MEC-based Stable Topology Prediction for Vehicular Networks

Blueprint

Asif Mehmood, Afaq Muhammad, Wang-Cheol Song, Taekyung Lee

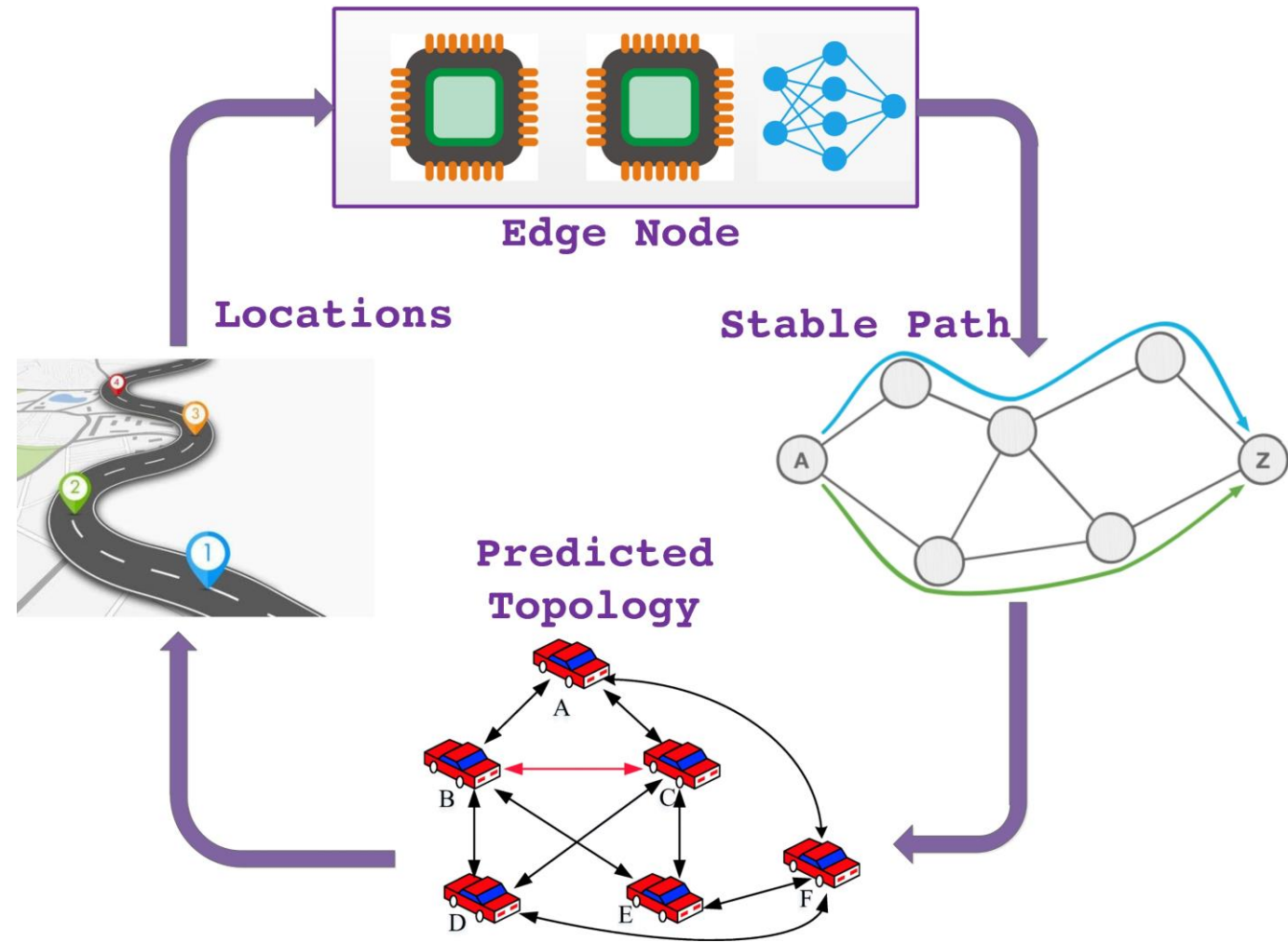Jeju National University, ATTO Research

AKRAINO

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Motivation
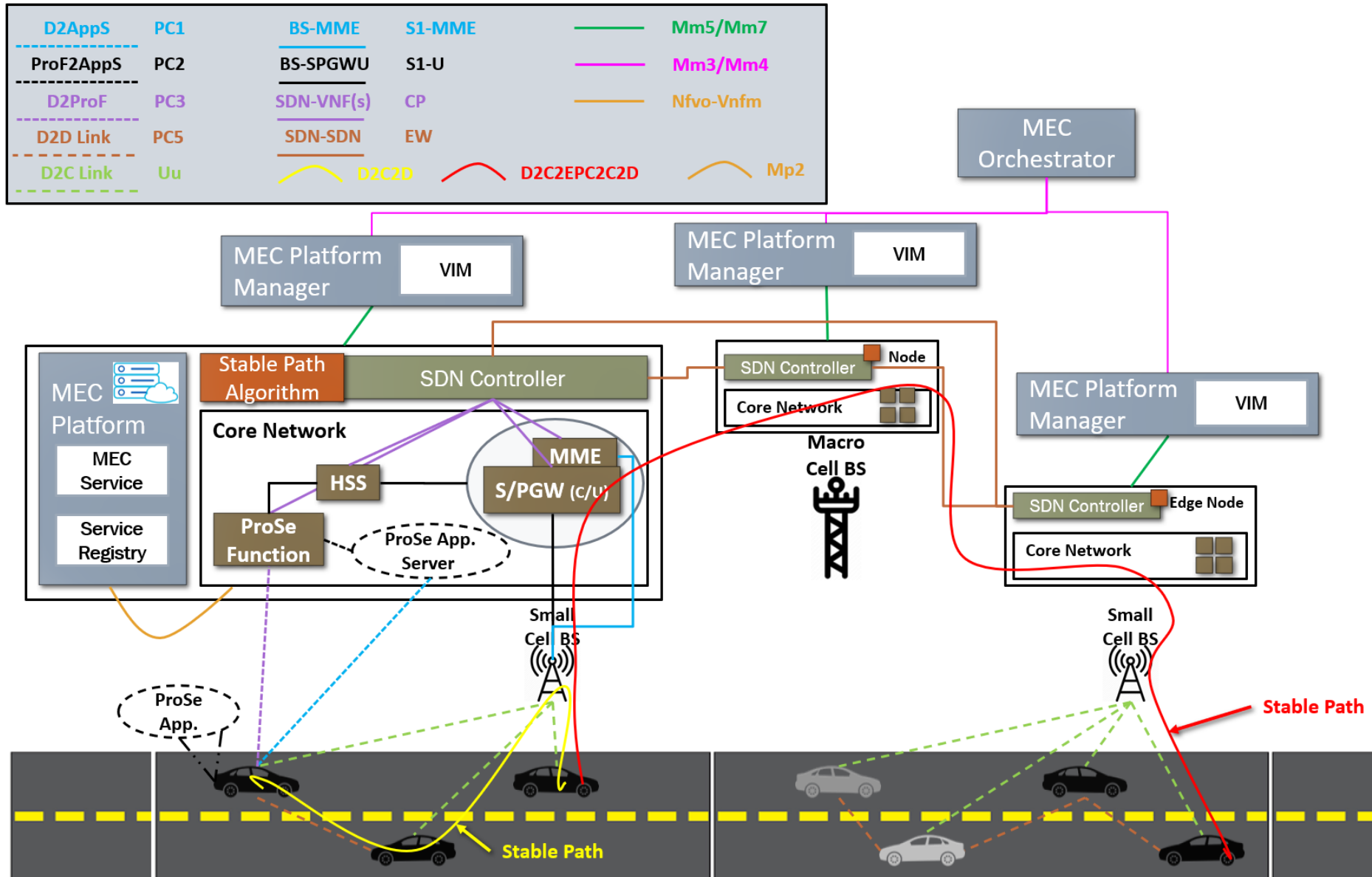
Motivational aspects are:

- The topology in a vehicular network is updated and retrieved frequently
    - This causes path instability
- Vehicular networks are wireless
    - However, Software-defined networking (SDN) is originally designed for wired networks
- Leads to the need for topology stability in vehicular networks
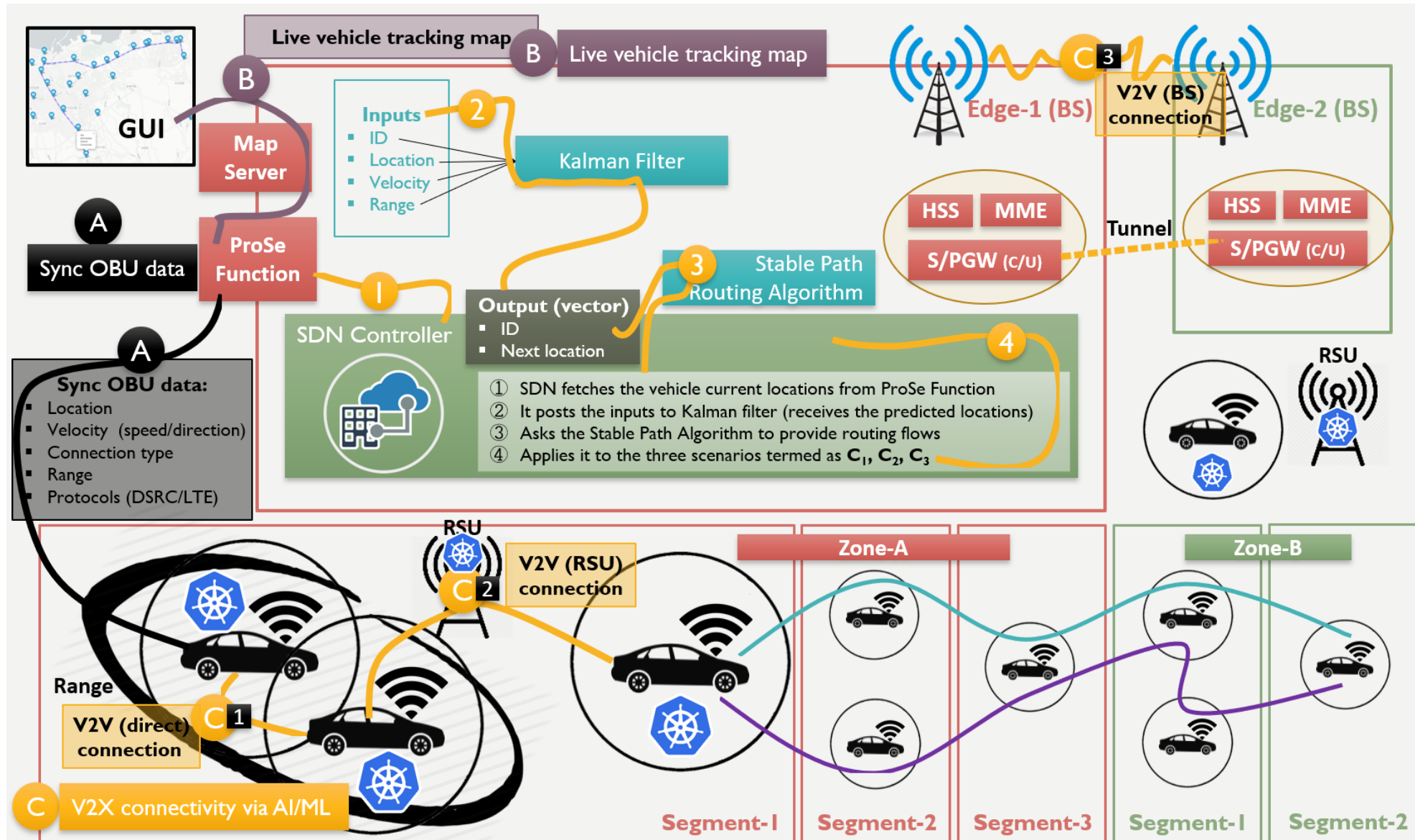
To this end, we introduce:

- Computation at the Edge
- Topology prediction to proactively stabilize the paths in vehicular network
- Proximity Services

Edge Node

Locations

Stable Path

Predicted Topology

Architecture Overview

Architecture In depth

Live vehicle tracking map

B Live vehicle tracking map

GUI

Map Server

Inputs
- ID
- Location
- Velocity
- Range

2 Kalman Filter

A Sync OBU data

ProSe Function

1

3 Stable Path Routing Algorithm

Output (vector)
- ID
- Next location

SDN Controller

A Sync OBU data:
- Location
- Velocity (speed/direction)
- Connection type
- Range
- Protocols (DSRC/LTE)

① SDN fetches the vehicle current locations from ProSe Function
② It posts the inputs to Kalman filter (receives the predicted locations)
③ Asks the Stable Path Algorithm to provide routing flows
④ Applies it to the three scenarios termed as C_1, C_2, C_3

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Edge-1 (BS)

C 3 V2V (BS) connection

Edge-2 (BS)

HSS **MME** **S/PGW** (C/U)

Tunnel

HSS **MME** **S/PGW** (C/U)

RSU

RSU

C 2 V2V (RSU) connection

Zone-A

Zone-B

Range

C 1 V2V (direct) connection

C V2X connectivity via AI/ML

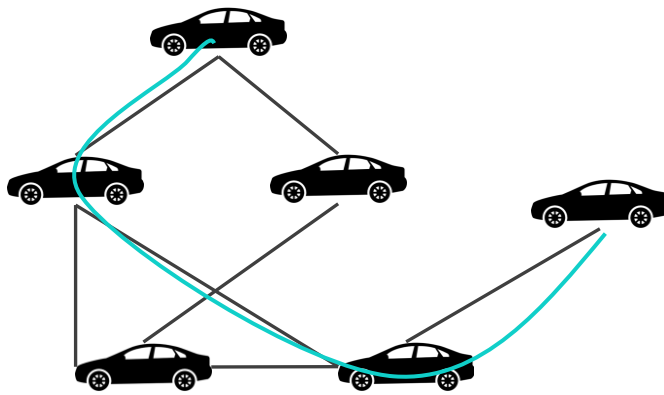Segment-1   Segment-2   Segment-3   Segment-1   Segment-2

Stable network topology in IoV (Attributes)
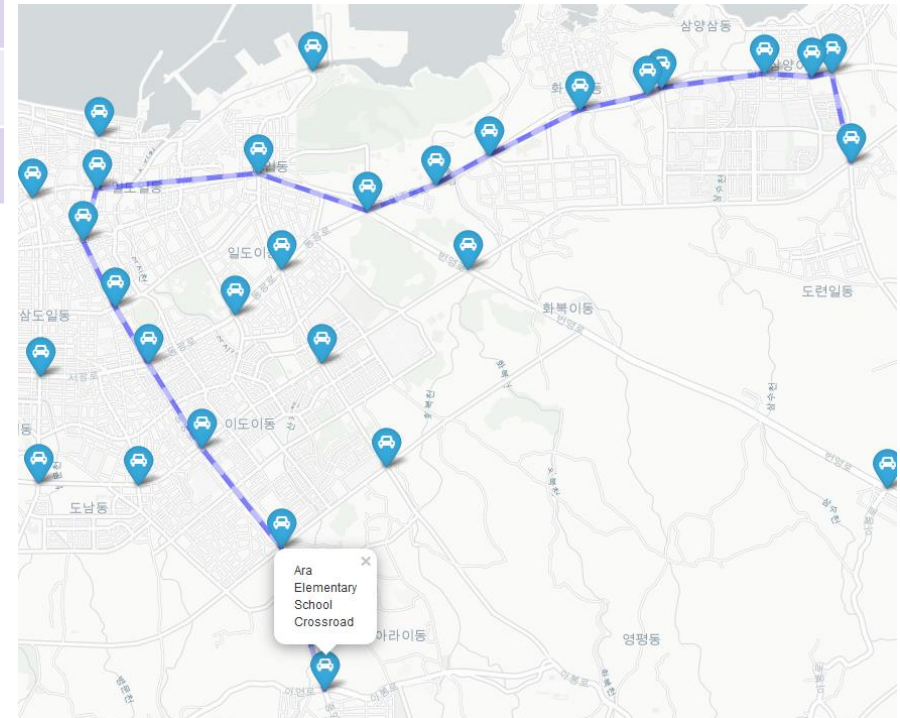
Stable network topology in IoV
Stable network for vehicle communication
Reliability of network connectivity for a longer time period
Less routing management overhead

Stable network topology

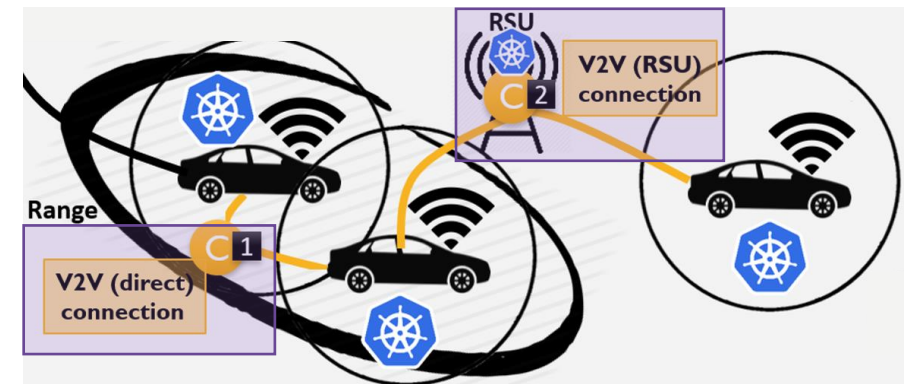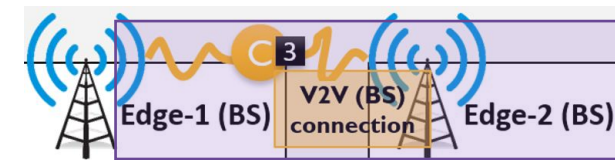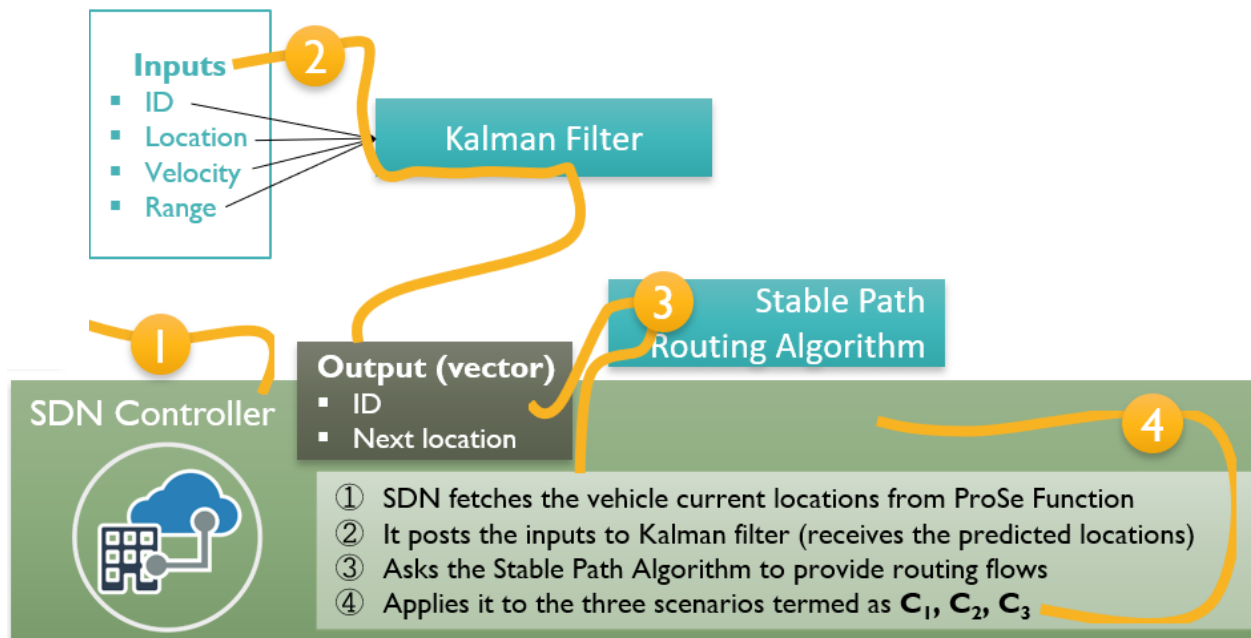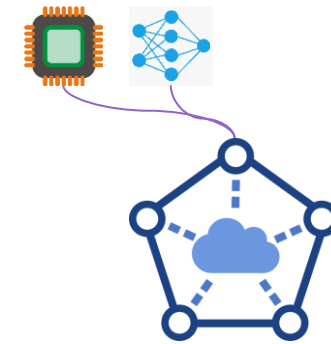# Road aware, proactive, and proactive connection (Attributes)

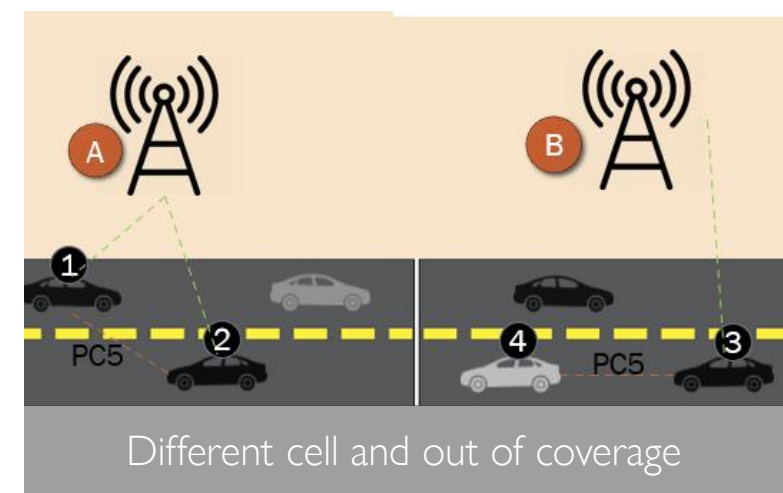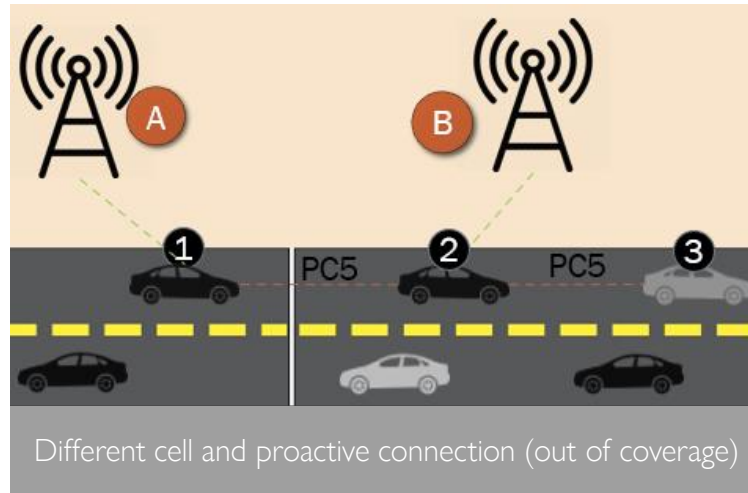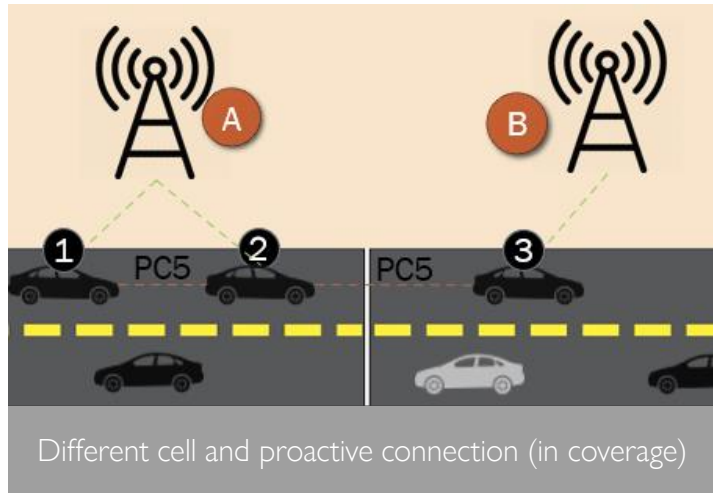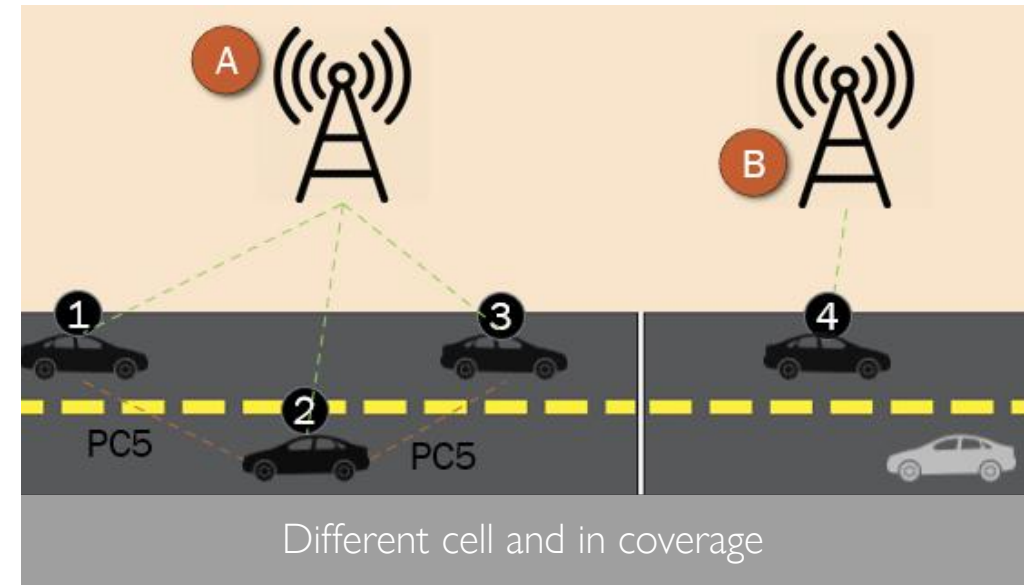| Road aware, predictive and proactive connection |
| --- |
| The network management is road aware |
| Machine learning based prediction is used in this work |
| The connection is reestablished before unavailability |
| Different connectivity scenarios |

Inputs
- ID
- Location
- Velocity
- Range

② → **Kalman Filter**

③ **Stable Path Routing Algorithm**

① **SDN Controller**

Output (vector)
- ID
- Next location

① SDN fetches the vehicle current locations from ProSe Function
② It posts the inputs to Kalman filter (receives the predicted locations)
③ Asks the Stable Path Algorithm to provide routing flows
④ Applies it to the three scenarios termed as C_1, C_2, C_3

Edge-1 (BS) — **C 3** V2V (BS) connection — Edge-2 (BS)

RSU — **C 2** V2V (RSU) connection

Range — **C 1** — V2V (direct) connection

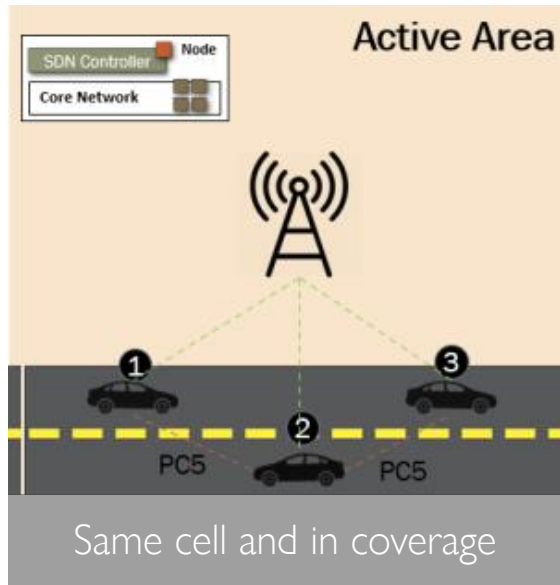# Stable Path Scenarios

#	Cell	In Coverage/ Partial Coverage	Description
1	Same	In Coverage	Cellular assisted D2D
2		Partial Coverage	Cellular assisted D2D/Cellular
3	Different	In Coverage	Cellular assisted
4			Road aware D2D
5		Partial Coverage	Cellular assisted D2D/Cellular
6			Road aware D2D

Stable Path Scenarios

Same cell and in coverage

Same cell and out of coverage

Different cell and in coverage

Different cell and proactive connection (in coverage)

Different cell and proactive connection (out of coverage)

Different cell and out of coverage

Progress

Containers

- Proximity Service
- Map
- Vehicle (container)
- …

Documentation

- Approach to implement / Software to use
- Tasks to do
- Introduction / Architecture
- Implementation Plan
- References
- Contributors

Major tasks

- Prepared Dataset
- Created Edge systems
- Predicting Locations
- SDN Controller config. with CNI
- Routing Algorithm
- Deployment of EPC
- Deployment scripts
- Integration with LF servers

Contributors

#	Name	Company	Email (Contact)	Profiles
1	Asif Mehmood	Jeju National University	malikasifmahmoodawan@gmail.com	
2	Afaq Muhammad	Jeju National University	afaq@jejunu.ac.kr	
3	Wang-Cheol Song	Jeju National University	philo@jejunu.ac.kr	
4	Taekyung Lee	ATTO Research	taekyung.lee@atto-research.com	

References

- ATTO Research

- Website - Akraino

- Wiki - Akraino

- Gerrit - Akraino

- Mailing lists - Akraino

- Blueprints - Akraino

- Calendars – Akraino

- Meeting ID: 921 3175 4772
  Passcode: 276820
  Time:
  - KST 11:00 AM – 11:30 AM
  - PST 6:00 PM – 6:30 PM