MEC-based Stable Topology Prediction for Vehicular Networks

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Objectives of Blueprint

Problem:

- Vehicle-OBUs have different processing latency in sensors.

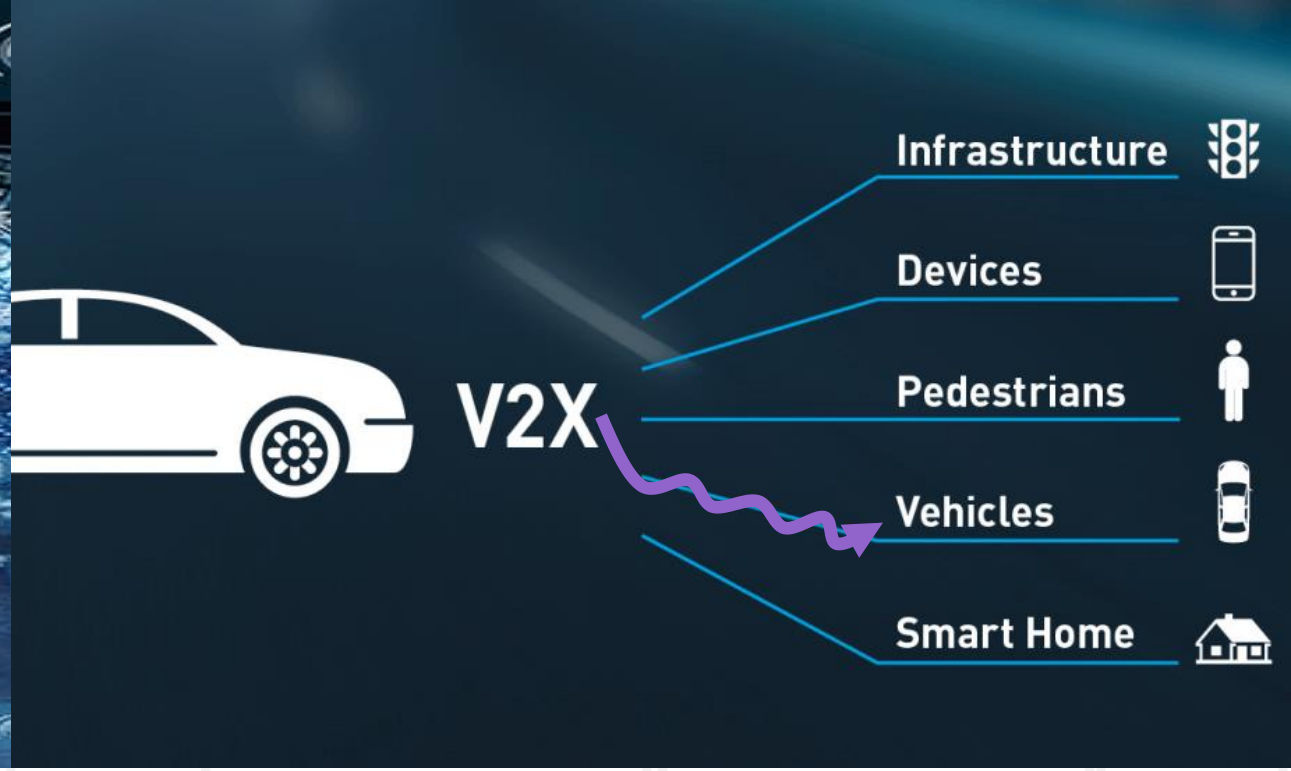
Solution:

At the edge:

- Predict the locations using Kalman filter (rectify the location coordinates)
- Expose the predicted information to edge applications

Use case:

- What? To orchestrate the resources required for vehicular networks at the edge.
- How? Proactive orchestration of the edge-resources for vehicular networks based on ML-based predicted resource utilization at the edge.

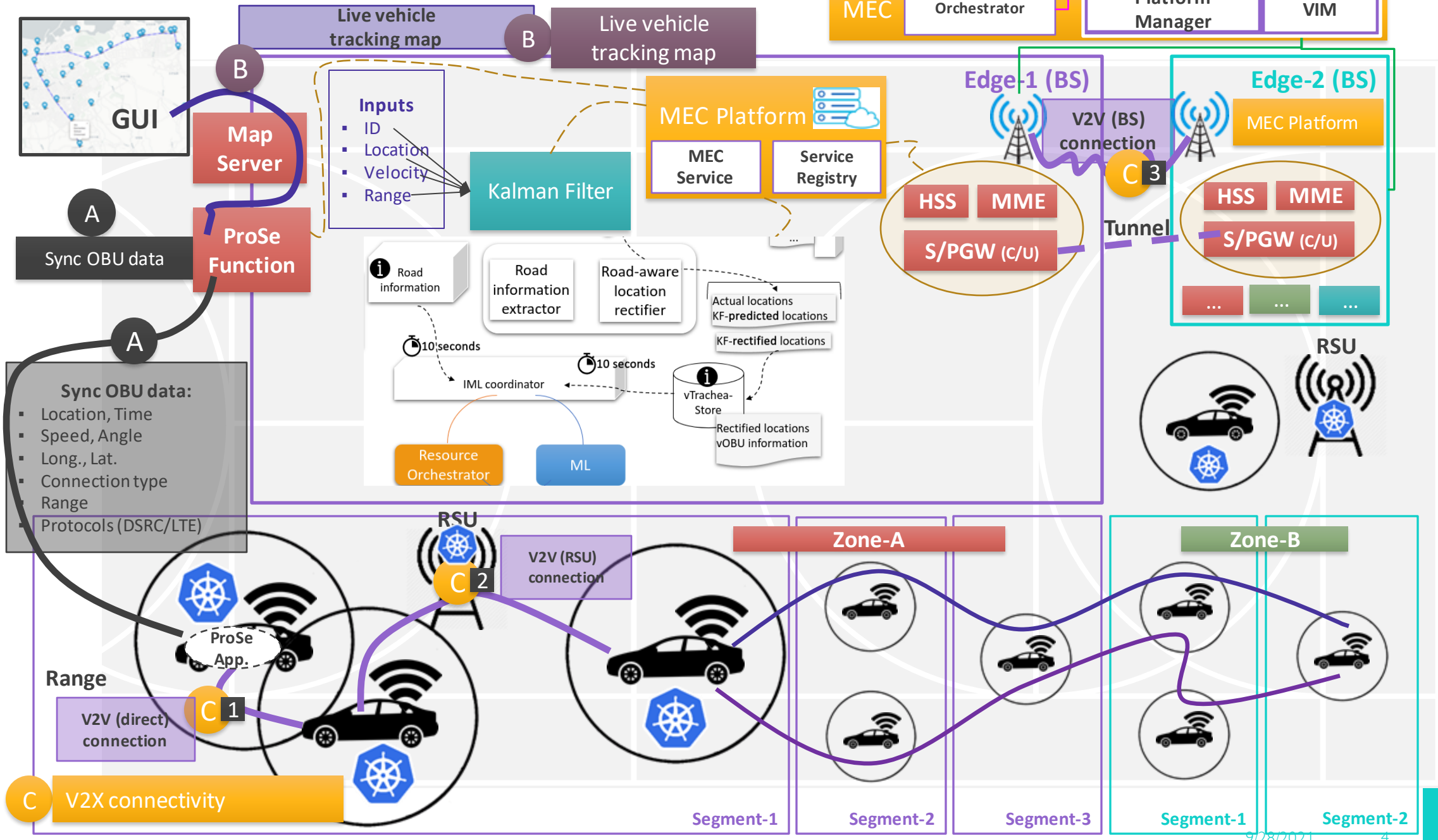


Automotive

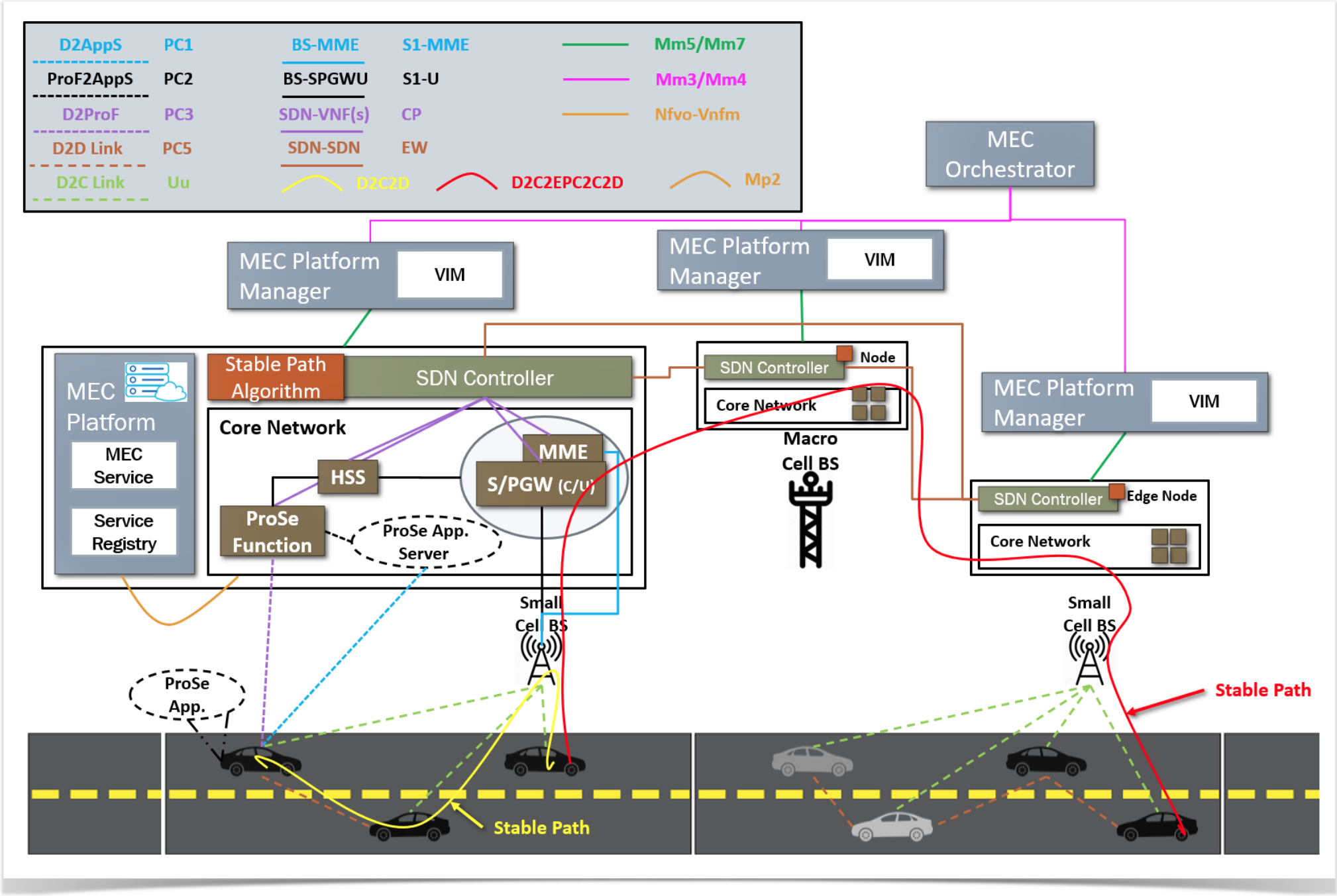
New cellular networks like 5G enables additional applications such as:

- Autonomous driving
- V2X communications

ARCHITECTURE



INTERFACES



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Datsa-set generation

Kalman filter prediction

Vehicle to edge **ProxAppServer** push mechanism

API exposure (on which vehicle-info will be pushed)

Road-info extraction mechanism

ERD design for storing road-info

Rectification procedure

Machine Learning Model (ML)

Resource Orchestration (RO)

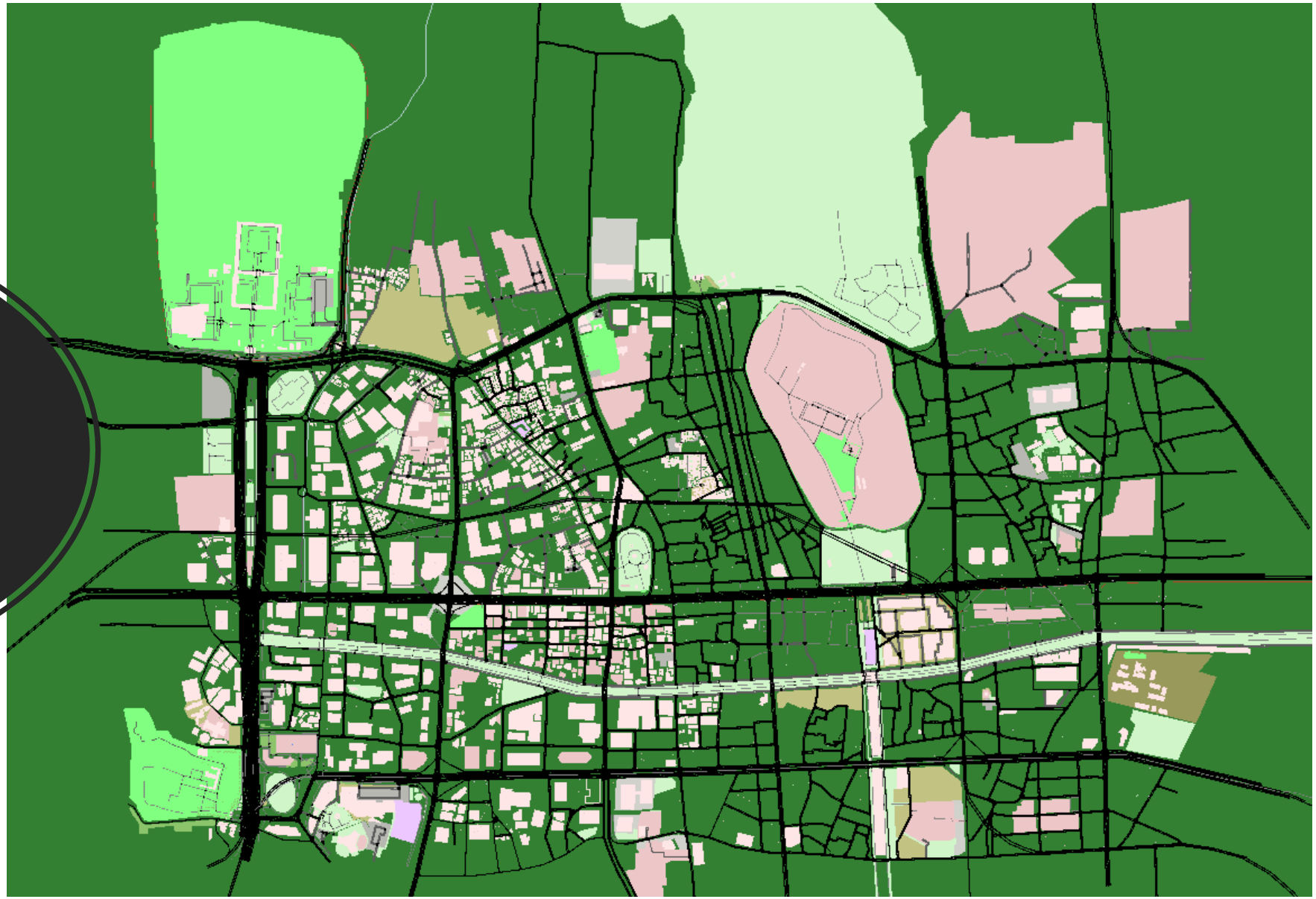
Trying to adopt as much standards

ETSI MEC
3GPP
NGMN

Much more to do

Data-set on Map of

Seoul, South Korea



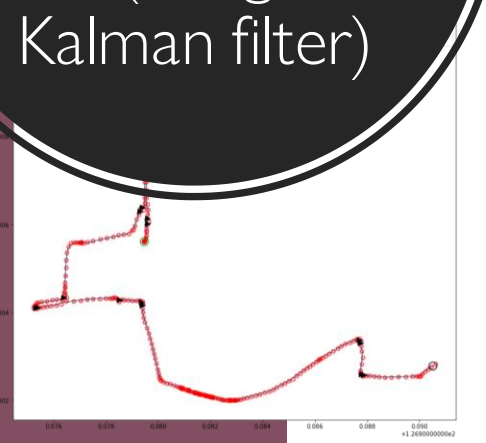
Dataset / API-info

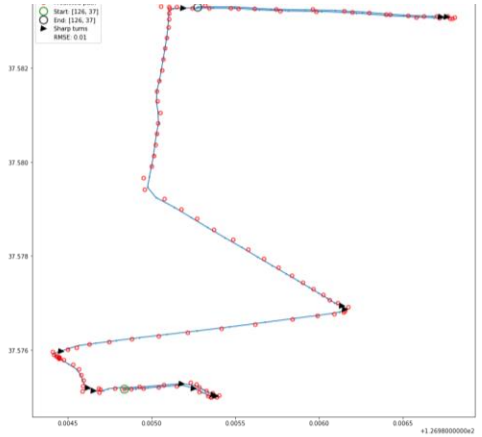
Kalman filter model API information			
Model	**Parameter type**	**Parameter name**	**Description of parameter**
Kalman filter	Inputs	vehicleid	the unique identifier of a vehicle.
		time	current timestamp 't'.
		longitude	Geographic coordinate that specifies the east–west position of a vehicle on the Earth's surface.
		latitude	Geographic coordinate that specifies the north–south position of a point on the Earth's surface.
		angle	Angle 0-359.99 to approximate the direction of a vehicle.
		speed	Speed of the vehicle at time 't'.
		lane	Lane number on which the vehicle is running.
		pos	Position of vehicle on which the vehicle is running on.
	Outputs	longitude	Predicted longitude.
		latitude	Predicted latitude.
Note: The API has not yet been developed but is a work in progress.			

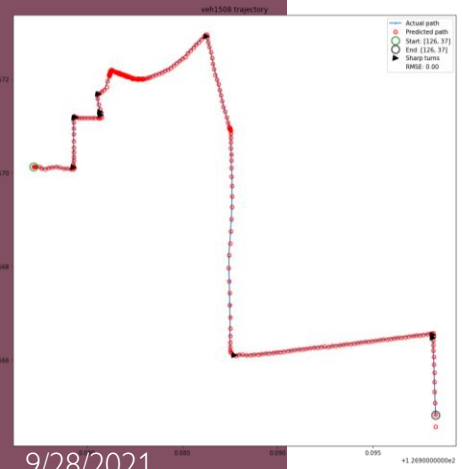
10,000 vehicle trace data-set

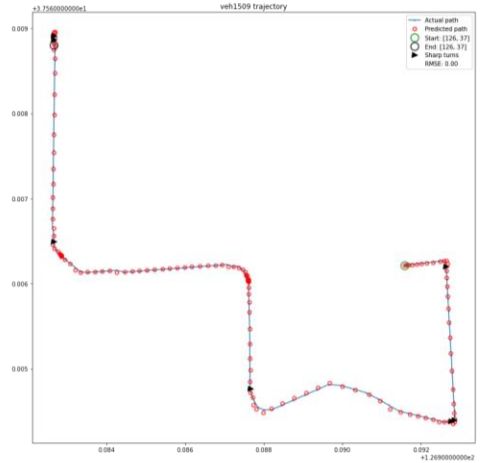
Vehicle trajectory prediction (using Kalman filter)

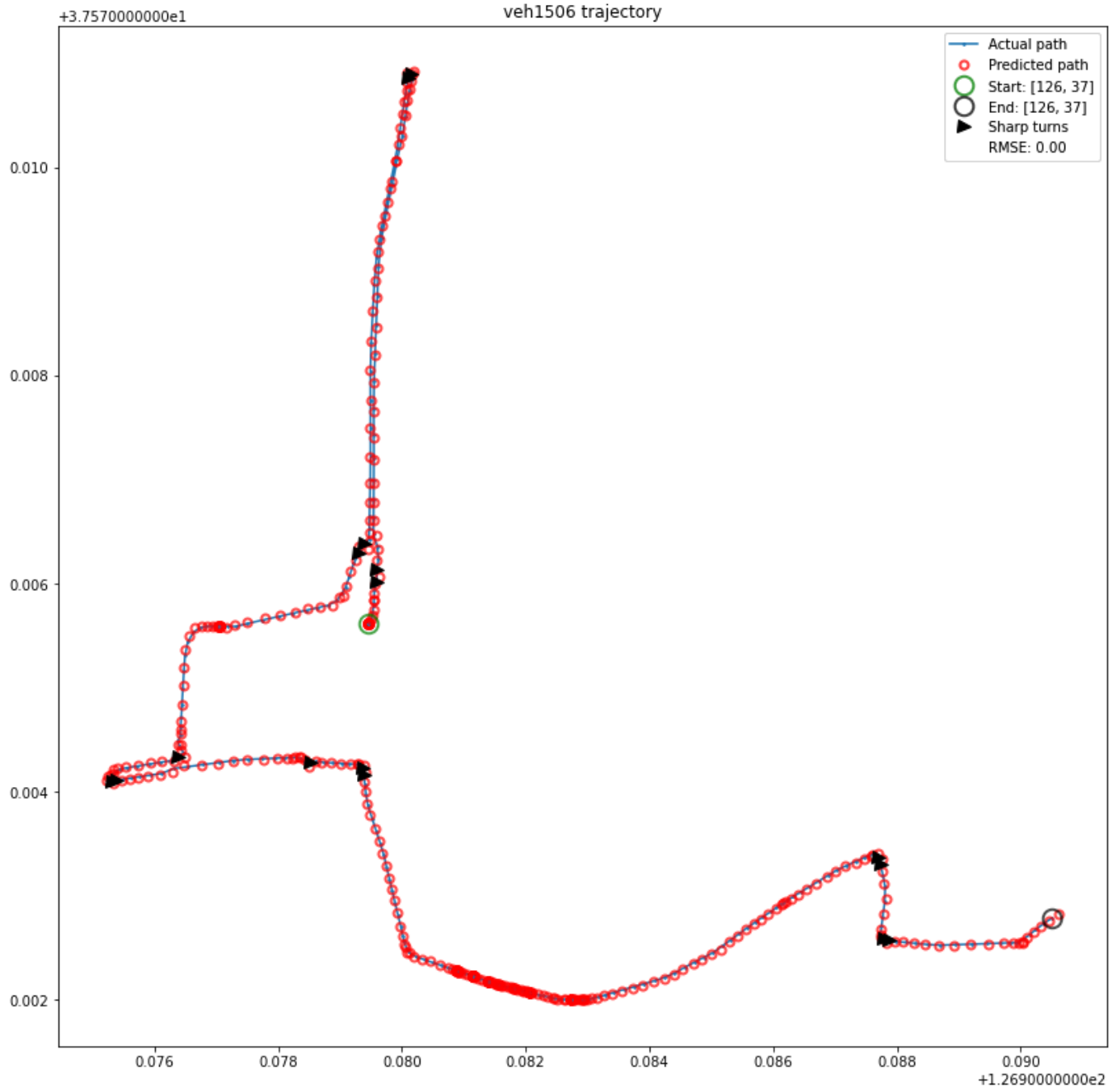
RMSE: 0.004











For	Name	Version/Info
Running Notebooks Kalman filter predcitions =>	Conda:	4.9.2
	Python:	3.8.10
	Jupyter Core:	4.7.1
	Jupyter Notebook	6.4.0
	Conda Environment File:	env_kf_model (file)
Pushing CD Logs Jenkins	Jenkins:	2.303.1
	Docker-hub image link:	mehmoodasif/jenkins
	pip3	20.0.2
	lftools:	0.35.10
Running Containers Docker	Docker:	20.10.8
	Docker build:	3967b7d
Map and Data-set Generation Data-set Generation =>	SUMO:	1.10.0
	TraceExporter.py	traceExporter (file)
	Netedit:	Netedit - SUMO
	Netconvert:	Netconvert - SUMO
Note:		

Software

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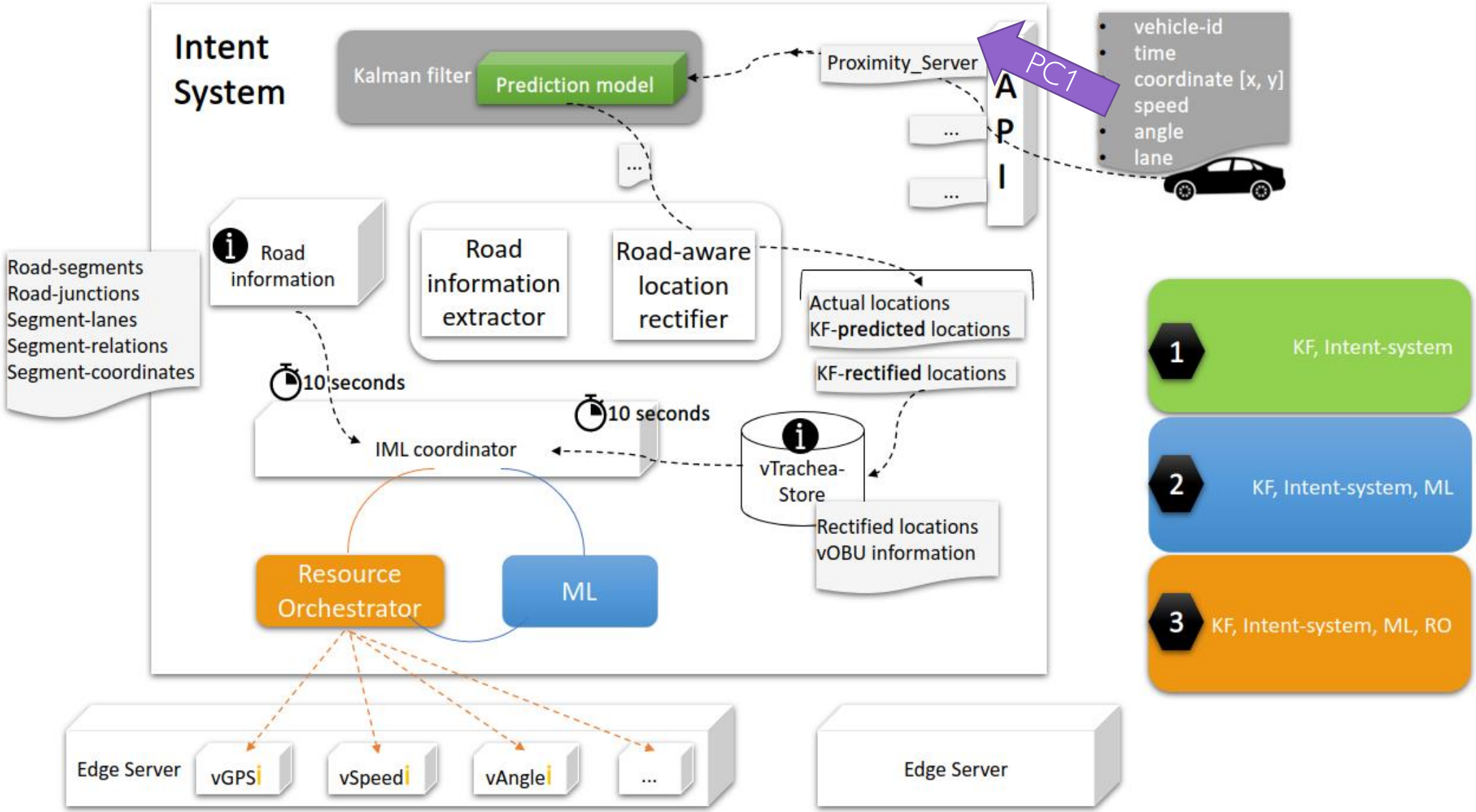
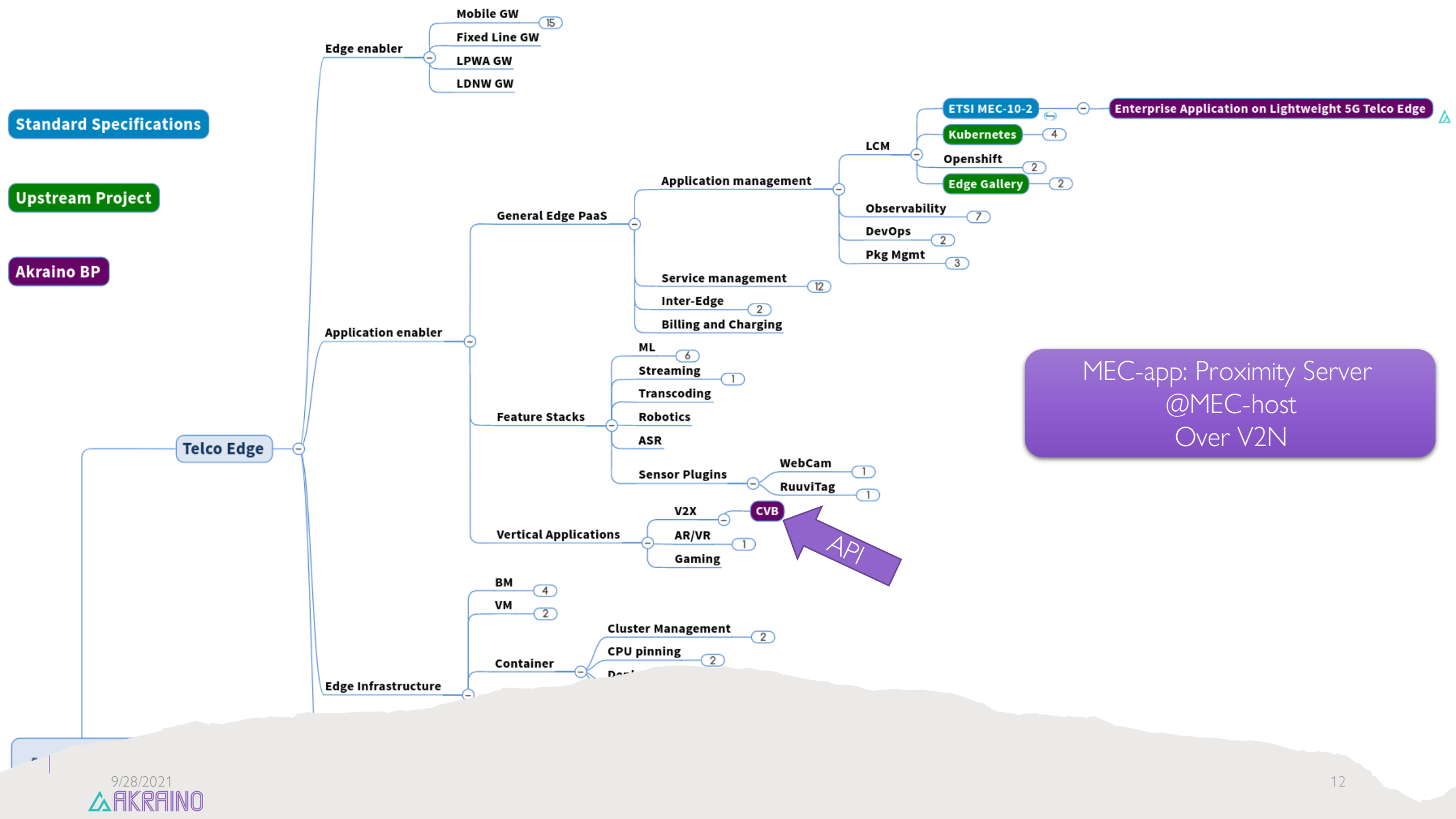
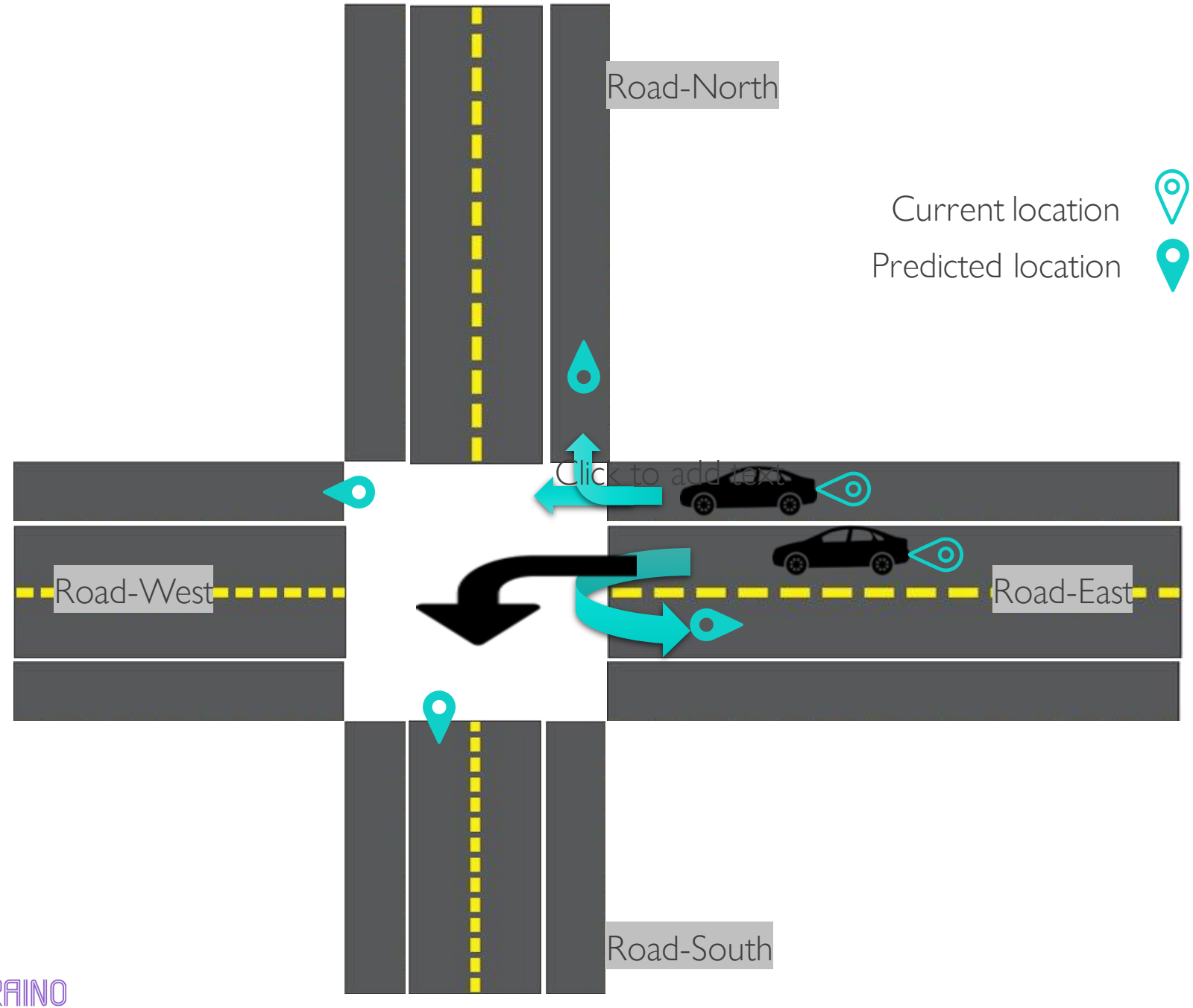
NEXT ...


Intent System
Kalman filter
Prediction model
Proximity_Server
API
PC1
vehicle-id
time
coordinate [x, y]
speed
angle
lane
Road information
Road-segments
Road-junctions
Segment-lanes
Segment-relations
Segment-coordinates
Road information extractor
Road-aware location rectifier
Actual locations
KF-predicted locations
KF-rectified locations
10 seconds
10 seconds
IML coordinator
vTrachea-Store
Rectified locations
vOBU information
Resource Orchestrator
ML
Edge Server
vGPS
vSpeed
vAngle
Edge Server
1
KF, Intent-system
2
KF, Intent-system, ML
3
KF, Intent-system, ML, RO


Standard Specifications
Upstream Project
Akraino BP
Telco Edge
Edge enabler
Mobile GW
15
Fixed Line GW
LPWA GW
LDNW GW
Application enabler
General Edge PaaS
Application management
LCM
ETSI MEC-10-2
Enterprise Application on Lightweight 5G Telco Edge
Kubernetes
4
Openshift
2
Edge Gallery
2
Observability
7
DevOps
2
Pkg Mgmt
3
Service management
12
Inter-Edge
2
Billing and Charging
Feature Stacks
ML
6
Streaming
1
Transcoding
Robotics
ASR
Sensor Plugins
WebCam
1
RuuviTag
1
Vertical Applications
V2X
CVB
AR/VR
1
Gaming
API
Edge Infrastructure
BM
4
VM
2
Container
Cluster Management
2
CPU pinning
2
MEC-app: Proximity Server
@MEC-host
Over V2N

ROAD/LANES



api
database
others

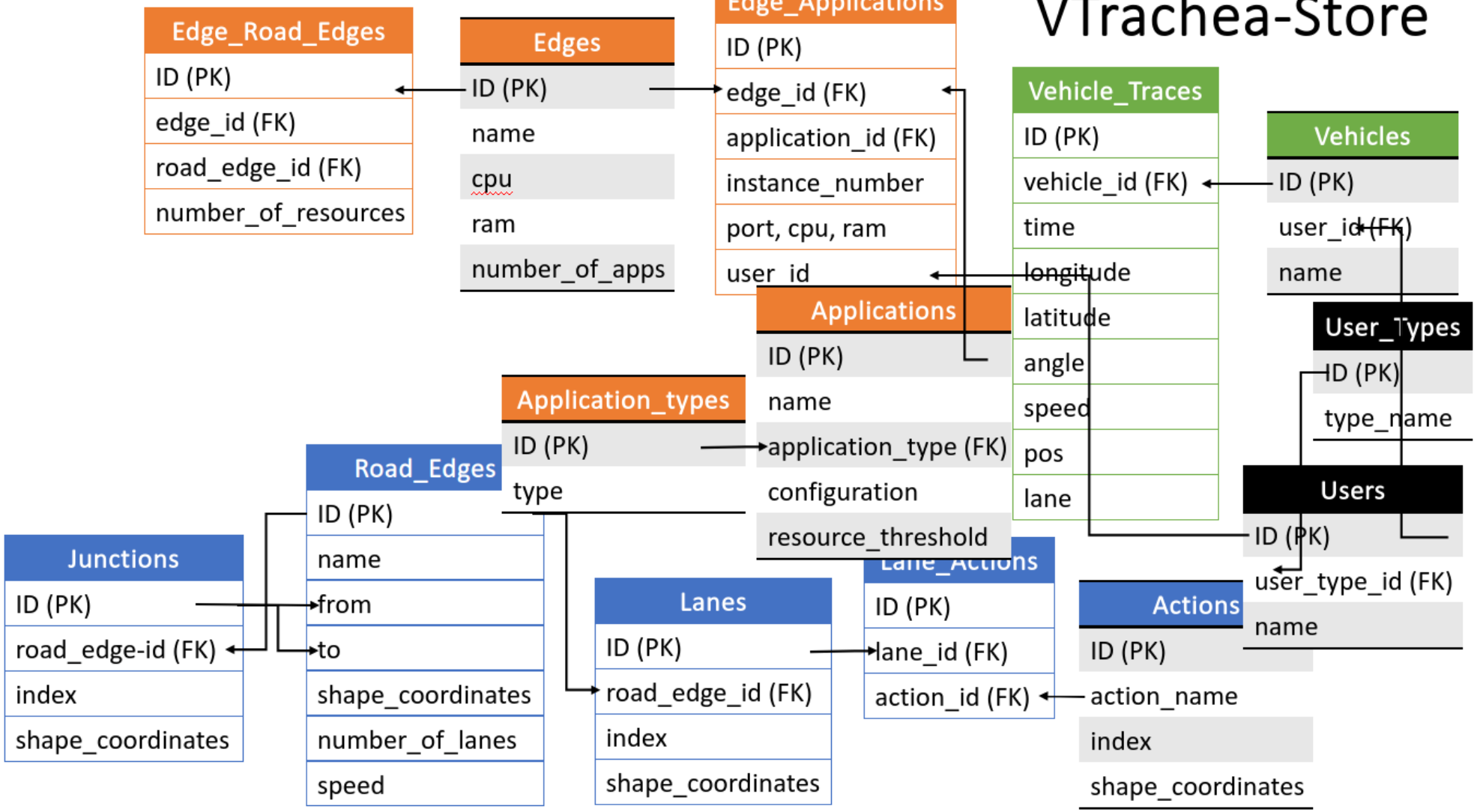
esp
mno
customer

left
right
straight
about-turn

MEC Resources | Vehicle Information | Road information

VTrachea-Store

ERD



ETSI GS MEC 002
Multi-access Edge Computing (MEC); Use Cases and Requirements

- A.7: Active device location tracking
- A.36: In-vehicle MEC hosts supporting automotive workloads

ETSI GS MEC 003
Multi-access Edge Computing (MEC); Framework and Reference Architecture

- 5: Multi-access Edge Computing framework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- Gerrit - Akraino
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- Blueprints - Akraino
- Calendars - Akraino