

Converging Technologies Bring the Smart Factory to Life

To transform technology, processes, and people on its journey to Industry 4.0, EXOR International is collaborating with Intel and the 5G wireless ecosystem to converge networking, cloud, and edge computing technologies in an agile and modular application environment.

At a Glance

- Manufacturers are under pressure to be more efficient and flexible in response to the marketplace.
- EXOR has built a smart factory using their own solutions like the X Platform and CORVINA Cloud, along with a breadth of Intel technologies, including networking, CPUs, FPGAs, and VPUs complemented by AI and edge software.
- Benefits include improved access to company-wide data, increased efficiency, reduced waste, and improved workflow.
- A joint Intel – EXOR 5G Innovation Lab at the factory helps demonstrate the value of 5G connectivity and the use cases that can enable in a manufacturing environment.

Do more with less. This trend has been amplified by the recent global COVID-19 pandemic. Manufacturers increasingly seek ways to increase cost efficiency and reduce time to market while simultaneously boosting product quality and customer satisfaction. Through the convergence of information technology (IT) and operations technology (OT), smart factories use artificial intelligence (AI), the Industrial Internet of Things (IIoT), next-generation networking technologies, and a mix of cloud and edge computing to achieve benefits like lower maintenance costs, less downtime, enhanced quality control, and more flexible operations.

Challenge

EXOR International, a leading producer of industrial automation equipment, wanted to make better use of its manufacturing data to adapt to a constrained supply chain more quickly. The company also wanted to further its journey to Industry 4.0 by increasing the level of automation in its manufacturing processes.

Solution

Working with Intel, Telecom Italia (TIM), and JMA Wireless, EXOR has built an end-to-end smart factory that showcases the benefits of Industry 4.0 digitalization to manufacturers of all sizes. The factory uses open, industry-standard platforms and technologies. Co-located at the factory is a joint 5G Lab where manufacturing engineers can experiment and evaluate specific use cases.

Results

From AI-driven visual quality inspection to autonomous human resources scheduling to real-time order status updates, the new factory showed what is possible with the latest AI, networking, cloud, and edge computing technologies in an agile and modular application environment.



Work Smarter, Not Harder

For manufacturers like EXOR, today's greatest challenge is responding ever more quickly to the marketplace across all customer touchpoints, from new product design to logistics to supply chain. That trend became even more prevalent during the COVID period. For EXOR, the solution was to accelerate the digitization and connectivity of its manufacturing processes to enable greater machine automation and agility. EXOR is no stranger to Industry 4.0—the company's main focus has been manufacturing Human-Machine Interface (HMI), control, and Industrial IoT (IIoT) solutions for nearly 50 years. The global smart manufacturing market is expected to reach roughly USD 506 billion by 2027, at a compound annual growth rate of 12.2 percent.¹ Yet, questions remained, such as:

- How to best converge technologies like artificial intelligence (AI), real-time data analytics, and the IIoT, and have them available both at the edge on the factory floor and in the cloud?
- Is it possible to create an open, industry-standard platform that offers interoperability with the myriad communication protocols and equipment types found in today's factories?
- Can a private network based on 5G provide the high bandwidth, low latency, and ultra-reliability necessary in a manufacturing environment?

Answering these questions opens vast opportunities for lower maintenance and energy costs, less downtime, enhanced quality control, better workforce productivity and job satisfaction, and more flexible operations based on new business models. EXOR and Intel teamed up to find the answers and share them with other manufacturers.

“The only way to respond faster to the marketplace across all of your customer touchpoints is by having access to real-time data.”

Mark Olding, Chief Commercial Officer,
EXOR International

End-to-end Smart Factory in One of Italy's Oldest Cities

It seems fitting, says Mark Olding, EXOR's chief commercial officer, that Verona is home to one of the world's most advanced smart factories. Famous Italians, like Michelangelo, were often artist cum scientist cum engineer. And Verona itself has been settled since the first century BCE, and was an important commercial and cultural junction between Italy and northern Europe. So where better to locate a factory that marries IT and OT into a cohesive fabric that enables the factory to learn about the

processes that are taking place inside it and is able to, with the help of humans, adapt to those conditions? For example, if a component shortage occurs, real-time data analytics enables plan changes at a touch of a button and all the people who need to know are instantly notified.

Far from an isolated effort, EXOR's smart factory is a result of close teamwork between EXOR, Intel, TIM, and JMA (see “Technical Components of the Solution”). The factory features EXOR's own products, such as the X Platform, CORVINA Cloud for platform as a service (PaaS), a Remote Monitoring and Management (RMM) system, and the JMobile Suite for communication across multi-vendor, multi-protocol, and multi-device environments and for sending data to local or cloud storage. A breadth of Intel hardware and software products underlies the solution from edge to cloud across IT and OT (more details are available in the “Intel Expertise and Complete Solutions Accelerate EXOR's Smart Factory Success” section). For example, automatic optic inspection equipment produces enormous amounts of image data. It would be too expensive to move all this data to the cloud, so EXOR uses distributed data storage on local IT servers.

JMA provided two antennas for two different connections. To authenticate on the 5G network requires a Subscriber Identity Module (SIM), provided by TIM, which allows the devices to make the first connection on the 4G antenna. Then if the device and the antenna realize that the device can go faster, the connection is moved to the 5G network and then to JMA's 26GHz 5G antenna—thus achieving 8-14ms latency. EXOR, together, with JMA and TIM, were able to configure the antennas and therefore the laboratory to go beyond 1Gbps. This speed up enables EXOR to continue studying the behavior of industrial protocols and connectivity with 5G technology.

An important aspect of EXOR's approach to smart manufacturing is a commitment to using an open, industry-standard, and modular platform. Such a platform avoids vendor lock-in and enables the entire ecosystem to benefit from—and contribute to—the progress EXOR has made. When solutions are based upon standards with open architectures, it further lowers the barrier to entry for small and mid-sized organizations, while making it easier for large organizations to scale across many facilities. As Olding points out, the smart factory must continue to evolve. “If the smart factory of our customer is connected to the smart factory of EXOR, we can have more intelligence and more algorithms to further improve production efficiency.”

EXOR isn't stopping at just using AI, IIoT, and cloud and edge computing to automate and improve manufacturing processes. A typical factory uses an IT network for certain connectivity functions and field buses for OT connectivity. But a 5G-based private network as the backbone of the factory provides both connectivity and security. Located underneath EXOR's manufacturing facility is a 5G Lab that allows EXOR to capitalize on the benefits of Industry 4.0, and provides engineers with the ability to collaborate, explore, test, deploy, and enable digitized technology. EXOR welcomes other manufactures to come tour its smart factory floor and 5G lab, to see how they can move to Industry 4.0 with wireless communication.

“ We built this smart factory from the ground up to take advantage of the latest 5G and AI technologies from TIM and Intel. We can’t wait to share what is now possible for manufacturers of all sizes with Industry 4.0 solutions. ”

Claudio Ambra, Chief Technical Officer,
EXOR International

Technical Components of the Solution

- **Intel hardware:** [Intel® Xeon® Scalable processors](#), [Intel® FPGAs](#), [Intel Atom® processors](#), [Intel® Movidius™ VPU](#)
- **Intel software:** [Intel® Distribution of OpenVINO™ toolkit](#), [Intel® Edge Controls for Industrial](#), [Intel® Edge Insights for Industrial](#)
- **5G spectrum** and Subscriber Identity Module (SIM) provided by Italian service provider [Telecom Italia](#) (TIM)
- **4G and 5G antennas** provided by [JMA Wireless](#)

Transforming Manufacturing from Push to Pull

While individual technologies, like AI or IIoT or cloud versus edge computing are important aspects of building a smart factory, the cumulative goal of marrying IT and OT and applying these technologies to various use cases is to fundamentally transform the manufacturing environment from a push model to a pull model. Let’s consider an example. In the traditional push model, a manufacturer produces thousands of widgets per day. Everything is fine as long as demand for the widgets continues to grow, and as long as critical supply chains remain strong. But what happens if demand drops suddenly, or a crucial part becomes unavailable? In this scenario, the manufacturer’s business is at risk because there was no advance warning—production lines are still at 100 percent even as demand drops by 50 percent, or demand is at 100 percent, but production is at a standstill.

At EXOR, AI is the driving force behind the smart factory. EXOR has introduced AI and machine-learning algorithms within the production flow. These algorithms are able to independently monitor and detect the quality of critical components and to identify or predict anomalies based on large amounts of data that is constantly collected and analyzed. The algorithms increase EXOR’s adaptability, which translates to more business flexibility and resilience. It is important to note that AI does not make people irrelevant—a smart factory is not one without humans,

but one that makes smart use of humans, such as freeing them from tedious tasks so they can create more algorithms and act as a multiplier force for the individual technologies.

Here are just a few examples of how EXOR is using AI, network, cloud, edge, and IIoT to transform its business:

- A visual quality inspection machine, using Intel® Movidius™ VPUs and the Intel® Distribution of OpenVINO™ toolkit, automatically flags defects, dust, and scratches in near real time. The solution also classifies those defects before sending the information to factory workers for assessment. With this information, workers can identify and resolve in-line process issues to improve yield and product quality.
- Autonomous scheduling and planning not only improves factory efficiency, but also ensures EXOR is meeting customer expectations. For example, automated human resources scheduling enables EXOR to quickly react to changes in customers’ orders and employee availability in real time. Real-time updates on order status and work-in-progress advancements, regardless of order size, enable planners to keep an accurate pulse check on what’s happening when.
- Facilities operation is improved because automated systems check to see if everything planned for the week, including supplies, components and documentation, is in order and ready for production. If the system doesn’t give the “green light,” workers can adjust schedules and plans so that the week’s work goes smoothly.

Overall workflow has been enhanced through EXOR’s use of AI and analytics. The entire production cycle is digitized, so that the system is always aligned with the actual state of work. This state is acquired in real time from various sources, including the workstation, special processes, the enterprise resource planning (ERP) system, and other data sources. Therefore, the production decision process is supported by analytical data, while the quality of results and the repeatability of the process can be evaluated using consistent data. Workstations and other equipment are integrated into the system and are managed automatically at the production level. The availability of real-time data and system integration has enabled EXOR to shorten the time spend on scheduling production activities from half a week to just two days.

While it’s easy to focus on technology and processes, EXOR’s experience indicates these aspects are not the only hurdles to achieving manufacturing transformation. People are also an important consideration. Therefore, change management, culture cultivation, and encouragement for a brave and adventurous mindset (something not always considered ideal in a typical factory) are also important. As Olding points out, the data has always been there—it’s not new. But with AI and IIoT and edge computing, now people can begin to use it to build new business models and improve things.

Leading the Way with 5G

5G has an important part to play in EXOR’s smart factory. Beyond mere speed, 5G’s benefits include domestic bandwidth that can handle time-constrained connections between devices, reduced latency for real-time AI and

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analytics, and distributed cloud, where workloads are placed closer to the edge for better quality of service. Plus, a private network means data stays on-premises, enhancing security and privacy. 5G is crucial to achieving EXOR's vision of the autonomous factory (from customer order to component acquisition to product manufacture to testing to shipping). In particular, 5G is absolutely required for autonomous machine-to-machine (M2M) communication, such as when autonomous mobile robots (AMRs) need to speak to certain machines. At EXOR, all machine communication and all calculations are 100 percent orchestrated by a separate Corvina Smart Edge cloud, and EXOR considers a 5G backbone key to enabling improved continuous integration/continuous delivery (CI/CD).

EXOR's on-premises 5G lab demonstrates how manufacturers can build private networks and integrate with existing solutions to deliver business value. The lab will explore a 5G network to evaluate the following:

- Improve communication in an extreme factory design setup (dusty, humid, greasy, hot, etc.).
- Enable peer-to-peer communication through the use of industrial robots.
- Positively impact edge computing cluster connectivity versus wired connections.

Intel Expertise and Complete Solutions Accelerate EXOR's Smart Factory Success

Intel and EXOR have been collaborating since 2016 to transform EXOR's smart factory vision into reality. Overall, EXOR has had access to a large software and IP library as well as infrastructure. Here are some examples of Intel hardware that EXOR uses in its smart factory:

▪ Edge compute in a harsh environment.

Intel Atom® processors are designed to operate even in the face of unfriendly environmental factors like humidity, heat, and dust or grease. EXOR uses these robust processors in its industrial PCs and other edge devices.

▪ High-performance, AI-optimized IT servers.

The Intel® Xeon® Scalable processor family provides the number-crunching capabilities required by applications like machine learning and deep learning. These processors sport advanced features like Intel® Deep Learning Boost for built-in AI acceleration and Intel® Advanced Vector Extensions 512 for acceleration of encryption and decryption.

“We are reaching a tipping point, not just in terms of 5G, but in terms of ‘goodbye lean, hello agile and flexible.’ When other manufacturers see that companies of our size can achieve what we’ve achieved, then there’s no reason why anyone can’t do the same.”

Mark Olding, Chief Commercial Officer,
EXOR International



Figure 1. The 5G Lab at EXOR's smart factory in Verona, Italy. (credit: EXOR).

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- **Software-defined acceleration.** Intel® Field Programmable Gate Arrays (Intel® FPGAs) enable EXOR to accelerate specific compute or network functions to optimize performance on IIoT devices. In addition, using FPGA can result in less power consumption in smart devices like sensors, motors, or I/O controllers.

But hardware is only half the picture. EXOR chose to work with Intel because Intel offers a complete solution, including hardware and IP and software, along with technical guidance (sometimes daily) from Intel engineers. For example, time-sensitive networking (TSN) is complex; choosing the right frequency to achieve the desired latency depends on many factors, including how much metal is in the environment. By providing the TSN IP core and providing engineering expertise, Intel continues to help EXOR solve its TSN challenges. As another example, the Intel® Distribution of OpenVINO™ toolkit helped EXOR more quickly develop its visual defect detection tool (which uses Intel® Movidius™ VPUs). “Without OpenVINO, we would have taken many more months to achieve results,” says Olding.

EXOR also uses Intel® Edge Controls for Industrial—a software reference platform with compatible hardware that makes it possible to transition industrial control systems to software-defined solutions. The platform was designed to achieve time-deterministic compute in a dense compute environment. Intel Edge Controls for Industrial lets manufacturers migrate away from inflexible, purpose-built industrial control systems by using a range of IT-style technologies—like containerization, virtualization, and orchestration—while meeting industrial-grade requirements for real-time compute and high levels of operational availability. To complement this platform, EXOR also takes advantage of Intel® Edge Insights for Industrial software. This production-ready software stack can securely ingest, analyze, and store video and time series data at the edge, to help improve operational and production efficiency.

The interesting aspect of the EXOR/Intel collaboration is that EXOR is not only using Intel technology in its smart factory, but is also incorporating the technology into its own products. As Intel continues to evolve its processor and FPGA products by introducing advanced semiconductor products, EXOR can do the same with its system-level industrial offerings. In this way, EXOR can enable its customers to quickly replicate EXOR’s smart factory experience, and over time, change the entire world of manufacturing.

EXOR Gains Clear Benefits from its Smart Factory

From dashboards in the conference room that provide decision makers with fast access to data, to autonomous scheduling of weekly production runs, EXOR’s smart factory provides benefits across the company. Thanks to AI, the director of operations no longer has to come in on Sunday to make sure everything is ready. Worker stress is reduced because smart operations manages all components except for those needing human attention. Product time to market can be significantly reduced by using AI algorithms to identify ideal components,

reducing product testing time and overall product defects. Supply chain disruptions can be identified in real time so workarounds can be executed. And in a time of economic uncertainty and increasing importance of sustainability, intelligent manufacturing processes can reduce waste—helping both EXOR and the environment.

With open, industry-standard technologies like TSN along with accelerators, graphics, next-gen CPUs, and open-source software, EXOR is entering a world of opportunity and enabling a robust ecosystem of solution partners. Through easy and reliable 5G heterogeneous connectivity, AI workloads, storage, and real-time controls infrastructure can be optimally placed anywhere on the network. And while the Industry 4.0 journey may have just begun for some manufacturers, EXOR is well on its way to Industry 5.0, whereby a complementary balance between human and machine contributions is achieved.

Spotlight on EXOR International

[EXOR International](#), an Italian manufacturer with a global presence, has been designing, developing, and manufacturing solutions in Human-Machine Interface (HMI), control, and Industrial IoT (IIoT) for nearly half a century. The firm provides products and services that support the growing need for intelligence in industrial automation markets during the rapid, ongoing digital transformation and streamlining of nearly every industrial process in nearly every factory on the planet. EXOR’s customers can improve performance and securely acquire data from almost any critical location across multiple vendors and protocols, work with this data in real time at the edge, and send this data to a robust cloud to visualize, analyze, and generate valuable information for control and efficiency.

With more than a dozen branches around the globe, EXOR began its own Industry 4.0 journey in 2009, with its newest factory, located in Verona. The company is dedicated to creating technology that respects “man and the environment” and disseminates a culture of quality, environmental responsibility, and safety obligations throughout the company.

Learn More

You may find the following resources helpful:

- [Intel Manufacturing Industrial Overview](#)
- [Intel Industrial IoT](#)
- EXOR on [Intel Solutions Marketplace](#)
- [EXOR International](#)
- [Best Practices for Accelerating Industry 4.0 Transformation](#) video
- [Why 5G in Industrial Smart Factories?](#) video

Lessons Learned

Start—or continue—your own Industry 4.0 journey by taking advantage of some of the lessons EXOR learned on its way to smart manufacturing:

- Clearly identify the company’s strategic objectives then develop key performance indicators (KPIs based) upon those objectives.
- Perform an honest evaluation of the current state of the digital framework.
- Choose one or two small problems that exist inside the production facility and resolve them using the digital framework, while ensuring that the problems match the established strategic KPIs.
- Understand that one or two projects may not, by themselves, delivery direct financial benefits—they set the stage for significant, continuous process improvement.
- Build a passionate team that can fail fast and isn’t afraid to learn from mistakes.
- Use as open a platform as possible so that algorithms and solutions can migrate from one use to case another in the smart factory.
- Learn from your customers, and enable them to learn from you. Value lies in bidirectional cooperation that creates a virtuous circle.

Find the solution that is right for your organization. Contact your Intel representative or visit <https://www.intel.com/content/www/us/en/edge-computing/overview.html>.



¹<https://www.fortunebusinessinsights.com/smart-manufacturing-market-103594>

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