

crosscontrol

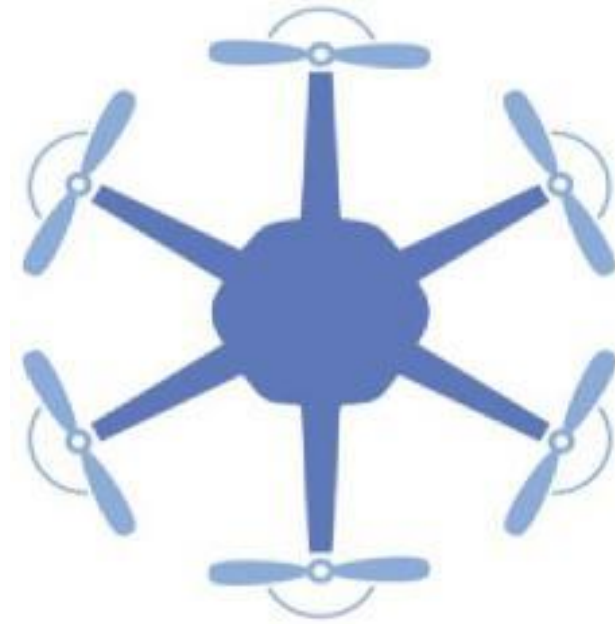
CrossControl role in ADACORSA

As presented at EF ECS2020

2020-11-19

Marko Elo
R&D Manager

Marko.Elo@CrossControl.com



ADACORSA

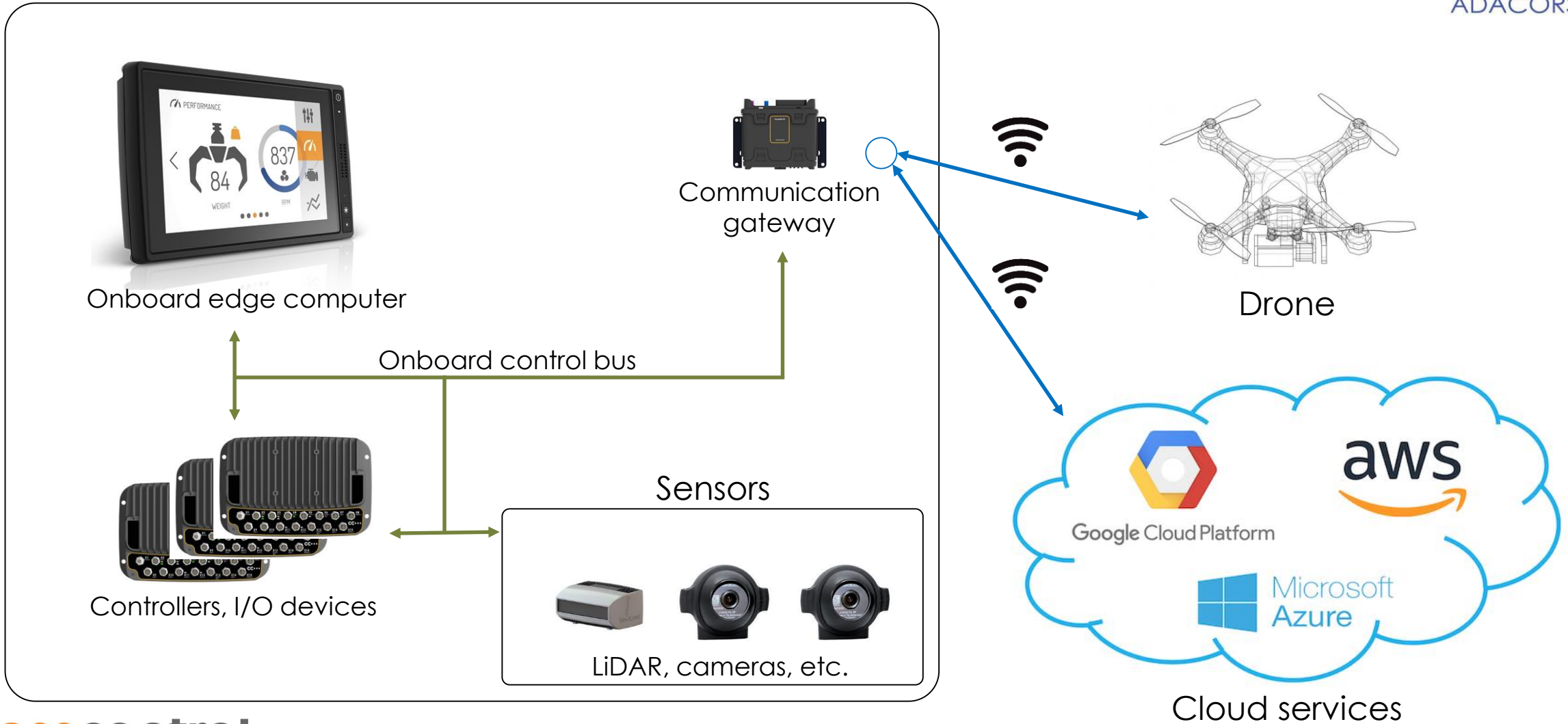
This project has received funding from the ECSEL Joint Undertaking (JU) under grant agreement No 876019. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Germany, Netherlands, Austria, Romania, France, Sweden, Cyprus, Greece, Lithuania, Portugal, Italy, Finland, Turkey



DEVICE TOPOLOGY AT GROUND VEHICLE



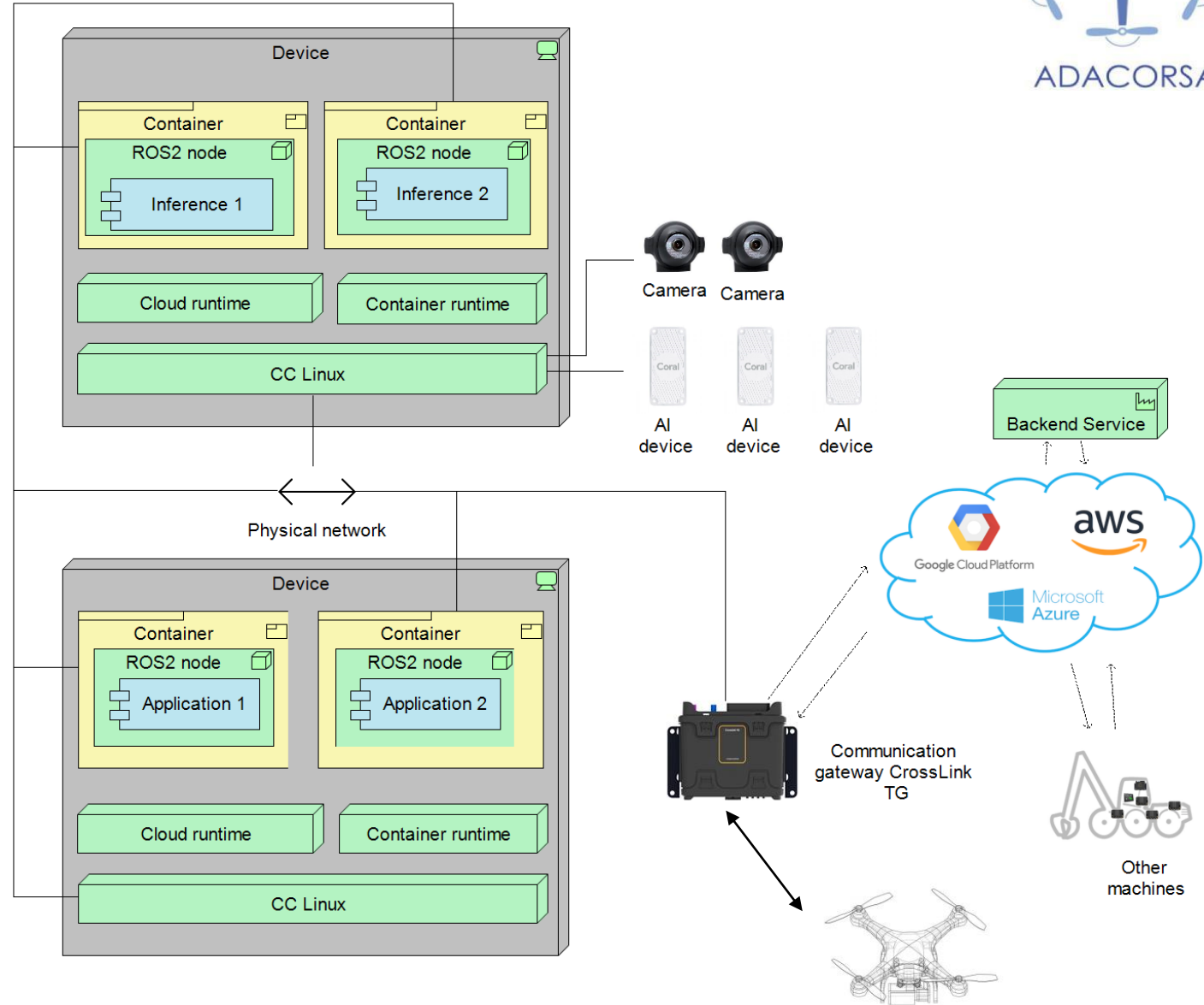
Ground vehicle



EDGE COMPUTING PLATFORM



- Application nodes communicate with each other **locally** using ROS2
- **Remote** communication is done via cloud interface
- Cloud interface is used to
 - Deploy all containers
 - Communicate with cloud backend service
 - Communicate with other machines
- CC Linux image contains basic blocks for building the system
 - Cloud runtime
 - Container runtime
 - Drivers for the AI devices and sensors



TOWARDS A CO-CREATED IMPLEMENTATION

- We are contributing to two research pilots as a vehicle onboard HMI/edge provider
- Functional requirements specification for the pilots being started in November

1. Enable automation of vehicles and trucks at a construction site

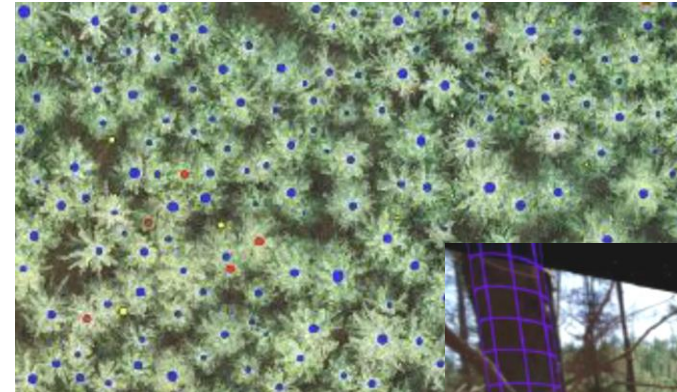
- **Mission:** Enable self-operating construction vehicles to operate in coordination with drones at the construction site



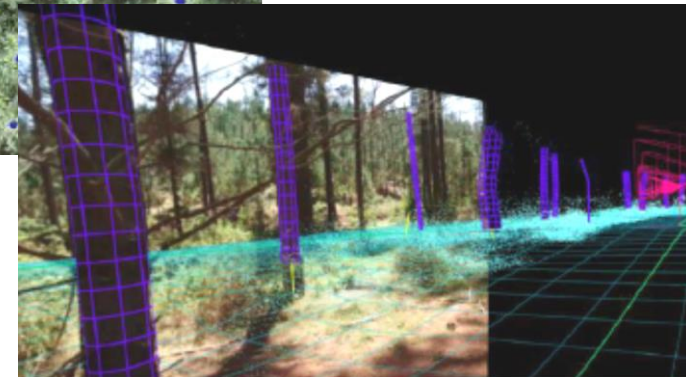
Picture by Ford Otosan

2. BVLOS controlled drones

- (a) mapping large forest areas at higher flight altitudes and
- (b) getting horizontal video of trees and terrain flying below tree canopy
- **Mission**
 - (a): Provide mapping of forest lands
 - (b): Detect individual tree parameters crucial for forestry decision-making



Pictures by Katam AB



PUBLICATIONS

- Paper and presentation at Automaatiopäivät24 event, April 2021 in Tampere
 - Biannual event arranged by Automaatioseura in Finland
 - Live event planned – for now
 - Paper submitted, "Utilization of ROS2 with Edge Computing"



ADACORSA

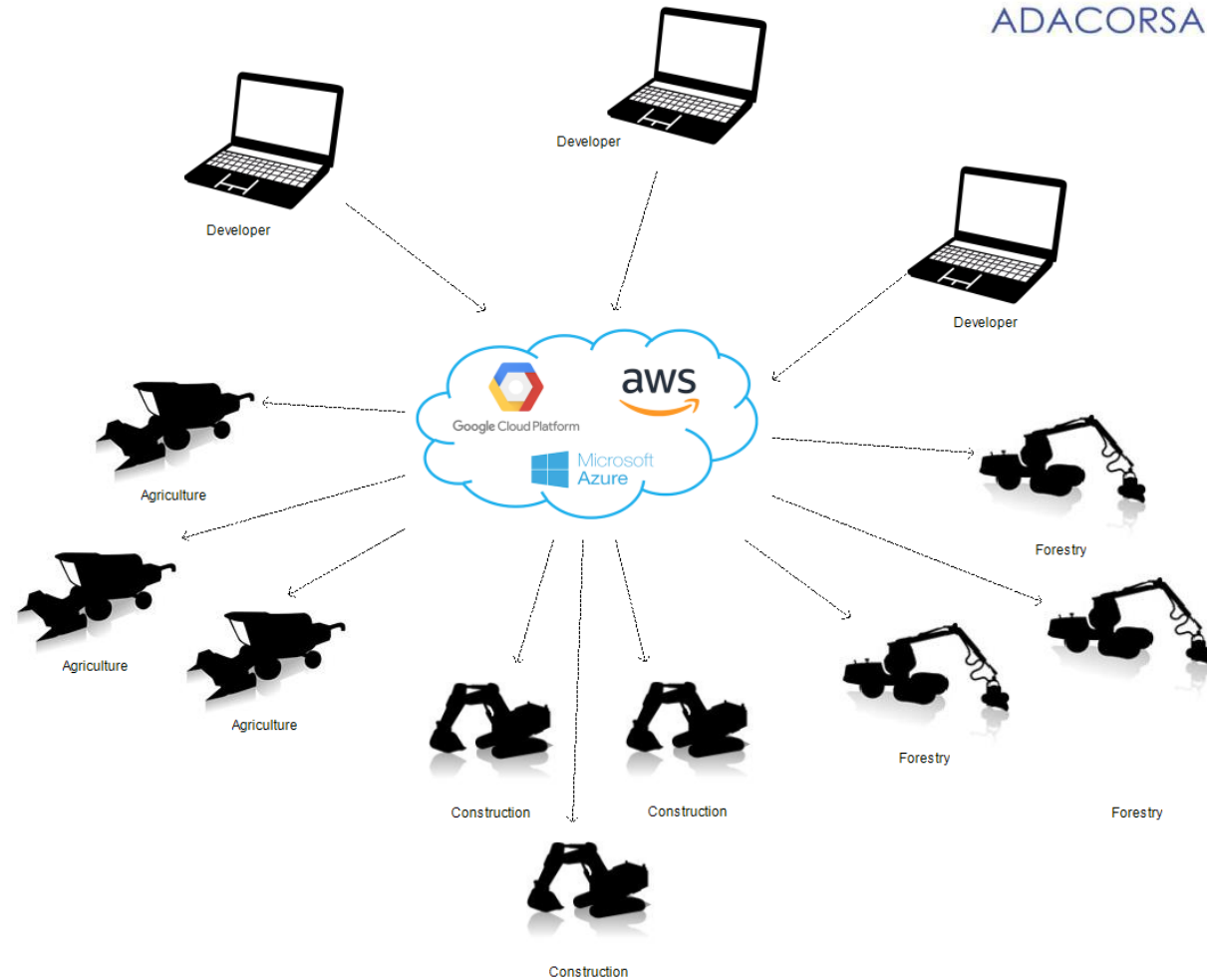
ADDITIONAL SLIDES



CLOUD COMPUTING



- ADACORSA evaluates the **benefits of cloud computing in connection with onboard edge**
- Microsoft Azure IoT Edge used in the first phase
- Identified benefits
 - Simplified SW deployment
 - Inter-machine communication
 - Big data collection for AI model training
 - Continuous AI model training – updating – deployment
- Risks to be evaluated
 - Cloud communication requires network uplink connection from edge devices to cloud – how limiting is that in future machines?
 - Cost of the cloud services and container registry?
 - Docker and IoT edge runtime support required in device image
 - Performance impact due cloud and container runtimes?
 - Performance impact from application containerization
 - RAM, disk and CPU usage
 - Container bootup time



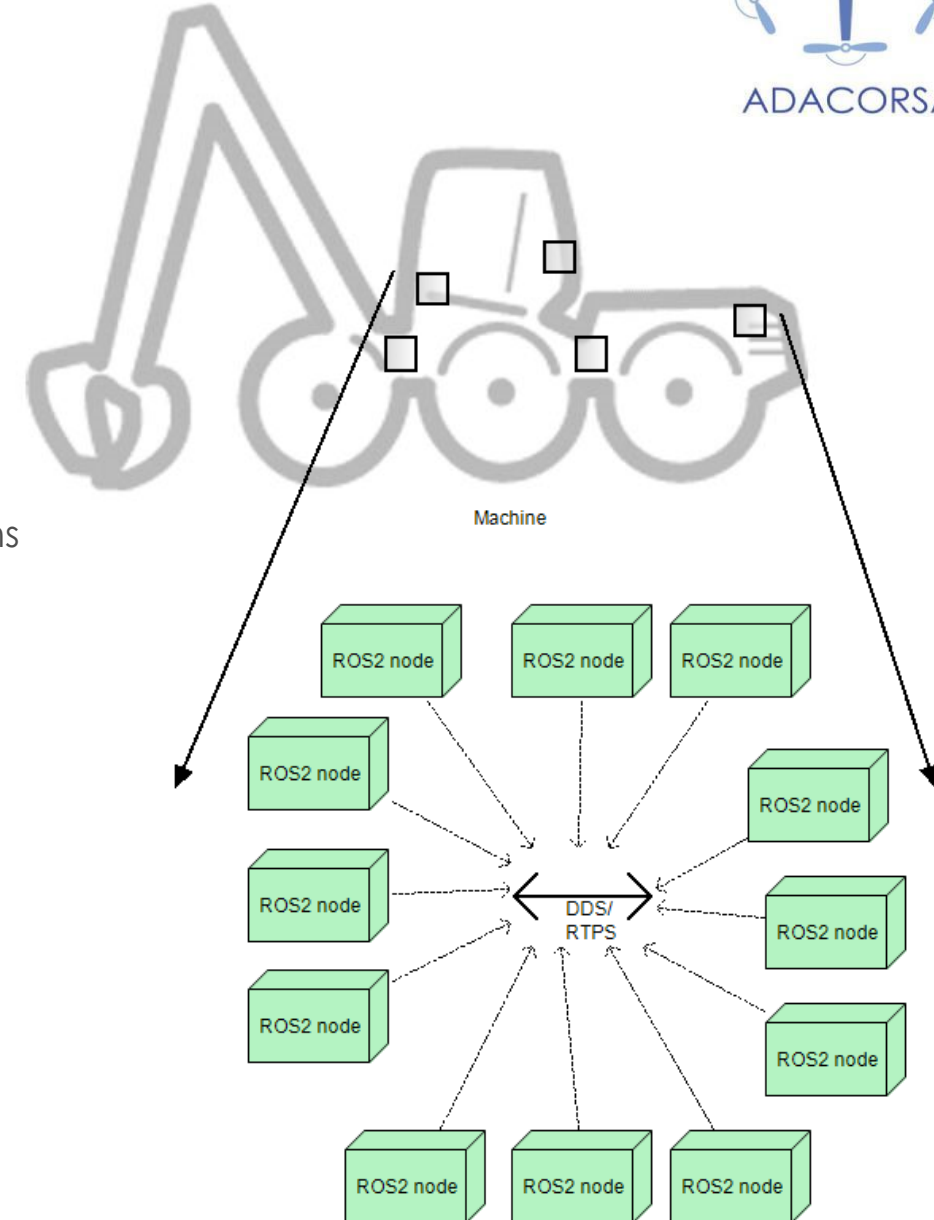
DISTRIBUTED COMPUTING



- ADACORSA evaluates the **benefits of distributed computing** using Robot Operating System 2 (ROS2)

Identified benefits

- HW resources abstracted behind node interfaces
 - Possible to change underlying HW without SW modifications
- HW device boundaries are abstracted
 - Nodes communicate directly with each other without knowledge of the devices
 - Possible to move nodes from one device to another without SW modifications
- Standard communication interface between nodes
 - Possible to replace nodes with other implementation as long as interfaces remains the same.
 - Genuinely reusable SW components
 - Faster application development with less cost
 - Many free ROS2 packages available on the Internet
 - New business opportunities: 3rd party components from partners
- Built in security and QoS settings
 - Define needed communication robustness level

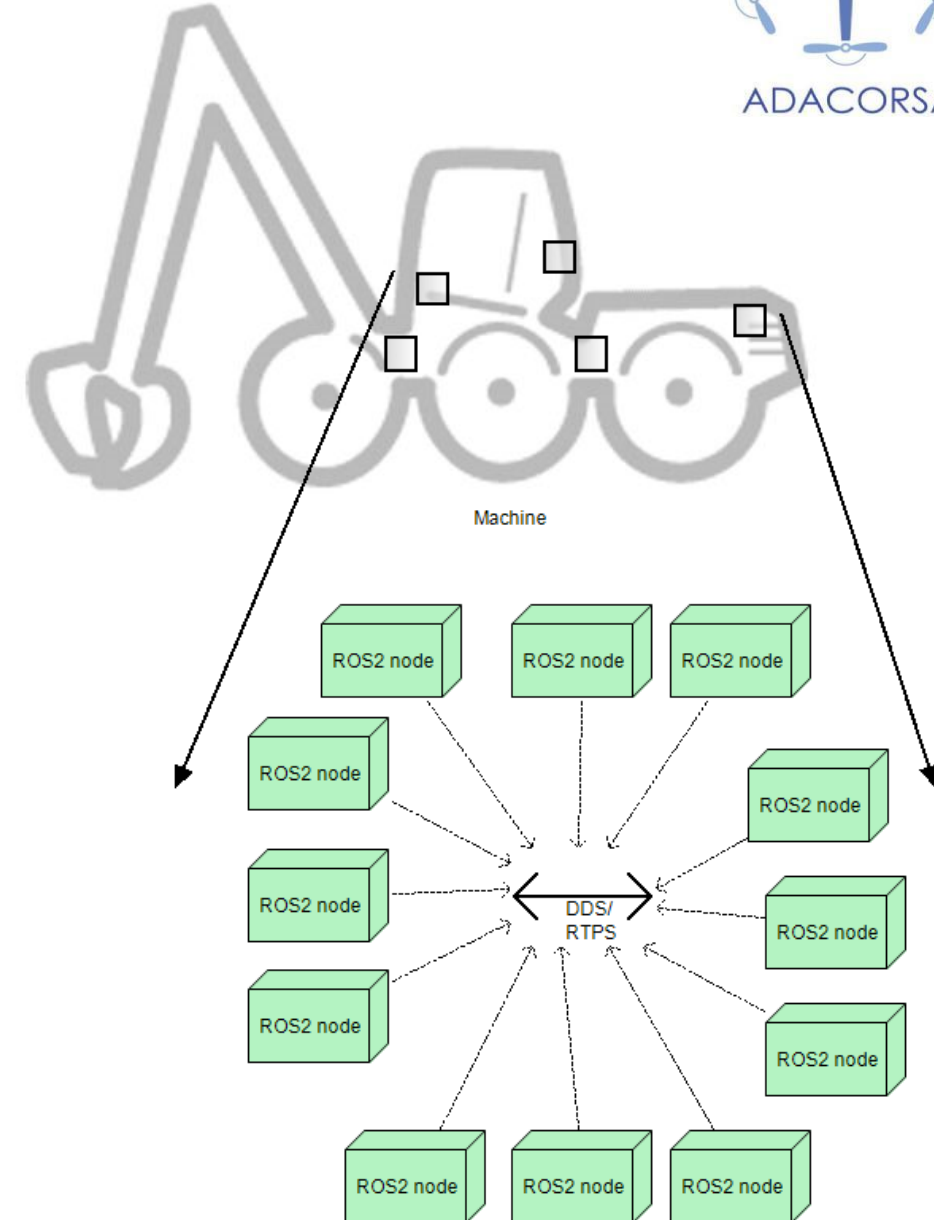


DISTRIBUTED COMPUTING



Risks to be evaluated

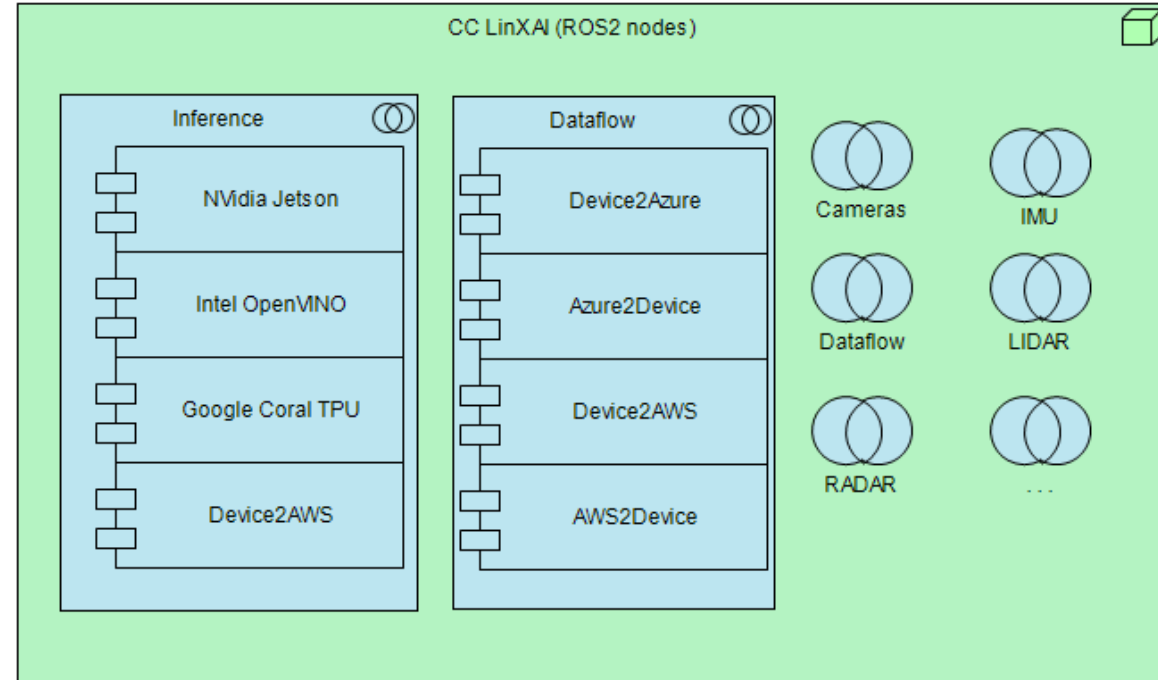
- ROS2 communication with UDP requires physical network connection. CAN connection is not sufficient.
- Performance considerations
 - Memory usage
 - CPU usage
 - Startup time
- Security impact on performance
- Large data messages' impact on performance



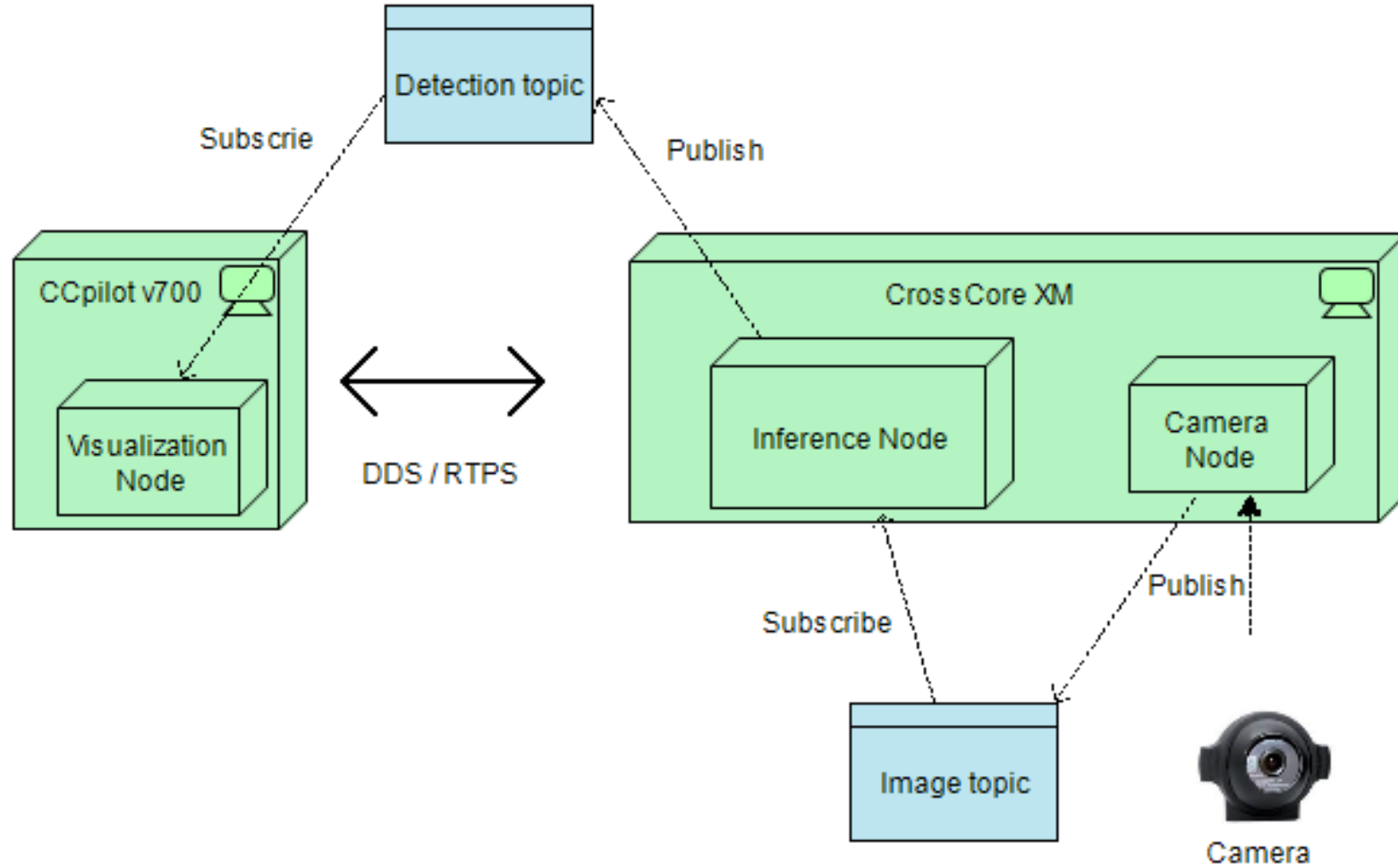
LinX AND ROS2 COMBINED



- What is ROS2?
 - Open (BSD license), industrial-strength middleware for creating distributed robotics applications
 - Collection of tools, libraries, and conventions that aim to simplify the task of creating complex and robust applications
 - Collection of nodes available for categories such as inference engines, cameras, radars, cloud connections etc.
 - Standard API per category enabling plug-n-play
 - Modularity: change of device requires just to change the node and keep the rest of the application intact
 - Possible to use 3rd party ROS2 modules; lots of open-source ROS2 development ongoing in developer ecosystems
- What's in it for us?
 - ROS2 enables to build a rapid AI/ML application prototype for ADACORSA, while reusing assets from LinX



ROS2 APPLICATION EXAMPLE



crosscontrol