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Towards Intrusion Detection Systems dedicated to Agriculture based on Federated Learning

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Context and Motivation

The rapid development of IoT devices in agriculture is revolutionizing traditional farming methods by providing fast and reliable information to feed decision analysis systems, but as the number of connected devices keeps increasing, IoT devices become a target for cybercriminals, which is why this research aims to develop a Deep Learning(DL)/Federated Learning (FL)-based Intrusion Detection Systems (IDS) specific to IoT networks dedicated to agriculture.

Objectives

- Study the current state of the art in the use of FL in IDS.
- Set up simulation/emulation environment and develop algorithms to detect attacks on IoT devices.
- Deploy the solutions on real-life platforms to evaluate the performance in real-life conditions.

Smart Agriculture

Sensors are the most common IoT devices used in agriculture today. They can monitor various parameters such as rain, moisture, humidity, temperature, and wind to help farmers forecast necessary actions to maintain high production levels.

- IoT everywhere in fields: sensors, actuators
- Edge-computing used for AI-based precision agriculture
- Complex systems coupling IoT, UAV (drones), AIV (autonomous tractors), edge servers
- Growing threats on actors/production
- Low security

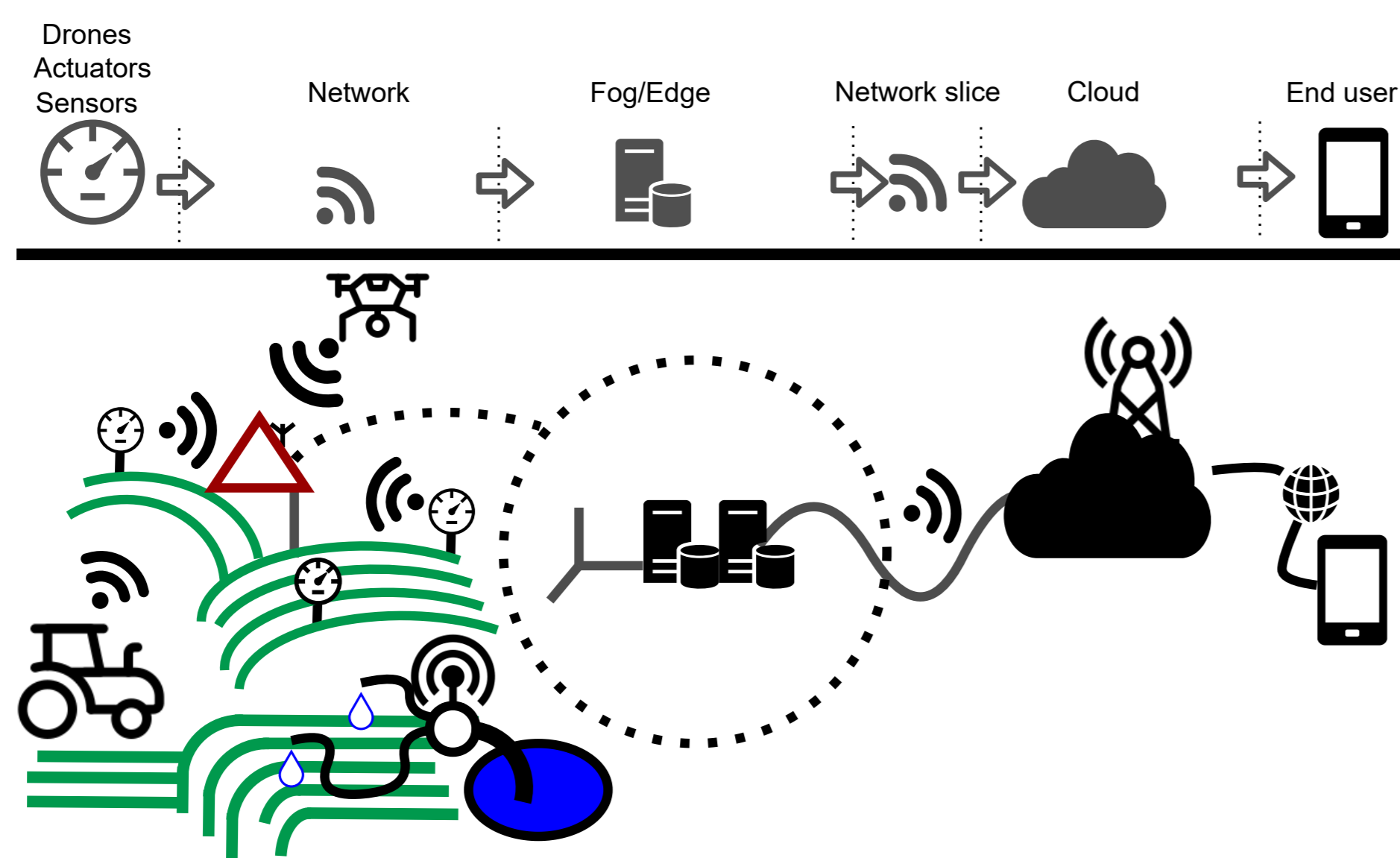


Figure 1: A Fully equipped agricultural exploration

Network-based IDS

For decades, research is been conducted to improve the efficiency of IDS. The advances in artificial intelligence (AI) and machine learning (ML) have opened a new niche for research by incorporating ML into an IDS, for example. [3, 2, 4]

- IDS filter traffic
- Signature-based, Anomaly-based or AI-based
- FL + IDS in AI-based setup
- from preliminary experiments, federated learning shows promising advantage in learning from data not centrally located.
- Many open challenges: resources, efficient management of IoT, aggregation, personalization.

This research will work with a software-defined (SDN) network architecture as shown in fig 2 to develop an IDS classifier for IoT in Agriculture.

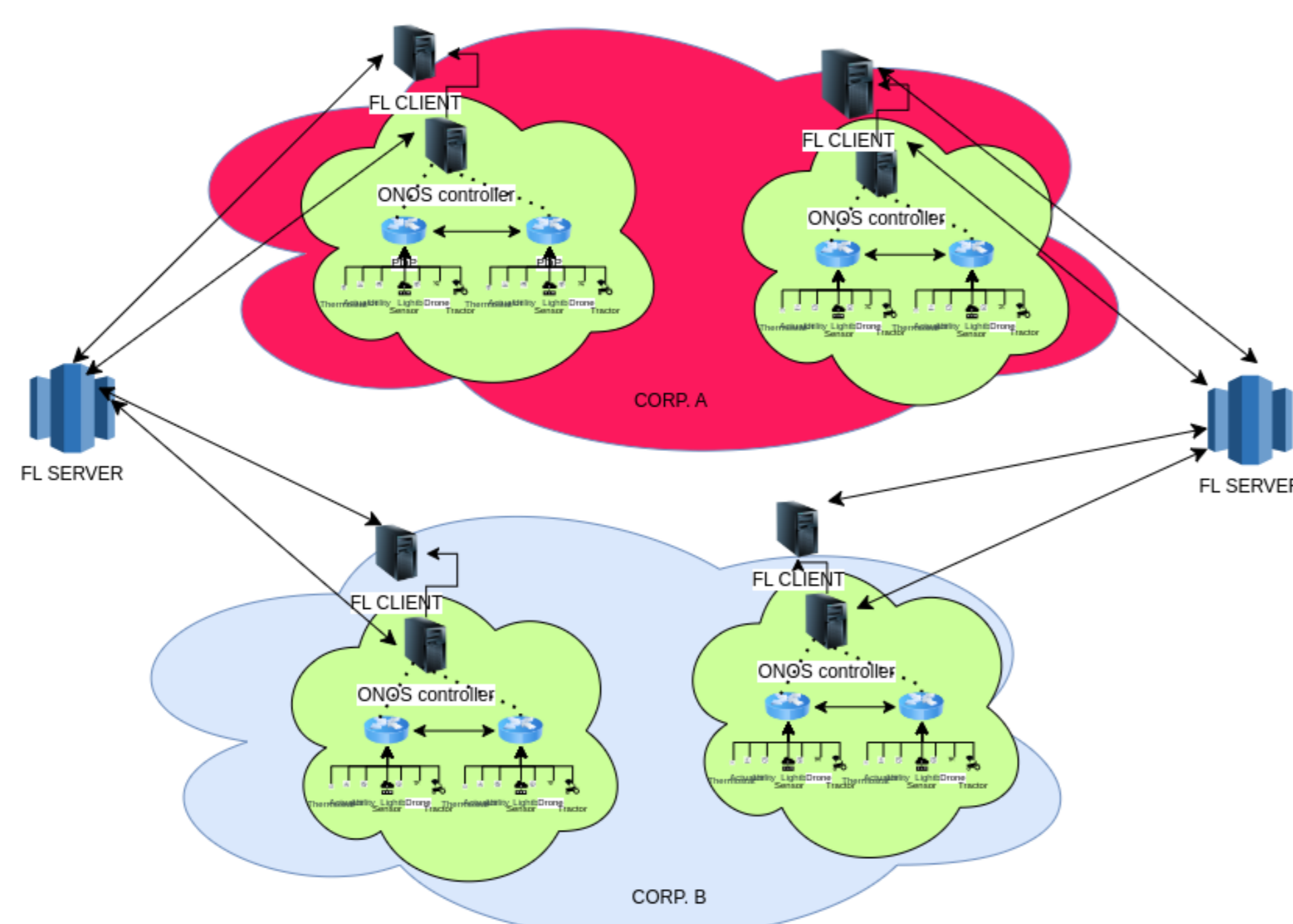


Figure 2: A schematic SDN-based architecture of IDS in network edge

Federated Learning

Federated Learning provides a framework for deep learning models to be trained in a collaborative manner without sharing data with a central data repository. FL provides a lot of benefits, such as improved privacy, and reduce communication costs. Some research works studied have proposed an FL approach to IDS. [1]

- AI distributed learning
- Local learners share their models
- Server aggregates models and send the result back to learners
- Local entities decide which model is the best.

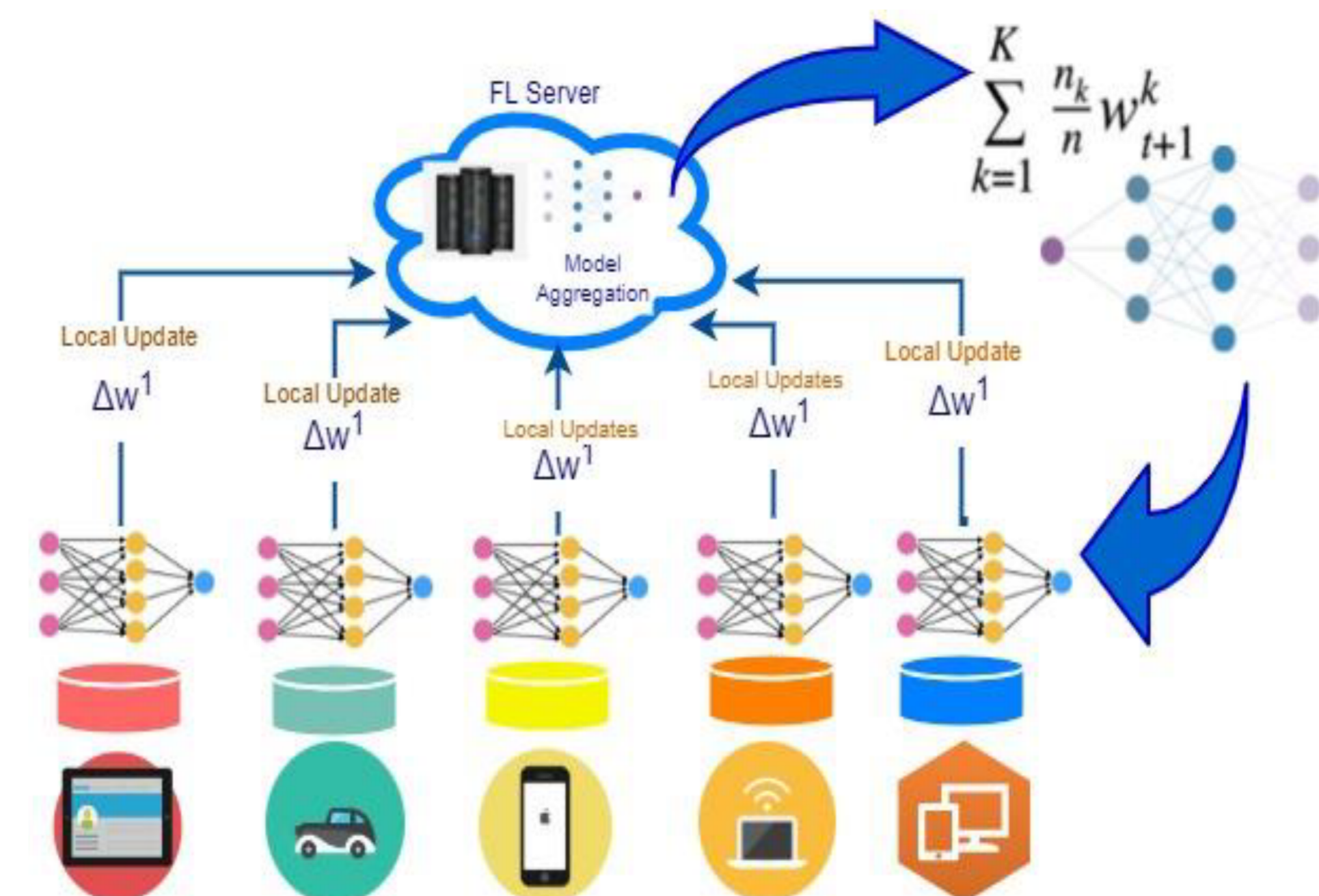


Figure 3: Federated Learning Framework

Smart Agriculture, Intrusion Detection Systems, and Federated Learning (OUR ROAD-MAP)

Agricultural environments have so many challenges with regard to connected devices which may not be limited to:

- Low computing/energy devices
- Remote location, possibly disconnected
- Specific protocols

this research will consider all these and bring together IDS and FL to secure such devices.

Conclusion

- This research aims to develop solutions against threats to IoT devices in agricultural environments that can be deployed in real-life.
- We hope to show that it is possible to secure IoT devices in agriculture.

Acknowledgements

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