AIoTwin

Twinning action for spreading excellence in Artificial Intelligence of Things

In-Network Computing: P4 Language for Data Plane Programming

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In-network computing paradigm

In-Network Computing paradigm[1]:

- executes programs **traditionally run on end-hosts** directly **within network devices.**
- leverages **existing network infrastructure**, utilizing devices already responsible for **forwarding traffic**.
- reduces the **load on the network** by **terminating transactions** as they traverse the network

[1] In-Network Computing, by **Noa Zilberman** on Apr 25, 2019. **Link:** https://www.sigarch.org/in-network-computing/

Key Enabling Technologies

Programmable network devices:

- Traditional network devices typically only forward packets.
- **Programmable network devices** can perform additional tasks such as:
  - Data aggregation
  - Packet filtering
  - AI inference as data passes through the network

Benefits of In-Network Computing

Reduced Latency:

- Network devices can support sub-microsecond latency.
- Eliminates the need to send data to end-hosts, thereby reducing unnecessary latency caused by the end-hosts.

Improve Throughput:

- Reduces the volume of data transmitted across the network, optimizing bandwidth.
- Aggregates data in-network, minimizing the need to send raw data to an end-host for processing.

Enable self-configuration and self-adaptation

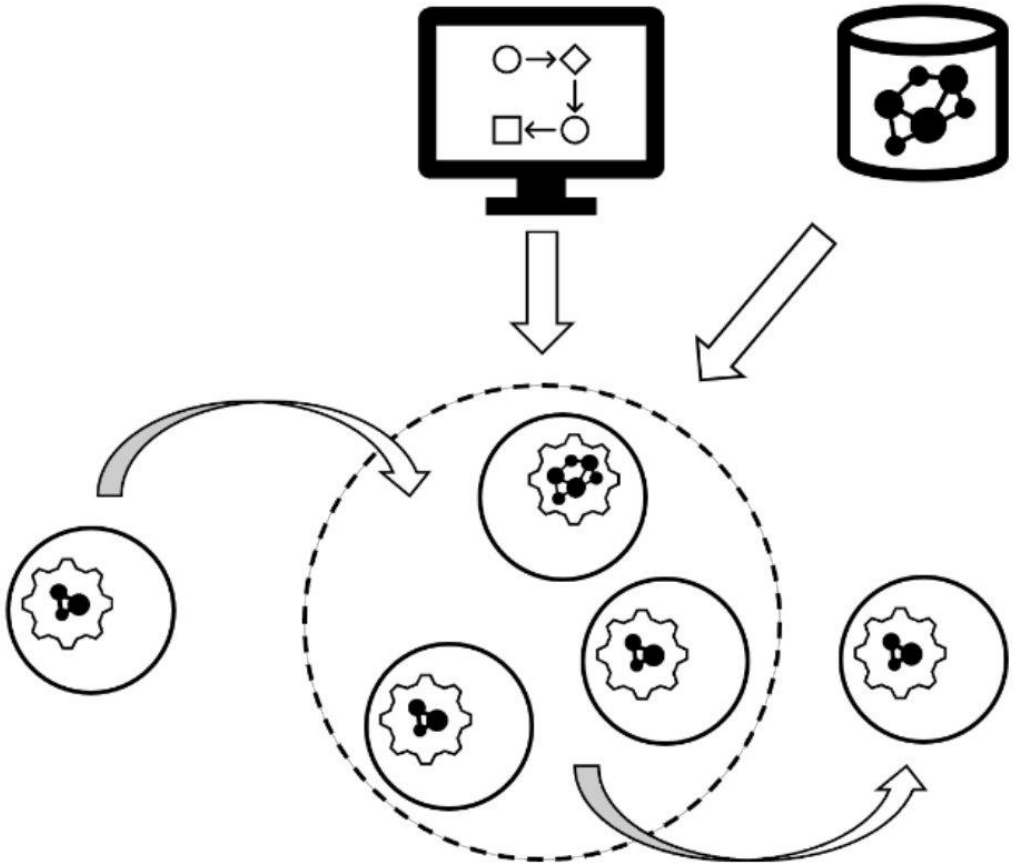
SmartEdge Project

- Enable decentralized **edge intelligence** for smart IoT applications on **Device-Edge-Cloud Continuum**.
- Focus on **reliability, security, privacy, and scalability**.
- Achieved through **Cross-layer low-code toolchains** for **autonomous intelligent swarms**.

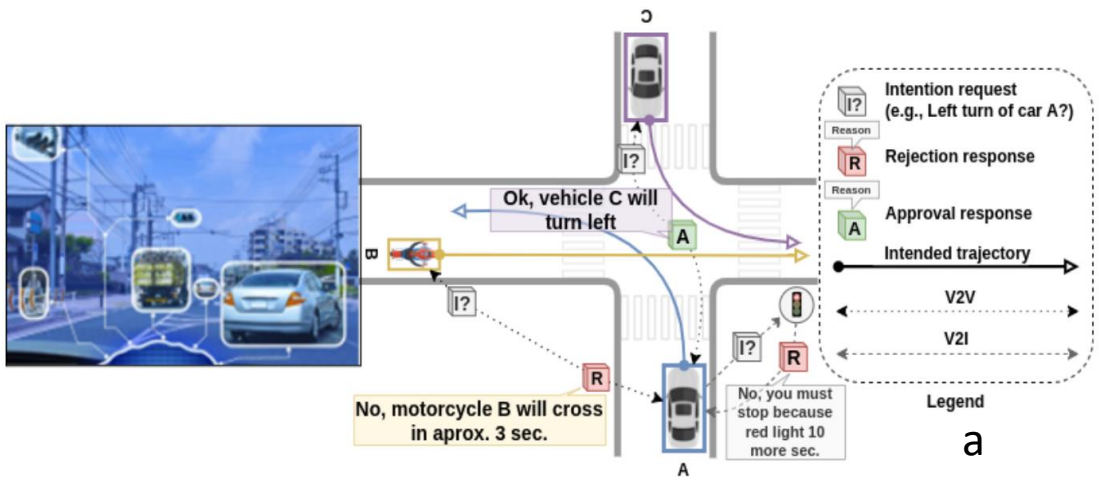
[2] https://www.smart-edge.eu/project/

SmartEdge Intelligent Swarm

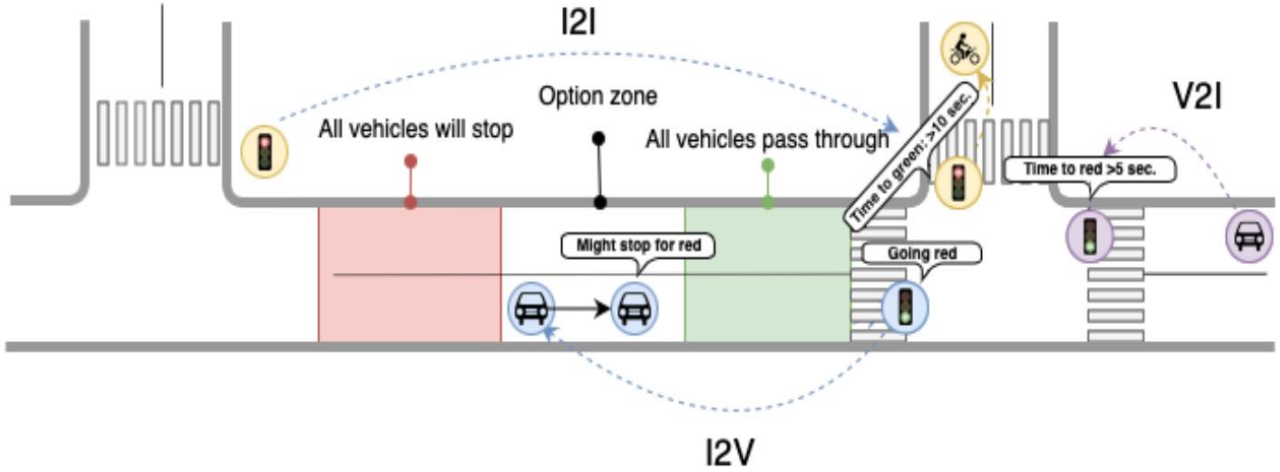
- A swarm is a **collective** of diverse **edge devices**, **vehicles**, **sensors**, and robots working **together** to achieve **shared objectives**.
- Clouds can involve to define the swarm's composition and goals **but do not directly control** its real-time operations, which are managed **internally by the swarm members**.
- Effective **collaboration** among swarm members **is crucial** for accomplishing the objectives set by the cloud.



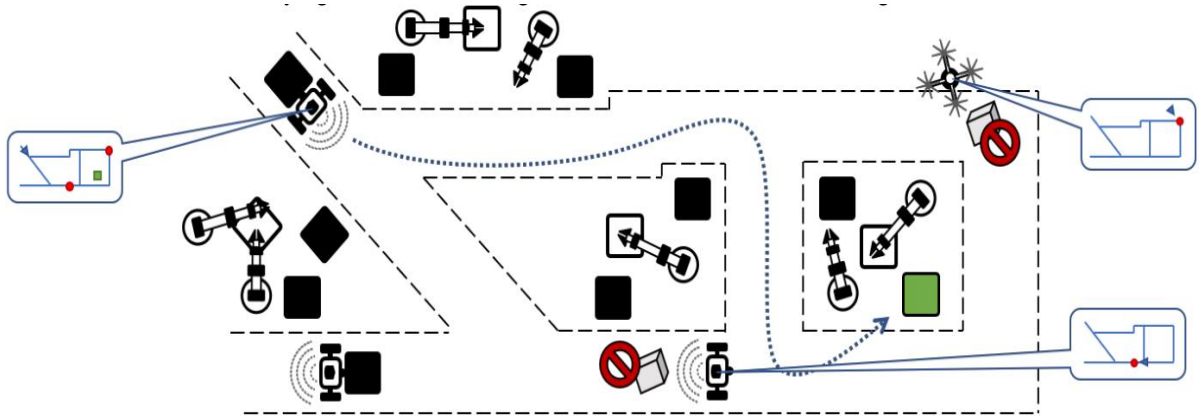
SmartEdge Scenarios



Scenario 1: Cooperative Perception for Driving Assist



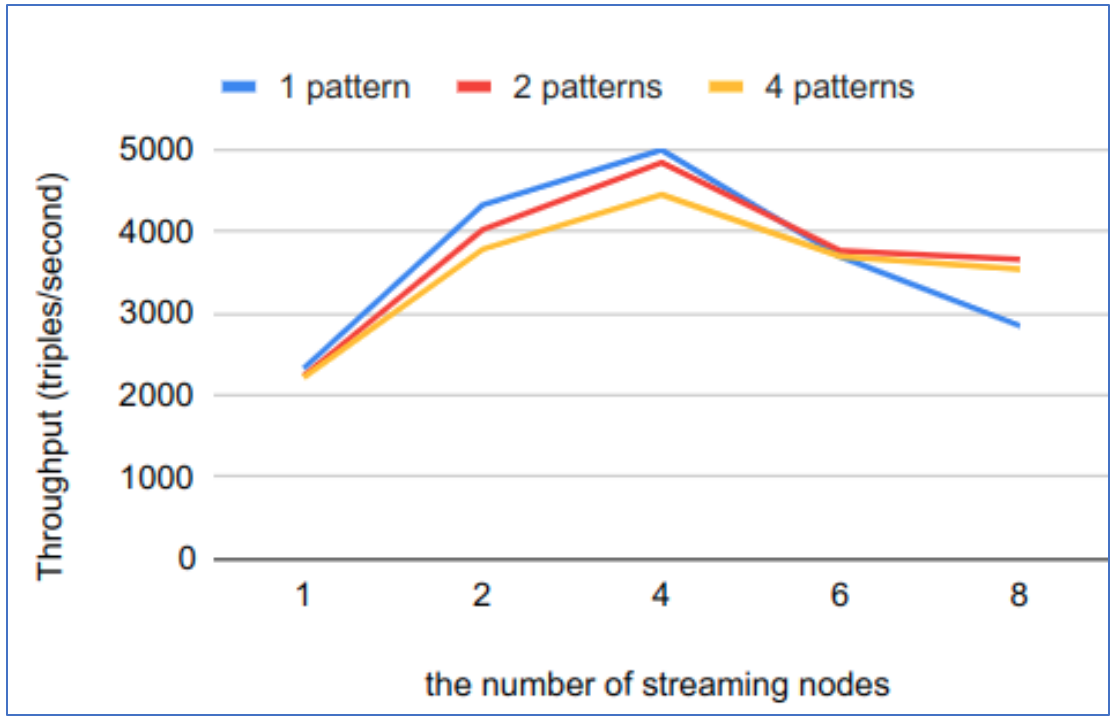
Scenario 2: I2V Intelligence Swarm



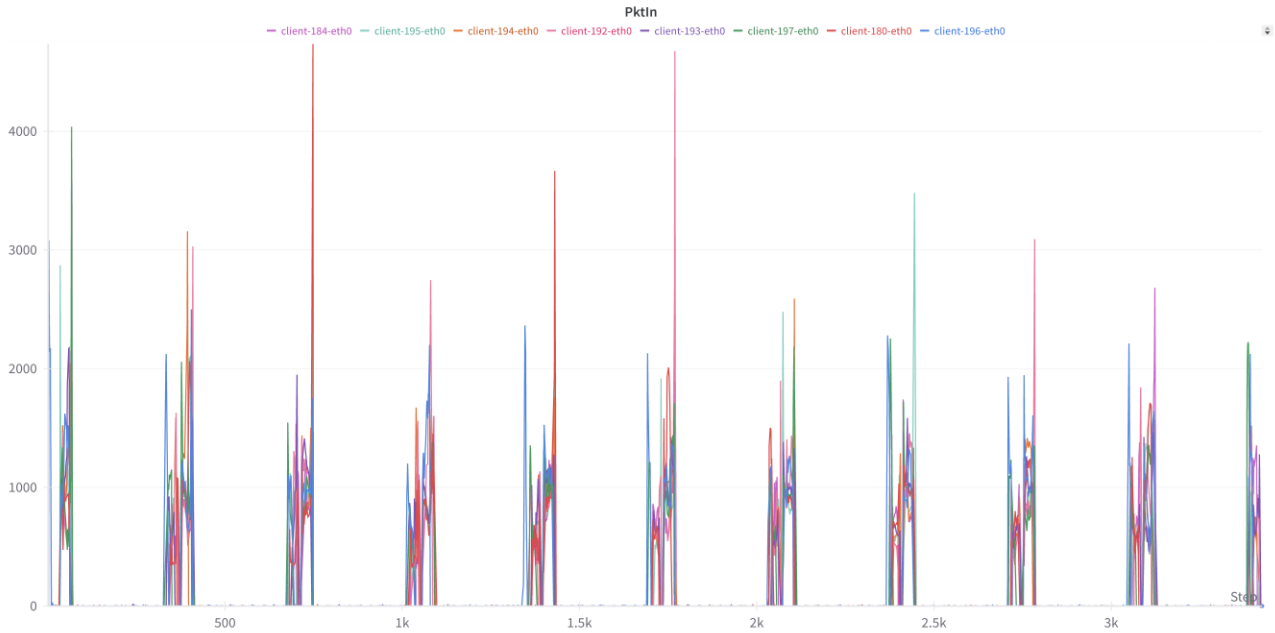
Scenario 3: Collaborative Robotic Movers

Scaling out Issue

- Adding more nodes **increases** the **throughput**.
- Simply adding more nodes **does not.**



Federated Learning frameworks often suffers from **network collision issues**.



In-network presentation in our summer school

- Workshop Paper: **Dynamic Knowledge Graph Based Swarm Networks**
  Authors: **Xuanchi Guo**

- **Accelerating Data Processing through Hardware/Software Co-Design in SmartEdge**
  Keynote by **Prof. Philippe Cudre-Mauroux** (University of Fribourg)