5G-enabled Swarm Autonomy Makes Smart Cities More Responsive

Deploying AMRs over long distances and at large scale with ADLINK's ROS 2 Robot and 5G MEC Solutions

ADLINK
Leading EDGE COMPUTING

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Making smart cities more responsive

As smart city growth continues, the benefits of living in a mobile technology society have been a net positive for people. And as mobile technologies advance, so too will the societies that adopt them. However, technological advances are not a cure for all problems. Climate change continues to put pressure on the world's population, while the global pandemic has forced businesses to reconsider their organizational structures in response to the effects on their workers. While service sector businesses such as hotels and offices have had to change their normal operations to accommodate employees telecommuting, e-commerce logistics, warehousing, and delivery businesses have similarly been affected. Because of these factors, there has been an exponential increase in the demand for mobile connectivity. This challenges calls for new technologies such as 5G and autonomous mobile robots (AMRs) to make smart cities more responsive to people's needs in a future where social distancing influences personal interaction.

5G-enabled Swarm Autonomy: Deploying AMRs over long distances and at large scale

As AMRs will ultimately be deployed at large scale in smart cities to transport over long distances, controlling them will require flexible, decentralized, robotic fleet management systems to dispatch tasks efficiently with reliable communication technology to ensure smooth operation and performance. A robotic fleet management system adopting swarm autonomy and 5G technologies can increase productivity and the total cost of operations. Applied to robotics, AI swarm autonomy is inspired by the behavioral models of social insects, enabling robots to achieve a desired collective behavior based on inter-robot and environmental interactions. Central to swarm autonomy technology is the Data Distribution Service (DDS) communication protocol.

AMRs developed with Robot Operating System 2 (ROS 2) use a uniform data exchange environment DDS. Unlike standard transmission protocols based on a publication and subscription model, the concept behind DDS calls for a rigorous hierarchical architecture with low latency and high throughput where each user can define the communication quality required. Despite the size and complexity of such an information-sharing network, DDS can be easily configured to optimize and enhance overall network efficiency. 5G-enabled industrial wireless communication is capable of supporting the wide-ranging needs arising from communication between AMRs, humans, machines, and sensors, with high reliability, low latency, long transmission distance, multiple application scenarios, and optimal portability for mobile equipment in a smart city.

Swarm Autonomy Benefits

- *Awareness: Combines data locally sensed by the robots in a swarm into a big global picture, allowing the swarm to make collective decisions such as avoiding obstacles or other robots*
- *Solidarity: Allows a swarm of robots to autonomously classify tasks and to allocate an appropriate robot or group to perform a specific task*
- *Dynamic reconfiguration: Allows task replication/replacement to any robot to optimize performance, so that any faults caused by deficiencies of individual robots can be automatically recovered*

Building inspection and maintenance AMRs lessening the impact of climate change

Buildings are not immune from the effects climate change. As weather patterns change, the stresses on buildings from things like seasonal storms, or deteriorating indoor climate, will greatly reduce their lifespan. With the dangers of climate change facing building maintenance operations, it is imperative that the continued operation and productivity of equipment and infrastructure, such as buildings, bridges, and offshore installations, be secured.

Facility inspection by robots is a prominent robotic task. These robots can carry out data acquisition and execute simple physical operations, such as operating switches, valves, or handles with integrated sensors that enable them to avoid obstacles. They are ideal for monitoring environmental conditions such as air quality, radiation, and smoke detection, as well as inspecting more remote sites.

These robots can be categorized by following characteristics:

- *Mobility—Customized wheels or tracks to suit varying environments. They can also have legs, magnets, or rotors to create feature-specific inspection and maintenance systems.*
- *Sensors—Application-specific sensors, from simple rotational units to full robotic arms, for increased kinematic dexterity.*
- *Communication units, for remote operation, or sensor signal transmission.*
- *Operating centers for monitoring and documenting task execution to plans, or direct/remote-control operation of the robot*

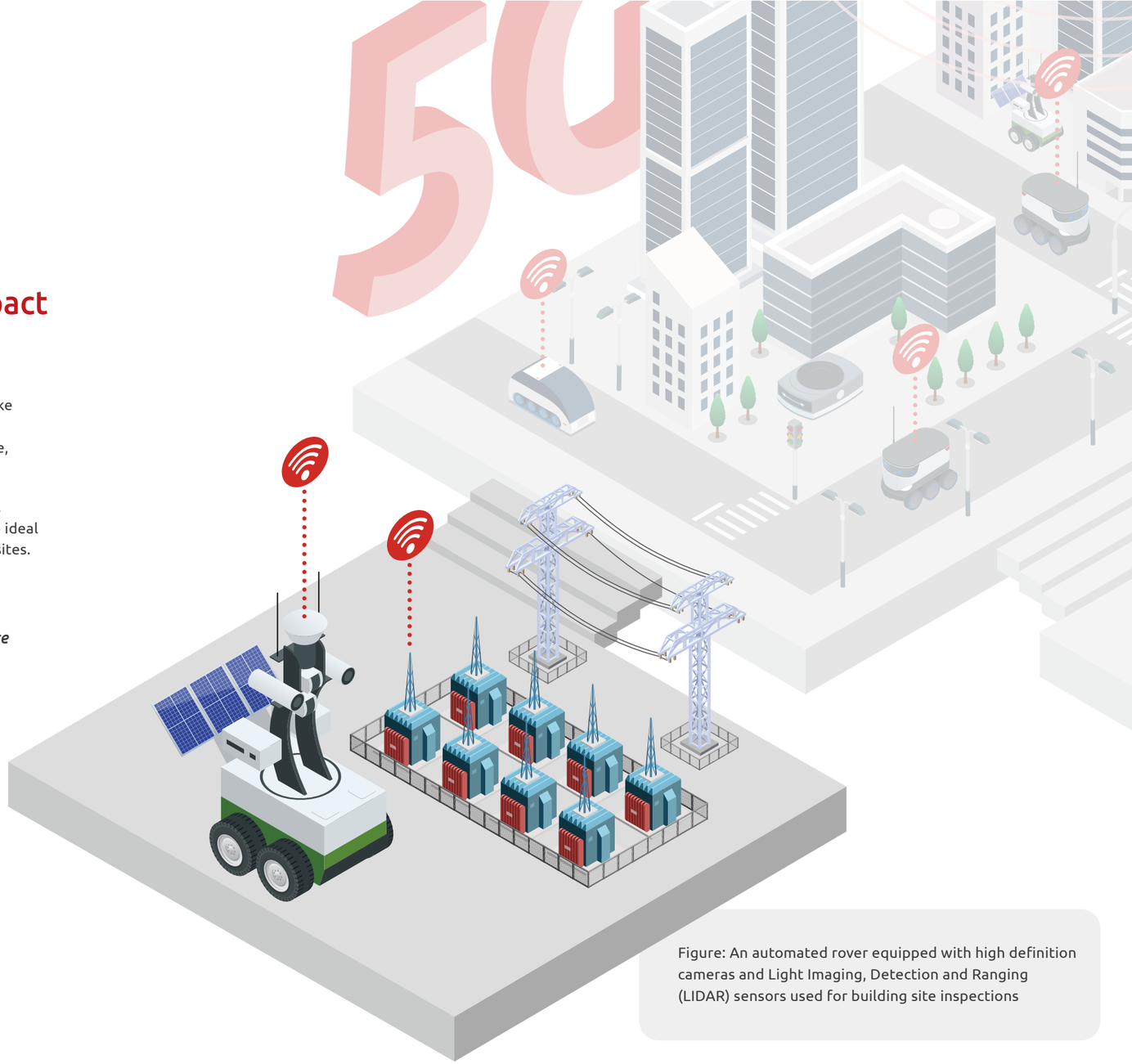


Figure: An automated rover equipped with high definition cameras and Light Imaging, Detection and Ranging (LIDAR) sensors used for building site inspections

Figure: Self-driving delivery robots reduce human contact

Warehouse and delivery AMRs enhance e-commerce logistics

Working from home is driving e-commerce businesses to rethink their need for automated warehousing. For businesses, adopting AMRs makes sense when faced with possible labor shortages. AMRs can boost operational efficiency, are reliable, and offer more rapid and eco-friendly delivery systems that drive demand for satellite warehouses and distribution hubs located closer to the majority of customers where products can be dispatched by AMRs to their end destinations.

Typical tasks for warehouse AMRs:

- *Transportation: Loading pallets and transferring loads*
- *Warehousing: Moving products from docks to storage*
- *Order Picking: Moving ordered products to trailer-loading areas for distribution*

AMRs can be found in the entire logistics supply chain, including end-of-chain delivery such as:

- *Home delivery logistics networks*
- *Autonomous grocery and mail-order article shopping and packaging*
- *Support vehicles for letter and parcel deliveries*

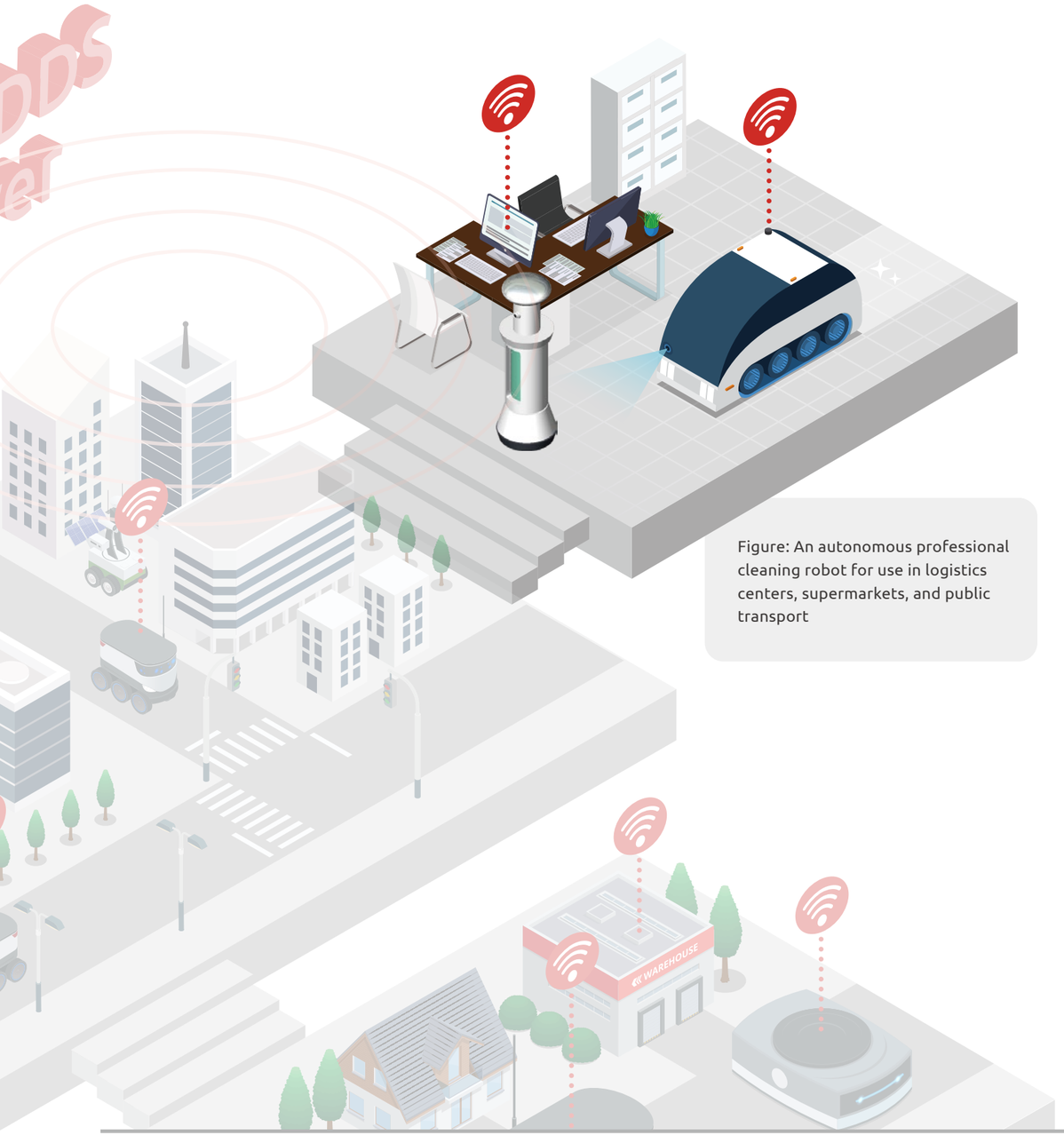


Figure: An autonomous professional cleaning robot for use in logistics centers, supermarkets, and public transport

Disinfecting and cleaning AMRs for public spaces

In response to the global pandemic, hotels, department stores and offices around the world are implementing new cleaning protocols for public spaces to reassure guests and workers.

Conventional industrial floor cleaning robots are usually based on standard cleaning machines equipped with the robotic equipment for autonomous untethered movement, including a navigation control system and sensors (ultrasonic, laser scanner, bumper switches) for detecting environments and preventing collisions with obstacles. These robots are categorized as:

- ***Sweeping***
- ***Vacuuming***
- ***Scrubbing***
- ***High-pressure cleaning***

Specialized disinfection robots are used to disinfect areas requiring more intensive cleaning such as quarantine areas, hotel rooms, and bathrooms. These robots can have additional cleaning features like UV-C lights with the ability to reach specific places like sinks, door handles, or beds, for targeted disinfection.

ADLINK's ROS 2 Robot Solution

Software and Hardware Integration in ROS 2 Controller Supports Rapid Development of AMRs

Learn More

As the robotics industry continues to grow, the development of techniques to build smarter robots more quickly is at the forefront of innovation. ADLINK's ROS 2 controllers, embedded with Neuron SDK, ADLINK's commercial ROS 2 development kit, is ideal for rapid development and deployment of AMRs.

ROS 2 Real-time Controller and Demo Kit

AI

PRO

DEV

PoC

ROScube–X

High-performance AI computing for intelligent robot

- High-performance AI computing
- Low energy consumption
- Real-time capability

w/ expansion box

ROScube–I

Real-time architecture for robotics development from mainstream to high end

- Supports complex algorithms
- Diverse I/O
- Real-time capability

w/ expansion box

ROScube Pico Coming Soon

Module-based kits for rapid development and cost-efficient deployment

- SMARC and Jetson platforms
- Robot development and deployment kit
- Power management capability

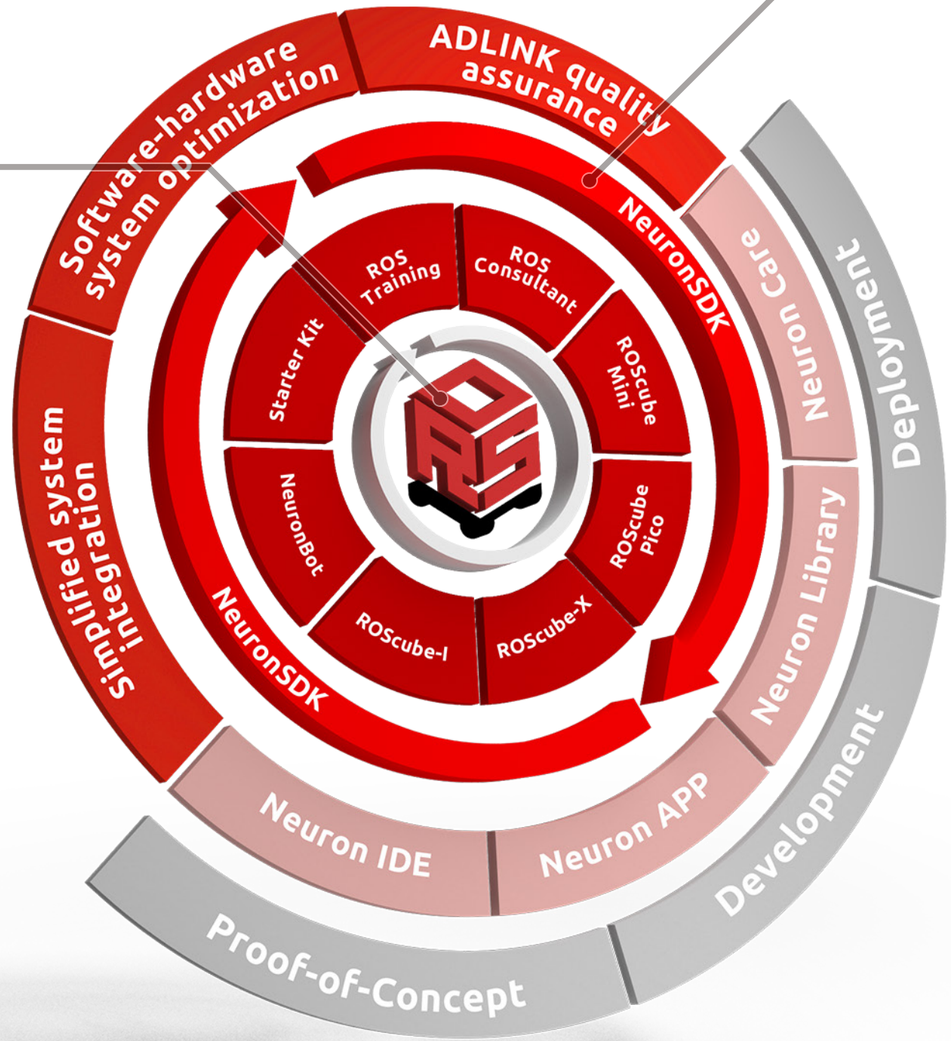
NX/Nano/TGL/Lanai

NeuronBot Coming Soon

Demo Kit for robotics companies and educational institutes

- Integrated vision, control, AI and motion modules
- Designed for rapid prototyping
- Powerful open source ROS libraries

w/ front bracket



ROS 2 / DDS Development Platform

Neuron SDK

Neuron DDS+
Ensures real-time, reliable communications and enhances system performance

Neuron Booster
ADLINK commercial shared memory mode provides ultra-low latency and high throughput

Neuron RT
High-performance, low-latency real-time system architecture for specialized applications.

Neuron IDE
Web-based visualization development interface and package management platform

Neuron APP

Neuron Extension
New extension function for customer use

Third-party Widget
Verified, open-source ROS packages that run on ADLINK ROS controller

Neuron Care

Customer Portal
Web-based user portal that allows customers to ask questions about ROScube and Neuron SDK

Neuron Update
Allows customers to continually update their Neuron SDK

Multi-access Edge Computing (MEC) Advantages

MEC is an evolution of cloud computing that moves data processing from centralized data centers out to the network edge and closer to application end users, essentially in enabling service providers to deliver on their 5G promises by significantly reducing latency, increasing connection speed, enhancing network security, and improving Quality of Service.

Centralized Cloud	WHAT IS MEC?	Edge
DATA CENTER	Deployment	NETWORK EDGE
CLOUD	Location	NEAR END-USER/APPLICATIONS
DESIGN CENTRIC FOR PROCESSING	Hardware Design	APPLICATIONS SPECIFIC
SERVER-SIDE DATA	Data Processing	CUSTOMER-SID DATA

ADLINK Edge Servers Meet Key Requirements for MEC Applications

Validated for NGC-Ready, AWS IoT Greengrass and Intel® Select Solution for uCPE, ADLINK's OTII-compliant edge servers provide a versatile, cost-effective and scalable white-box solution to facilitate deployment of 5G RAN and private networks, and enable a wide range of 5G MEC use cases across industries including telecom, retail, manufacturing, automotive and healthcare.

Rugged Design
OTII-compliance for Extended Temperature and Flexible Deployment

High Performance
Powered by Intel® Xeon® Scalable & Xeon® D Processor

Flexible & Expandable for IoT, AI Applications
Support 2x PCIe x16 for FPGA, GPU Accelerators, IO Expansion

Designed for TSN
Support IEEE 1588, Remote Management and Upgrade

ADLINK MECS Series 5G Edge Servers

MECS-7210
2U Edge Server with Intel® Xeon® Scalable

MECS-6110
1U Edge Server with Intel® Xeon® D

Learn More

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