Evaluation of Network Resource Allocation Based on Monitored Traffic Condition Inspired by Human Brain Cognition Process

Semin AN, Yuichi OHSITA, Masayuki MURATA

Graduate School of Information Science and Technology,
Osaka university

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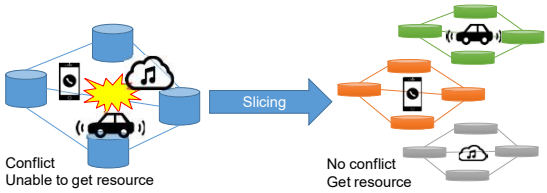
Network Slicing

- **The physical network is divided to some "slices"**
  - Service provider occupies resources for each slice
  - ✓Slicing can respond to diversification of services



- **Prediction is required for network slicing**
  - With only the ever-changing current communication traffic, the resource allocation cannot be in time for future traffic increase
  - ✓**Prediction** can correspond to future traffic increase

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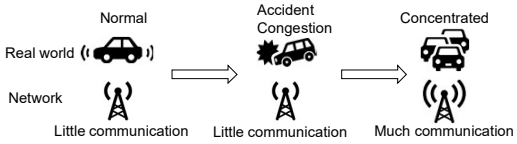
Real world and network

- **Real world helps communication traffic prediction**
  - Ex: Increased communication traffic due to real-world congestion



- **Modeling challenge**
  - Difficult to model the relationship between real-world information and network traffic

To model the relationship between real-world information and network traffic, we use the **human brain cognition model**

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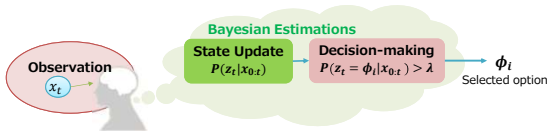
Bayesian Attractor Model[1]

- Cognition model based on human perceptual information
  - Keep observing information and determine which of the pre-learned options is closer
  - **State Update** : Update state z_t by Bayesian estimation on observation information x_t
  - **Decision-making** : Adopt one of pre-learned options
    - Typical observation information $\mu_1, \ldots, \mu_K$ memorized in advance
      - μ_i corresponds to a fixed point ϕ_i $(i = 1, \ldots, K)$ in the state space of z
    - Calculate posterior probability (confidence) $p(z_t = \phi_i | x_{0:t})$ where the state value z_t is the choice i
    - Select options with confidence that exceeds the threshold λ



[1] S. Bitzer, J. Bruineberg, and S. J. Kiebel, "A Bayesian Attractor Model for Perceptual Decision Making," *PLOS Computational Biology*, vol. 11, Aug. 2015.

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Goal and approach

- Goal
  - **Proposal of predictive allocation using monitored traffic condition in network slicing**
- Approach
  - Accurate prediction is difficult to only with communication traffic

✓**Use vehicle information (=monitored traffic condition)**

  - A resource allocation model using communication and vehicle traffic cannot be build clearly

✓**Use Bayesian Attractor Model**

Proposed Method

Network Resource Allocation
Based on **Monitored Traffic Condition**
inspired by **Human Brain Cognition Process**

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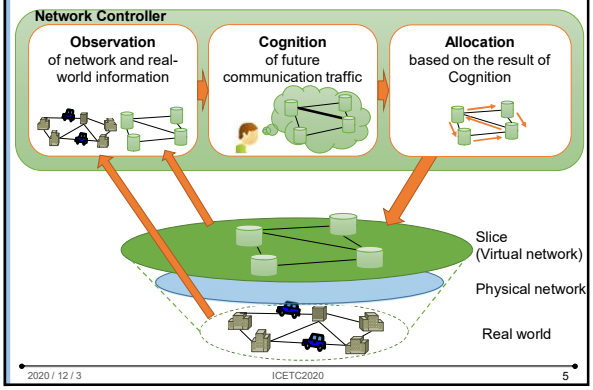
Overview of resource allocation



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Environment

- **Vehicle information generation**
  - Generated by SUMO (Simulation of Urban Mobility)
    - Road network : OpenStreetMap for 2.4 square kilometers around JR Shinjuku Station, Tokyo, Japan
    - Movement attribute : Open PFLOW, Multiply a normal random number with an average of 8 variances of 1 for scale adjustment
- **Communication traffic generation**
  - The communication traffic is the number of connected cars plus a normal random number with an average of 0 variance of 10
- **Parameters**

Parameter	Value
Cognitive interval	1 minute
Predicted time slot : P	5
(BAM) Sensory uncertainty	0.3
(BAM) Dynamic uncertainty	0.6
(BAM) Confidence threshold	10^-10

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Proposed and compared method

- **BAMwithSensing : Proposed method**
  - Resource allocation by BAM using network traffic and traffic flow sensing information
- NNwithSensing : Conpared method 1
  - Resource allocation by Nearest Neighbor using network traffic and traffic flow sensing information
    - Nearest Neighbor : A method to output the learning point closest to the input point as a cognitive result
- BAMwithoutSensing : Conpared method 2
  - Resource allocation by BAM using only network traffic

Point

- ✓ Are resources allocated well by using **BAM**?
- ✓ Are resources allocated well by using **vehicle information**?

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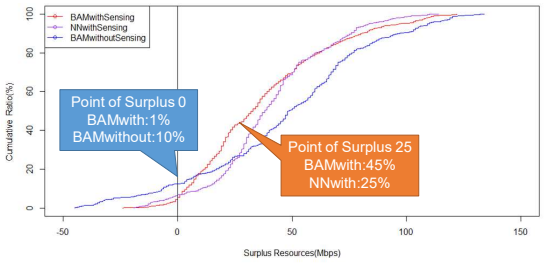
Result

- Cumulative ratio of surplus resource amount
  - Surplus resource = Allocated resource − Current traffic



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Summary and future work

- **Summary**
  - We proposed resource allocation control in the network based on vehicle information using BAM
  - Resource shortage can be avoided by using the vehicle information
  - Surplus resources can be suppressed by using BAM
- **Future work**
  - Survey of the environment in which the proposed method works effectively
    - If it is difficult to predict the road traffic, traffic sensing information may not be effective for the network
    - We plan to investigate the resource allocation results when the accuracy of traffic prediction is changed.

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