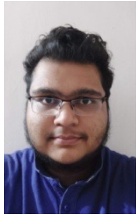
Computation Offloading in Dynamic Mobile Environment

Capstone Project Phase 1
2 Credits
Project ID : W1

Team Composition

Dheemanth R Joshi	PES1UG20EC059	
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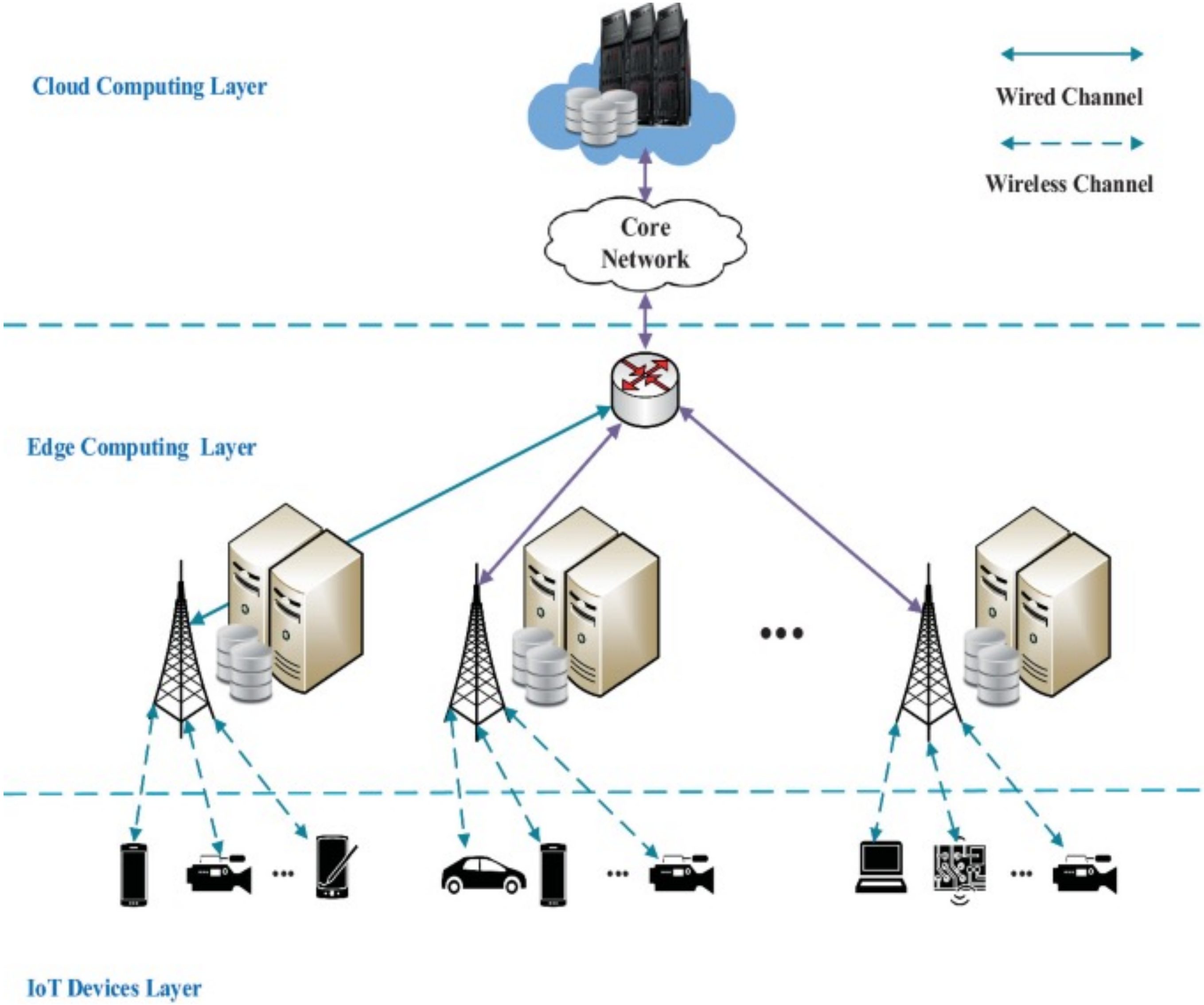
Introduction

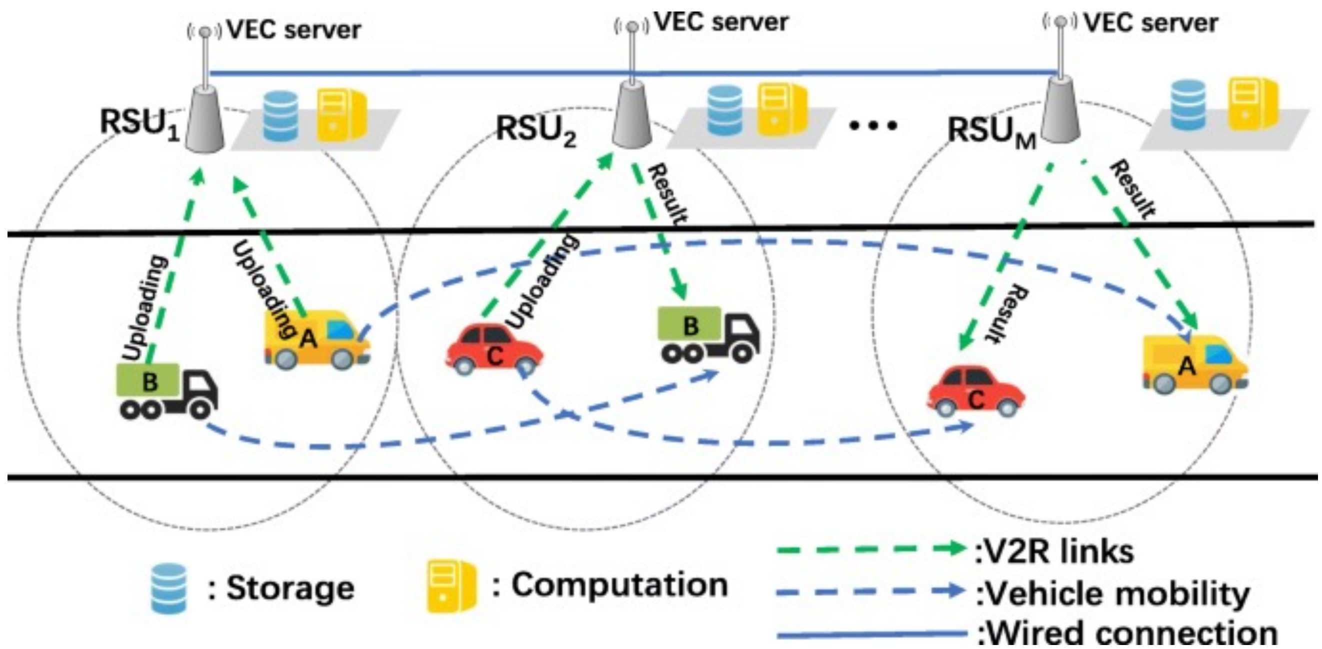


Introduction

- Vehicular edge computing is expected to help vehicles with various service requirements (e.g., autonomous driving, object detection, navigation)
- Assignment of bandwidth for communication and computing resources requires understanding of the mobility pattern of vehicles.
- Vehicles offload their tasks according to the assignments
- Learning algorithms play an important role in solving the assignment problems

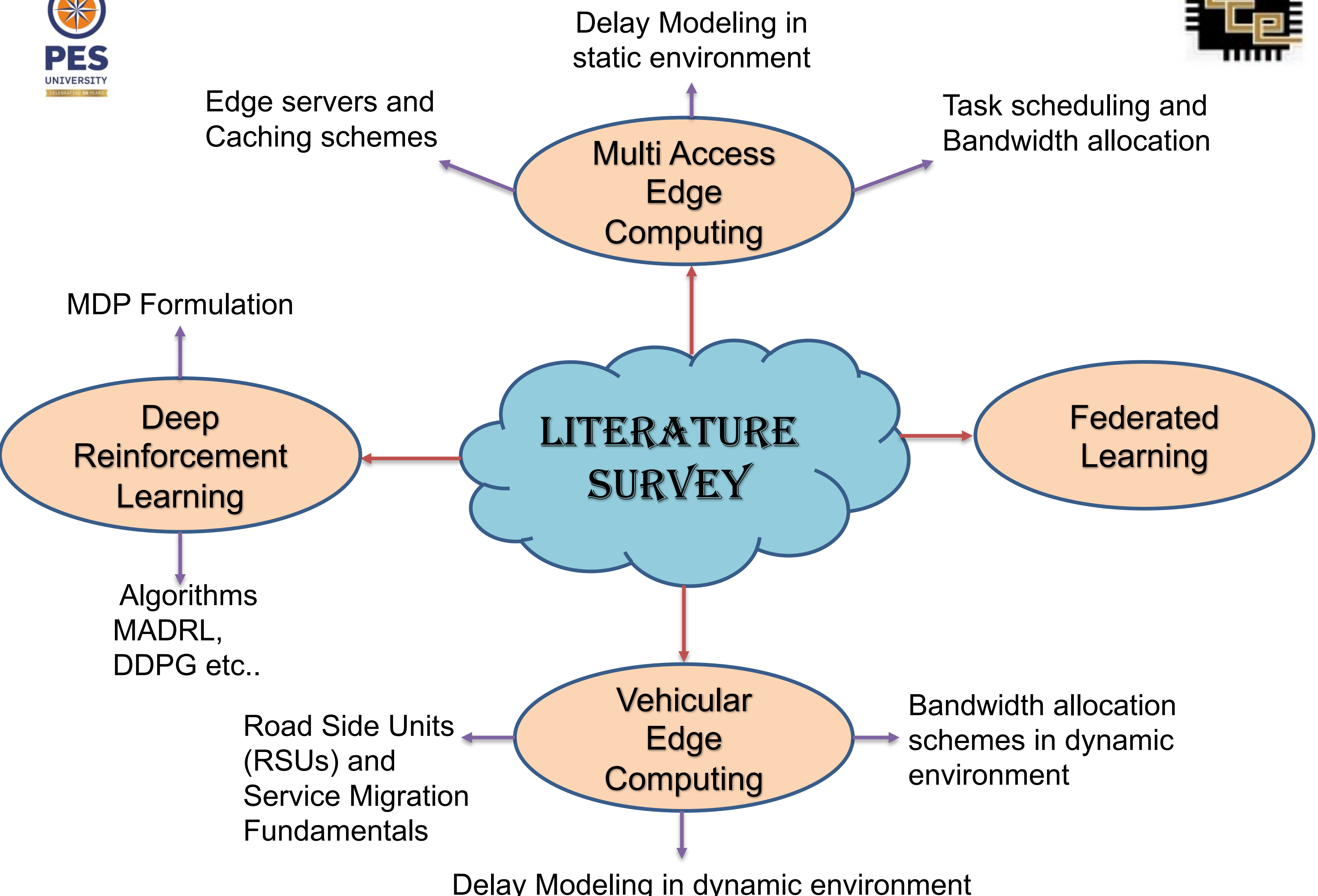
Introduction

- Vehicular environment is highly dynamic and mobile in nature
- Hence, task offloading becomes a challenging



Problem Statement

- To collect the data from vehicles and build a model to understand their mobility pattern
- To assign optimal bandwidth and computing resources for the vehicles according to the mobility pattern
- Use the mobility pattern to perform service placement and service migration for the vehicles
- To build a multi-agent system which minimizes service migration cost of the vehicles


Delay Modeling in
static environment
Edge servers and
Caching schemes
Task scheduling and
Bandwidth allocation
Multi Access
Edge
Computing
MDP Formulation
Deep
Reinforcement
Learning
LITERATURE
SURVEY
Federated
Learning
Algorithms
MADRL,
DDPG etc..
Road Side Units
(RSUs) and
Service Migration
Fundamentals
Vehicular
Edge
Computing
Bandwidth allocation
schemes in dynamic
environment
Delay Modeling in dynamic environment

R. Sharma, K. Gummaraju, P. Anantharam, O. Saraf and V. K. Tumuluru, "Decentralized Computation Offloading in Mobile Edge Computing Systems," *2021 International Conference on Smart Applications, Communications and Networking (SmartNets)*, Glasgow, United Kingdom, 2021, pp. 1-6, doi: 10.1109/SmartNets50376.2021.9553007.

Key Aspects of the System Model	Research Gaps	Learnings from This paper
Mobile units offload the data independently with their own delay estimate models.	Mobility was not considered	Key components of a MEC system.
Network Delay was estimated using moving average model.	Bandwidth of the channel was allocated equally between the mobile units.	Power Optimization problem formulation
Optimization problem was formed which minimized the power consumption satisfying the delay constraints	Task dependency was not considered	Network delay estimation method

Y. Qi, Y. Zhou, Y. -F. Liu, L. Liu and Z. Pan, "Traffic-Aware Task Offloading Based on Convergence of Communication and Sensing in Vehicular Edge Computing," in *IEEE Internet of Things Journal*, vol. 8, no. 24, pp. 17762-17777, 15 Dec.15, 2021, doi: 10.1109/JIOT.2021.3083065.

Key Aspects of the System Model	Research Gaps	Learnings from This paper
Model Setup: Road Side Units (RSUs) installed near high speed lanes to capture offloaded data by vehicles	Very simple and predictive environment and velocity was considered constant.	Working of an RSU in real time environment.
Communication, processing and feedback delays were modelled based on vehicle's dynamic position	Energy/Power consumption was not considered in the optimization problem.	Delay constraint modelling in mobile environment.
Objective of the optimization problem was to partition data size and bandwidth such that the delay constraints are met and was solved by a TATO + binary search method	User Privacy was not considered	Dynamic bandwidth allocation scheme

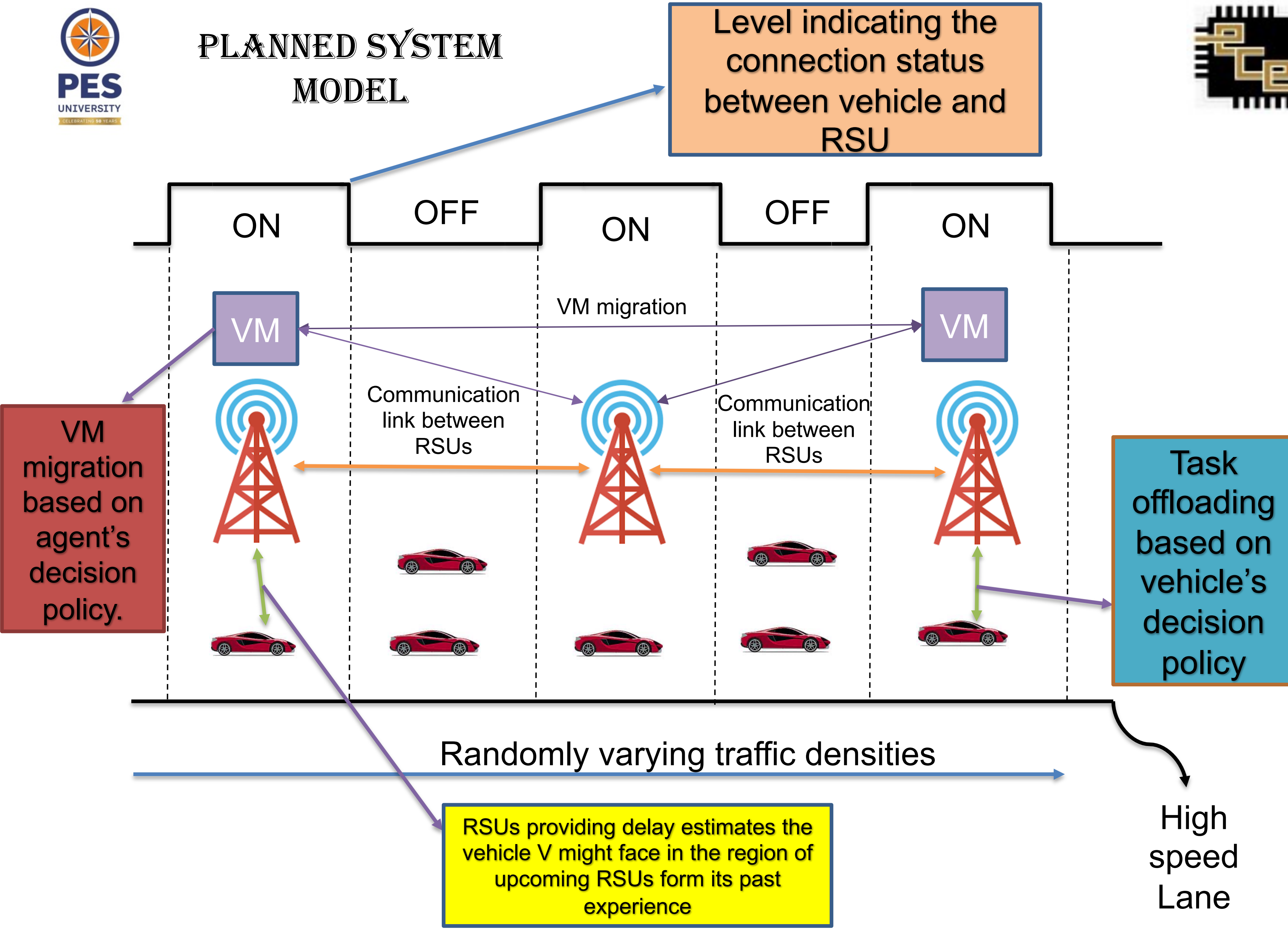
Z. Zhu, S. Wan, P. Fan and K. B. Letaief, "Federated Multiagent Actor–Critic Learning for Age Sensitive Mobile-Edge Computing," in *IEEE Internet of Things Journal*, vol. 9, no. 2, pp. 1053-1067, 15 Jan.15, 2022, doi: 10.1109/JIOT.2021.3078514.

Key Aspects of the System Model	Research Gaps	Learnings from This paper
Delay constraints were modeled and Markov Decision Process (MDP) is formulated	Energy/ Power consumption not considered in the optimization problem	Federated Learning (FL) basics
Deep Reinforcement learning Model is designed to take heterogenous inputs to learn mixed policies for trajectory planning, data scheduling and resource allocation.	State space of the MDP was not clear.	Implementation of DRL and FL algorithms in gym environment simulations
Federated Learning mode is introduced at edge, which collaborates with the MEC to protect user's privacy.	Doesn't deal with service migrations	Time varying state action pair modelling depending on the modelled parameters.

Q. Yuan, J. Li, H. Zhou, T. Lin, G. Luo and X. Shen, "A Joint Service Migration and Mobility Optimization Approach for Vehicular Edge Computing," in *IEEE Transactions on Vehicular Technology*, vol. 69, no. 8, pp. 9041-9052, Aug. 2020, doi: 10.1109/TVT.2020.2999617.

Key Aspects of the System Model	Research Gaps	Learnings from This paper
A joint service migration and routing scheme was proposed which "Proactively" reshapes the distribution of the service entities based on demand.	The decision maker of service migration was not clear.	Fundamentals of service migration.
Delay constraints were modeled (Network, service entity backhaul links, communication and computing).	No consideration of new vehicles coming to the RSU's active region.	Reward modelling of the DRL (negative reinforcement based on defined cost parameters) .
Optimization problem was formulated based on MDP, which minimized service migration and transportation costs satisfying the delay constraints.	The Optimization problem formulated dealt only with delay constraints.	Spatial Grid modelling for routing simulation. (hexagonal grid and Voronoi tessellation).

PLANNED SYSTEM MODEL

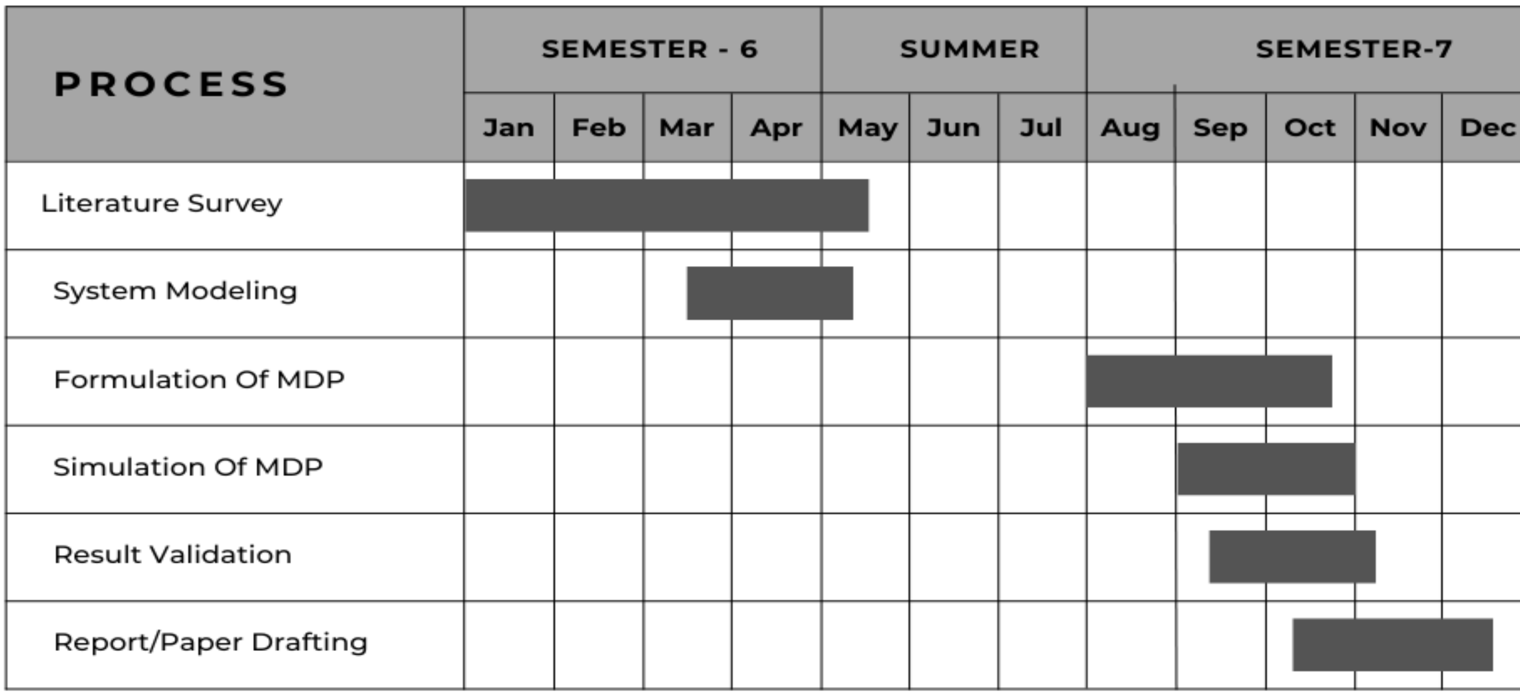


Deliverables

- A multi-agent DRL algorithm which helps individual vehicles to perform service migration
- A comparative study of the proposed model with the base paper in terms of service migration cost and mean number of tasks offloaded by the vehicles
- Analysis of service migration cost due to traffic density
- Analysis of service migration cost due to load on the edge servers
- Analysis of service migration cost due to load on the RSUs

Capstone Timeline

Gantt Chart



Q & A
Thank you