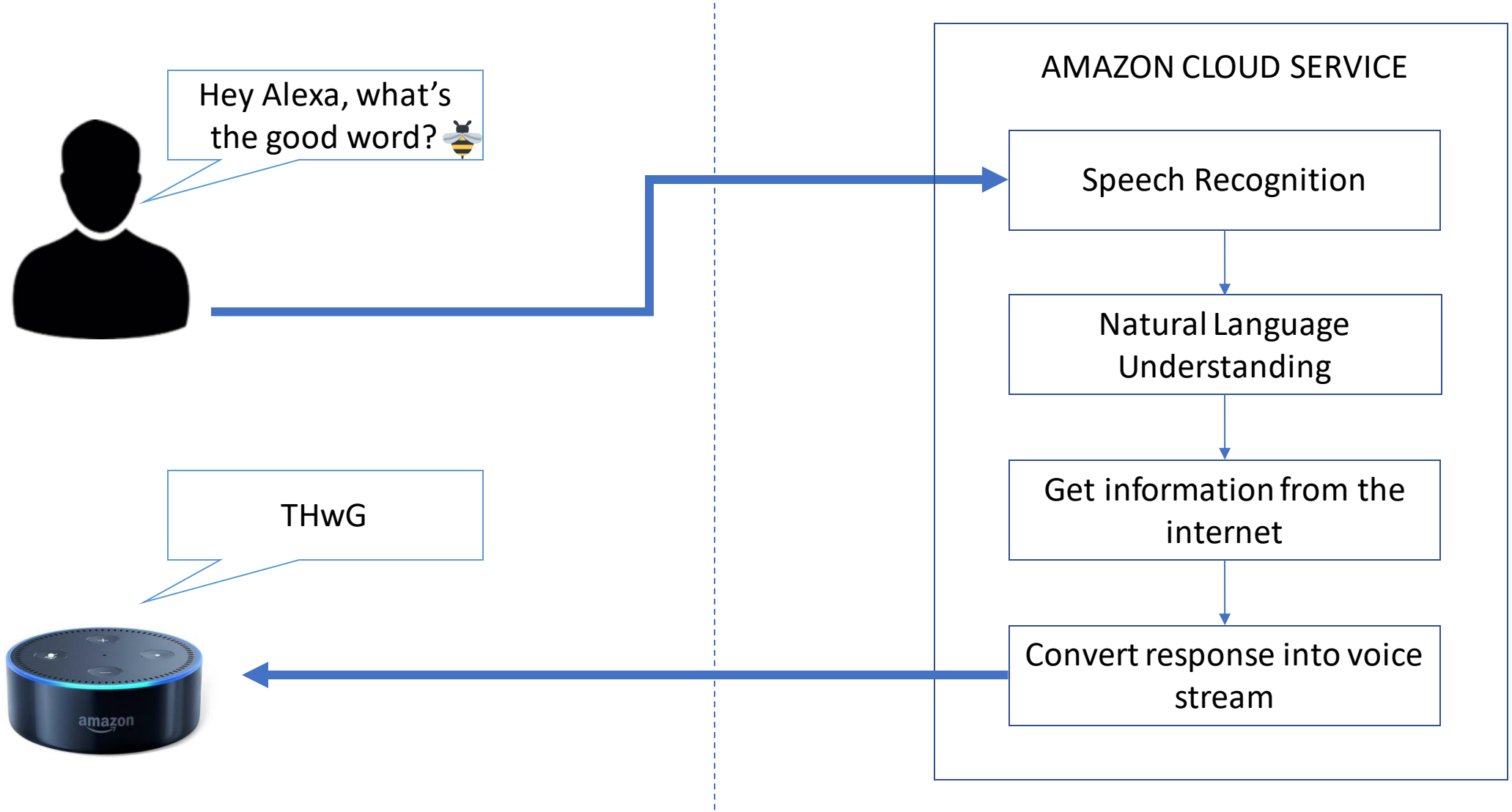
A system for tracking all vehicles all the time at the "Edge of the Network"

Harshil Shah

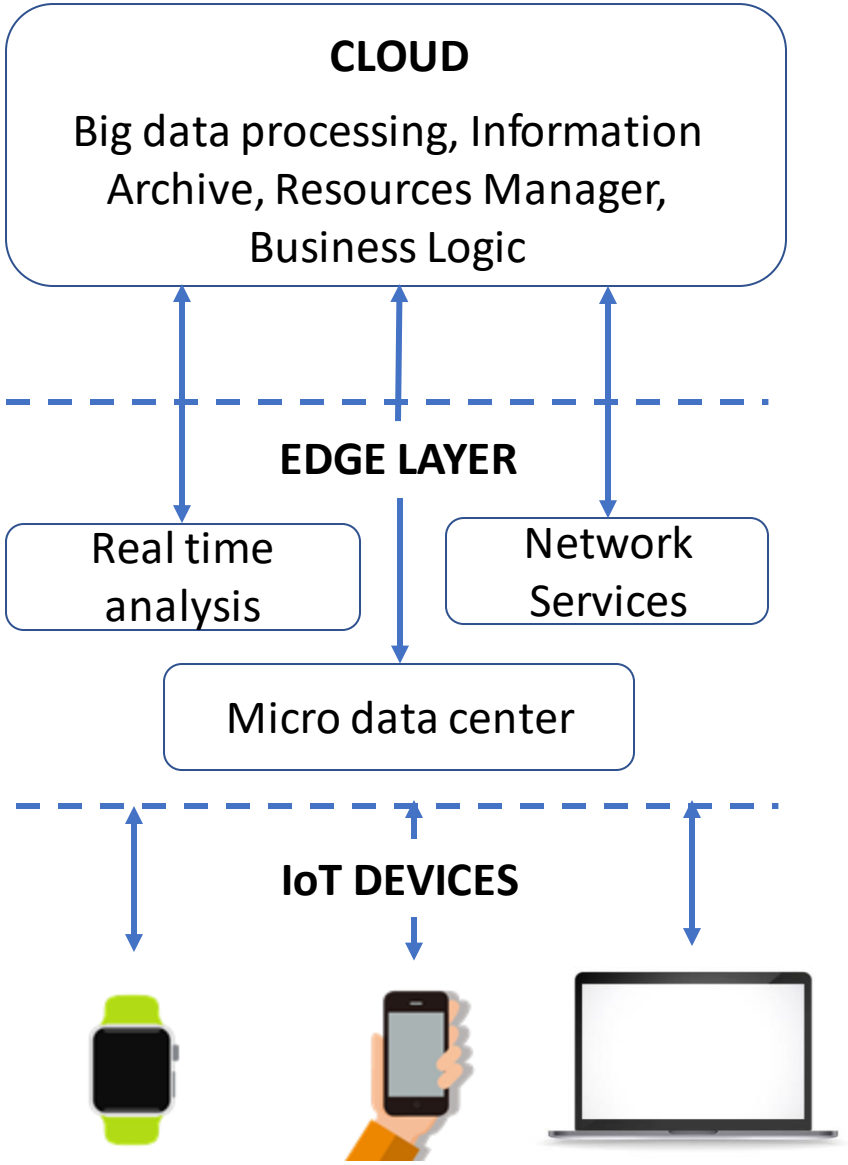
Mentors: Dr. Umakishore Ramachandran, Ph.D Zhuangdi Xu

What is "Edge of the Network"?



What is "Edge of the Network"?

- Extend cloud's resources to the edge nodes.
- Decentralize data gathering, analysis, and computations.
- Alleviate latency involved in exchanging information with the cloud because of geographical proximity and network bandwidth.



Problem Statement and Motivation

- The current state of traffic surveillance system requires:
  - large storage space to save monitored streams
  - manual inspection for tracking suspicious vehicles
  - high latency

- The research proposes a novel way of:
  - leveraging Edge Computing to create a network of smart traffic cameras
  - storing space-time trajectories for optimum space usage and faster query responses.

- Existing technologies:
  - Alert-based traffic surveillance

Goals

- Create a Publish-Subscribe(Pub-Sub) policy for cameras in the network.
- Forward propagation of vehicle information.
- Automatic static camera topology management.

Technical Challenges

- Synchronization and singularity of information in the network.
- Ability to extract information from the video feed spontaneously using compute resources of the Edge node.

Pub-Sub Camera Communication Policy

- Each camera subscribes to a topic for receiving message.
- Each camera segregates messages into classes and publishes them on the queue.
- Message is the vehicle activity in the range of the camera.

Why Pub-Sub?

- To achieve loose coupling in the network of cameras.

Problem with Pub-Sub

- Performance declines with the growing size of the camera distribution.
- Broadcast leads into wasteful network bandwidth.

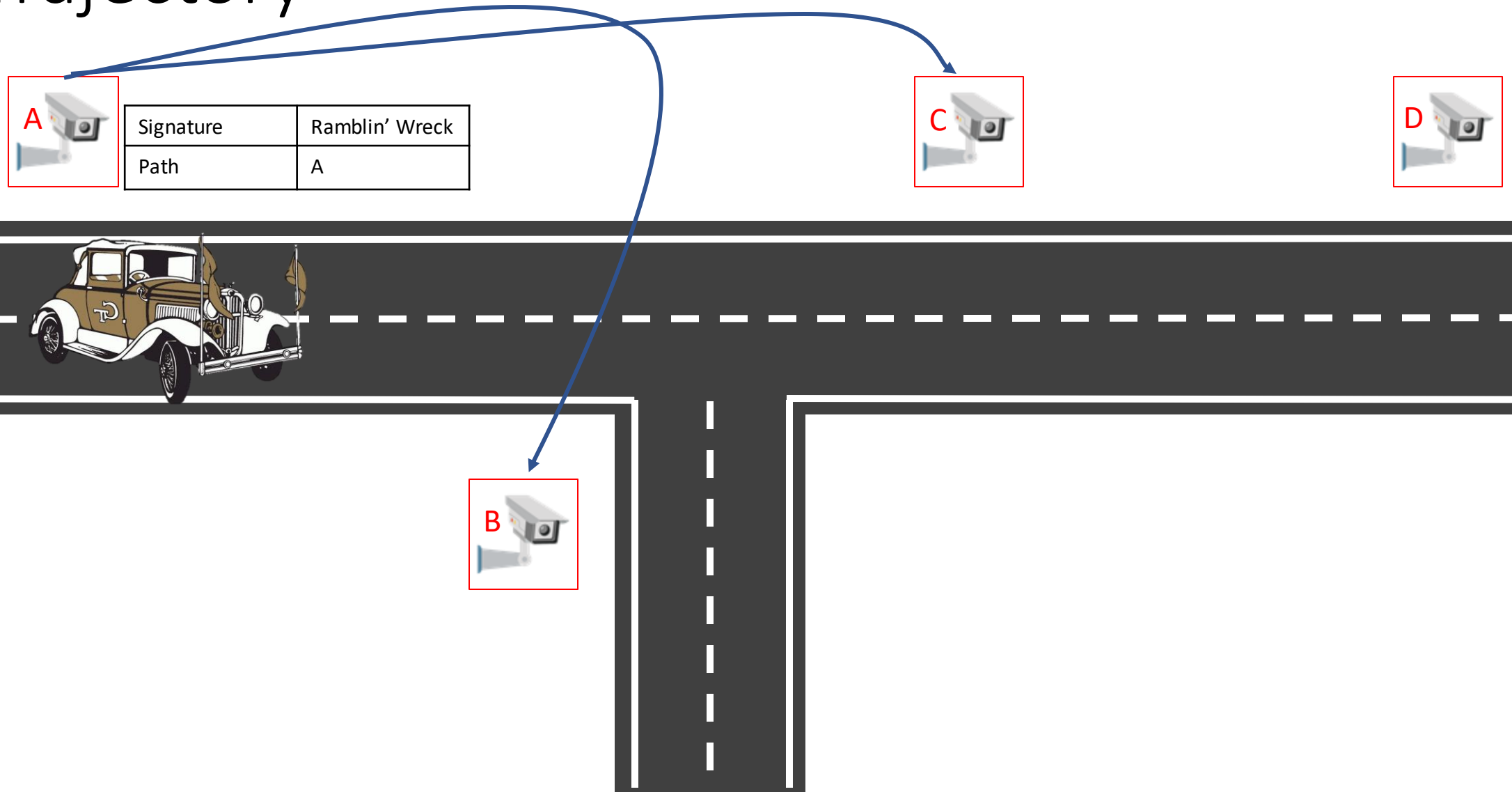
How do we address this problem?

- Forward Propagation in a geographically restricted region.

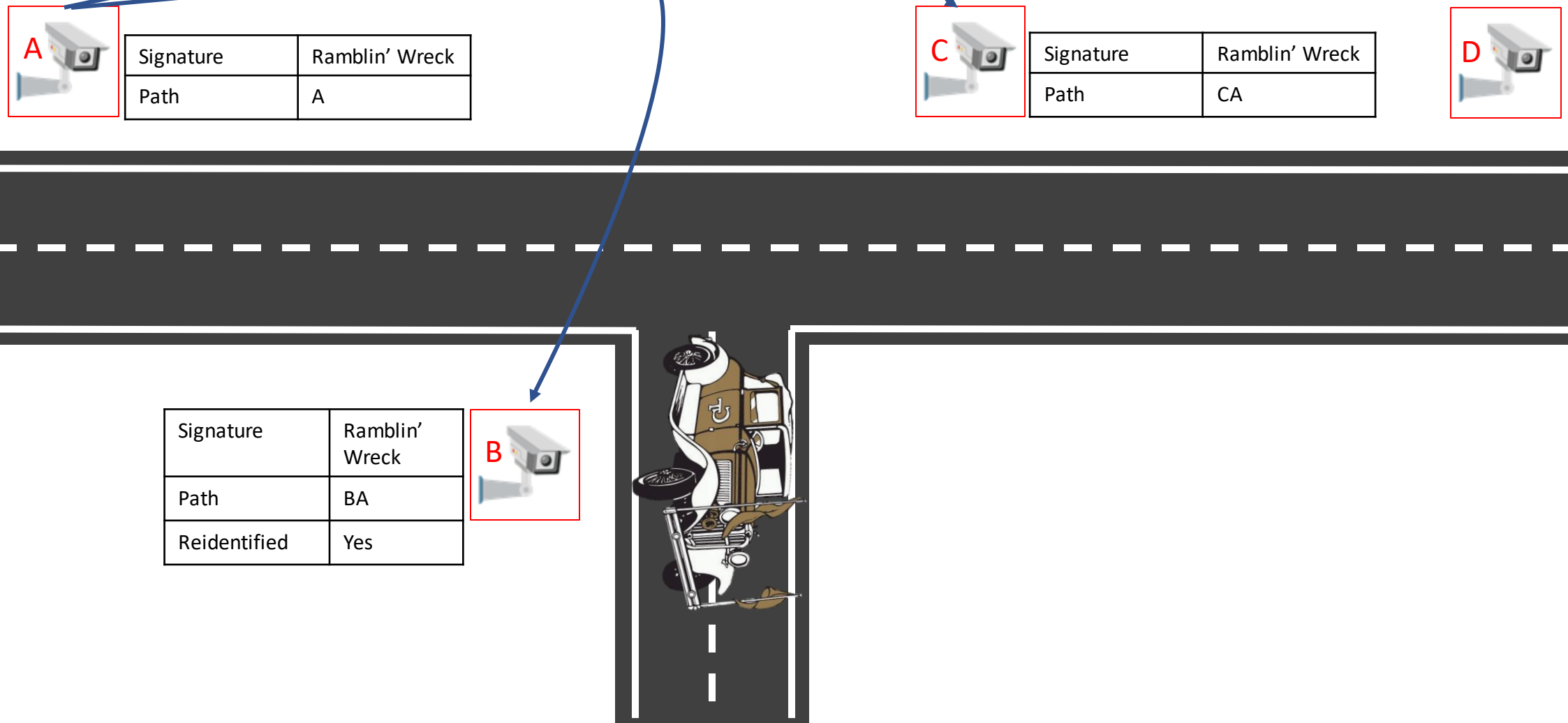
Forward Propagation

- Upon detection of a vehicle, the metadata is passed on to downstream cameras in a neighborhood to help with re-identification.
- The number of downstream cameras are finite in a given region for a particular camera.
- The current camera is appended to the partial trajectory of the vehicle to form its path.

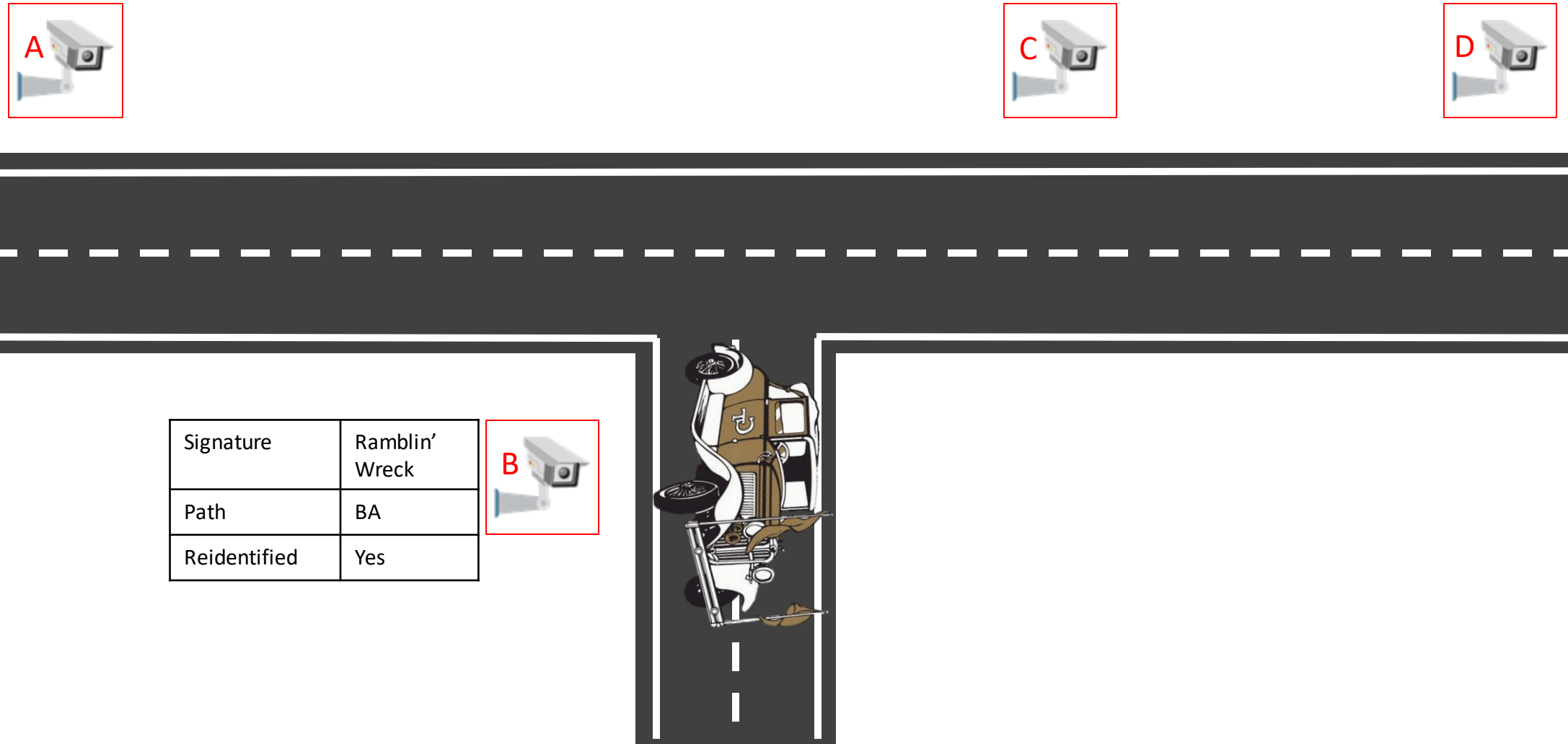
Forward Propagation To Generate Vehicle Trajectory



Forward Propagation To Generate Vehicle Trajectory



Forward Propagation To Generate Vehicle Trajectory

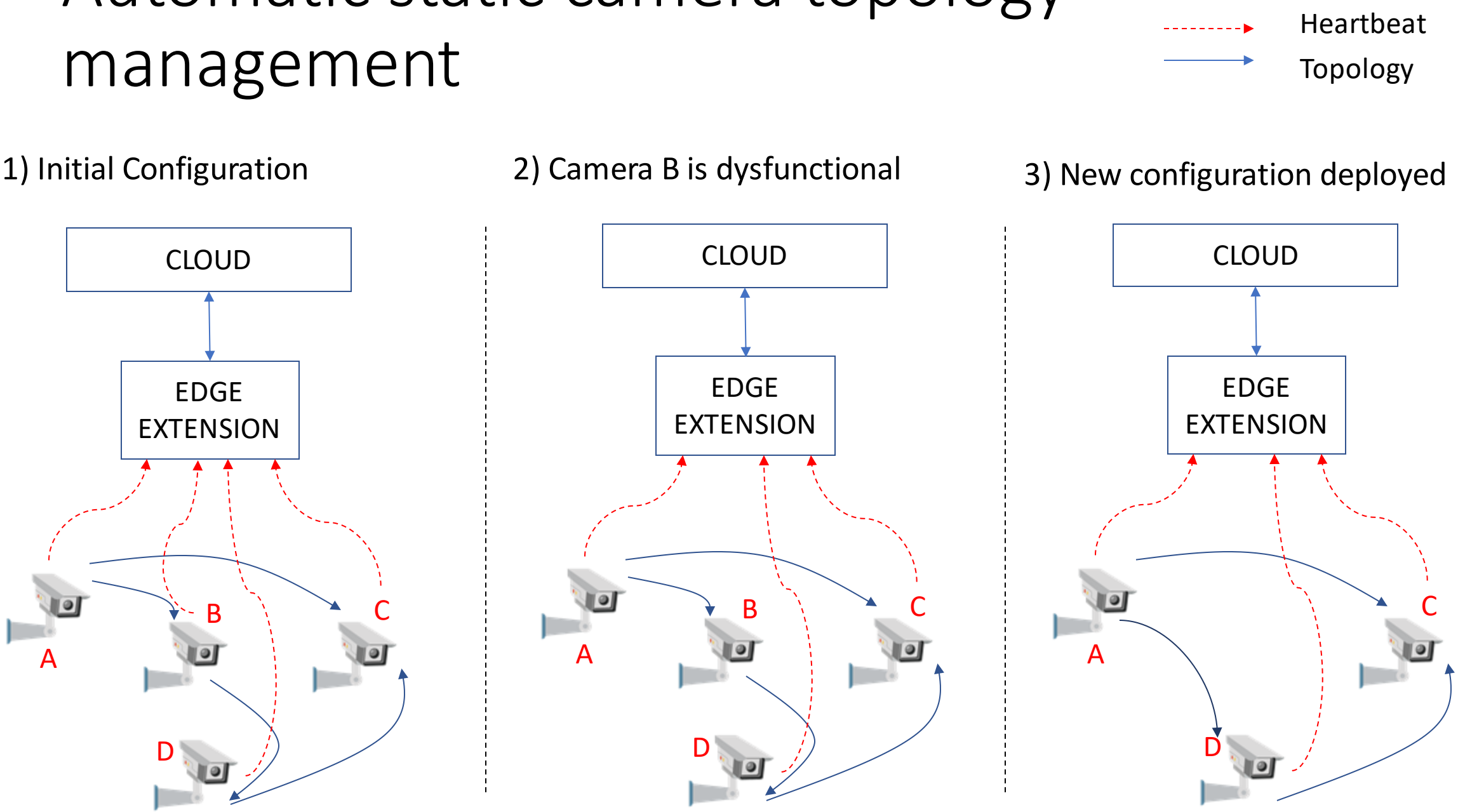


Signature	Ramblin' Wreck
Path	BA
Reidentified	Yes

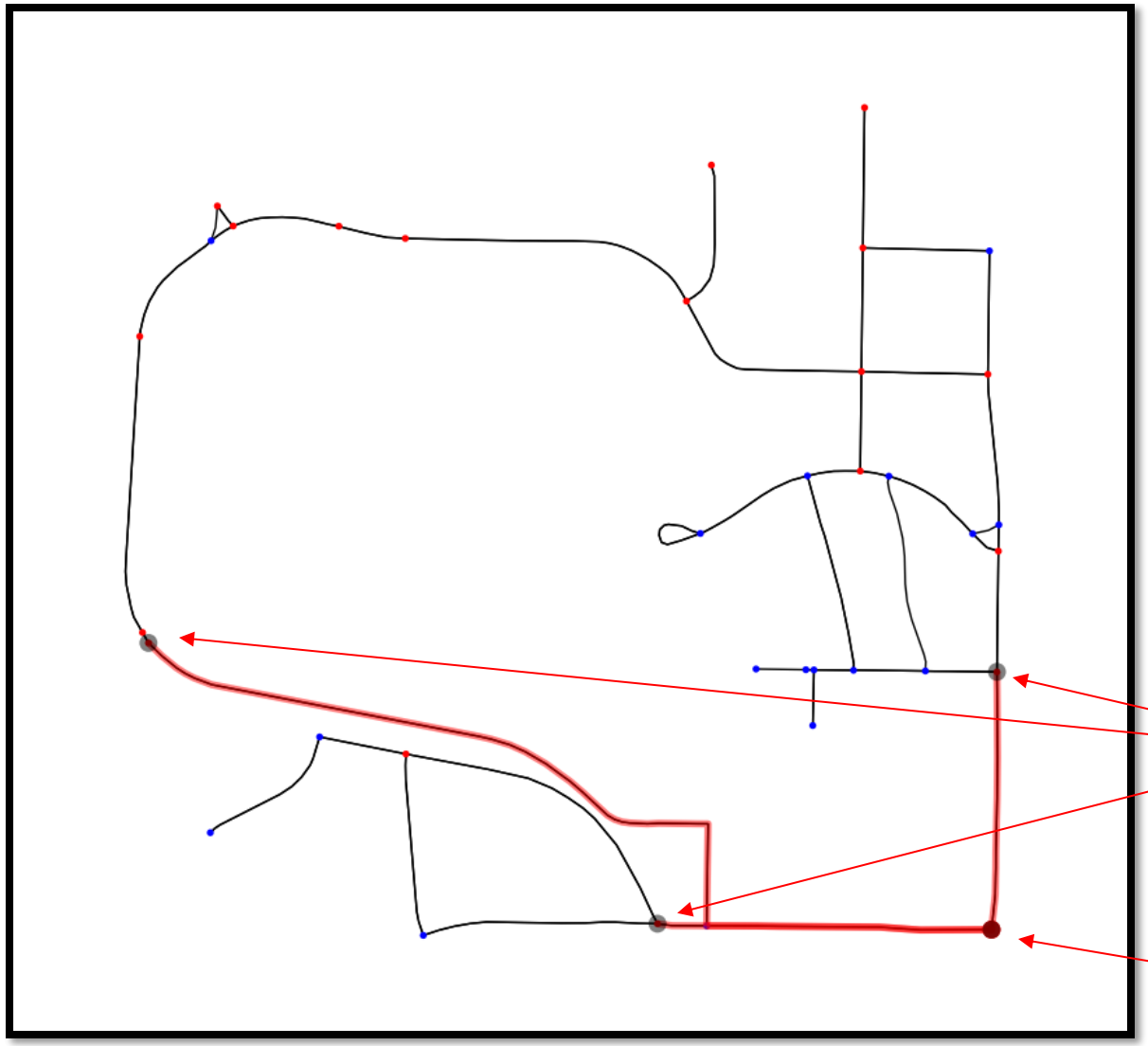
Automatic static camera topology management

- Because of technical errors, power failures, or other external factors, cameras in the network can stop working.
- The network needs to take corrective action to operate smoothly irrespective of the dysfunctional camera.

Automatic static camera topology management



Evaluation/Results



Python simulation result of forward propagation and automatic topology reorganization on the simplified map of Georgia Tech loaded with 37 cameras at all intersections

Notified Cameras

Vehicle detection

Future Work

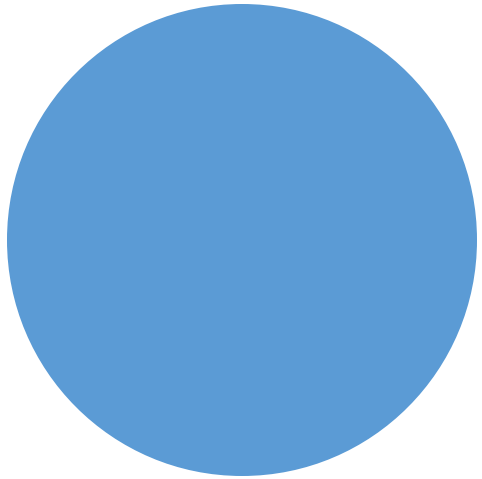
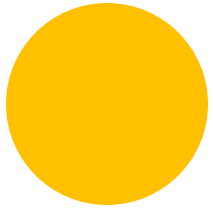
- Extend the idea of static camera topology management to that of moving cameras on emergency vehicles.
- Improving camera network performance horizontally by leveraging distributed/grid computing.
- Extending cloud first services like Cassandra, Amazon ElasticSearch, Kafka etc. to operate on Edge.

Conclusion

- Recent implementation of Edge Computing: Google Stadia

- Edge computing will provide high performance in this time-sensitive, geo-distributed application of this vehicle tracking system.

QUESTIONS?

THANK YOU!