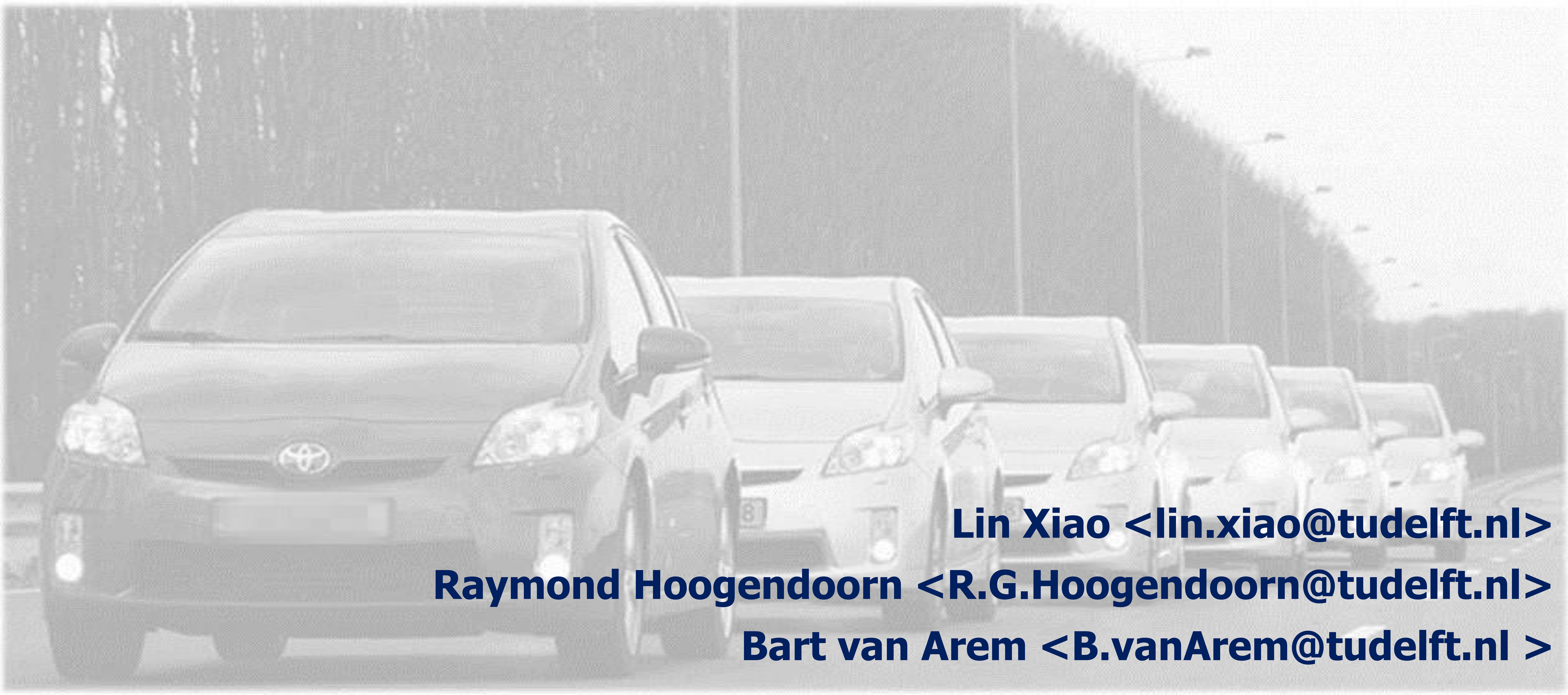
Challenges

- ❖High expectation on high performance automated vehicle platoon
- ❖Restricted Traffic flow efficiency by platoon joining & separation
- ❖Increased platoon separations by diverse OD pairs
- ❖Unknown separation strategies for mixed ODs platoon
- ❖Inflexibility platooning strategy for unique OD platoon

Destination Celled Platooning

——Using Cooperative ACC to Form High-Performance Vehicle Streams



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- Mixed OD platooning
- High platoon performance
- Less energy consumption
- Destination groups control

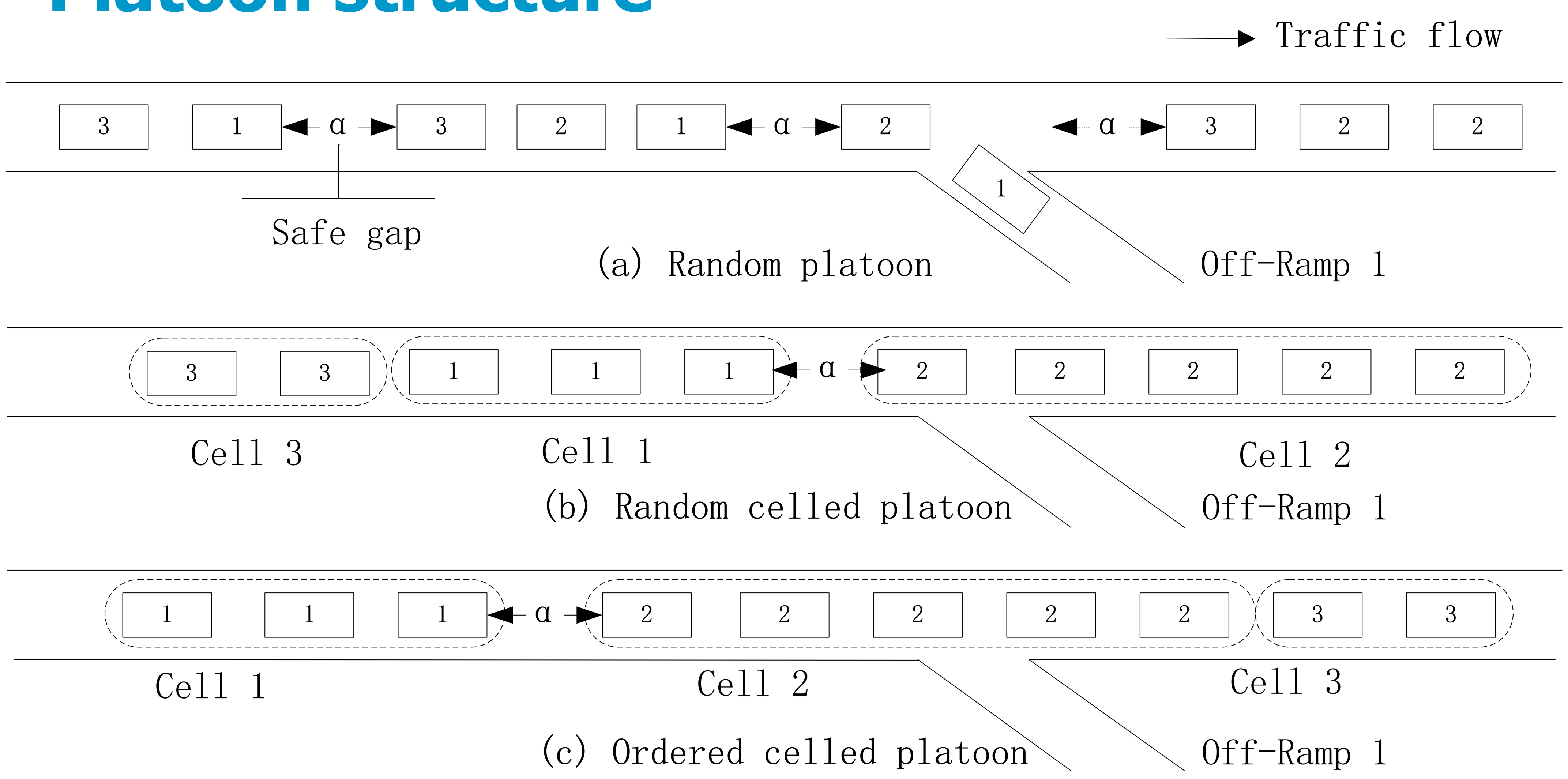
Concept

Destination celled platooning is a cluster of vehicles with destination cells inside. All of the vehicles with the same destination will be put together and placed in one cell.

❖ **Random Celled Platoon**
Destination cells are in random order.

❖ **Ordered Celled Platoon**
Destination cells are positioned based on destination distances.

Platoon structure



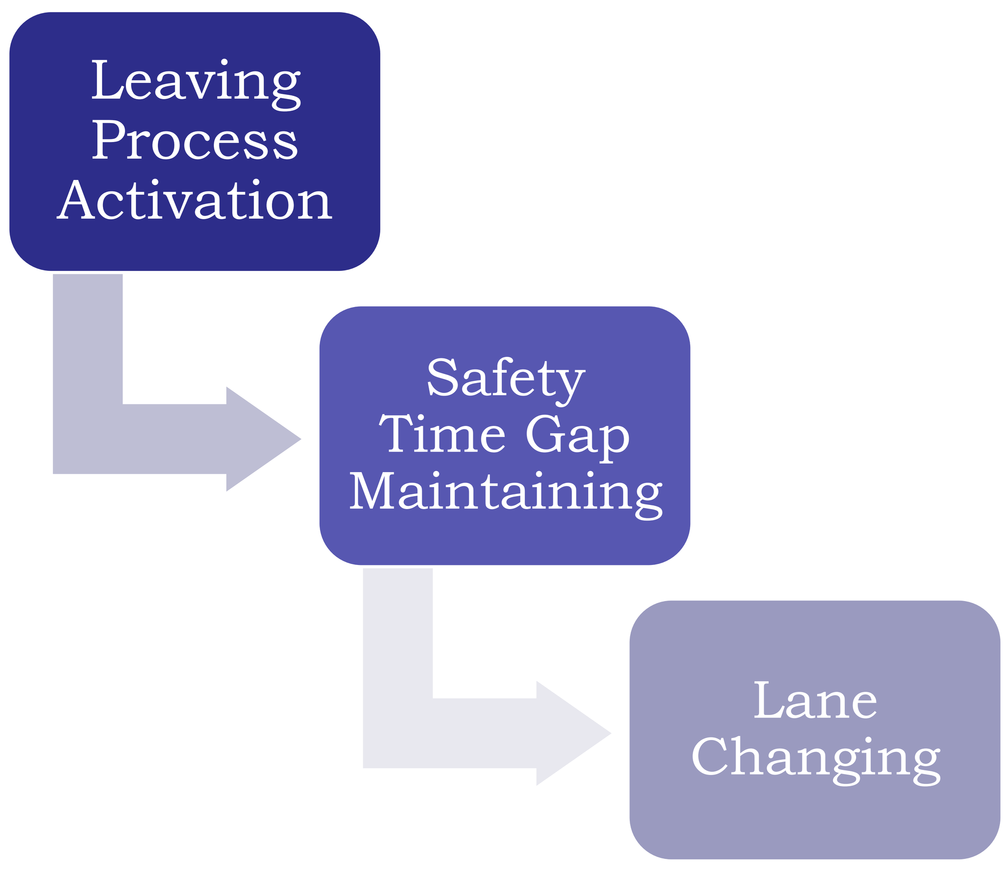
Features

- Vehicles with same destination bunch together
- Unique destination in one cell
- In Random Celled Platooning Strategy, cells are randomly distributed.
- In Ordered Celled Platooning Strategy, the cell for next off-ramp is always at the tail of platoon.

Superiority

- Reduced numbers of platoon separation
- Integrated leaving behaviors control
- Increased platoon throughput
- Less delay at off-ramp
- Less disturbance
- Flexible destination group units

Leaving Behaviors



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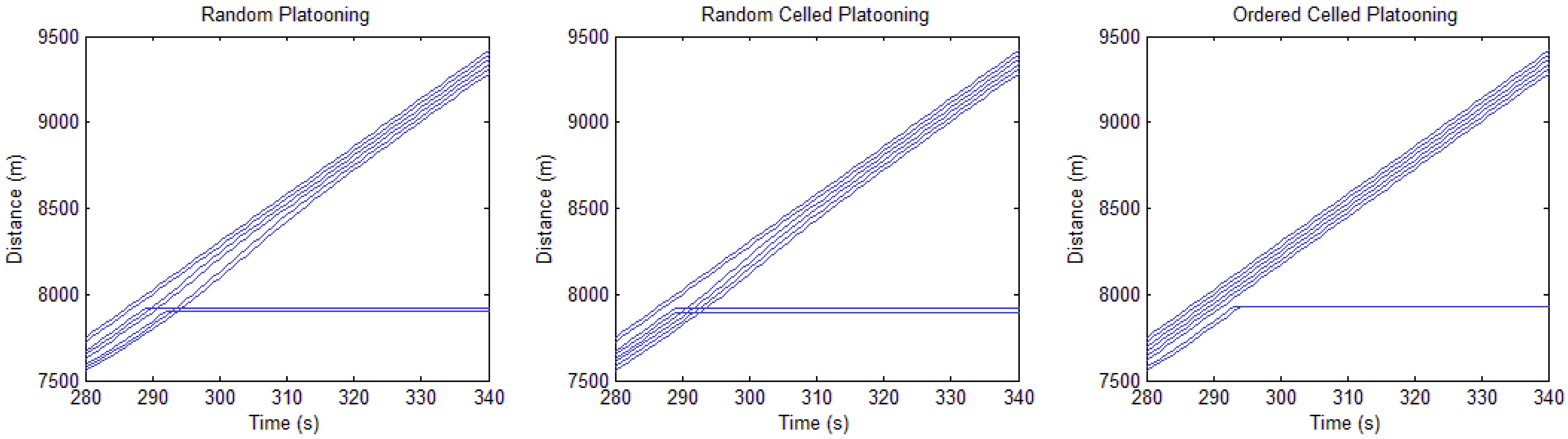
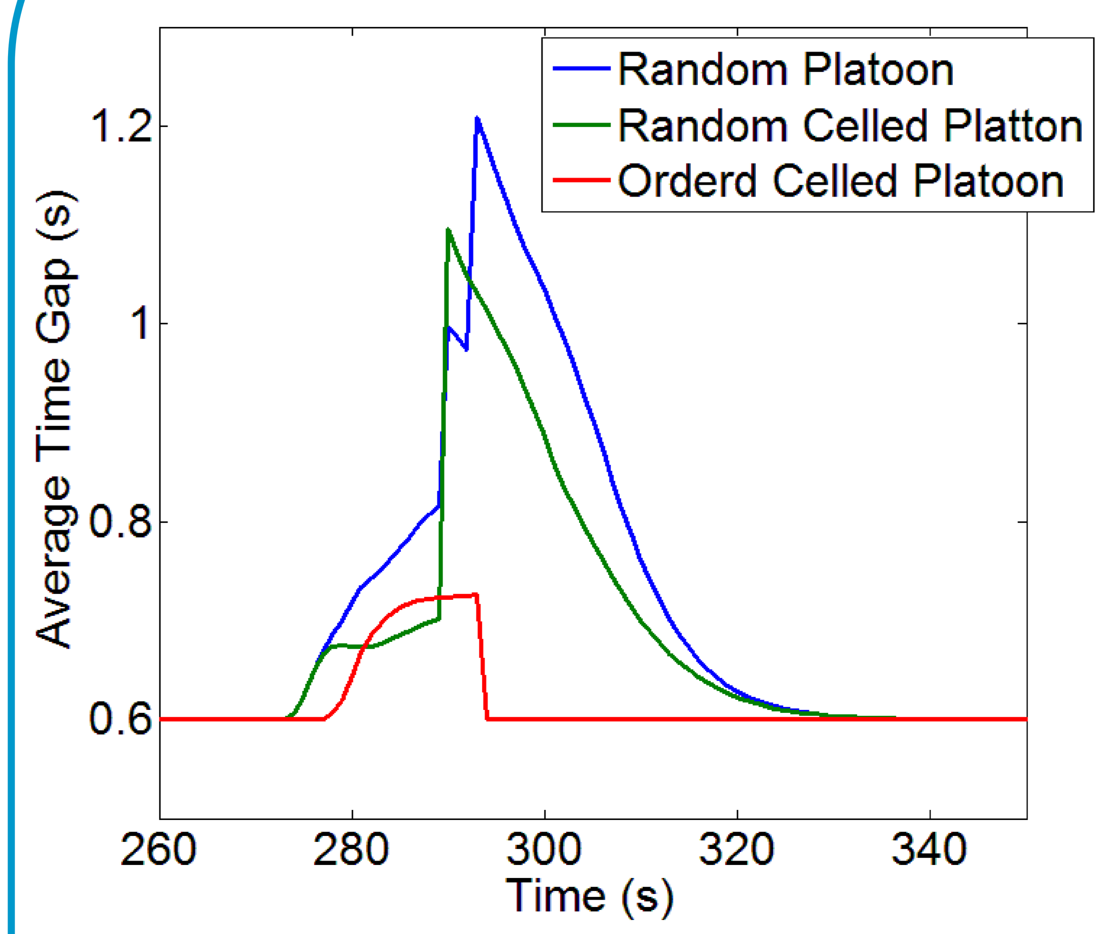
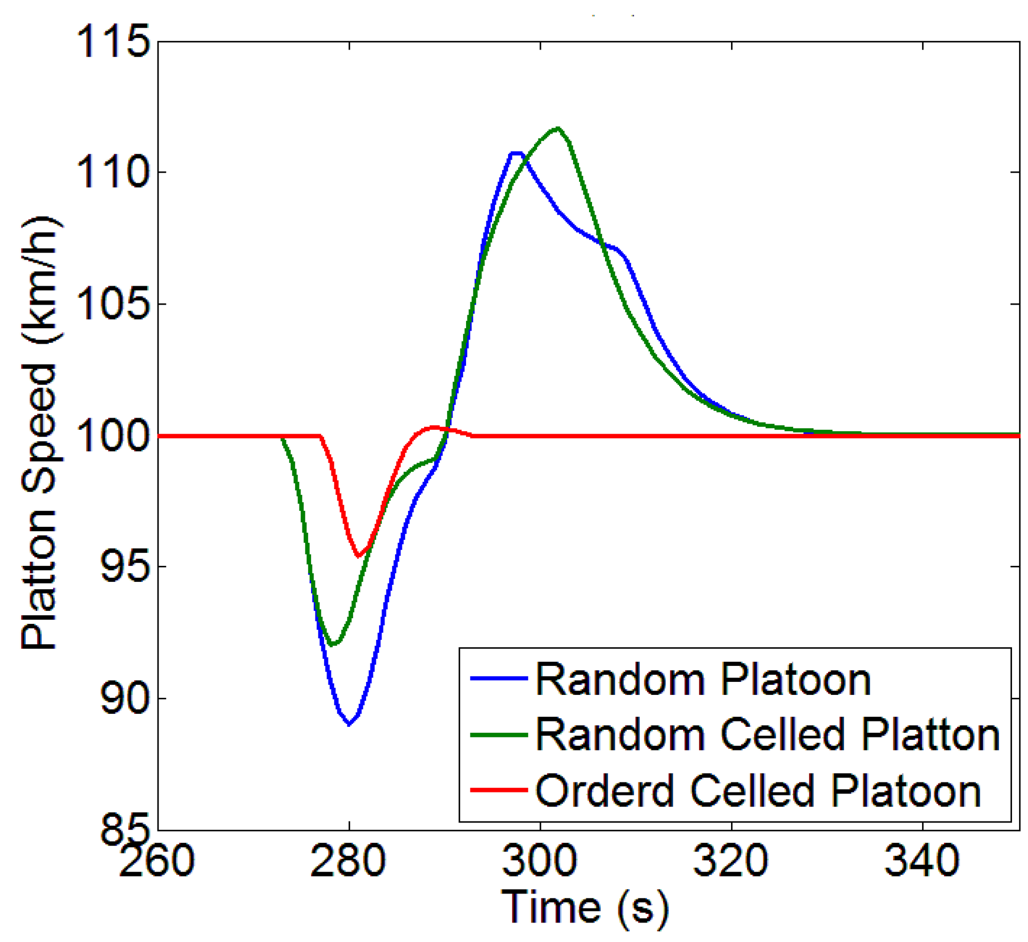
Results

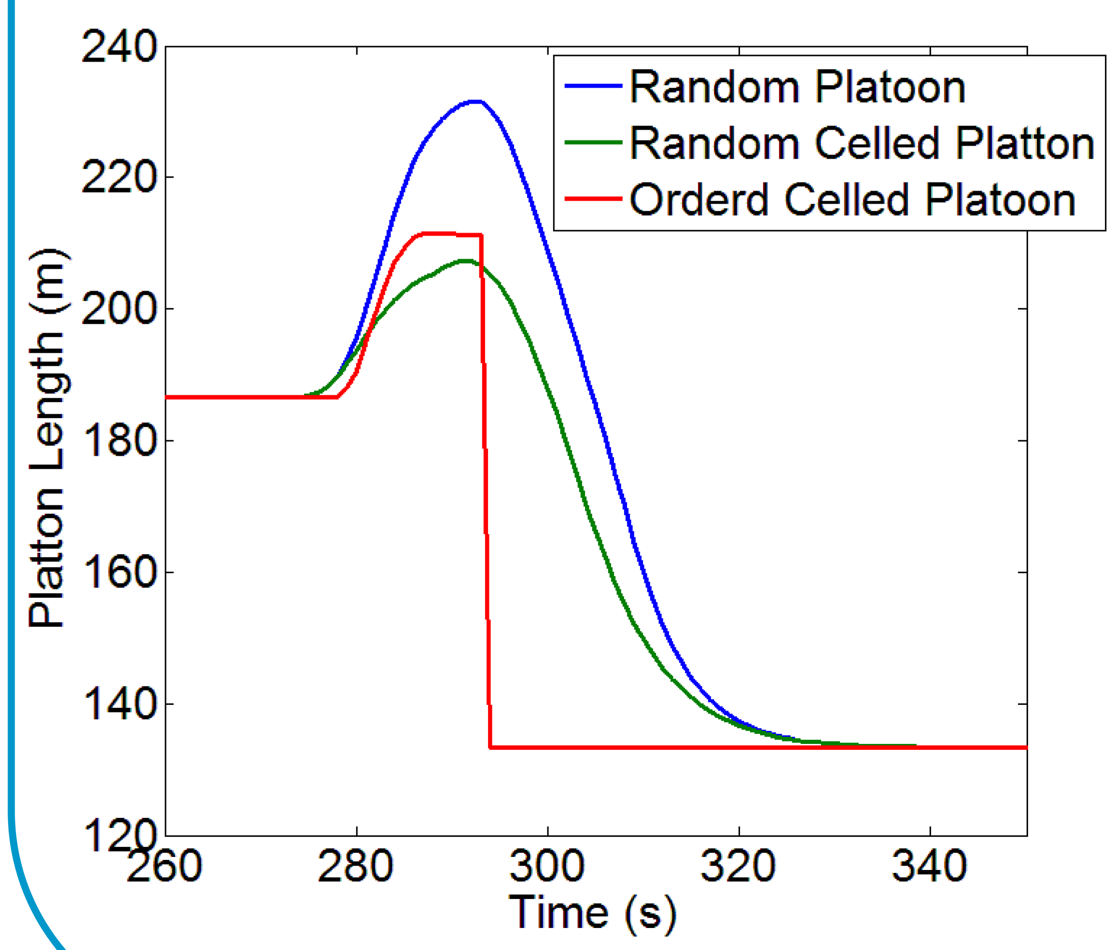


Trajectories

Comparison







- ✓ Smaller average time headway
- ✓ Sooner recovery
- ✓ less travel time delay
- ✓ Less speed reduction
- ✓ Less probability for producing traffic disturbance
- ✓ Shorter platoon length
- ✓ Less time-space consumption

Conclusion

Sorting vehicles according to their destinations into cells within a platoon shows benefits both in increasing traffic efficiency and reducing traffic disturbances. Especially in the early stage of automated platoon, low CACC penetration requires more flexible as well as high performance platooning strategy without additional supportive infrastructures.

Ordered Celled Platoon limits the number of platoon separation at one off-ramp, reduces the delay caused by leaving vehicles, improves the road capacity, avoids unnecessary traffic disturbance and provides flexible control unit for destination group without queuing space at the on-ramp. However, more platooning details such as platoon formation process and its impacts on traffic should be specified and study further.

This research is conducted in cooperation with the California PATH program, UC Berkeley and sponsored by the FHWA Exploratory Advanced Research Program.

Coding in MATLAB…

Initialization

- Highway with a off-ramp
- Dedicated lane for CACC vehicle
- 8 CACC vehicles' platoon
- Platoon speed 100 km/h
- Car following controller: Wilmink Model (2007)
- Following time gap 0.6s.

First leaving vehicle

- Sends leaving message at 500m upstream of the off-ramp and lane changing at the 100m.
- Safety time headway for first leaving vehicle 1.5s and 0.6s for following leaving vehicle

Three scenarios

(a) Random Platooning: the third and sixth vehicle take the off-ramp;

(b) Random Celled Platooning: the third and forth vehicle take the off-ramp;

(c) Ordered Celled Platooning: the seventh and eighth vehicle take the off-ramp.

CACC Longitude Control Algorithm *-Wilmink Model*

Speed controller

$$a_{ref\_v} = r_{st} \cdot (v_{ref} - v)$$

Constant time gap and min. Δv controller

$$d_{ref} = d_0 + t_{ref} \cdot v$$

$$a_{ref\_d} = k_d (d - d_{ref}) + k_v v_{rel\_p} + \frac{k_v}{n-1} \sum_{j=i-n}^{i-2} v_{rel\_j}$$

Restrictive acceleration

$$a_{ref\_CACC} = \min(a_{ref\_v}, a_{ref\_d})$$

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