Joint Task Assignment and Resource Allocation Mechanism for In-vehicle Augmented Reality

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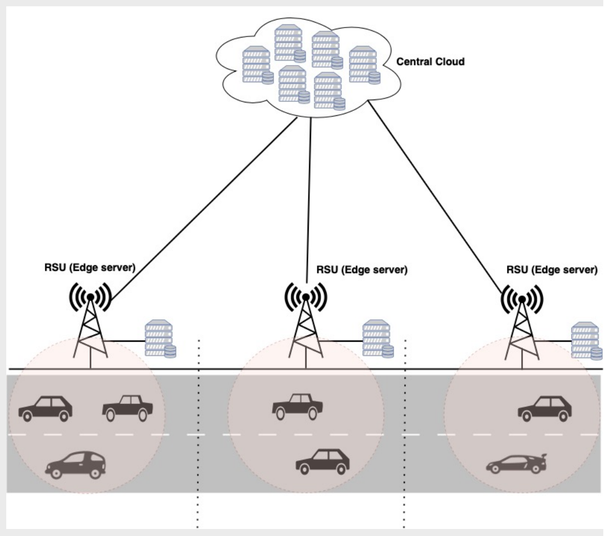
System Model

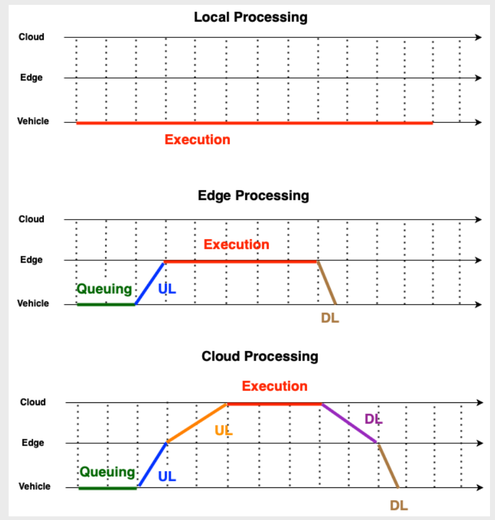
- The considered edge-cloud system consists of the following components:
  - A set of vehicles $\mathcal{V} = \{1, 2, \dots, V\}$
  - A set of RSUs $\mathcal{U} = \{1, 2, .., U\}$
  - A cloud center
- An RSU is considered to be a 5G cell tower that communicates with vehicles via V2X communication
- Each vehicle v generates AR-related tasks with the arrival rate λ_v
- Each task n is defined by the following parameters:
  - L_n: Input size of task n
  - C_n: Required CPU cycles n
  - $d_n^{\max}$: delay tolerance of task n



Problem Definition

Delay minimization with the optimization of task assignment, radio resource allocation, and computing resource allocation.

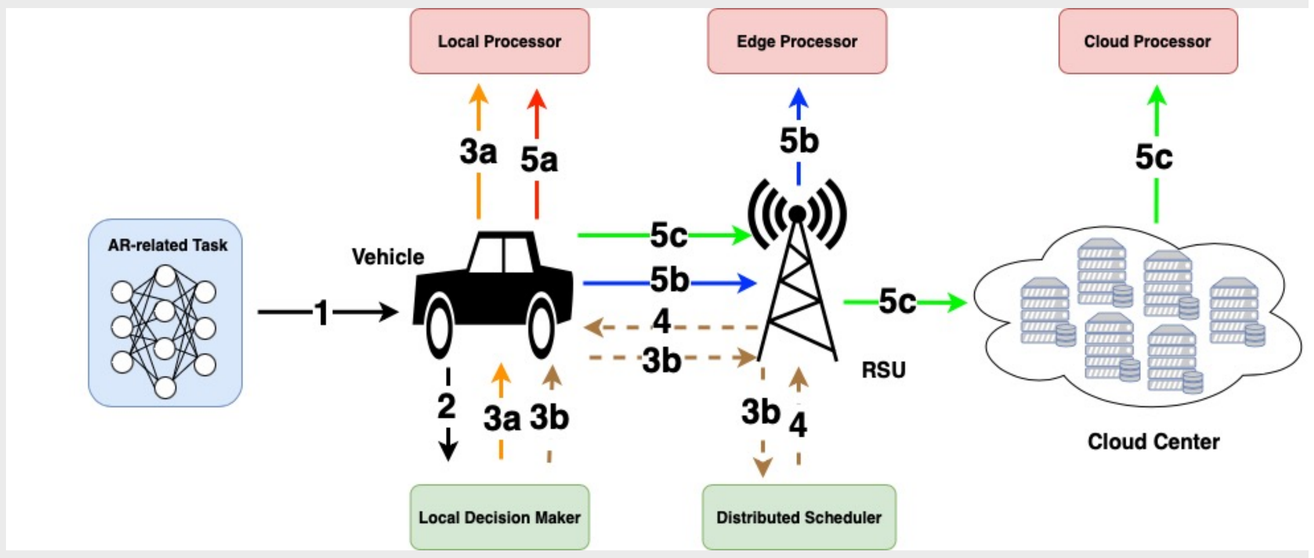
- ***Task assignment:*** A task can be executed on either the local vehicle (local processing), the edge server (edge processing), or the cloud center (cloud processing).
- ***Radio resource allocation:*** An offloaded task (executed either on edge or cloud) requires radio resources for data transfer.
- ***Computing resource allocation:*** Computing resources on vehicles, edge servers, and the cloud center are allocated to tasks for execution.



Methodology

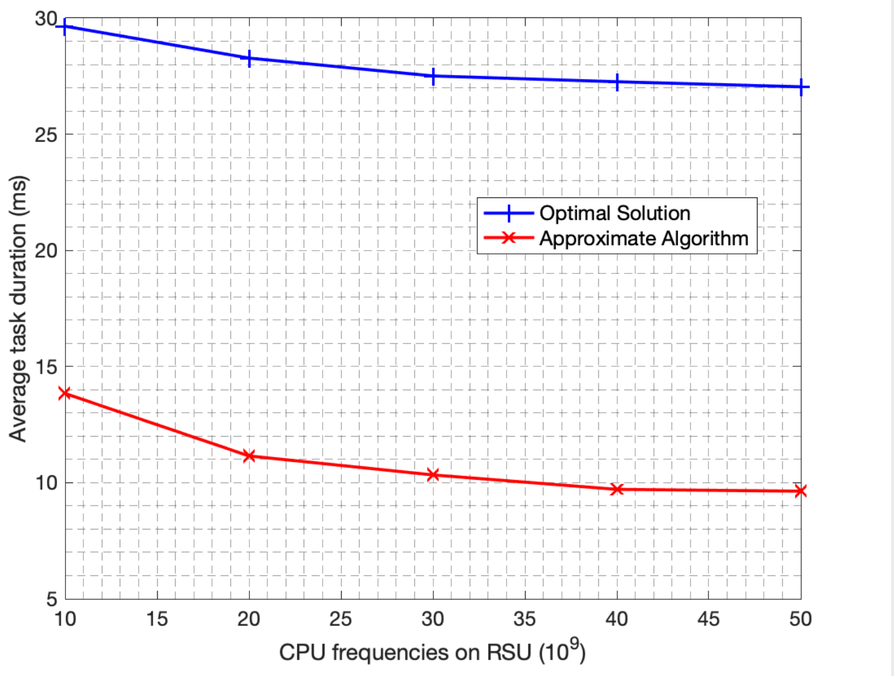
The proposed heuristic algorithm makes a task assignment decision and resource allocation via the following protocol in an online distributed manner:

1. An AR-related task is generated by a vehicle
2. The local decision maker on each vehicle determines whether to send the task assignment request to the scheduler of the RSU.
3. The decision is made based on the task deadline and estimated communication overhead.
   a. The task is executed by the local processor
   b. The task assignment request is sent to the scheduler
4. The scheduler makes task assignments and resource allocation and sends the control message back to the vehicle based on task parameters and resource information on vehicles, RSUs, and the cloud center.
5. The vehicle sends the task to the assigned tasks
   a. Execution via local processing
   b. Execution via edge processing
   c. Execution via cloud processing

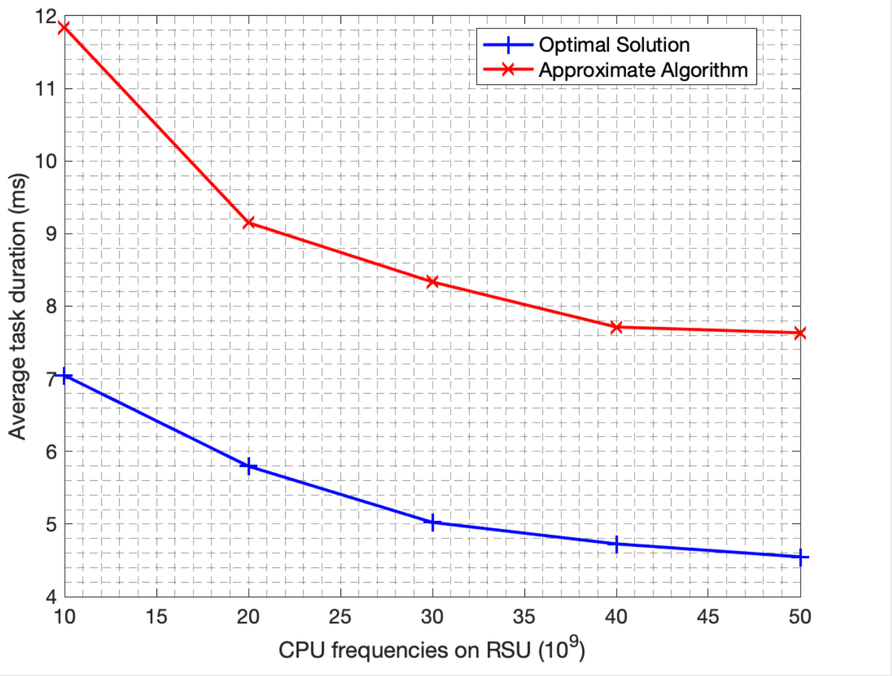


Simulation Results

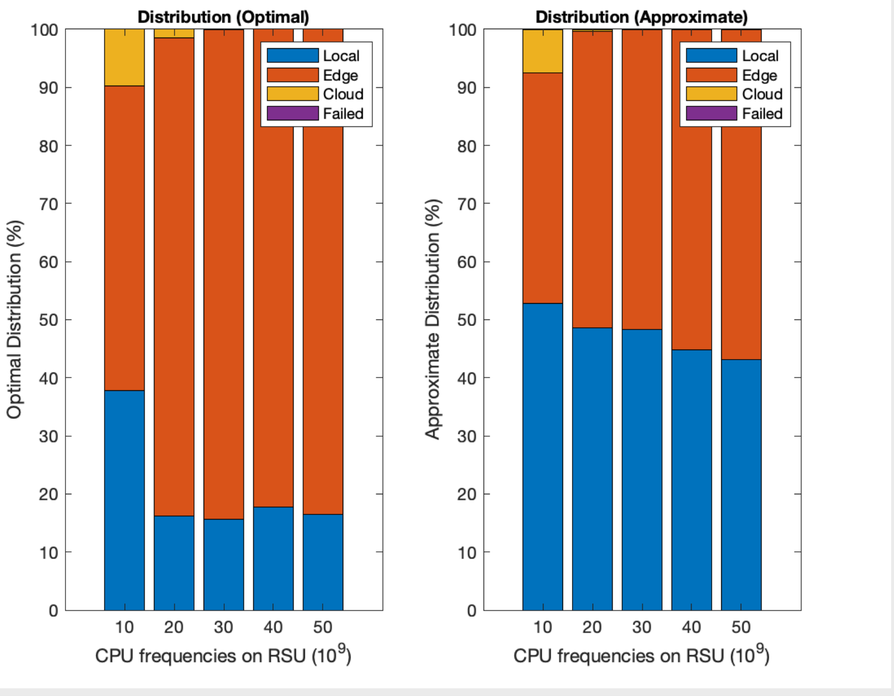
Average task duration versus CPU frequencies on RSU (U = 3)



Average task duration w/o comm. overhead versus CPU frequencies on RSU (U = 3)



Task distribution versus CPU frequencies on RSU (U = 3)



Runtime versus CPU frequencies on RSU (U = 3)