MEC-based Stable Topology Prediction for Vehicular Networks

Blueprint

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

Jeju National University, ATTO Research

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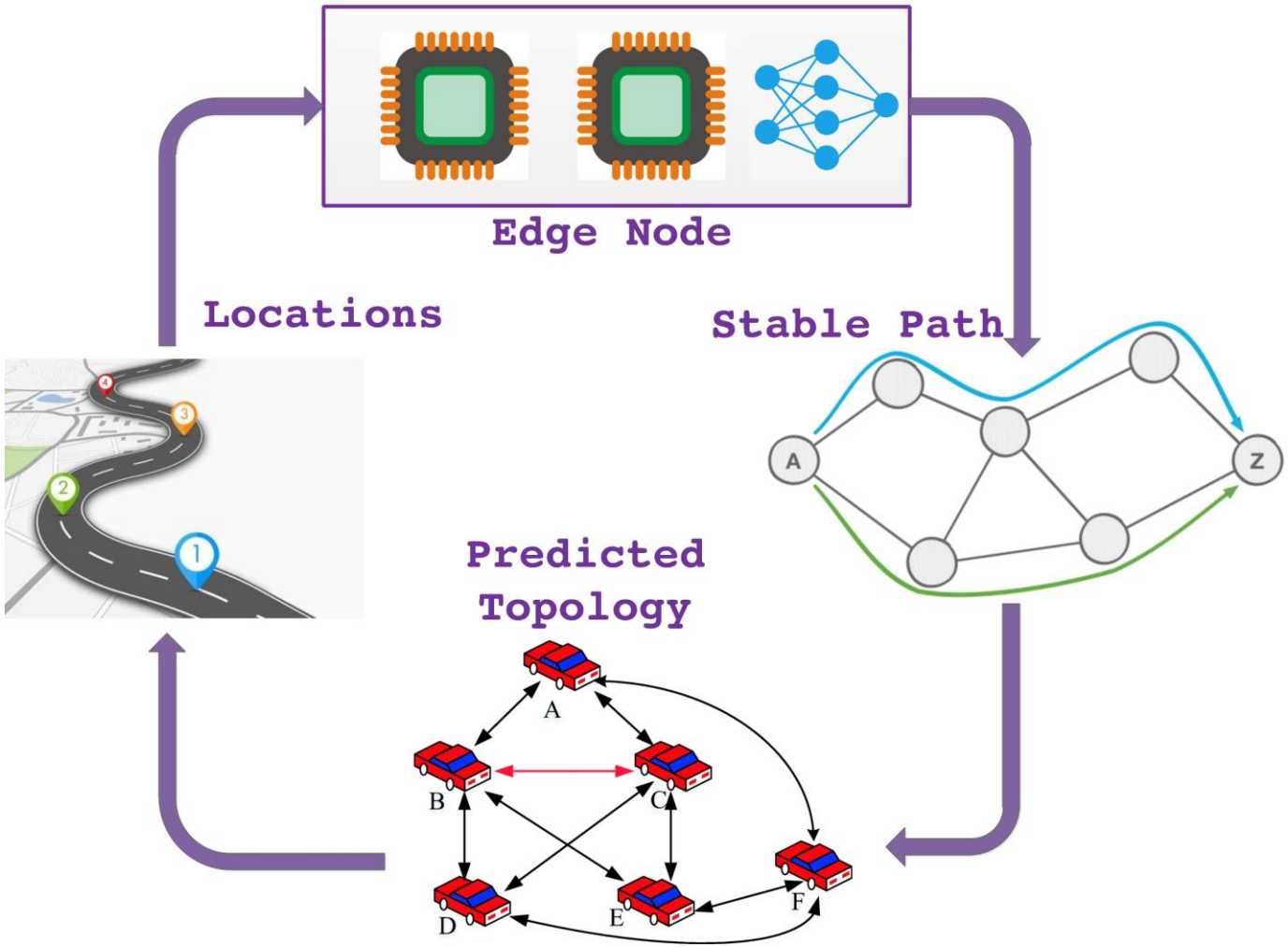
Motivation

Motivational aspects are:

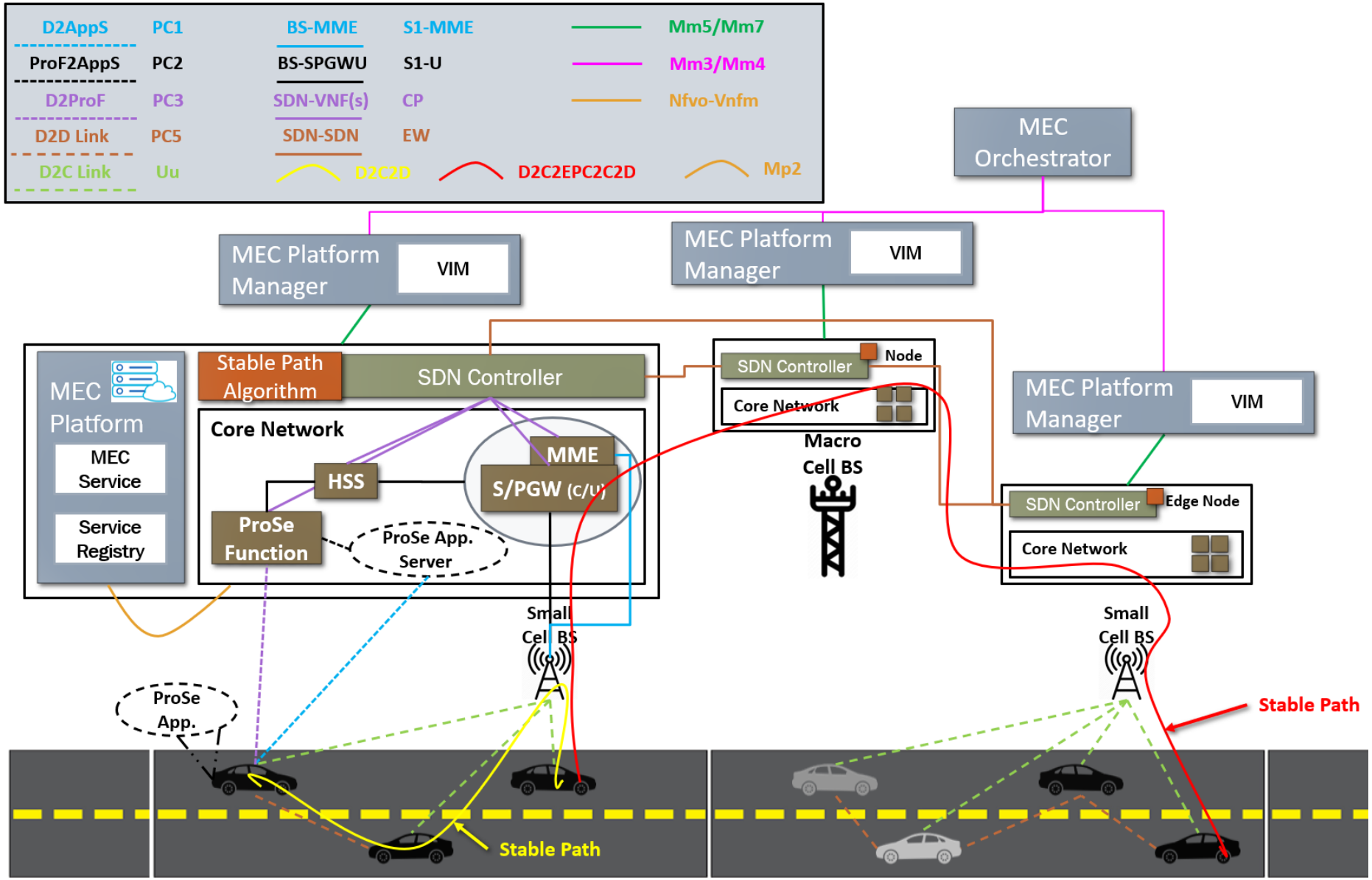
- The topology in a vehicular network is updated and retrieved frequently
  - This causes path instability
- Vehicular networks are wireless
  - However, Software-defined networking (SDN) is originally designed for wired networks
- Leads to the need for topology stability in vehicular networks

To this end, we introduce:

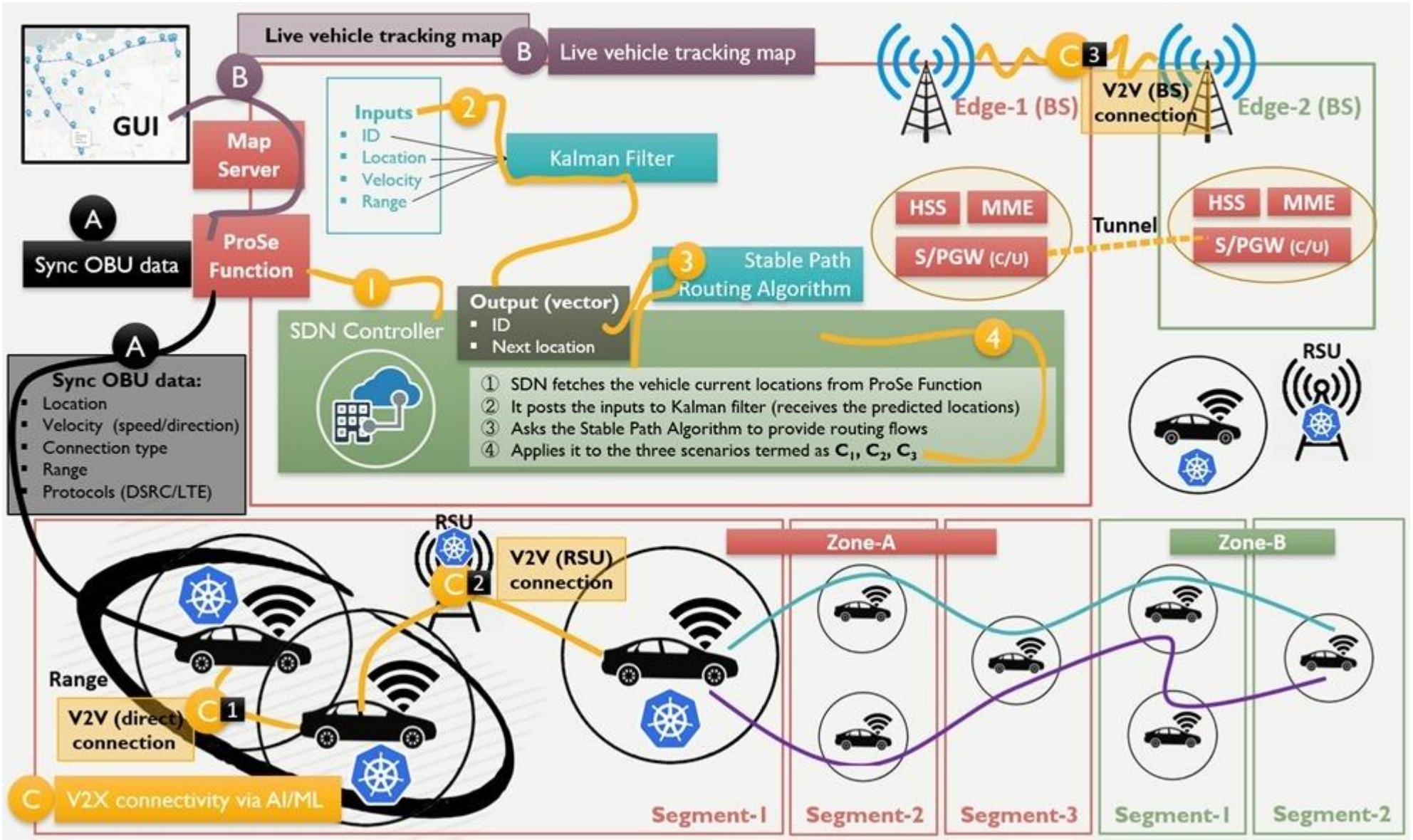
- Computation at the Edge
- Topology prediction to proactively stabilize the paths in vehicular network
- Proximity Services



Architecture Overview

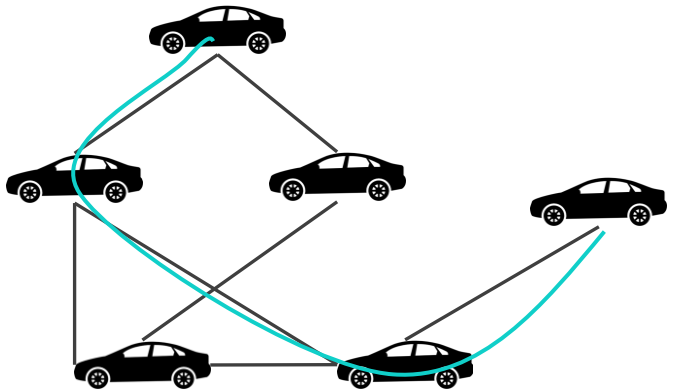


Architecture In depth

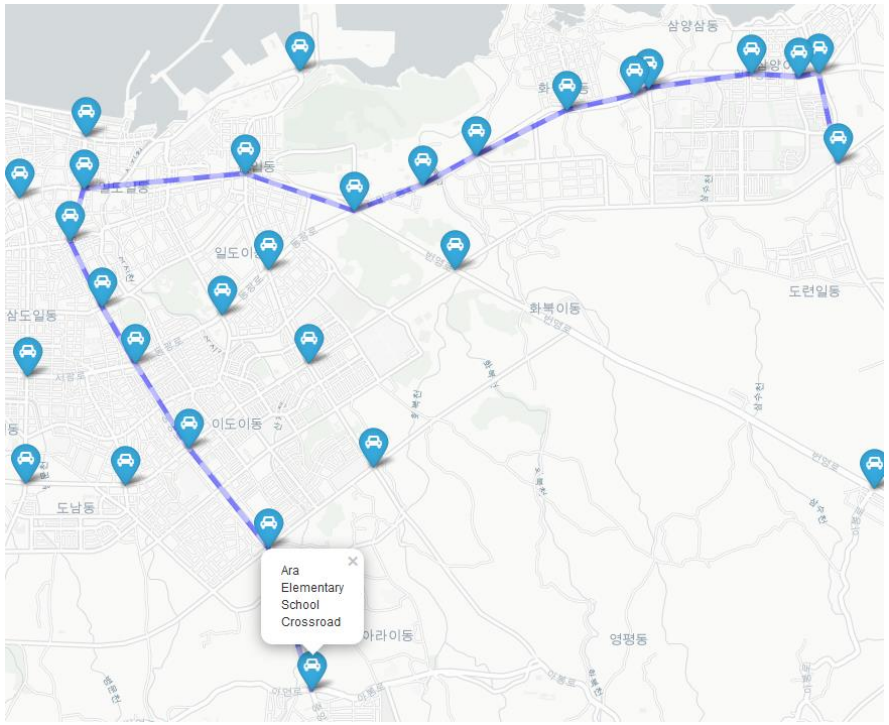


Stable network topology in IoV (Attributes)

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

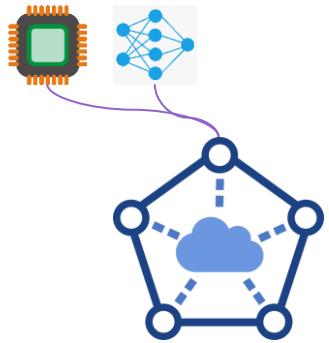


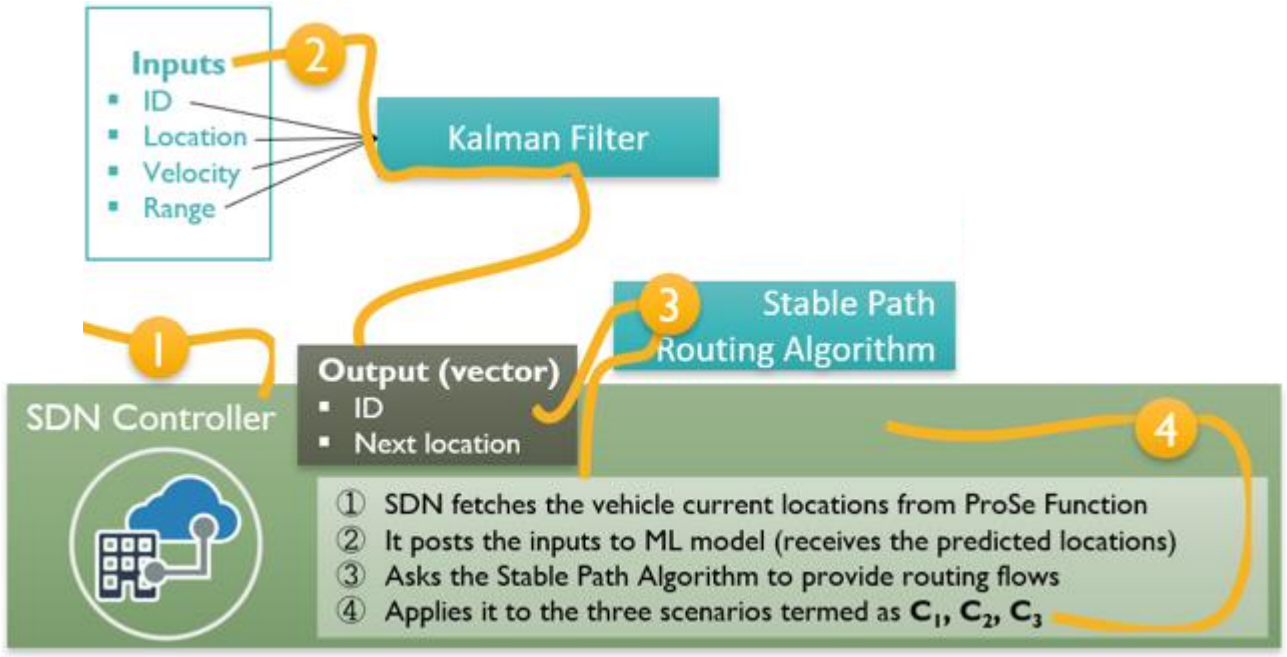
Stable network topology

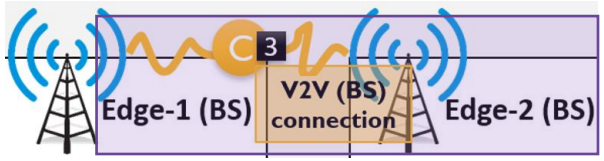


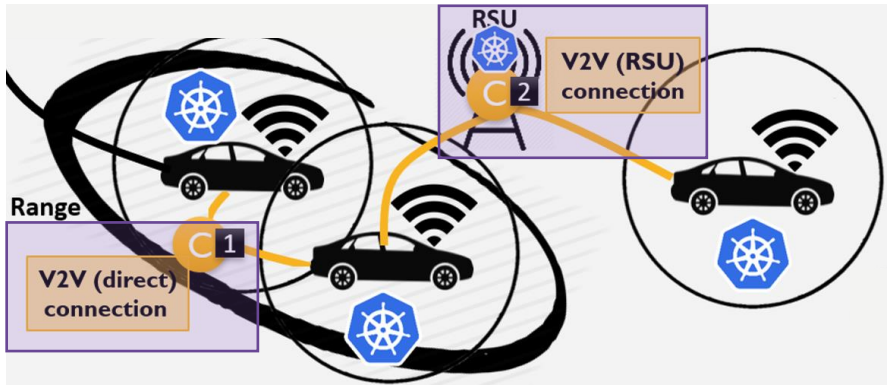
Road aware, proactive, and proactive connection (Attributes)

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





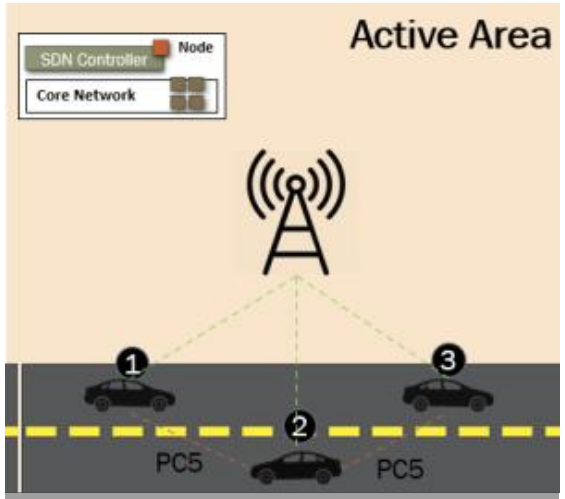




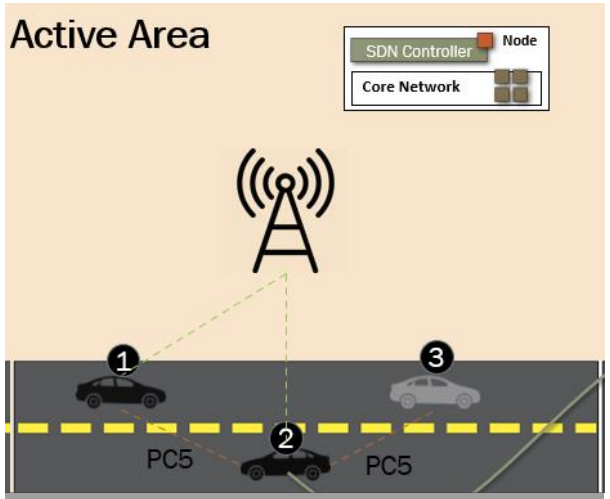
Stable Path Scenarios

#	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 

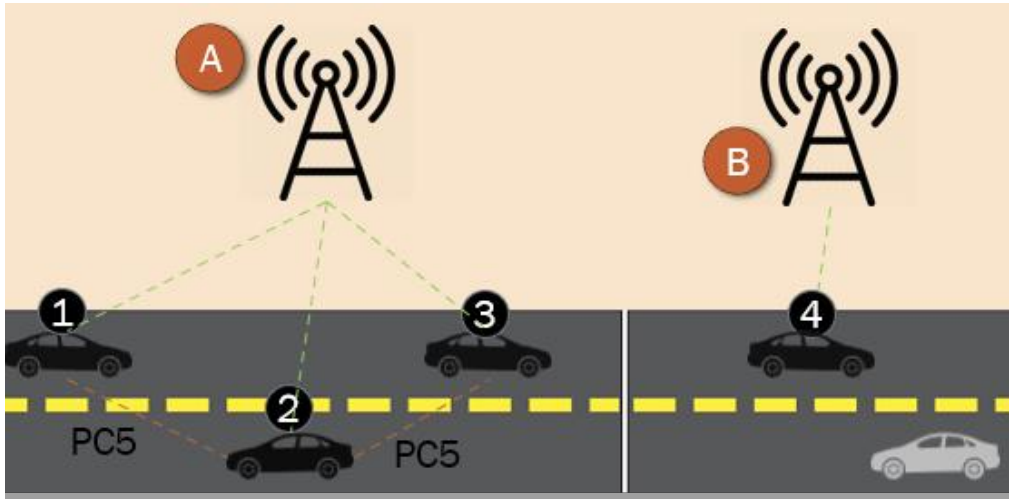
Stable Path Scenarios



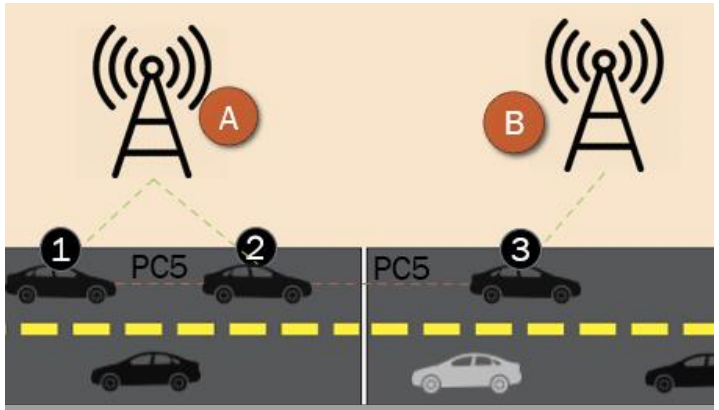
Same cell and in coverage



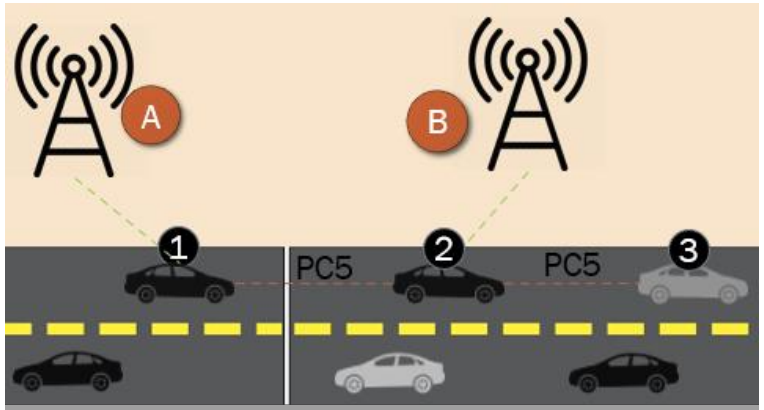
Same cell and out of coverage



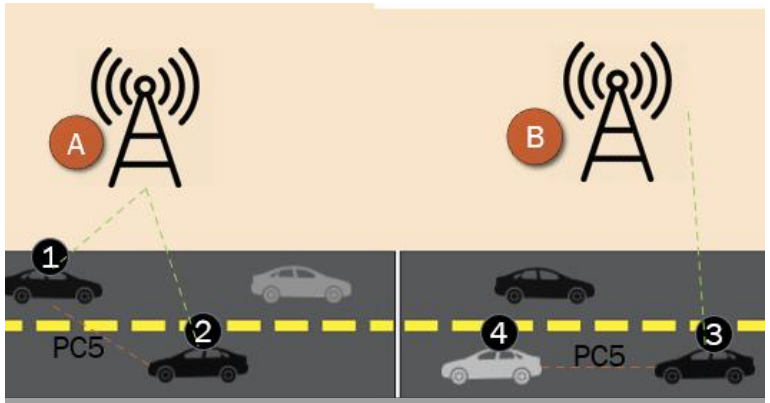
Different cell and in coverage



Different cell and proactive connection (in coverage)

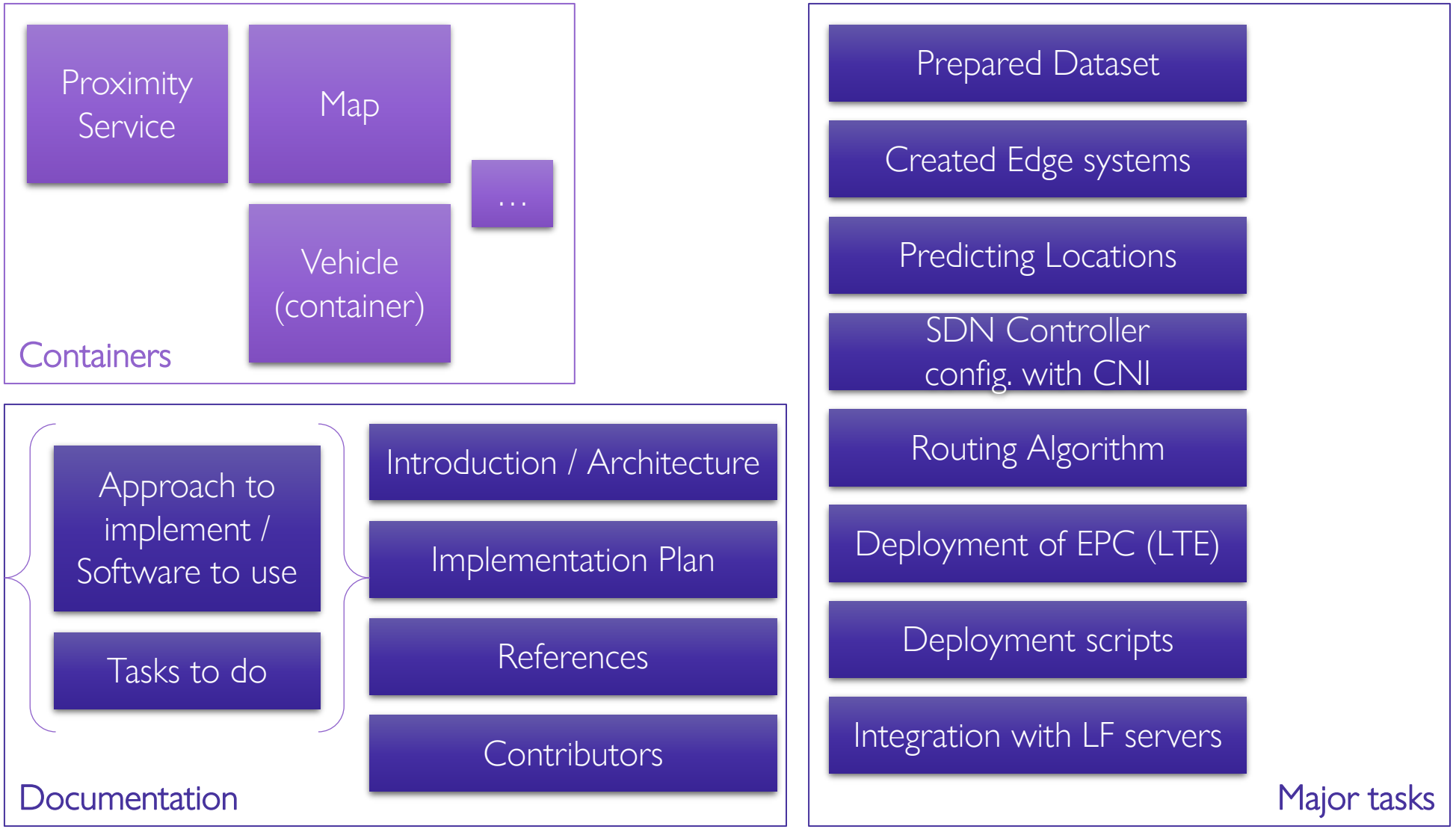


Different cell and proactive connection (out of coverage)



Different cell and out of coverage

Progress


Proximity Service
Map
…
Vehicle (container)
Containers
Approach to implement / Software to use
Tasks to do
Introduction / Architecture
Implementation Plan
References
Contributors
Documentation
Prepared Dataset
Created Edge systems
Predicting Locations
SDN Controller config. with CNI
Routing Algorithm
Deployment of EPC (LTE)
Deployment scripts
Integration with LF servers
Major tasks

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

Proposal: MEC-based Stable Topology Prediction for Vehicular Networks

Use Case Attributes	Description	Informational
Type	New	The use case is proposed under the ICN BP family
Industry Sector	Area: SDN & NFV Company: ATTO RESEARCH University: Jeju National University Country: Republic of Korea	ATTO RESEARCH focuses on the problems related to networking and software technology for a better connection. It has created a technology that allows to build IT infrastructure and aims to grow into a 'Software-defined Infrastructure' company.
Business driver	The stable vehicular network is essential to enable various applications such as autonomous driving through VANETs. Proposed MEC architecture tends to enable a promising infrastructure where a stable network topology can be predicted locally to improve the network performance by providing intensive calculation for vehicles in the adjacent roads. Thus, converging the two concepts of MEC and topology prediction can provide a strong use case for the vehicular networks such as proactive path stabilization.	The MEC-based Efficient Routing Algorithm can provide a stable path by using the predicted future position for the nearby vehicles. The information can also be made available to the adjacent road resulting from being useful to provide a stable topology on the road tracks.
Business use case	▪ Edge cloud deployable at RSUs to support applications such as ML-based location prediction, topology stabilization	

Proposal: MEC-based Stable Topology Prediction for Vehicular Networks

Use Case Attributes	Description	Informational
Business cost – Initial build	Minimal configuration is three servers in total: ▪ Master/Database node (1st server) ▪ Edge node 1 (2nd server) ▪ Edge node 2 (3rd server)	Price factor depends on the cost of RSU quality, and should be only considered for physical deployment. i.e. wireless or wired.
Business cost – Operational	Virtual environment does not require cost.	
Operational need	Using the frontend GUI to: ▪ Orchestrate virtual resources ▪ Manage the edge applications	
Additional details	▪ Support of path within a Single operator domain	PPT is attached as proposal statement.

Appendix: Assessment Criteria

Criteria	Edge Computing-based Stable Topology Prediction for Vehicular Networks
Each initial blueprint is encouraged to take on at least two committers from different companies.	Network Convergence Lab (Jeju National University), ATTO Research
Complete all templates outlined in this documents.	Detailed in this slide
A lab with exact configuration required by the blueprint to connect with Akraino CI and demonstrate CD. User should demonstrate either an existing lab or the funding and commitment to build the needed configuration.	Test facility will be provided by Atto Research laboratory
Blueprint is aligned with the Akraino Edge Stack Charter.	All open-source, Edge use case, Aligned with Akraino Charter
Blueprint is code that will be developed and used with Akraino repository should use only open source software components either from upstream or Akraino projects.	Yes, all open-source
For new blueprints submission, the submitter should review existing blueprints and ensure it is not a duplicate blueprint and explain how the submission differs. The functional fit of an existing blueprint for a use case does not prevent an additional blueprint being submitted.	MEC-based Stable Topology Prediction for Vehicular Networks does not exist in Akraino yet.
Name of the project is appropriate (no trademark issues etc.); Proposed repository name is all lower-case without any special characters.	MEC-based Stable Topology Prediction for Vehicular Networks
Project contact name, company, and email are defined and documents.	Prof. Wang-Cheol Song, Jeju National University (philo@jejunu.ac.kr) Dr. Afaq Muhammad, Jeju National University (afaq@jejunu.ac.kr) Mr. Taekyung Lee, ATTO Research (taekyung.lee@atto-research.com)
Description of the project goal and its purpose are defined.	Makes the management efficient and reduces the cost.
Scope and project plan are well defined.	Targeted for R5 release
Resource committed and available.	There is a team, resources and a lab in place.
Contributors identified.	Jeju National University, ATTO Research
Initial list of committers identified (elected/proposed by initial contributors).	Jeju National University
Meets Akraino TSC policies.	The project will operate in a transparent, open, collaborative and ethical manner all the time.
Proposal has been socialized with potentially interested or affected projects and/or parties.	Have already reached a consensus with sponsors.
Cross Project Dependencies.	VMs/Containers, OSM/OpenStack/Kubernetes/ONOS/ONAP/WeaveNet