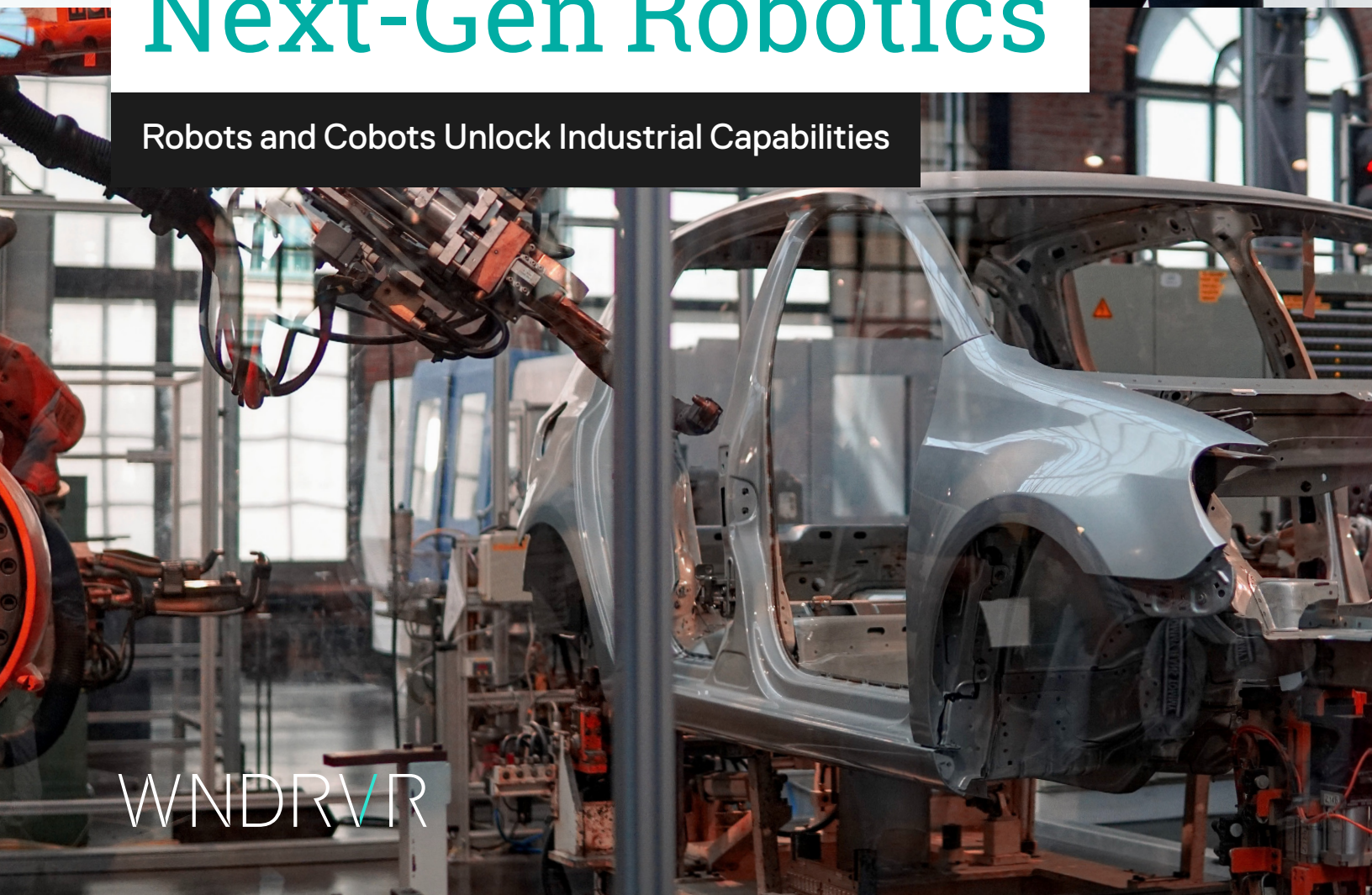
Intelligence at the Edge Enables Next-Gen Robotics

Robots and Cobots Unlock Industrial Capabilities



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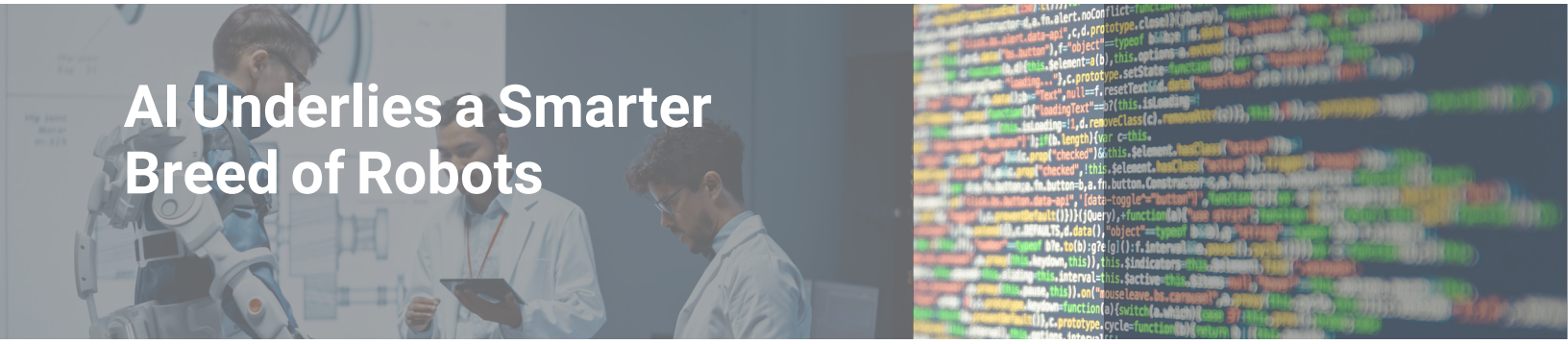


AI Underlies a Smarter Breed of Robots

We've come a long way since Gort, the alien robot enforcer in the 1951 film The Day the Earth Stood Still**, threatened humankind with ultimate destruction if changes were not made. Today, smart machine technologies and the intelligent edge have created tremendous opportunities as Industry 4.0 concepts and practices reshape everything from autonomous automobiles to pharmaceutical labs to robot-guided manufacturing processes.**

Drawing on a broad swath of supporting scientific endeavors and disciplines — including space exploration, social and behavioral sciences, computational and system biology, neuroscience, and more — industrial robots are gaining senses and reasoning powers akin to those of humans. Exciting developments in the field of affective computing are leading to robots and devices that can visually recognize faces and objects, interpret activities in their immediate surroundings, process complex inputs to drive deterministic decision-making, and enhance interactions with humans.

Cobots, AI-enabled collaborative robots designed to work in concert with humans to perform difficult tasks, are increasingly being developed for specialized activities. Sensor-equipped cobots that can use touch, computer vision, balance, positional feedback, work cell monitoring, and navigational capabilities are ushering in a new era of robotics. Workplaces, manufacturing floors, smart cities, and home environments can all benefit from connectivity to the intelligent edge. 5G networking, low-latency wireless communications, advanced machine learning, and breakthroughs in AI are all helping fuel these new opportunities.

> "The world is moving from a human-based internet to a machine-to-machine internet. We are talking here about Industrial IoT, where the internet itself thinks."
>
> **— Andrei Kholodnyi,**
> **Principal Technologist,**
> **Wind River**

New Use Cases for AI and Robotics

AI figures in many of the intelligent edge use cases involving robots and cobots. Among the application areas where these technologies are flourishing — improving worker safety, boosting productivity, enhancing and extending human capabilities — are the following use cases:

32.5%

The predicted CAGR of the cobot market in this decade[1]

Logistics robotics in warehouses and smart factories: Originally, robots capable of autonomously locating and retrieving stock were useful in warehouse and large-scale stockroom settings. Now, logistics robots have gained a greater presence in smart factory implementations where a wider variety of tasks can be handled effectively. In these settings, robots can customize products at the flip of a switch, use machine learning to refine and enhance the precision and efficiency of processes, and even "teach" procedures to other robots and cobots on the production line.

5G wireless networks and low-latency connections make it possible for intelligent robots to be untethered, moving freely through the workspace guided by AI algorithms that support deterministic decision-making.

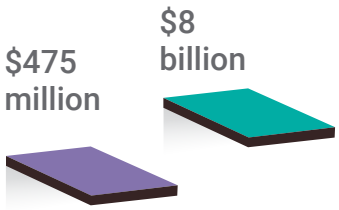
Surgical robots: Rapidly advancing breakthroughs in both robotic construction and network connections underlie assistive and fully automated robotic surgery. In assistive surgery, doctors exert control over the equipment used to make incisions, position medical devices inside a patient, and close up an incision after surgery. Fully automated tools are being developed that can perform full surgical operations without any kind of human intervention.

1 *"Cobots Continue to Gain Interest for Flexible Automation, Tipping the Market over US$600 Million in 2021," ABI Research (Cision PR Newswire press release), May 26, 2021*

HealthTech describes recent progress in this area by writing, "Increasing adoption of 5G networks, combined with advancements in autonomous and artificial intelligence solutions and the secondary effects of pandemic-driven telemedicine mandates, has created a unique opportunity for healthcare agencies. Robotic surgery tools capable of assisting doctors in lifesaving efforts at a distance — or completing less complex tasks with minimal oversight — may serve to augment human professionals in a variety of roles."[3]

AI-guided farming methods using robotics: Projects are underway around the globe that demonstrate the potential of planting, growing, and harvesting agricultural crops using automated processes and robotics. Within this labor-reducing model, a single farmer can manage larger areas of farmland, collecting data from sensors to measure soil conditions, the presence of pests, and weed growth.

5G RuralFirst, a U.K.-based organization sponsored by Cisco and the University of Strathclyde, is identifying ways that 5G wireless and mobile connectivity in rural environments can yield benefits. One of its initial projects, Hands Free Hectare, has been exploring the use of drones, robots, and automated vehicles to help farmers be more productive. Several years ago the venture successfully grew and harvested 4.5 tons of barley without anyone ever venturing out into the field.[4]



Rise in global cobot revenue, in U.S. dollars, 2020–2030[2]

2 *"Cobots Continue to Gain Interest for Flexible Automation, Tipping the Market over US$600 Million in 2021," ABI Research (Cision PR Newswire press release), May 26, 2021*
3 *Doug Bonderud, "What Does the Future Hold for Robotic Surgery?" HealthTech Magazine, February 2021*
4 *Spencer Feingold, "Field of Machines: Researchers Grow Crop Using Only Automation," CNN, October 8, 2017*

Robots and Cobots at the Intelligent Edge

Projects involving robots and cobots are popping up worldwide, taking advantage of a number of supporting technologies that are amplifying the possibilities and yielding many important benefits for companies adopting these technologies. Examples of practical, real-world uses follow.

Cobots Keep Working After the Humans Go Home

Fischer Gears, based in Randers, Denmark, has been producing gear for a wide variety of international customers. Since 1942, its gears have been used in ship engines, Rolls Royce automobiles, mining operations, and more. The company's traditional manufacturing processes have evolved recently to include extensive use of cobots, equipped with computer vision and dexterous digits, enabling them to create precision gears at large-scale volumes.

$22 million

Amazon cobots save the company as much as $22 million every time a newly opened warehouse begins to use them[5]

Lars Nielsen, the factory manager and chief operating officer at Fischer Gears, explained, "Smaller parts can be handled by cobots. They can take the part, put the part in the machine, and close the doors [then] take the part out and put it on the pallet." Built-in computer vision lets the cobot recognize its immediate surroundings and begin working as soon as an employee selects the program to run. Nielsen believes robots can reduce repetitive strain injuries among human workers, improve safety in the manufacturing areas, manufacture gears 24/7 even when workers aren't present, and increase the company's competitiveness in the market. (This video shows the cobots in action.) Omron, the robot manufacturer, has also developed an autonomous mobile robot that can navigate intelligently around the workplace floor aided by computer vision, performing such tasks as inspection, picking and placing, sorting, and assembling.

Robots or autonomous machines are involved in pilot projects at 40% of airlines and are in major programs at 14% of carriers.[6]

5 *Eugene Kim, "Amazon's $775 Million Deal for Robotics Company Kiva Is Starting to Look Really Smart," Business Insider, June 15, 2016*
6 *Air Transport IT Insights 2019*

Cobots Work Alongside Humans to Build Cars

To boost production and relieve employees of repetitive stress injuries, Ford introduced cobots into its manufacturing processes at a major production site in Craiova, Romania. The cobots perform a variety of tasks, including checking assembled engines for oil leaks using a UV light and camera; the camera communicates with the cobot through Ethernet. Ford engineers developed an end effector, or gripper, that allows the cobot to operate the camera and control its movement.

Another cobot in the plant greases the camshaft followers, another takes care of system tests and training, and yet another fills the engine with oil. Adrian Calangiu, area manager at the Ford plant, said, "We wanted to help the operators [who] perform repetitive and challenging jobs, having the cobot act as a colleague to the operator instead of as a replacement. The UR cobots have the flexibility to work near the operator without jeopardizing his safe zone. The collaborative robots also relieve him of monotonous, repetitive tasks, giving him the opportunity to contribute in a creative manner."[8]

Beyond improvements in automobile manufacturing, the development of self-driving cars is being enhanced by the capabilities of 5G networking combined with advanced AI technology and machine vision. These technologies help improve driving safety, avoid collisions, guide navigation, and control traffic in smart city environments. Deutsche Telekom wrote this about recent advances: "Enabling an even faster connection between transport systems, the 5G network will offer new application options advancing the development of autonomous cars. Not only will they be able to make autonomous decisions in the future, they will also communicate and cooperate with each other. Automated driving is the term used to describe a scenario where a fully interconnected and intelligent road transport system is created as a result of these capabilities."[9]

The automotive sector uses robots more than any other industry, accounting for 28% of global installations in 2019.[7]

7 *Executive Summary, World Robotics 2020 Industrial Robots Report*
8 *"Collaborative Robots Optimise Ford Assembly Line," Manufacturers' Monthly, June 8, 2021*
9 *"5G Network as Foundation for Autonomous Driving," Deutsche Telekom*

Autonomous Robots Converse with Passengers at Heathrow Airport

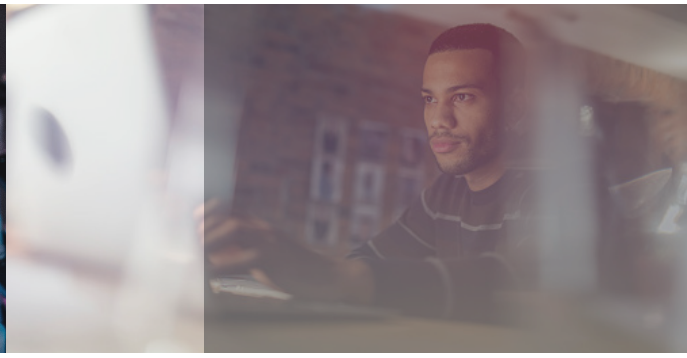
London's Heathrow Airport, one of the 10 busiest airports in the world, has introduced a pair of autonomous robots in Terminal 5 for guiding and informing passengers. Like many airports, Heathrow has been seeking multiple ways to automate processes and make air travel more pleasant for customers. The two robots, from BotsAndUs in London, communicate in multiple languages, offering real-time flight information and directional guidance to cafes, rest rooms, service counters, and other key locations. The robots are equipped with sensors (including 3-D LiDAR, ultrasonic, and infrared) and computer vision to provide obstacle avoidance and navigation.

Andrei Danescu, cofounder and CEO of BotsAndUs, noted, "Automation has already significantly changed how airports function, across all areas of operation — from passenger services to luggage maneuvering, security, and more. What we see as a key next step is actually bringing all these together so they can communicate and collaborate with each other, offering a seamless and safe experience from the car park to boarding the flight."[11]

In 2018, nearly 1/2 of the world's airlines and nearly 1/3 of airports expressed interest in exploring robotics and automated vehicles within three years.[10]

10 *Air Transport IT Insights 2019*
11 *Tim Hornyak, "Meet the Robots That May Be Coming to an Airport Near You," CNBC, January 11, 2020*

Underlying Technologies



Realizing the vision of Industry 4.0 and the ongoing shift to the intelligent edge in industrial environments requires a paradigm shift in which processing and data analysis, as well as decision-making, take place close to the source of operations and activities. This rethinking of the infrastructure, based on a disaggregated architecture primed to deliver fast, low-latency connectivity where it is needed most, meets key challenges in a number of industry sectors, including autonomous manufacturing operations, energy subsystem facilities, agricultural centers, supply chain warehouses, autonomous vehicle operations, and life-science facilities. The enabling technologies that play a role at the intelligent edge include over-the-air software updates, secure containerization processes, artificial intelligence (AI) and machine learning (ML), advanced data analytics at the edge, 5G networking components, and more.

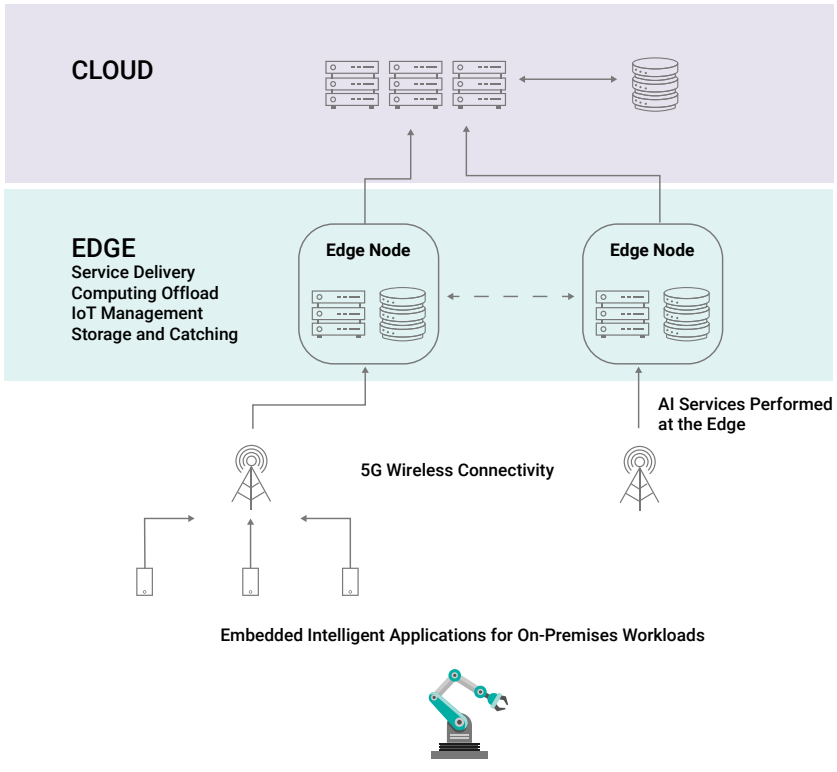


Figure 1. Industry 4.0 applications require greater intelligence at the edge[12]

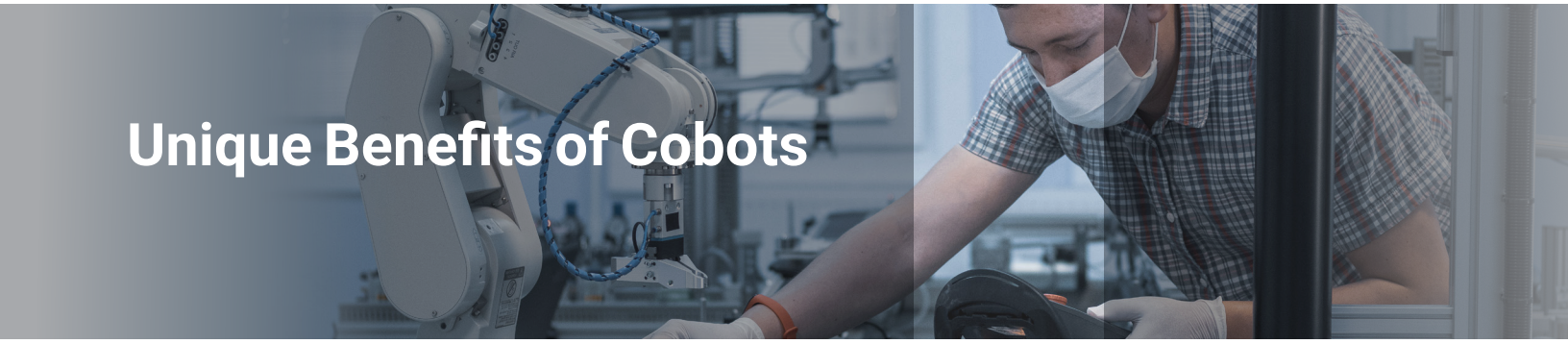
12 *Adapted from "The Edge Computing Infrastructure," Wikipedia*

Additional Resources

For insights into the technology advances bringing robots to the intelligent edge, view "Robots Get Real 'Time' Running TSN Applications on VxWorks," a video interview with Andrei Kholodnyi, principal technologist in the Technology Office of the CTO, Wind River.

To learn more about the full-lifecycle management of intelligent systems, visit Wind River Studio Developer Capabilities.

To learn about the latest advances in robotics technology, visit On the Cutting Edge: Robots Join the Sensor-Driven Revolution.



Unique Benefits of Cobots

Collaborative robots have sparked increased use of robotics technologies in a rapidly accelerating industry sector. The development costs of full-scale robotics projects are prohibitive for some companies, though they are steadily decreasing as the technology matures. In comparison, cobots — designed to work alongside humans and enhance the performance of specific tasks — typically require less development effort. As a result, companies can achieve a favorable ROI in less time.

This strong growth of the cobot market is spurred by a variety of factors. According to the Association for Advancing Automation, "Advances in edge computing have made collaborative robots more flexible and easier than ever to implement. Often, little to no programming is required to install them, reducing integration costs. Increasing flexibility opens up a wide range of new tasks and applications that collaborative robots can effectively automate."[14]

Another of the major benefits of cobots, noted by those who have launched manufacturing projects, is an improvement in the quality of the products produced. Zac Bogart, president of Productive Robotics, said, "In manufacturing, quality comes from consistency. Consistency is really the holy grail. If you can't build the same thing the same way every time, you might as well not even start."[15]

> "Machine learning has advanced to the point where software systems can recognize complex and subtle patterns in data. Collaborative robots that function in unstructured environments get the attention, but the use of artificial intelligence will soon help one robot learn from another."[13`]
>
> **— Association for Advancing Automation**

13 *"Next-Gen Robots Make Fact More Exciting than Fiction," Association for Advancing Automation, February 4, 2021*
14 *"Collaborative Robots Market Experiencing Exponential Growth," Association for the Advancement of Automation*
15 *Michelle Bangert, "Collaborative Robots Improve Quality," Quality Magazine, April 4, 2020*

Enabling Robots at the Edge: Wind River Solutions

Tools and solutions from Wind River® help speed robotics development at the intelligent edge, combining expertise in 5G networking, container technology, embedded solutions running on a real-time operating system, artificial intelligence, machine learning, and simulations of complex systems for testing and development.

- **Wind River Studio:** This cloud-native platform is a secure foundation for the development, deployment, operations, and servicing of vital intelligent edge systems. Optimized for DevSecOps methodologies, Studio enables application teams to employ continuous integration (CI) and continuous delivery (CD) workflows, drawing on agile development practices. These capabilities are paramount to the future of intelligent machines and responsive cloud-based infrastructures.
- **VxWorks®:** The world's leading commercial real-time operating system (RTOS), VxWorks now includes support for container technology, providing an effective means for keeping applications up to date on the intelligent edge. Well suited to high-performance IIoT applications, VxWorks is a mainstay in process control automation, robotics, and intelligent vehicle applications. To support industrial implementation, certifications are in place for IEC 61508 SIL 3, ISO 26262 ASIL D, and IEC 62304.
- **Wind River Linux:** With robust support for container technology, Wind River Linux delivers a ready means of loading and patching applications dynamically in an industrial automation system and across additive and adaptive manufacturing environments.
- **Wind River Simics®:** This comprehensive system simulation environment streamlines design, development, and testing of complex intelligent industrial automation systems. Simics accommodates DevSecOps software practices and enables teams to shorten development cycles and test embedded system designs before the physical hardware is available.
- **Wind River Helix™ Virtualization Platform:** Helix Platform supports virtualized frameworks in intelligent process control systems, spanning hybrid networks and multiple operating systems.

Solutions from Wind River are accelerating the development of intelligent edge applications, powering industrial infrastructures and delivering proven reliability. Our customers rely on our deep industry experience to support edge computing and 5G, complementary technologies that are turning the vision of intelligent IIoT solutions into a reality.

Wind River is a global leader of software for the intelligent edge. Its technology has been powering the safest, most secure devices since 1981 and is in billions of products. Wind River is accelerating the digital transformation of mission-critical intelligent systems that demand the highest levels of security, safety, and reliability.