Edge Computing Framework for CAV (Connected Autonomous Vehicles)

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Edge Computing

- Computing power with minimal latency and high responsiveness
- powerful computation to cover regions requiring additional computational power and or data processing needs
CAV and Edge

• Edge is a very important new concept as it is able to minimize the network congestion.

• Edge computing frees up the vehicle from any overhead in additional tasks.

• Amber alerts, accidents, traffic intersection safety and much more tasks can be achieved with minimal impact to the vehicle.
N to 1

Edge
N to N
Framework Ideologies

- Discovery and Trust - Assumed for between manufacturer and telecom companies
- Containerized Modular components
- Platform independent as long as the hardware meet basic needs
- Data provided by the vehicles are trustworthy - Assumed
- Provide low latency and overhead service to the CAVs in need
Robustness and Speed of Methods

![Diagram showing comparison of data aggregation methods in terms of time in seconds.](image-url)
Framework Designs

• **BC Framework**
  – MQTT (Message Queuing Telemetry Transport)

• **HJI Framework**
  – Multicasting
BC Framework
MQTT (Message Queuing Telemetry Transport)

Broadcasting Strategy with MQTT

Vehicle 1
Vehicle 2
Vehicle 3
...  
Vehicle n

Broker
Topic
Edge

Subscribe
Broadcast
Publish
Framework Returned Results
Framework Returned Results
## Test Results

<table>
<thead>
<tr>
<th>Group</th>
<th>Aggregation</th>
<th>Stitch</th>
<th>Detect</th>
<th>Broadcast</th>
<th>Total Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above</td>
<td>0.6</td>
<td>2.64696</td>
<td>3.63507</td>
<td>0.00544</td>
<td>6.88747</td>
</tr>
<tr>
<td>Below</td>
<td>0.3</td>
<td>1.60079</td>
<td>3.56692</td>
<td>0.00523</td>
<td>5.47294</td>
</tr>
<tr>
<td>Cool</td>
<td>0.3</td>
<td>0.97034</td>
<td>3.57243</td>
<td>0.00461</td>
<td>4.84738</td>
</tr>
<tr>
<td>First</td>
<td>0.2</td>
<td>1.72102</td>
<td>N/A</td>
<td>N/A</td>
<td>1.92102</td>
</tr>
<tr>
<td>Hi</td>
<td>0.3</td>
<td>1.25113</td>
<td>3.61586</td>
<td>0.00539</td>
<td>5.17238</td>
</tr>
<tr>
<td>Shaak</td>
<td>0.3</td>
<td>1.72399</td>
<td>3.63339</td>
<td>0.00693</td>
<td>5.66431</td>
</tr>
<tr>
<td>Stop1</td>
<td>0.3</td>
<td>1.53299</td>
<td>3.63738</td>
<td>0.00671</td>
<td>5.47708</td>
</tr>
<tr>
<td>Stop2</td>
<td>0.3</td>
<td>1.89981</td>
<td>3.61449</td>
<td>0.00449</td>
<td>5.81879</td>
</tr>
<tr>
<td>Sub</td>
<td>0.6</td>
<td>3.70769</td>
<td>3.68509</td>
<td>0.00872</td>
<td>8.0015</td>
</tr>
<tr>
<td>Tool</td>
<td>0.3</td>
<td>2.01195</td>
<td>3.65668</td>
<td>0.00649</td>
<td>5.97512</td>
</tr>
<tr>
<td>Vader</td>
<td>0.4</td>
<td>1.3641</td>
<td>3.61012</td>
<td>0.0046</td>
<td>5.37882</td>
</tr>
<tr>
<td><strong>AVERAGE</strong></td>
<td><strong>0.354545455</strong></td>
<td><strong>1.857343</strong></td>
<td><strong>3.622743</strong></td>
<td><strong>0.005861</strong></td>
<td><strong>5.510619091</strong></td>
</tr>
</tbody>
</table>
Test Results

1080p Images Test Time Segments

(s)
HJI Framework
BC Framework

Vehicle On-Board Unit (Host)
- Expose Container
  - /mydata
  - /shared_folder
- Subscribe Container
  - /output
  - /feedback

Edge Computer (Host)
- Aggregation Container
  - /rawdata
- Fusion Container
  - /images
  - /output
  - /fusioned
- Detection Container
  - /image
- Broadcast Container
  - /result
  - /result
HJI Framework

Vehicle On-Board Unit
- Address Dispatch Container
- Expose Container
- Receiver Container

Shared_Folder
Serve_Folder

Edge Computer
- Address Receiving Container
- Aggregation Container
- Fusion Container
- Detection Container
- Multicast Container

Shared_Folder
Process_Image
Multicasting

Vehicle On-Board Unit

Vehicle On-Board Unit

... Vehicle On-Board Unit

Listen

Transmit

EDGE COMPUTER

IP Address

Range:
224.0.0.0 - 239.255.255.255
Test Results

Framework By Segment

Time In Seconds

Image Count

Aggregation  Stich  Detection  Broadcast  Total

2  3  4  5  6  7  8  9
Future Works

- Hardware Adaptation
- Edge to Edge integration
- Amber alert
- Accident investigation
- Framework persistence
- Real world deployment testing
Thank You.