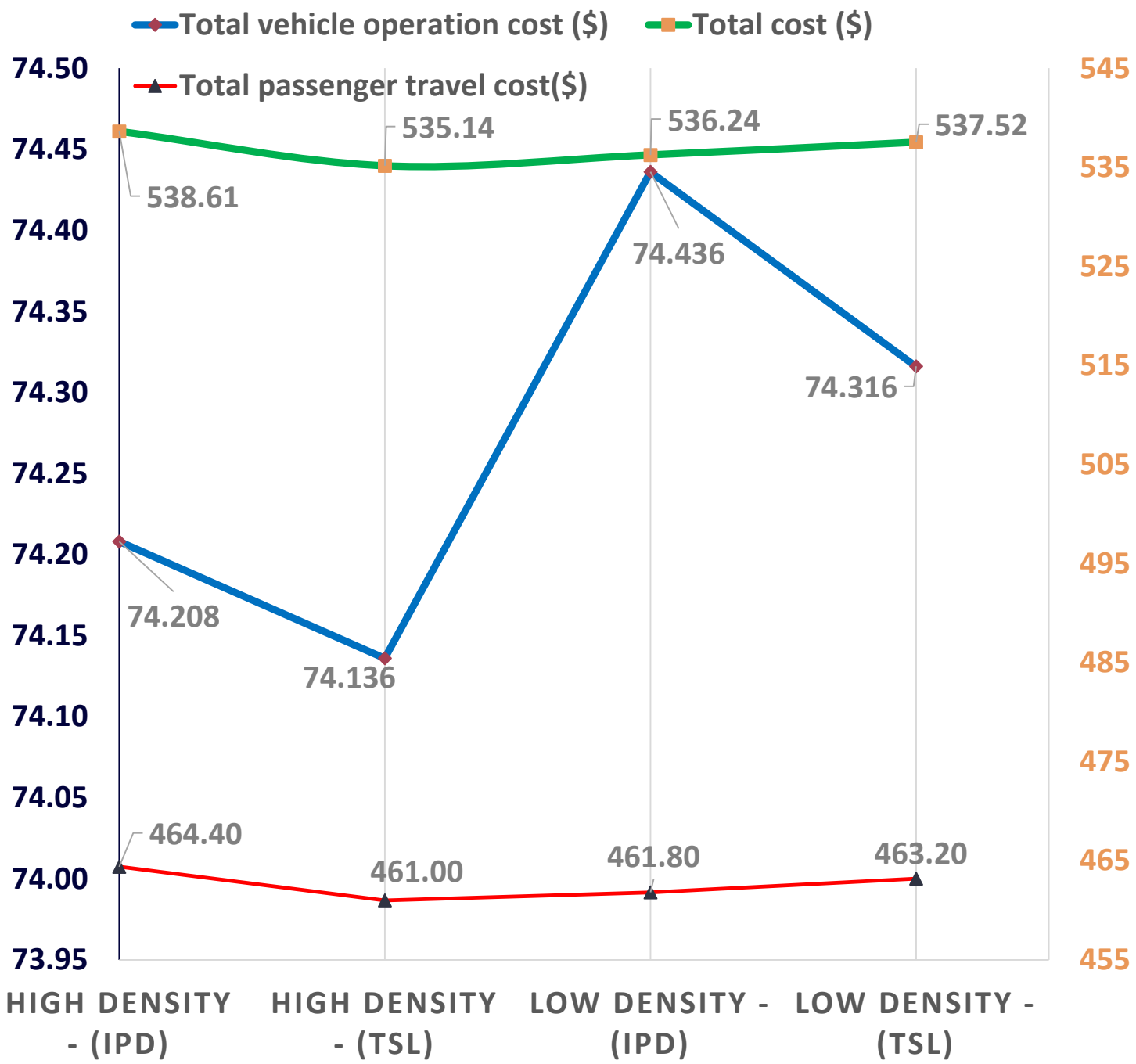

Analysis of results

- Passengers are close together
  - *When density of passengers is high, alighting/boarding of passengers at temporary stopping points by grouping them seems to be more efficient*
- Passengers are far from each other
  - *When density of passengers is low, alighting/boarding of passengers at their locations seems to be more efficient*

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Conclusion

- The performance of two different routing algorithms for demand responsive feeder transit has been presented
- When passengers are located far from each other, using an approach for alighting/boarding passengers at their location should be more efficient; however, when they are close, using TSL can reduce total costs
- Basically, using temporary stopping points always has lower operating costs
- The developed routing algorithms could handle the problem
- Using hybrid approaches and methods in future studies may bring more efficient solutions

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THANK YOU

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