

Advancing Automation

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Digital Transformation for
Industrial Solution Providers



Evolving consumer expectations, changes in business environment and advances in technology are pushing solution builders to co-innovate with technology leaders to better serve their customers.

DELL Technologies

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INTRODUCTION

Digital Transformation: The Time Is Now

Agility and resilience are key attributes in business today more than ever. Industrial companies are being expected to innovate fast to meet quickly changing customer needs and supply chain realities. Industrial solution providers who do not leverage transformative technologies now are at risk of being left behind. Digital transformation—for your company and for your customers—is no longer optional.

Whether you are an industrial solution provider who designs and installs next-generation machines, or one who strives to better monitor and maintain your installed base, you are being pushed from multiple directions. Trends affecting manufacturing, such as hyper-personalization, supply chain agility, business resilience and cybersecurity, both come at you as a company and show up as needs that your customers want addressed. Technological advances can both entice OEMs with promises of cost savings or efficiency and challenge

them with integration hassles, conflicting customer demands and steep learning curves.

Digital transformation, therefore, is both necessary and daunting. In this edition of *Advancing Automation*, produced by Automation.com, industrial solution providers can find ways to make the digital transformation of their own businesses—and their customers' businesses—easier. Dell Technologies OEM Solutions in collaboration with Intel provides insights into the megatrends pushing for digital transformation and the technologies that are enabling it.

You'll learn about important Industry 4.0/smart manufacturing technologies such as artificial intelligence (AI) and machine learning (ML), edge and cloud computing, 5G wireless communications, augmented and virtual reality, and robotics that can add value to industrial applications and transform operations.

Learn about innovative applications of these technologies, like digital twins for product development and testing, AI-powered predictive maintenance of equipment and machine vision systems for quality control, that are using data in new ways to enable Smart Factories.

Read the stories of OEMs like you who have found a partner in Dell Technologies OEM Solutions and Intel to help them innovate faster and benefit sooner from the rapid changes happening in the industrial space.

[Accenture's](#) advice is this: "If you want to go fast, go alone. If you want to go farther, go together. Cross-function collaboration ... must be a central organizational imperative for companies... and a strategic focus for executives tasked with sustaining digital transformation efforts."

Renee Bassett, Chief Editor,
Automation.com

INDUSTRIAL SECTOR TRANSFORMATION:

How Megatrends Are Transforming the Industrial Sector

Foundational drivers that are pushing industrial solution builders toward transformation

By David Weldon,
Automation.com

Manufacturers started to actively invest in digital transformation in recent years in order to impact efficiency, product quality, throughput, changeover time and other key metrics to better serve their customers and stay competitive.

Now requirements brought on by evolving market needs continue to lead manufacturers to embrace new strategies, revisit business processes and tie new technology investments to specific business goals.

According to [Accenture](#), “A tectonic shift is underway. Product development, design engineering, manufacturing and the supply chain are the next digital transformation frontier. It requires a complete reimagination of how to meet customer demands and expectations. And it’s creating new levels of productivity, growth and sustainability. To get it done,

organizations need to transform the core operations of their business and build a digital backbone and thread that runs from their consumers all the way through their value chain—and back again.”

Industrial solution builders need to understand these forces so they can innovate faster to stay ahead of the curve while also enabling digital transformation of the customers they serve.

While the pressures on companies within specific industry verticals can vary, these four interrelated forces are making demands on manufacturers around the globe. They are:


- **Hyper-personalization and flexibility** – This no-two-are-alike market demand requires new ways to order, manufacture and ship products. It also requires

unprecedented levels of business system/operational system integration.

- **Supply chain agility and business resilience** – From natural disasters to pandemic shutdowns, events in the recent past have demonstrated the urgent need for organizations to quickly react to changes. Between the raw materials coming in and personalized products going out, organizations need dependable processes and

systems to ensure that operations have no unplanned downtime.

- **Cybersecurity** – With the benefits of digital processes and interconnected systems come potential risks. Industrial organizations need to better assess vulnerabilities, find knowledgeable partners and implement best practices to mitigate risks or respond to incidents.
- **Technological advances** – Edge computing, cloud, advanced analytics, machine learning (ML) and artificial intelligence (AI), new connectivity technologies such as 5G, robotics, digital twin, virtual and augmented reality, and more are enabling design, product development, automation, monitoring and control of industrial systems in new, transformative and cost-effective ways.



“Like most shoppers, they [OEMs] want the best possible system that will make their end customers happy. They don’t want to pay a lot for it and they don’t want any unnecessary complexity. They also don’t want to pass any unnecessary costs or complexity to their end customers.”

Alan Brumley, CTO at Dell Technologies OEM Solutions

Hyper-personalization and flexibility

Customers today know exactly what they want. They demand it immediately. And they want you to know they will settle for nothing less. This makes hyper-personalization a must-have part of the manufacturing process for many organizations. But this is a strategy that will require change at all levels.

“The customer will be able to change many aspects of a product directly

with the factory, rather than just taking a vanilla configuration and having some basic customization of that,” says Greg Moore, EMEA Field CTO with Dell Technologies OEM Solutions. “Speaking of vanilla, ice cream is a good analogy. Traditional offerings are mass produced and allow you to choose mass produced products from the fridge, at the lowest cost. But you can also go to an ice cream shop where you can choose your cone or cup, you can choose from any of the flavors and

you can choose the toppings you like. This has a higher cost, but you get exactly what you want.”

The growing requirement from consumers to get exactly what they want is driving hyper-personalization strategies, Moore says. Hyper-personalization obviously requires a lot of integration between cloud retail portals and the production line in the factory. The factory will also be dramatically different, as production lines will need to be able to build

products to many different specific requirements. The logistics will also change as each unique product will be shipping to the end customer.

“When you talk about hyper-personalization, I think of the example of a car vendor,” Alan Brumley, CTO at Dell Technologies OEM Solutions, says. He explains that, sure, you can buy a minivan off a dealership lot as-is, but each manufacturer also allows fleet customers to order whatever kind of car they want and will build it exactly how they’ve specified. “We see that coming from our OEM customers as well,” he says. “Like most shoppers, they want the best possible system that will make their end customers happy. They don’t want to pay a lot for it and they don’t want any unnecessary complexity. They also don’t want to pass any unnecessary costs or complexity to their end customers.”

But the journey of digital transformation should also prompt a series of tough business questions that each organization must ask itself and a host of conversations that it must have with its partners and suppliers.

“As you are moving toward digital transformation and creating smart factory space, you must watch your organization’s evolution and your customer’s evolution—all of which is going to be changing,” explains Bill Pfeifer, Edge Message Director at Dell Technologies.

“As we get more toward hyper-personalization, all of your suppliers are going to be evolving,” Pfeifer says. “Will they be changing faster or slower than you? You need to be roughly at the same pace. How do you keep that together? So now, all of a sudden, factories aren’t just placing orders with their suppliers. They’re having

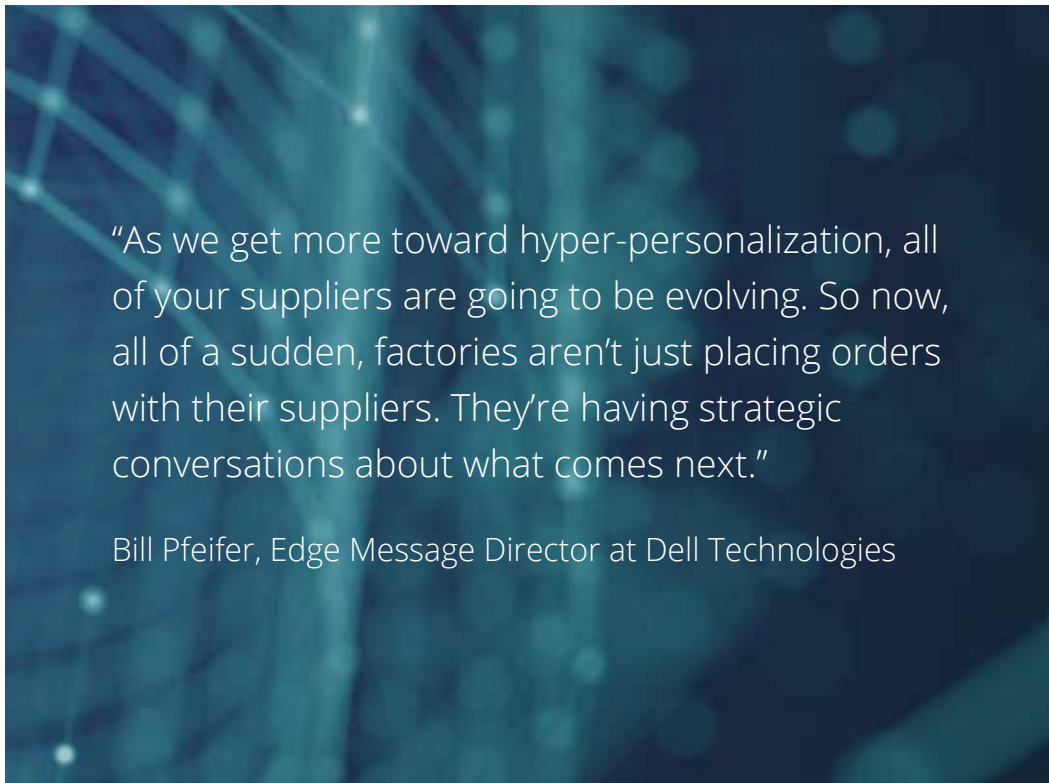
strategic conversations about what comes next; what that timeline looks like; and how the interfaces between the different companies change as customers push for new features, new capabilities and different ways of doing things.”

“The need is for flexibility to integrate into various systems, not just a single machine,” says Todd Edmunds, Global Chief Technology Officer, Industrial IoT and Edge Computing at Dell Technologies. “You don’t want a stand-alone island of automation. Increasingly, integration involves the use of open, non-proprietary systems and common APIs. You want to make sure the capabilities are built into your business processes and operations that can assess what is going on and inform you of changes,” Edmunds adds, “because hyper-personalization isn’t typically going to happen all on its own. You’re going to have pieces of equipment and other systems integrated into the process and systems.”

Edmunds also sees an increased need for software-defined capabilities to enable hyper-personalization for the customer. Organizations need the ability to not only share data and share information about what is going on in any machine, but also to take in other information to make the necessary changes. “Best-in-class manufacturers are also integrating artificial intelligence (AI) and machine learning into the process,” Edmunds says. AI is especially good at helping predict product demand and managing inventory costs.

Right now, Bill Pfeifer sees hyper-personalization as a “point of differentiation.” But he says that will be changing soon.

“I would bet that within three to five years, it’s going to be table stakes,” Pfeifer predicts. “If you’re not giving me my customized shopping experience and offering me exactly the product that I want, or the ability to make it exactly the product I want,



“As we get more toward hyper-personalization, all of your suppliers are going to be evolving. So now, all of a sudden, factories aren’t just placing orders with their suppliers. They’re having strategic conversations about what comes next.”

Bill Pfeifer, Edge Message Director at Dell Technologies

I'm going to go to someone else who will."

Once hyper-personalization gains traction, the work involved for each manufacturer will be significant, and automation technologies will be critical to handle the process at scale.

"As you hyper-personalize, it requires seamless integration with your supply chain, with customers and with your retail outlets," Pfeifer stresses. "Part of the hyper-personalization process is probably also going to involve combining multiple products, custom packaging a product, delivering it with

a particular service, perhaps custom installation, or customization that can only happen on site or when integrating a product on site with other products that you already have. That's quickly going to become the thing. Manufacturing is going to be product by product."

"Part of the hyper-personalization process is probably going to involve combining multiple products, custom packaging a product, delivering it with a particular service, perhaps custom installation, or customization that can only happen on site or when integrating a product on site with other products that you already have."

Bill Pfeifer, Edge Message Director at Dell Technologies

Supply chain agility and business resilience

Perhaps more than ever before, manufacturers need the ability to be nimble and flexible. According to [Deloitte](#), agility could be key to manufacturing industry resilience. By continuing to invest in digital initiatives across their production process and supply network, manufacturers can respond to the disruptions caused by the pandemic and build resilience that can enable them to thrive.

"From our standpoint, the need for nimbleness is about fulfilling our customer needs, being able to deal

with the unexpected and still maintain the flow of product to the customer without major disruptions," Brumley explains.

Manufacturers need flexibility with both operations and supply chain management. Brumley illustrates the point with an example at Dell Technologies.

"We have supply chain flexibility and we dual source whatever we can. But we also have operational flexibility," Brumley says. "A while back we had a tornado come through Nashville and hit one of our facilities. We were immediately able to pivot over to another facility in the States and keep

building and then augment that with a facility in Mexico. We were able to keep the supply chain flowing so that our customers could get their products on time. It's very important to our customers that delivery is when promised. So that's the kind of flexibility Dell Technologies brings to the table."

That could mean a natural disruption such as a hurricane or flood, the loss of utility or internet services, or the loss of a key employee with critical business knowledge.

"Resiliency from disasters, natural or not, is key to an organization living in the digital world," Moore stresses.


“The base need is to protect data, be able to recover that data and have access to that data according to the business needs, no matter what.”

From a technology perspective, there are countless situations where things can break down in the supply chain and needed machines, parts or devices can't get to customers when they need them.

“One of the top issues is the fact that you can design an awesome system, then go into production and the products aren't there for you, or you can't get them on time. That's why having a mature and reliable technology partner is so important,” Brumley says.

“When you work with Dell Technologies OEM Solutions, your products become our products,” Brumley continues.

“We have people in the procurement chain and in the factory chain that are dedicated to our OEM customers. When only a limited amount of the components come in to us, we can make sure that you get prioritized appropriately and still get your fulfillment for your customers so you can meet your business objectives. We can balance that out amongst all of our customers and keep as many people as possible happy.”



“The need is for flexibility to integrate into other systems, not just have a single machine. You don't want a stand-alone island of automation.”

Todd Edmunds, Global Chief Technology Officer,
Industrial IoT and Edge Computing at Dell Technologies

Cybersecurity

Technological advances and changing industry structure are creating opportunities and vulnerabilities. As digitalization has increased manufacturers' reliance on technology, it also has increased security threats. “We're just starting to hear about all the breaches that are happening, because security is often forgotten about or bolted on after the fact,” Pfeifer says.

“Historically, in a manufacturing plant there have been islands of automation. They don't connect to

anything. They just do what they do and they do it really well. They're very fast and reliable,” Edmunds says. “But in today's world, that's not enough. You have to take the broader ecosystem into consideration: How do you interact with other machines, other assets and other users? How do you open it up to have remote access, to predict downtime, to be able to really look at that machine and make sure that it's running at peak optimal capacity? That obviously opens up cybersecurity risks because you're connecting to the internet and the Internet of Things. You've got to

make that part of your cybersecurity strategy.”

“There's going to be so much more technology and intelligence between the factory floor, the logistics systems and the retailers,” Pfeifer explains. “That represents a huge expansion of the attack surface. You can't massively expand your attack surface without having people notice and start to take advantage of it.”

Brumley agrees. “Obviously, we are putting a lot more computers into the mix as we move out to the edge. We are putting more systems out there,

each running its own software stacks. This adds more opportunities for intrusion. It's critical that security is baked in from the beginning in both your hardware and your software stacks. Make sure all surfaces are designed from the ground up to repel attacks."

Recognizing the increased threats that organizations are under, Dell Technologies has tight security measures built into its products and operations.

"If you buy our laptops or our servers, we can tell you that we sourced the chip from a responsible location," Pfeifer explains. "When a server or device is turned on it gets registered by serial number and we can tell you that the original items put in the box are still the items that are in that box. Nothing has been changed. The case was not opened. The USB ports are disabled if you wanted those disabled. We can securely deliver it to your door and certify that the box that was delivered to you is the box that we built for you. Nothing was changed."

This approach is enabling Dell Technologies and Intel to extend security shields around a product to keep it secure, Brumley explains. "It does require thinking and forethought and designing the product with security as the core principle. Initially, the minute a product boots up, it doesn't trust the firmware that's on it until it has passed some tests. There is a Root of Trust that happens all the way from the first power-on up until it's running into the operating system."

Pfeifer confirms that this added security is "not sexy at all and it's not something that most people think about. But when you start distributing and installing thousands of devices all over the world, then all of a sudden

it's going to become a huge part of doing business."

Information technology is creating a more connected world and our dependence on technology for all aspects of our lives continues to increase. According to a recent study performed by [Accenture](#), businesses expect 5G to revolutionize network evolution, underlining technology security concerns. This extraordinary growth of digital connectivity and the demand for supporting infrastructure and client endpoints has driven dynamic and globalized IT supply chains.

However, the advanced technology and sophisticated logistics networks that support this connectivity are facing unprecedented attacks that may undermine the trust on which growth, prosperity and international relations depend. Further, the complexity, sophistication and potential impact of attacks have increased substantially over time.

A single incident can lead to operational disruptions, lost revenue, compromised data, diminished productivity, and a tarnished brand or corporate reputation. For these reasons, customers are rightly seeking assurance that the technology products they purchase have not been tampered with or maliciously modified, jeopardizing their ability to protect the data they intend to store and process on those devices.

The security of IT hardware and the supply chain that supports its production and delivery has never been more at the forefront of our customers' minds. In *Four Keys to Navigating the Hardware Security Journey* by [Futurum](#), it was noted that 44 percent of organizations said they have had at least one hardware-

level or BIOS attack in the prior 12 months, making securing IT hardware a priority.

These reasons drive Dell Technologies' focus on creating and maintaining world-class supply chain security measures.

A safe and trusted environment reduces systemic risk while increasing the security of the supply chain ecosystem. Dell Technologies' strategy of "defense-in-depth" and "defense-in-breadth" involves multiple layers of controls to mitigate threats that could be introduced into the supply chain. These controls, along with effective risk management, help establish supply chain security.

Dell Technologies and Intel are collaborating to drive next-generation capabilities with a comprehensive portfolio of trusted solutions to accelerate security in areas such as threat detection and response, cryptography, and data privacy and security.

Business-as-usual-security can't keep pace with the threats organizations face today. A holistic, new approach is required that can adapt to unexpected changes and factor in users, IDs, devices, assets and data. The technology must be intelligent and automated, and security must be intrinsic, built into everything.

Applying secure development principles, Intel delivers technology that improves foundational security, data and workload protection, and software reliability. Dell and Intel's customers benefit from robust technologies that improve their security position and support a Zero Trust infrastructure that addresses today's evolving threats.

CYBER RESILIENT ARCHITECTURE

Design to Manufacturing Controls
Root Of Trust
Secure Boot
Chassis Intrusion Detection
Supply Chain Assurance
and more...



Cyber Secure Servers: Dell Technologies' Secured Component Verification Program

Over the years, Dell Technologies has developed a robust cyber resilient architecture to mitigate risks that occur not only at an application and OS level, but also at the hardware and firmware infrastructure level. Key elements have been developed, each one providing higher levels of hardware integrity. Dell Technologies now brings a new supply chain threat mitigation program to its PowerEdge

portfolio: Secured Component Verification, or SCV.

The various means of transportation involving multiple actors can increase the potential for tampering or unintended changes during shipment. Dell Technologies' SCV gives assurance to an end user that no changes to the system have occurred between the time it left Dell's factory and the time it arrived at the customer site.

After a customer chooses SCV, the server is manufactured and a process runs that identifies components and their unique IDs. A cryptographic certificate is

securely created and transferred to the server's hardware crypto vault before the server is shipped out.

A Dell Technologies customer can power up the servers upon arrival and use the SCV application to do an assessment. The validation process performs an inventory of the system as delivered and compares that to the inventory in the cryptographic certificate. If tampering or unintended changes have occurred, a report is generated showing mismatched components. When no tampering or unintended changes have occurred, the report will indicate a 100% match.



[Watch video](#)

Technological Advances

The industrial sector used to be a closed, isolated, technologically slow-moving segment of the global economy. But no more, says Bill Lydon, an Automation.com contributing editor and author of the [Automation & Control Trends Analysis annual report](#). Industrial companies are embracing Industry 4.0 and smart manufacturing concepts that are powered by intelligent products, smart production processes and integrated manufacturing systems. Industry 4.0 identifies recent technological changes that have led to important advances:

- Data storage is no longer a barrier (advances in storage technologies, cloud)
- New algorithms for data processing are being developed (AI/ML)
- Computational power is fast enough to process large amounts of data in reasonable amounts of time (data analytics)

- Devices, items and things can actively send and receive data, and can be equipped with internet connections (Internet of Things, or IoT)
- Wireless data transfer is possible with the same or better performance as wired data transfer (5G communications)

These technological advances and others that build on them—edge computing, robotics, digital twins, virtual and augmented reality applications, and more—provide the means for manufacturing companies to become “smart” rather than continue operating as a collection of functional silos, says Lydon. The expected benefits of these advances are explained by the definition of “smart manufacturing” from ISO resolution 114/2017: “Manufacturing that improves its performance aspects with integrated and intelligent use of processes and resources in cyber, physical and human spheres to create and deliver products and services, which also collaborates with other domains within an enterprise’s value chains.”

Ultimately, Lydon says, Industry 4.0/ smart manufacturing should result in more rapid product development, facilitated customized production, improved handling of complex production and testing environments, more efficient supply chains, better use of production resources, and more holistic lifecycle management.

“Industrial operations are also experiencing a massive shift toward digitalization made possible through multivendor open solutions. Open systems enable efficient and frictionless integration—a path the information technology industry has been on for many years. In manufacturing, the use of open source code and standards has been accelerated by the Internet of Things,” says Lydon.

Understanding new technology solutions and creatively applying them to improve manufacturing and production processes will become a key success factor for manufacturers and machine builders to sustain a competitive advantage. ■

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[Accelerating the 5G Future of Business](#), Accenture

[Four Keys to Navigating the Hardware Security Journey](#), Futurum

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Why Now? Seven Key Technologies Transforming the Industrial Sector

Industrial solution providers are already putting these technologies into their systems and their business plans. The status quo is not an option.

By Bill Lydon, Automation.com

The Industry 4.0 movement, started in Germany, has grown into numerous global initiatives pursuing connected manufacturing in many forms. Along the way, it identified key technologies that industrial organizations could use to digitally transform and achieve the goal of holistic and adaptive automated operations.

In the early stages of Industry 4.0, smart sensors and smart devices made their debut on the factory floor. Over time, we saw the emergence of smart factories that leveraged inventory and analytical systems. Vision systems followed, bringing higher levels of accuracy to assembly lines and quality inspection. Today, edge computing and 5G technology have enabled smart factories, where new and legacy systems can communicate and exchange huge volumes of data. Smart, interconnected factories are now capable of linking into core business systems and shaping customer demand to match the factory and supplier capabilities. Technology infrastructure must evolve as well to support this transformation.

Industrial solution builders are using new technologies today to transform their operations, develop new products and services, and help their customers become more productive and efficient. Here we look at seven clusters of advanced technologies that are rapidly being implemented to see why industrial solution builders should be investigating them now. They are:

- 1. Proliferation of edge computing, cloud and virtualization**
- 2. New connectivity technologies including 5G**
- 3. Advanced analytics, artificial intelligence and machine learning**
- 4. Intelligent robots and collaborative robots**
- 5. Digital twins and software simulations**
- 6. Augmented and virtual reality**
- 7. Blockchain**

1. Proliferation of edge computing, cloud and virtualization



“Data is now the lifeblood of smart factories,” says Greg Moore, EMEA Field CTO with Dell Technologies OEM Solutions.

“Modern factories are now capturing rich data along every step of the manufacturing process. In the past, data was just a part of the factory’s IT infrastructure, but today it is now definitely part of the factory’s OT infrastructure. This new role is at the heart of digital transformation and is enabling successful and sustainable changes in business strategies.”

The computing architectures that support operational technology (OT) are shifting from all hardwired connections and on-premises data centers to complex mixtures of wired and wireless communications moving data to the most effective compute resource for the task. That might take place in a public cloud, in an off-site data center housing a private cloud, in on-premises edge servers or on edge

devices, such as Internet of Things (IoT) gateways and sensors.

“It’s not like the edge is emerging, but it is finally getting realized,” says Alan Brumley, CTO at Dell Technologies OEM Solutions. “It’s pushing compute out to where data is coming from. But it’s really more than that. With the right technology choices, the architecture can really be critical to success.”

Technology choices for edge workloads can involve both hardware and software. Edge devices generate, gather, transfer or consume data close to the machine or production process, reducing the amount of data flowing back to a compute-centric location. Therefore, edge devices need to connect meaningfully with each other and with a management layer that keeps them secure and up to date. Smooth integration is key.

[Gartner](#) predicts that “while 10% of data is processed outside of the

datacenter today, 75% of data will be processed outside of a traditional datacenter or cloud by 2025.” The growth is being accelerated by 5G technologies and by the fact that the cost of making any device intelligent has dropped dramatically. And those intelligent devices will use their data processing capabilities to drive levels of automation that were previously unavailable to most businesses.

“The increasing need to automate systems, factories and transportation systems is fueling the acceleration of edge and far edge architectures,” agrees Moore. “This will provide a wealth of benefits to organizations that make these investments successfully. Aggregating, storing and processing data at the edge—where the data is created and where access to it begins—offers the lowest latency, versus distributed computing or cloud-based computing.”

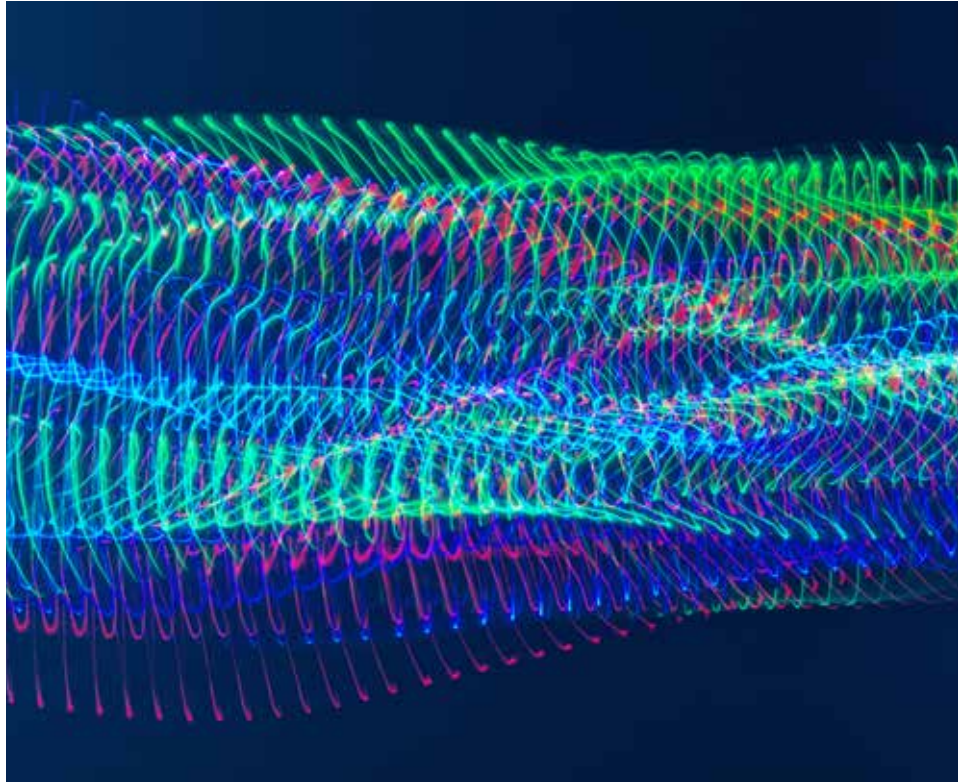
2. New connectivity technologies including 5G

Pervasive wireless technology for industrial automation has long been on the wish list of manufacturing engineers, and what may finally enable it is widespread implementation of 5G communications technology. 5G delivers higher performance and deterministic throughput than current wireless methods, and many industrial companies are planning to or have already installed private 5G networks in their manufacturing plants.

The three major benefits of 5G networks, according to [IEEE](#) are: high data rates (1-20 Gbit/s), low latency (1 ms), and larger network capacity and scalability. A related topic important to industrial control is Time-Sensitive Networking (TSN), which is enabled by the high data rates and low latency of 5G.

5G makes the monitoring and control of a broader range of industrial IoT devices practical, says Philip Burt, Product Management Senior Consultant at Dell Technologies. For example, a connected screwdriver and nut runner can automatically control torque and communicate quality and productivity data. In addition, multi-access edge computing can allow the data collected through the private 5G network to be processed locally.

5G technology is ramping up to support high-speed applications and high-volume production, which is the same phenomenon that created the compelling case for standard Ethernet to be adopted for industrial communications networks. It is now being incorporated into industrial edge devices to connect IoT devices and is also enabling the growing number of smart sensors with embedded processors to efficiently communicate.



Dell Technologies and Intel are driving 5G transformation. Intel brings its heritage as a leader in cloud computing to transform 5G networks from the cloud to the edge—becoming part of the fabric of the network in the same way that it's the backbone of the data center. Since the success of 5G depends on a broad ecosystem, Dell and Intel are committed to developing the ecosystem for this new technology, working together across telecom, cloud, IoT and enterprise to define 5G solutions and standards-based technologies.

Academia and industry are starting to envision the sixth generation of cellular wireless technology (6G) and many research projects have already begun. Based on the timeframes of previous wireless network deployments, [ABI Research](#) forecasts

that 2028 and 2029 will see the first commercial deployments of 6G, with the first standard technology expected around 2026.

"X Reality (XR), which is a combination of Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR), is a promising solution for 6G to create a mixed real and virtual environment with either real-time or non-real-time human-machine interaction," says Jiancao Hou, 5G & Mobile Network Infrastructure Senior Analyst at ABI Research. Self-organization and self-healing capabilities of a network—to support autonomous driving, drone swarming and pervasive networking applications—are needed to reduce the time and cost of network deployment.

"In the 2030s, 6G could be the key enabler for realizing ubiquitous

connectivity with a wide range of devices and sensors used in diverse communication environments,” Hou says. He adds that 6G could also well address the needs of data analytics, cloud-native computing and networking, AI/ML, and open-source computing and network security.

Additional Resources

[Benefits of 5G Technology. Unleashing Innovation](#), Intel

[The first reference MEC solution for the Dell Services Edge Vision](#), TelecomTV

[5G: The Future of Digital Economies](#), Dell Technologies

3. Advanced analytics, artificial intelligence and machine learning

The explosion of data created by IIoT edge devices and the ability to move and manage that data among edge, enterprise and cloud computing resources is enabling OT-specific advanced analytics, including artificial intelligence and machine learning (AI/ML) applications. Edge computing technology allows the platform to have analytics and AI/ML embedded directly in the manufacturing process—sometimes embedded in the manufacturing equipment itself—for the most efficient and reliable implementation and operation.

“While initial and real-time data aggregation and analytics happens at the edge, data will also be valuable in the cloud. The cloud will continue to be a primary place for deep analytics, new rules, artificial intelligence training models that use historical data, and where ‘things to look for’ will be created. The ability to manage data in the cloud and consolidate and sample data from several edge sites can deliver tremendous insights,” says Alan Brumley, CTO at Dell Technologies OEM Solutions.

“We believe AI is the next revolution that will turbocharge the factory floor. As AI technologies standardize across industries, becoming an AI-driven organization will be fundamental to survival,” Brumley adds.

By having technology integrated in the base platform, Intel and Dell simplify the customer journey. Intel integrates AI capabilities into their processor technology to meet the changing needs of customers. Creating AI applications can take months, and this is why companies can benefit from leveraging turnkey solutions from technology leaders such as Intel and Dell.

The AI ecosystem is transforming how data is gathered, stored and used as machines run new algorithms on innovative processing architectures. This presents an enormous inflection point for data-driven innovation, new infrastructure opportunities, different ways to build products and more efficient processes.



Acceleration technologies are set to play a key role in managing AI/ML workloads. These accelerators perform parallel computation and faster execution of AI decisions, compared to traditional CPU architectures. Offload technology is currently being developed for AI workloads at the edge as well as in the data center and in the cloud.

Accelerators are driving optimization for specific areas such as natural language processing, AR/VR, speech recognition and computer vision. Typical applications for AI accelerators include algorithms for robotics, IoT devices, and other data-intensive

or sensor-driven tasks, according to Philip Burt, Product Management Senior Consultant, Dell Technologies. “There is a need to accelerate both inferencing and training at the edge and this is enabled by both traditional accelerators (GPUs and FPGAs) and by AI inferencing chips,” says Burt.

When accelerators are applied to the correct workloads, the outcome creates a phenomenal advantage in compute performance for training or inferencing. The addition of accelerators can deliver measurable results that include cost-efficiency, lower latency and faster decision-making.

Ultimately, success with AI means creating insights that can be more valuable than the collective knowledge of the organization and acting on those findings in the most efficient and effective way. This combination of a “data first” culture, backed by AI insights and unprecedented levels of automation, changes everything from supply chain, materials, quality and order management through to production processes, factory equipment maintenance, order fulfillment, logistics and services.

4. Intelligent robots and collaborative robots

Robot adoption is accelerating worldwide with innovative and clever applications encompassing large robots, collaborative robots (cobots), autonomous guided vehicles and innovative combinations of these technologies for production and material flow. Advances in artificial intelligence, image recognition and location awareness technologies are enabling a wide range of new, intelligent applications in robotics.

Collaborative robots are a new breed of lightweight robots with safety features that allow people to work cooperatively with these devices in a production or warehouse environment. Because cobots can sense humans and other obstacles and respond, protective fences and cages are not required. That means they often can be deployed more easily and with lower implementation costs. They are also much easier to program than earlier generations.



Similar to the forces that ignited the personal computer revolution, the proliferation of cobots is clearly an instance in which technology availability is pushing the transformation of industrial operations: Cobots have less power

than larger offerings, but they offer added value, including greater ease of use.

“The most direct [benefit of cobots](#) is not in their ability to collaborate with humans,” says Rian Whitton, Principal

Analyst at ABI Research. “Rather, it is in their relative ease of use, improved interface and the ability of end-users to redeploy them for different tasks. The barriers between cobots and standard industrial robots are beginning to break down, as many vendors are experimenting with dual-

mode robots that can have a cobot and industrial mode. What is more, cobots are beginning to develop heavier payloads, in line with evolving regulations.”

ABI Research projects that cobots are going to significantly expand the

potential for automation for small- to medium-size enterprises, while also enabling large vendors to develop a more flexible production line based on movable platforms and no need for fencing.

5. Digital twins and software simulations

Digital twins have evolved from a niche concept to an integral part of the industrial processes in a very short time. Digital twins are not a technology, but rather a composition of solutions aimed at bridging the physical and digital worlds, from design through simulation, manufacturing, assembly, and after-sales service and support.

The fundamental idea of the [digital twin](#) is to have a virtual model of the ideal manufacturing operations and processes that will benchmark the actual production metrics in real time. The broadest implementation models include all of the factors that affect efficiency and profitability of production, including machines, processes, labor, incoming material quality, order flow and economic factors. This provides a wealth of information that organizations can use to identify and predict problems before they disrupt efficient production. The digital twin is a prominent example of a practical macro level closed-loop control that is now feasible with the advanced hardware, software, sensors and systems technology now available.

Historically, business systems, particularly enterprise resource planning (ERP), were not

synchronized with production in real time. Manufacturing execution systems (MES) and manufacturing operations management (MOM) are the production systems that have had to change to satisfy the needs of modern supply chain challenges. Digital twins can respond to customer needs, energy demand or shortages, or sustainability requirements. Eventually, they can be used to enable completely autonomous operations.

As they digitally transform, some plants are in the early stages of the journey from industrial automation to industrial autonomy. According to a global process industry survey from industrial automation and control system vendor [Yokogawa](#), 64 percent of end-users expect to establish autonomous operations over the next decade.

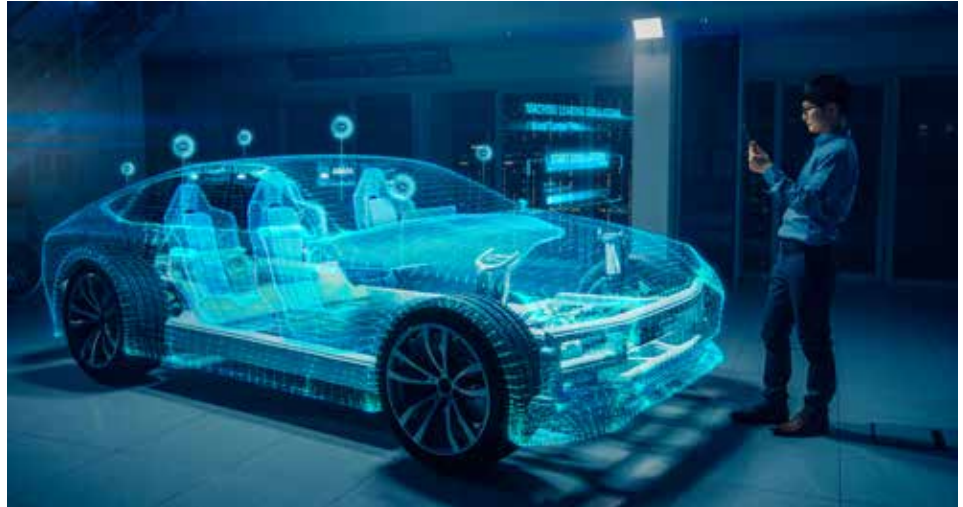


6. Augmented and virtual reality

Significant advances in augmented reality and virtual reality, initially driven by the entertainment and gaming industries, are making these technologies useful for manufacturers. The range of industrial applications includes worker training, machine operator assistance, maintenance support, and product design and development.

AR, where new and/or live information is overlaid on an existing image, delivers digital data into the real world to enable, for example, collaboration between front-line workers and remote subject matter experts. In addition, captured AR session information can be used to obtain real-world knowledge from experienced workers that can help to smoothly transition new workers and automate routine tasks.

VR is becoming a highly effective and efficient training tool for experiential learning. Immersing people in virtual versions of real-world applications, VR couples data with spatial computing to become the ultimate example of physical and digital convergence. Depth-sensing cameras can capture a manufacturing space to create



dynamic 3D digital twin models of plants that understand all the dimensions of people, product, process and location.

Eric Abbruzzese, Augmented and Virtual Reality Research Director at [ABI Research](#), says that after a tumultuous 2020, the need for digitization and for keeping workers connected became crystal clear. This is especially true for industrial markets, in which workflow complexity, knowledge retention and share, and the financial impact from downtime and other inefficiencies are particularly severe. He predicts industrial sites will quicken their

adoption of AR smart glasses and mobile devices to enable workers in any location and to minimize costly inefficiencies.

“As a high-value element of digitization, augmented reality adds a visual element to a data-heavy system that can sometimes devalue the human worker. AR brings the worker back into the equation and creates a synergistic relationship between the worker and IT/OT systems where each component benefits from the other,” says Abbruzzese.

7. Blockchain

Blockchain is a still-emerging technology for many. Started as a way to securely track digital currency, blockchain enables a firm to have a chain of data in a secure digital ledger that cannot be easily modified. It greatly enhances how transaction data can be securely shared between organizations.

“Having this trusted ability to share data and also track the life of data ensures that everybody in the blockchain can operate at a level of assured trust in that data,” says Moore.

“The security built into blockchain enables the better integration of manufacturing and logistics between multiple vendors. Also, new concepts such as data confidence fabrics further enhance data governance by applying a confidence score to all data flowing in the fabric.”

This allows for the automatic rating of data, alerting if sources have been compromised, and enables the valuation of conflicting data within a fabric.

Most manufacturers have not aggressively invested in blockchain technologies at this point and most don't have the skills in-house to successfully do so or to understand how to tie it to business processes. Moore advises manufacturers that wish to start their blockchain journey to:

- Conduct an assessment of their complete digital environment to accurately define the business need.
- Define an initial phase, with an achievable plan to address the core business requirements.

Upon successful completion (with lessons learned), move to the more complex business requirements.

- When creating the platforms and solutions to address the requirements, ensure that the latest agile technologies are deployed. They should address the needs of today, but also enable the scope for future growth and changes with a focus on the new technologies, including virtualization or containerization, blockchain, cyber resilience and data protection.

“Blockchain doesn't make sense everywhere. Often, there are existing technologies that can fill the actual customer need with better performance,” Brumley says.

“But we have experts here at Dell Technologies that specialize in blockchain and the right applications of blockchain.”

Some manufacturers are also exploring the use of blockchain technology in the building of digital twins during product development, according to Todd Edmunds, Global Chief Technology Officer, Industrial IoT and Edge Computing at Dell Technologies. “If, for example, you're a robot manufacturer, you can create a digital twin of a robot and inform a customer that, ‘I'm going to sell you a digital twin of that robot.’ You have a virtual representation of that robot,” Edmunds explains. “The manufacturer can then do design-and-review with their customer digitally. Blockchain enables and protects the process without the need of a central command. That is obviously important for remote access capabilities.”



Conclusion

Industry 4.0, Smart Manufacturing, Connected Manufacturing and other initiatives were invented to help define a way forward for manufacturers based on emerging technological advances and market trends. The technologies listed in this article have improved rapidly in a short time, and their adoption and evolution have accelerated in the last few years.

Industrial solution providers who haven't already investigated

and incorporated some of these technologies in their machines, systems and operations need to make a plan, find and engage the right technology partners and get some projects started in order to stay competitive.

From the supply chain to the smart factory, enterprises are using AI, robotics, edge computing and the cloud to make informed, timely decisions. Dell Technologies and Intel see the new industry inflection point bringing digital and physical

worlds together to create responsive, interconnected operations. They work with OEMs to provide secure and scalable building blocks for industrial solutions that bring intelligence to operating assets and reveal insights from data. Built on open, standards-based solutions and an extensive partner ecosystem, they let customers choose the best-of-breed applications with confidence. The results: potentially lower maintenance costs, new business opportunities and increased productivity. ■



About the Author

Bill Lydon, contributing editor of Automation.com, a subsidiary of ISA - The International Society of Automation. He brings more than 10 years of writing and editing expertise, plus more than 25 years of experience designing and applying technology in the automation and controls industry. Reach him at <https://www.linkedin.com/in/blydon>.

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Applying New Technologies to Transform Industrial Systems



Industrial solution builders are incorporating new technologies and empowering their customers to succeed.

By Renee Bassett,
Automation.com

Discrete and process manufacturing companies are using available technologies to completely reimagine their business models. The transformations will be widespread and far reaching, and [many have already begun](#). Information technology (IT), operational technology (OT), engineering technology (ET), supply chain, asset management, services and customer-facing systems all will be impacted.

It started a decade ago but has accelerated in recent years. Some businesses started reimagining operations based on a new digital architecture; others dove into applications and pilot projects that are already bringing returns. They are getting help from industrial solution builders who are partnering with leading technology providers such as Dell Technologies and Intel to design transformative industrial solutions.

Edge computing, virtualization and 5G: Enabling intelligence everywhere you need it

Edge computing plays a critical role in how manufacturers leverage their data and new data sources to drive specific and differentiated business outcomes. It places compute and storage capabilities into the real world, such as a factory floor, allowing manufacturers to get real-time access to data that will generate insights and deliver value faster and where it is needed most.

Real-time data in conjunction with AI (artificial intelligence), ML (machine learning) and streaming analytics can greatly increase productivity and growth, while operational technology combined with edge computing can use data to transform how challenges with equipment, products, workers and safety are monitored and addressed.

Edge computing and 5G networks provide the capability to run smart factory applications at the edge, near where production data is generated. At the edge, autonomous action can occur more reliably, securely and quickly than when processing data through a remote cloud or data center.

Dell Technologies and Intel work together to provide the technology infrastructure to enable edge computing and 5G networks. The two help customers simplify their edge with insights on the factory floor, intrinsic security to protect operations and data, and consolidation of IT operations, data and infrastructure as their edge expands.

OTTO Motors' autonomous mobile robots (AMRs) demonstrate these trends by using artificial intelligence and 5G communications to navigate complex production environments and move parts, goods and even other robots to where they are needed. OTTO Motors provides fleet management systems, a data pipeline, applications, engineering, simulations, and digital twin (simulation) functionality so customers can easily get started with AMRs.

AMRs are being used effectively in one [remarkable factory](#) making engine components for commercial jets. To be specific—they're making turbine shrouds out of Ceramic Matrix Composites. These engine housings can handle temperatures of more than 24,000 degrees, and they weigh less than a third of metal parts they're replacing.

This single part is making flying 1.5% more fuel-efficient. Multiply that by all the planes in the sky and all the miles they fly, and you are talking about saving millions of dollars in fuel costs and millions of tons of carbon emissions. But as cool as that is, what's cooler is the robots. These robots plan their own tasks, adapt to changing situations, and interact naturally with their human colleagues.

A fleet of low, flat platforms glides through the factory carrying stuff that would otherwise have to be lifted, or pulled, pushed, or tugged by humans or moved by a forklift. Before these new robots came to town, the plant would turn out 50 units a week. They are now on track to produce 1,500 units per week by early next year. They've retrained staff to make that happen too. People now spend their time doing higher value tasks, while the robots do the heavy lifting.

"The role of 5G technologies at the edge cannot be underplayed, as it is the key enabling technology," emphasizes an ABI Research report. "Specialized, high-cost, high-value and pioneering edge deployments are underway, and the technology is beginning to permeate down to the general use layer, so new use cases will start to grow exponentially." Without 5G networks, the sheer volume of data could not be transferred for meaningful analysis.

The variety of connected devices will be a unique technical challenge, as edge devices will vary from simple connected sensors that measure temperatures and pressures to

Autonomous Mobile Robots (AMRs) that perform real-time environmental analysis and collision avoidance. All of these devices will communicate using different protocols—both transmission control protocol (TCP)-based and non-TCP based—and many devices will use non-standard industrial protocols.

"By wrapping functions in a virtual machine or container, you can treat that function as an autonomous entity," says Alan Brumley, CTO at Dell Technologies OEM Solutions. "The advantages are that you can independently roll out or replace virtual functions in a modular fashion without impacting other functions."

"The modularity of these functions also allows you to build a multi-purpose solution," says Brumley. "For example, in the case of the smart, interconnected factory, you can drop both the virtual machine vision solution plus a predicting maintenance solution into a single appliance, size it and go. It really represents the best of every world."

The wealth and depth of available data is complemented by the ability to manage systems from any location, not just from a control room. Edge computing architectures allow Virtual Desktop Infrastructure (VDI) and Software Defined Wide Area Network (SD-WAN) to be used to securely access critical infrastructure, according to Greg Moore, EMEA Field CTO at Dell Technologies OEM Solutions.





SOLUTION PROVIDER:
ROCKWELL AUTOMATION

INDUSTRIAL DATA CENTER BRINGS BENEFITS OF VIRTUALIZATION TO MANUFACTURING

Rockwell Automation bridges the IT-OT gap for its industrial customers.

Rockwell Automation provides industrial automation and information solutions and serves a wide range of industries from wastewater to consumer packaged goods to oil and gas.

Inbar Blankenship, Product Manager for Virtualization, Rockwell Automation, says, "Information technology and operational

technology convergence provides a challenge for our customers. The rapid technology changes in IT and in OT assets create a gap where the manufacturing floor wants to be able to focus on its application, or line data, but doesn't have the skills or staff to be able to manage the needs of the IT infrastructure. Our customers need a turnkey solution that can provide a validated, tested and long-term supported infrastructure."

That's where Rockwell Automation Industrial Data Centers come in. These solutions help customers realize the benefits of virtualization technology that were widely adopted as a standard in information technology and are now becoming a growing trend in manufacturing and production.

"Our Industrial Data Centers (IDCs) and VersaVirtual™ Appliances provide virtual turnkey solutions for our customers. Both are based on the Dell Technologies OEM Unique servers with extended life, stability and visibility," says Blankenship.

The Industrial Data Center from Rockwell Automation helps manufacturers realize significant cost savings.

"OEM Solutions has helped us provide these solutions to our customers," Blankenship adds. "We can create products and take them to market much faster. Dell Technologies' global footprint helps us reach more customers around the world and reduces the complexity of dealing with our global customers."

rip Railcar Inspection Portal
Automate and Streamline
Your Railcar Inspection Process

360° IMAGING

HIGH INTENSITY LED LIGHTS

V.I.E VEHICLE UNDERCARRIAGE EXAMINER

duostech

1.3 TB
of data processed and analyzed daily per inspection site

8 minutes
or less to visualize a typical freight train

120:1
reduction in inspection time

SOLUTION PROVIDER:
DUOS TECHNOLOGIES GROUP, INC.
(NASDAQ: DUOT)

AI AT THE EDGE IMPROVES RAILCAR INSPECTIONS ON THE FLY

Duos creates high-speed image processing system for rail yards.

Trains need to keep moving. Every second a train spends idling creates “dwell time.” With thousands of locomotives intersecting across North America pulling millions of railcars, the impact of prolonged dwell time is substantial. Through time-consuming manual inspections, there are major impacts on crew, locomotives, railcars, fuel and lading that can disrupt traffic across the continent and cost rail companies and consumers millions of dollars annually.

That’s why leading freight railroads such as CSX have turned to Duos for automated inspections. These solutions rely on Dell EMC PowerEdge servers deployed at the edge to capture images, model data and handle sophisticated analytics and reporting without halting the trains.

Duos’ challenge was finding a way to leverage technology as a force multiplier to meet customer requirements for a better, faster inspection process for trains running at full speed. Duos developed innovative data analytic solutions with artificial intelligence at the edge to conduct more reliable railcar inspections available 24/7/365 in all climates and conditions.

The PowerEdge XR2 rugged servers based on Intel are deployed for image capture with the PowerEdge R740 servers. The PowerVault ME4 Series provides data

retention with the Networking S-series switch optimizing traffic flows. This data includes 360° visualization of railcar defects as well as vibration, laser and LiDAR sensor readings, all while trains travel through the portal at high speeds. Data is processed and analyzed in real time to provide prompt, actionable insights to inspectors and operators.

“In the eight minutes it takes to use a flashlight and piece of chalk to inspect a single car, we can inspect a full train of 120 cars or more,” says Wm. Scott Carns, Chief Commercial Officer at Duos. “We strategically locate these systems 50 to 100 miles from inspection points. This way, when a train arrives, needed repairs and further inspections can begin immediately based on the data we provide.”

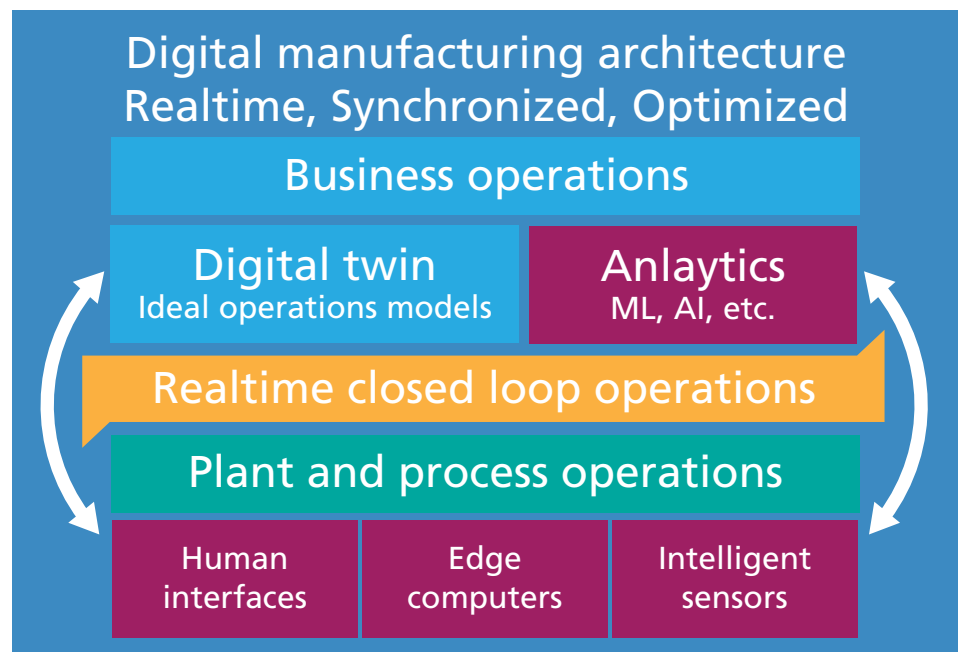
Digital manufacturing architecture unifies the entire organization to achieve greater success

Successful, flexible and synchronized digital manufacturing requires functional integration of information technology, operational technology plant-floor and field systems, production, maintenance and service layer systems.

“Enterprise systems have been absorbing plant floor computing through efforts to achieve real-time synchronization and to accelerate the integration of information technology and operational technology groups. Completing this task, manufacturing digitalization is transitioning to a highly integrated architecture,” says Bill Lydon, contributing editor of Automation.com

The new architecture provides immediate visibility throughout the entire manufacturing and production enterprise to all stakeholders. The most effective manufacturing and production architecture requires orchestrating and optimizing all the elements including supply chain and customer requirements for adaptability.

“OEMs who can deliver intelligent solutions that fit into these new paradigms are becoming trusted partners in the transformation of the industrial sector,” says Lydon. “They are giving rise to digitally integrated, self-optimized systems.”



Source: Bill Lydon, Automation.com

According to Moore, this new and growing edge ecosystem is evolving into two distinct subsets: the Enterprise Edge, including data center class systems such as servers, storage and hyperconverged infrastructure (HCI), and the Industrial Edge, including rugged client systems such as PCs, tablets and laptops.

Dell Technologies and Intel regularly work with companies who develop the digital ecosystem that enables data-handling capabilities at the edge—for example, at the factory floor. Dell Technologies OEM Solutions offers its customers a portfolio of industry standard hardware platforms powered by the latest Intel technology, as well as a suite of capabilities to customize

technology hardware to address specific deployment requirements.

“It could be simple rebranding to a customer’s logo, etc., or it may be a complex physical, mechanical or electrical customization to address customers’ unique requirements,” says Moore. “These capabilities enable Dell Technologies to address the growth in customer requirements for edge infrastructure, by taking IT solutions normally found in core datacenters and optimizing them for the edge.” That includes ruggedizing, reducing the physical footprint and providing services to enable solution providers to deploy and support the hardware regionally, nationally or globally.



AI enables innovation at the edge and beyond

Once operational data has been gathered, AI technology is the engine that can consume and study legacy data and apply these learnings to the factory of tomorrow. The applications are many.

AI can significantly improve quality control by identifying potential issues early in the process. Applying AI to images and measurements taken during various stages of a manufacturing process can help identify problems with a product as it is being assembled and before it is finished. This early detection saves factory resources and reduces wasted time in assembly.

How does this work in practice? If there are 20 manufacturing steps involved in making a product, the first symptoms of failure may be visible in the early steps, when inconsistencies are detected in the data, according to Brumley. AI can be trained on the

factory sensor data and final test logs to detect anomalies that humans might miss. Correctly identifying the potential failure in the early steps allows the factory to stop work and reduce future losses on a product that is less likely to be functional by the end of the line.

“When the cost of the steps associated with a failed product is weighed against the continually falling cost of creating and analyzing data from the assembly line, the advantages of AI at the edge become clear,” he says.

Another illustration of AI-enabled innovation is a motor in a factory line that continuously produces telemetry data as it runs and rotates. This motor creates vibration patterns in three axes, and all can be measured by computer. In the past, a summary of the data, including averages or outliers, would have been sent to the data center or the cloud. Today, with edge technologies, the compute resides right at the motor, where an

AI inference algorithm can monitor and instantly send alerts when something out of the ordinary occurs.

“Analyzing the raw sensor data provides refined insights about the health of the motor,” says Brumley. “We would not be able to access instantaneous insights by performing analytics with consolidated or aggregated data. Immediate access to unfiltered raw data is the key to identifying subtle trends that can indicate or predict failure.”

Advances in analytics and AI are empowering manufacturing plant personnel who understand processes and practical production characteristics to directly systematize operations. Data scientists are working with experienced operators and process engineers to capture knowledge and build the algorithms that will ultimately improve the productivity, profitability and competitiveness of manufacturers.



SOLUTION PROVIDER: EDAG GROUP

AI-BASED PREDICTIVE MAINTENANCE ENSURES UPTIME FOR AUTOMOTIVE MANUFACTURER

In the automotive industry, machine downtime must be prevented to avoid costly production outages.

Manufacturers cannot afford outages or disruptions; production must continue, even when changes and optimizations are pending. As the world's largest independent engineering partner for the automotive industry, the EDAG Group understands the automotive industry's demand for greater efficiency and optimization of cost structures. Founded in 1969, the company is active in the areas of vehicle engineering, production solutions and electronics, with a comprehensive service portfolio.

A large automotive customer wanted to implement a modern predictive maintenance solution to detect irregularities in its machines at an early stage and to use those findings to determine maintenance intervals. The EDAG Group was commissioned to implement predictive maintenance for this customer, requiring a combination of intelligent software and high-performance hardware.

Maintenance had been carried out at fixed, predetermined intervals. This practice also involved checking machines that were functioning improperly, taking production facilities out of use. "Digitalization and increasing efficiency are top priority for automotive decision makers, followed by reducing costs," says Mark Kramer, Head of Production IT (Smart Factory Solutions) at EDAG Production Solutions GmbH & Co. KG.

"Our customer wanted to optimize maintenance of its production facilities

by using intelligent technologies to become significantly more efficient in terms of cost, quality and time," he adds. "The challenges of this project were sophisticated, as the underlying software had to be developed individually. The customer's systems and infrastructure are very specialized, so a wide variety of expert knowledge was required to tailor the artificial intelligence system and the hardware to each other."

Processing big data can be a major difficulty in dealing with predictive maintenance. Being able to make reliable statements about the condition of machines and being able to quickly record possible disturbances entails collecting large amounts of data, relating not only to the condition of the systems, but also to their environment such as temperature and humidity. This data must be stored, processed and analyzed using intelligent algorithms. The size of the database as well as the intelligence and performance of the analysis algorithm are critical for the quality of the insights obtained.

"The first step in this project was to consider how we would collect the data, what data was still missing and how we could obtain it via additional sensor units," says Jacek Burger, Project Manager for Embedded Systems & Artificial Intelligence and Software Development Expert at EDAG Engineering.

"The next step was to analyze and understand the data in real time. We worked with specialist experts to formulate meaningful hypotheses." The resulting AI-based solution for predictive maintenance is connected via interfaces to all other systems such as logistics, product longevity program (PLP), manufacturing execution system (MES) and enterprise resource planning (ERP).

Solutions and results. The storage and processing of the huge amounts of data is handled by a Dell Technologies infrastructure package both in the data

center and on-site. This includes a mix of Dell EMC PowerEdge servers, including the XR2 servers, the Precision 3930 Rack Workstation, the OptiPlex XE3 Desktop PC, and Latitude 5000 and 7000 notebooks, all powered by the latest Intel processing technology.

"We implemented a pilot project with Dell Technologies that could only be achieved jointly and in close cooperation," says Burger. "A project like this involves pure research and you cannot simply fall back on something that is already available, that you simply pull out of a drawer."

Reducing downtimes increased the key performance indicator of overall equipment effectiveness (OEE) by 2 percent. "This improvement in overall plant efficiency is excellent in an automotive sector that has already trimmed its processes to maximum efficiency," says Kramer. "We initially assumed the figure would be lower, so the customer is really happy." The pilot project will now be rolled out to other plants and factories worldwide, and the data analytic cluster will be further expanded.

Benefits achieved from predictive maintenance:

- **Better maintenance and service interval planning**
- **Fewer service personnel deployments**
- **Fewer unplanned machine failures**
- **Optimized spare parts management**
- **Higher machine performance**
- **Better machine knowledge through analysis of the collected data**



SOLUTION PROVIDER:
OTTO MOTORS

SELF-DRIVING ROBOTS NAVIGATE FACILITIES AND MOVE MATERIALS

OTTO Motors robots use the power of the cloud, big data and AI.

The brilliant minds at OTTO Motors have [robots](#) solving very human problems, in a very practical way—at scale—doing the work that frees up humans to perform higher value tasks.

In a video, CEO and co-founder Matt Rendall talks about the way his machines are thinking for themselves, and how AI and machine learning in general will

improve our lives in unimaginable ways. The OTTO Motors team further predicts that self-driving vehicle technology will be one of the most important technological revolutions of our lifetime.

In the fast-paced, exciting world of self-driving technology, a daring idea has become reality. As a market leader that's paving the way in powering one of the most important technological revolutions of our lifetime, OTTO Motors, a Canadian mid-sized business, is creating autonomous vehicles that build maps of their environment and move independently.

By partnering with Dell Technologies and Intel, and harnessing the power of technologies such as cloud, big data and AI, OTTO Motors is democratizing robotics

technology for their customers and making it possible for companies of all sizes to adopt self-driving vehicles in their work environments.

Rendall said, "Every one of our machines is producing gigabytes of data per hour. Data is one of the greatest competitive advantages you can have. Without the Dell Technologies backend infrastructure, we would not be able to accomplish what we are doing today. We finally are at a point where robots can offer extreme value to very specific problems in the world. Ten years from now, everyone will look back and will not be able to picture a world without them."

Software simulations, digital twins and digital threads optimize operations and product development

Manufacturing companies are increasingly focusing on technologies that empower remote operations, enhance reliability for customers, boost revenue and maintain margins by keeping costs down. Digital twins play a role in all of these—from training new operations staff before they set foot in a plant to using simulations and real-time data for product design and development, and better business planning.

“Digital twins are no longer a niche concept but rather becoming mainstream with the help of IIoT dashboards and near real-time reporting,” explains Ryan Martin, Research Director, [ABI Research](#).

Ryan says manufacturers need a range of capabilities to deploy digital twins, including computer-aided design (CAD) modeling, connectivity, cloud computing, IIoT software platforms, remote monitoring, hardware for shop-floor workers

(tablets, AR glasses), physics-based simulation, machine learning and systems integration. This is because digital twins are not a technology, but a composition of solutions aimed at bridging the physical and digital worlds, from design through simulation, manufacturing, assembly, and after-sales service and support. ABI Research estimates average global adoption of digital twins will reach 34.9 percent by 2026.

Since the core of an industrial business system operates based on customer orders and supply chain factors, digital twins and related systems known as digital threads can be used to achieve synchronized real-time optimized production that adapts to external changes.

Makers of consumer-packaged goods (CPG) are examples of manufacturers working to optimize their processes using digital threads. “Manufacturers need to work with retailers and supply-chain operators to, among other things, anticipate and prepare for demand surges, have flexibility on their production lines

to accommodate trial flavors and new packaging, as well as have the required documentation available for regulators as evidence of how the facility handles ingredients,” say industry experts.

While creating digital threads across the supply chain will take time, “in the short-term CPG manufacturers need to ensure that their production plans are informed by as much relevant data as possible,” Larner points out. CPG manufacturers are investing in IIoT sensors and analytics to monitor temperatures and humidity levels in their facilities and the condition of ingredients and foodstuffs, alerting staff if conditions change beyond acceptable parameters. Digital threads will be essential for CPG manufacturers to meet the needs of various stakeholders.

According to the [ARC Group](#), today’s advanced virtual simulation technology is an integral component of the digital twin. Comprehensive simulation platforms can simulate and validate the functionality of product design concurrently, enabling the designers



to validate their designs as they go. In the context of the digital twin, real-time sensor data can be used to populate simulation applications that then emulate the physical product and enable design improvements.

By using VR simulation technology, depth-sensing cameras and spatial computing, manufacturers can create dynamic 3D models of their plants. These dynamic models contain all the process, mechanical and electrical/control design information needed to, for example, optimize the recovery boiler operations in an autonomous paper mill.

This digital twin can be used to virtually visit the location anytime and, paired with AI, create new opportunities for improvement. Since worker movements can be captured and analyzed with spatial computing,

such activities as increasing personnel safety, optimizing worker ergonomics or finding production bottlenecks can be undertaken.

AR and VR also enable immersive maintenance and training experiences while minimizing costly inefficiencies and increasing personnel safety.

Key Performance Indicators (KPIs) for industrial only further highlight how [beneficial](#) AR can be. Downtime is one of the most severe KPIs in terms of lost productivity and revenue. In the automotive industry, for example, US\$30,000 per minute of unplanned downtime is possible—large automakers can average one vehicle produced per minute. AR can help reduce unplanned downtime through more efficient maintenance with analytics, error-reducing task

guidance and verification, and when necessary, remote expertise. AR can also reduce planned downtime through similar means.

Industrial environments create a perfect storm of variables and needs for augmented reality to address and fill. Training and knowledge share are critical due to that complexity, and AR can enhance training efficacy and retention while also being used to capture, share and view that knowledge. "Integration into important platforms like IoT, product lifecycle management (PLM) and enterprise resource planning (ERP) enables a two-way benefit, where AR can improve those systems and those systems feed data to improve AR. All components working together can be a challenge, but the return grows exponentially," concludes Abbruzzese.





Photo courtesy of Altair

SOLUTION PROVIDER: ALTAIR

HPC APPLIANCE POWERS ENGINEERING SIMULATIONS

Altair high-performance computing platforms come in physical and virtual formats.

When it comes to digital manufacturing and design engineering, the importance of simulation continues to gain traction. So does the value of a multi-physics approach, embracing all elements and levels of system design. The goal is to reach better outcomes faster. But with the scope of simulation getting broader and deeper, and development cycles being squeezed, access to high-performance computing (HPC) is becoming critical.

Altair developed a fully managed HPC appliance powered by Intel for CAE known as [Altair Unlimited™](#). The appliance is available in both physical and virtual

formats and offers unlimited use of a wide variety of Altair software. Altair Unlimited boxes up software, system administration and infrastructure as a service into a single, intuitive platform. To keep it all working at maximum efficiency, HPC resource management and user-friendly web portal software also come included with every system in the industry-leading [Altair® PBS Works™](#) package.

The Altair Unlimited appliance addresses the unique needs of enterprises by simplifying access to HPC infrastructure at an affordable cost. This gives engineers and scientists access to hardware, software and HPC support that enables robust product designs.

Altair helps its customers maintain a competitive edge and bring better-performing products to market faster. Through its partnership with Altair, Dell Technologies and Intel, leading golf equipment manufacturer PING gains the resources it needs to apply high-performance computing systems and

applications to its design strategy. This collaboration has helped PING:

- Boost product line innovation with HPC
- Slash design cycle times
- Decrease variability in product performance
- Improve product quality without delaying time to market

Altair's collaboration with Dell Technologies and Intel ensures Altair Unlimited is built on industry-leading infrastructure such as Dell EMC PowerEdge servers, storage and networking, and Intel® Xeon scalable processors with an unrivalled track record.

"With the help of the Altair Unlimited appliance built on Dell EMC PowerEdge servers and powered by Intel Xeon Scalable processors, PING has been able to streamline its entire product development pipeline," says Eric Morales, Senior Engineer at PING.



SOLUTION PROVIDER: DOOSAN

PREVISION BRINGS FAULT DETECTION TO ENERGY PRODUCERS

Doosan PreVision software runs on Intel-based Dell EMC PowerEdge R640 and R740 servers as the platform.

Doosan Heavy Industries & Construction (Doosan) has contributed to the growth of the Korean economy, providing solutions for power generation systems, desalination facilities and more. Doosan has served customers in the thermal power, nuclear power, renewable energy and water sectors, and is now pursuing digital transformation.

Doosan created PreVision, a fault-detection and diagnostic solution for its customers to use to reduce maintenance, equipment replacement costs and unexpected shutdowns while improving power-generation safety.

With PreVision, customers could overcome the limited accuracy of existing process monitoring and control systems to meet the world's power needs. With PreVision's machine learning and Internet of Things (IoT) technologies, plant

managers would access graphical data on the real-time performance of machinery from sensors on the equipment. At the first sign of a potential issue, they could take action before failures disrupted production or put people at risk.

Doosan needed to take its PreVision idea off the drawing board and put it into production. By partnering with Dell Technologies OEM Solutions, Doosan could focus entirely on developing its software. It avoided the expense and possible delays from designing, building and testing a hardware platform for its product.

It chose Intel-based Dell EMC PowerEdge R640 and R740 servers as the platform—a highly reliable hardware that would give peace of mind to PreVision customers worldwide. Plus, Doosan could accelerate shipment processes with OEM Solutions ensuring PreVision software was installed before the servers left the Dell Technologies factory, saving time and effort when the hardware arrived at Doosan's offices. Finally, Doosan wouldn't have to invest in a network of support to assist customers once the servers were in the field, thanks to the availability of Dell Technologies' global support system.

Doosan enables customers globally to meet the energy needs of local populations by building more efficient and safer power plants. All PreVision customers are guaranteed the same high level of support around the world to ensure optimal performance. Plus, no matter the size of the power plant nor the needs of the individual customer, Doosan can tailor the PreVision appliance as required.

- **Doosan works with OEM Solutions to plan the hardware platform design.**
- **Doosan has the option of using debranded hardware when it's required.**
- **OEM Solutions integrates PreVision software with the appliance prior to delivery.**
- **Customers across South Korea gain enterprise-grade support services.**
- **OEM Solutions will scale up support services once the PreVision appliance goes global.**

Services: From remote monitoring to everything-as-a-service (XaaS)

With technology disruptions affecting manufacturers, many companies are demanding more flexibility and better ROI from their technology solutions. OEMs have been changing their traditional business model of selling products to one that allows customers to buy those products as a service. As-a-service consumption models allow customers to enjoy more flexibility and scalability and, at the same time, help solution builders monetize data to drive innovation and growth.

Some OEMs are already providing remote equipment monitoring services to their customers by leveraging the latest advances in data analytics, edge, IoT and AI/ML technologies. This helps their customers drive better asset management and avoid production interruption caused by machine failures on the factory floor.

According to Kateryna Dubrova, Research Analyst at [ABI Research](#), rapid deployment solutions, such as hardware-agnostic software-as-a-service (SaaS), are becoming increasingly important. “Vendors such as DataRobot are easing access to ML and AI tool sets through different deployment options at the edge, on-premises, in the cloud and through consumption using Platform as a service (PaaS) and Software as a service,” she says.

Over the past decade, leaders have become increasingly taken with the idea of everything-as-a-service (XaaS). XaaS—everything-as-a-service

or anything-as-a-service—refers to products, tools and capabilities that are delivered to users as services. Unlike traditional IT, which requires up-front purchase or licensing, the XaaS or flexible-consumption model allows customers to consume and pay for IT services based on what they need and use, typically through a subscription or pay-per-use.

Dell Technologies already provides as-a-service offerings as part of the recently launched project APEX that radically simplify the technology experience and deliver more agility and control. APEX lets Dell offer control layer for on-premise, multi-cloud and edge deployments, allowing companies to manage multi-cloud deployment through one vendor and console, all while utilizing the latest Intel products and technologies. Customers now can focus more on running their businesses and less on managing infrastructure, which helps them accelerate innovation, adapt to evolving requirements and stay in control of IT operations. APEX is based on innovative Dell Technologies infrastructure built with Intel flexibility and performance.

[GE has already adopted Dell's APEX](#) IT-as-a-service to manage its on-premise private cloud to quickly rebalance workloads across its business units and benefit from automated provisioning. Dell will now manage GE's IT infrastructure through the APEX system. Through Dell's APEX Data Center Utility, GE can scale up or down its data center, storage and compute resources on-demand, allowing GE to pay for what it uses.

“We need to have the ability to change as quickly as the world does regardless of whether we're manufacturing a new jet turbine in Ohio or AI-based ultrasound technology in Bangalore,” says Nancy Anderson, CIO at GE. “With data centers around the world, we are working with Dell to create a consistent way to support all of our business units that ensures the right IT resources are making it to the right teams when they need them most.”

Digital transformation may eventually help the “as-a-service” business model to become “outcome-as-a-service.” Although complete outsourcing of the operations and maintenance of an entire facility—such as process-plant-as-a-service—may be a long way off, smaller initiatives such as equipment-, process unit-, feedstock- or catalyst-performance-as-a-service are emerging, according to experts.

One example is IoT-enabled heavy equipment produced by [Caterpillar](#). The equipment maker worked with SAP to create what they call “a self-compensating, automated factory.” Marty Groover, Caterpillar's Operational Technology Leader, says, “We're creating a digital thread from our products in the manufacturing facility to our customers with our live factory that uses SAP Digital Manufacturing Insights and Vehicle Insights, and the SAP Digital Boardroom. Sensors on forklifts are just the beginning. We're also doing predictive maintenance using sensor collected data from our machines.”

While its customers operate their equipment, Caterpillar collects



Dell Technologies already provides as-a-service offerings as part of the recently launched project APEX that radically simplify the technology experience and deliver more agility and control.... Digital transformation may eventually help the as-a-service business model to become "outcome-as-a-service."



data from the connected products and turns it into actionable insight. Operators know precisely when to bring their machines in for routine maintenance, allowing them to increase product uptime and extend the product life cycle. The service meant one customer increased machine efficiency by nearly 28 percent, while another saved 40 percent on fuel costs.

An additional benefit from Caterpillar's side is the ability to analyze how businesses are using their products. Caterpillar engineers can redesign equipment to better meet customer preferences. If a product feature is being neglected, for instance, Caterpillar can remove that feature from future models.

These use cases and applications in industrial environments demonstrate that OEMs are on the path to find and start using the technologies and infrastructure they need to innovate faster and deliver transformative

outcomes for their customers. Finding the right strategic partners to make their digital transformation journeys a reality is key. ■

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DELL TECHNOLOGIES OEM SOLUTIONS & SIEMENS TECHNOLOGIES

Making buildings smarter with an integrated automation platform and high-performing infrastructure

Photo courtesy of Siemens

“When we’re handing a Desigo CC solution over to an end user customer, the people in the building, we need to make sure the software is installed on a reliable hardware platform, such as Dell EMC PowerEdge servers and Unity storage, and that it securely connects to building networks. That’s why we work with Dell Technologies OEM Solutions.”

Tom Rule, Segment Head of Digital Buildings at Siemens Smart Infrastructure

Situation Analysis

The performance of a building automation system can have a profound impact on its occupants and our environment and the businesses that depend on them.

Even as the Internet of Things (IoT) enables more individual devices to be monitored and controlled from a single station, the purpose of building automation systems has expanded from providing basic operation to creating high-performance buildings whose integrated technology can save energy, make maintenance easier and improve service to building occupants.

The management of a single building involves a complex web of essential systems and services: temperature controls, internal and external lighting, fire suppression, security, access control, video surveillance and power management. The monitoring and management of each of these building automation systems

disciplines traditionally requires many specialized software applications that send and receive data to specific controllers, such as heating, ventilation and air conditioning (HVAC) units, closed-circuit television (CCTV) cameras or employee badge readers.

INTEGRATION FOR HIGHER PERFORMANCE

Many custom integrations are needed to bring separate aspects together, or to add or upgrade controls. Somebody might have to build an adapter to support a proprietary protocol or design interfaces so different alarms and alerts make sense when viewed side by side. As sustainability and energy conservation goals are added, the system needs to not only maintain proper temperatures, but also optimize the performance of fans and chillers to reduce energy use or respond to weather changes. Creating high-performing buildings requires a holistic approach that can constantly evolve and adapt.



This kind of integration was possible before, but it was hard. Siemens Desigo CC software makes it easy.

Taking into consideration all these complexities and requirements, Siemens Smart Infrastructure developed the Desigo CC integration platform. Desigo CC provides the software required to turn existing buildings into high-performing ones. Desigo CC makes it easy and cost-effective to integrate existing automation systems or add new ones using general programming expertise.

For example, facility managers can use classroom-scheduling software to predict when their rooms are occupied or unoccupied. With that information, 15 minutes before class starts, the system can automatically turn on the lights, unlock the doors, set the temperature, deactivate the motion detectors and do anything else to ensure the room is ready for occupancy. Then, 20 minutes after class is over, it can lock everything down again and go back into an energy-saving mode.

APIs FOR EASY INTEGRATION

This kind of integration was possible before, but it was hard. Siemens Desigo CC software makes it easy. Desigo CC software uses application programming interfaces (APIs) to retrieve classroom schedules, pull them into the automation system and then align the building control schedules with the classroom schedules. The same technique could be used for other situations. Facilities are starting to monitor electrical vehicle charging stations, for example, and adjust their operation during peak time when energy costs are high.

The more systems that are connected, the more efficiently a building can be run. Then there's the lower cost of maintaining one software package instead of five or six: It's cheaper to create and maintain one set of graphic floor plans, set up one remote notification scheme and maintain user accounts


in just one application. Finally, a holistic view of all controls provides additional benefits. Users who can prioritize all the things going on in a building, discipline by discipline, can make sure the right things are getting attention in the right order.

"The Desigo CC building automation platform is used everywhere from a small office building and a K-12 school up to some of the largest university and hospital campuses. In some cases, the platform allows users to connect multiple buildings located in different parts of the world back to a central management station," says Rule.

Design Partnership

Siemens leverages Dell Technologies OEM Solutions to create the smart buildings platform.

While Siemens Desigo CC is a pure software application, the company also provides the automation



While the Siemens team came up with an engineered design to converge these networks, Dell Technologies OEM Solutions assisted with the hardware platform design, fulfillment, configuration and more.

controller hardware for many building operations, as well as network and system design, and installation services. For large installations, Siemens leverages a leading technology infrastructure provider—Dell Technologies OEM Solutions. Dell Technologies augments Siemens' resources by offering the hardware platform, collaborating on solution design, and providing development, installation, and post-deployment support services.

In completing building automation for one large corporate customer in the northeastern U.S., the Siemens Smart Infrastructure team in Philadelphia worked with Dell Technologies OEM Solutions to streamline hardware requirements, virtually commission a new converged network and deliver a turnkey solution.

DESIGNING A SECURE SYSTEM

The role of the Philadelphia team was to design a platform for integration and a reliable network for a critical facility. Patrick Downs, Sr. Executive Account Manager with Siemens Smart

Infrastructure, Building Technologies division, leveraged the Desigo Building Automation platform for the basis of design. Siemens designed and supplied the products to create a converged system that supported their client.

"The client was managing many physical servers. These independent, decoupled networks proved to be vulnerabilities for the client. The subsystems supported other automation subsystems, such as batteries, uninterruptible power supplies, meters, energy gateways, white space optimization, security and fire systems," says Downs. "Often, the 3rd party systems are set up as a separate islands of automation."

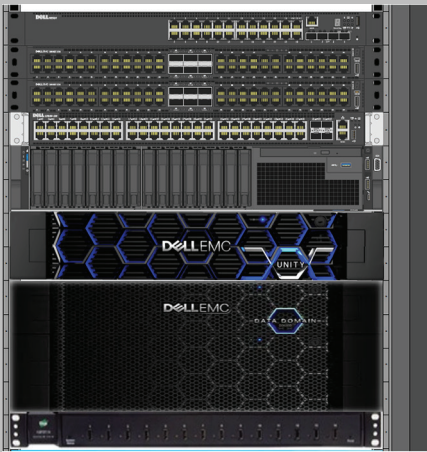
The Siemens teams' task was to create an engineered design to converge these networks and create a single cyber secure solution. "We listen a lot for what a client is trying to achieve. We have conversations to raise cybersecurity awareness, reduce security threats and help them manage the threats," says Downs.

"That includes reviewing network topologies of existing systems, making recommendations, and showing them reliable and supported equipment options."

SUPPORTING A CONVERGED NETWORK

While the Siemens team came up with an engineered design to converge these networks, Dell Technologies OEM Solutions assisted with the hardware platform design, fulfillment, configuration, installation, implementation, security verification and end state install onto the customer's floor. This "single vendor approach" allowed Siemens to focus on its customer's needs while trusting OEM Solutions to deliver a highly resilient and high-performing infrastructure with a great total cost of ownership.

The Dell Technology end-to-end support included pre-sales engineering of networking, compute, storage, software, security and services requirements; program management and support; onsite



Dell Technologies Solution for Siemens Desigo CC Customer

- Networking switches
- R740 PowerEdge servers
- Unity Storage Array using MetroSync replication for redundancy
- Data domain purpose-built backup appliance
- Data protection suite for VMware
- Microsoft licenses for Windows & SQL
- Vulnerability scan
- Turnkey implementation services SOW for entire stack
- Ongoing custom SOWs in support of the network

services to aid Siemens for the length of the project; and Dell Technologies' assistance in moving the infrastructure from Siemens' environment to the customer datacenter.

PRE-TESTING IN A VIRTUALIZED ENVIRONMENT

Moving the infrastructure from Siemens' environment to the customer datacenter was a step enabled by the virtual environment that OEM Solutions was able to create. Once the design was completed, the customer's entire Desigo CC solution—hardware and software—was set up in the Siemens local office in Bluebell,

Pennsylvania. It incorporated all the switching and loading of all the third-party software products so tests could be run on all systems.

All the third-party vendors brought a device to connect to this staging area network so the Siemens team could demonstrate that the pre-production network design, devices and servers worked successfully together. The team could make sure the ABA log backup was working with the antivirus software, for example, as well as create a disaster recovery plan for the entire system. The client could even witness a test of the failover-and-restore sequences.

The Dell Technologies' solution for Siemens Desigo CC customer included high-power, secure PowerEdge servers and Unity storage arrays using MetroSync replication for redundancy. OEM Solutions also performed a cybersecurity vulnerability scan of all the hardware during this pre-commissioning phase—a service Dell Technologies offers for all its PowerEdge servers.

"If you can prioritize events from all disciplines in your building, in a single application, then you really can make sure that the right things are getting attention in the right order," says Rule. ■



Dell Technologies OEM Solutions and Intel: Partners That Can Accelerate Innovation

Explore the capabilities of Dell Technologies OEM Solutions and its offerings powered by Intel

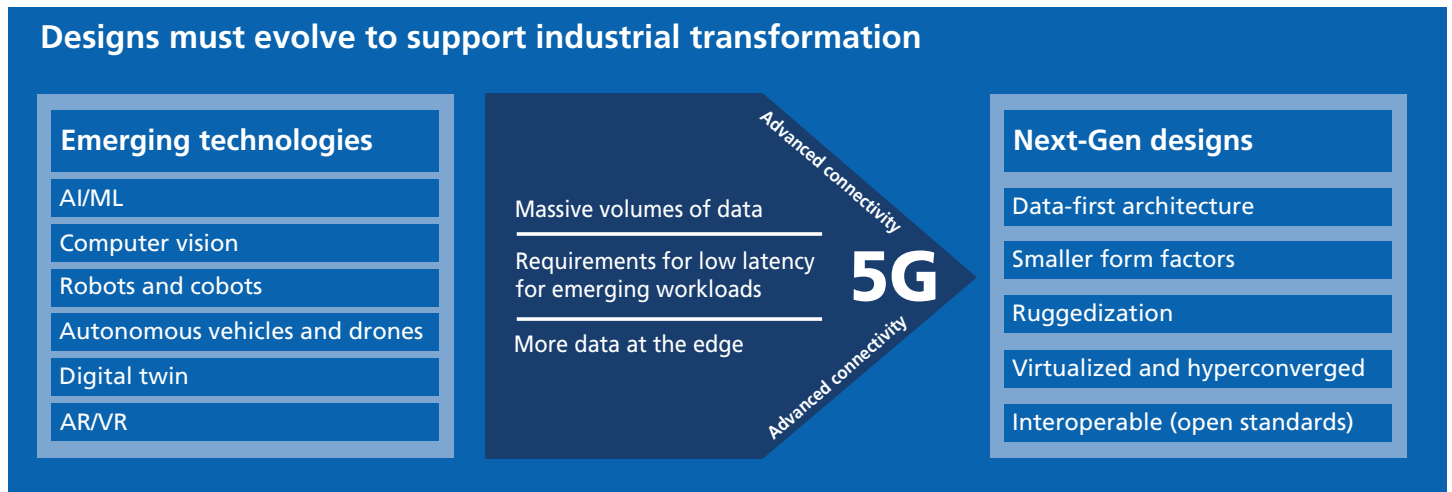
With changes that manufacturing companies are facing today that require them to keep pace with digital transformation, industrial solution providers need partners that can accelerate innovation and compress time-to-market. Products have to go to market with just the right

combination of technology, support and services to differentiate them and increase their potential for success. Dell Technologies and Intel regularly work with companies developing new products and solutions in the new, digital ecosystem.

Accomplishing more with next-generation designs

Emerging technologies and the use cases they drive, such as AI-powered predictive maintenance of equipment or machine vision-enabled quality

control, require next-generation designs. Dell Technologies OEM Solutions has built a portfolio of platforms powered by the latest Intel technology to support these use cases and the data demands they create.

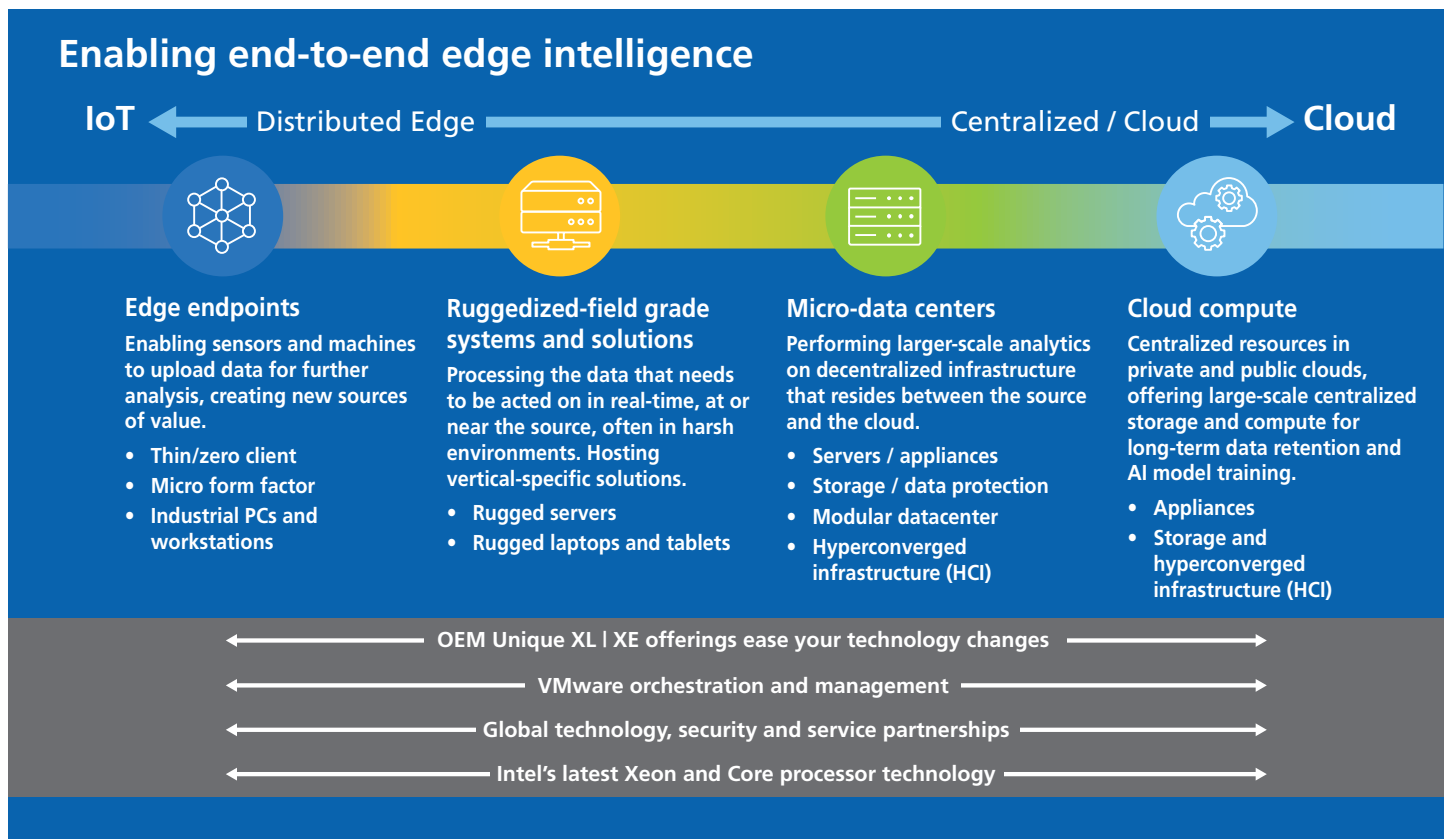


Dell Technologies OEM Solutions helps you accomplish more with next-generation designs.

Enabling intelligence everywhere you need it

Addressing the growth in customer requirements for edge infrastructure, Dell Technologies has developed a portfolio of systems that are purpose-built for industrial workloads. Dell has leveraged standard platforms that traditionally resided in data

centers and customized them for new, data-driven reality. Dell Technologies systems powered by Intel are ruggedized, have extended life and stability, and can fit into space-constrained environments—all built with enterprise-level security, interoperability, systems management and open standards.



Dell Technologies has developed a portfolio of systems that are purpose-built for industrial workloads.

Industry-standard and customized technology solutions

Dell Technologies OEM Solutions in collaboration with Intel enables business transformation with an increased focus on core differentiation, expanding future revenue streams and driving the creation of innovative, scalable solutions. Partnering with these technology leaders can help you develop the right solution, either based on industry standard platforms or customized to address your customers' specific requirements.

Solution builders work with Dell Technologies to select standard off-the-shelf or tailored OEM Unique

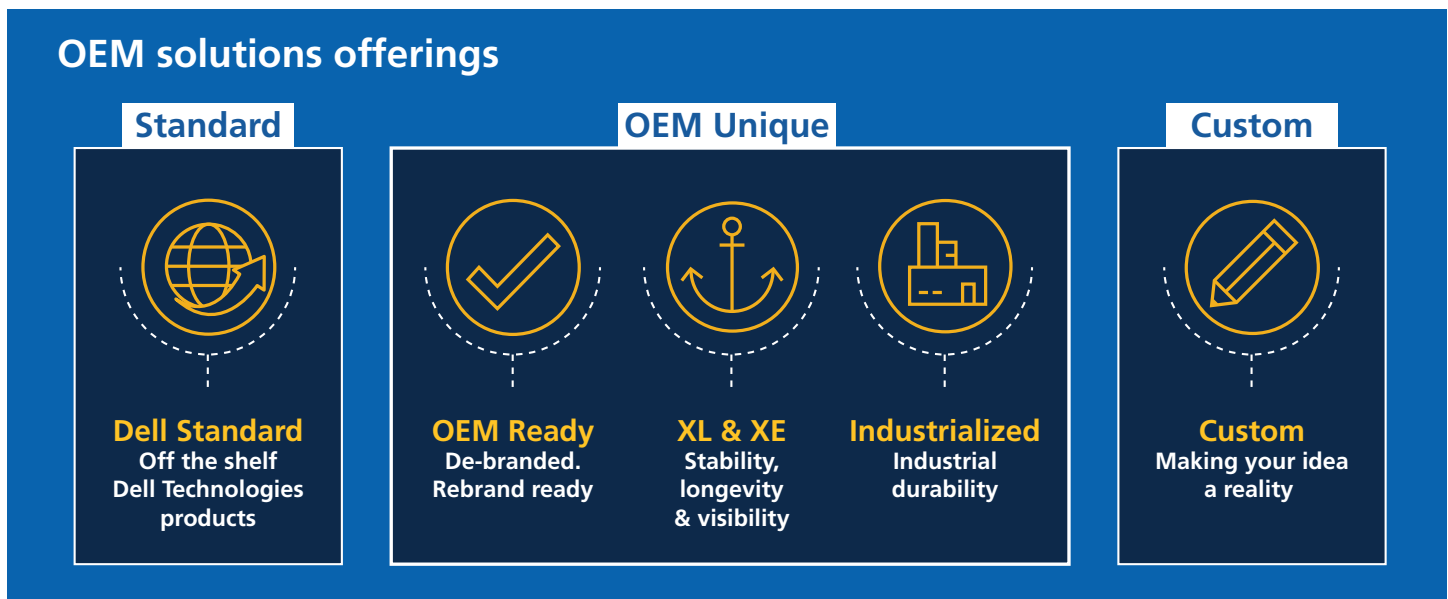
offerings from tier-1 vendors. Dell rugged solutions are designed to withstand extreme ranges in temperature and high-shock and -vibration environments, fit into tight spaces and comply with industry certifications such as MIL-STD for rugged / military, NEBS Level 3 for telecommunications or DVL-GL for maritime applications.

Dell OEM XL and XE Platforms come with in-advance visibility to key product transitions and changes that effectively help customers maximize resources and budget. An up to 9-18 months product transition period upon launch of the next generation products means a customer's time is spent on innovation and competitive

differentiation, not development churn.

When the tailored, off-the-shelf offerings don't meet the need, OEMs can also work with Dell Technologies to customize solutions, which can include rebranding to a customer's logo, specific services, or more complex physical, mechanical or electrical customization to meet unique customer requirements.

All these capabilities enable Dell Technologies OEM solutions powered by Intel to address growing customer needs for edge data demands and edge infrastructure.



Dell Technologies OEM solutions powered by Intel address a variety of customer needs for edge data and edge infrastructure.

Expertise from end-to-end

Dell Technologies helps OEMs innovate faster and accelerate time-to-market when it comes to building complex projects. With more than 55,000 Dell Technologies team and partner professionals, there is broad and deep technical expertise across functions and industries. Dell Technologies professionals can help you design your solution, which eliminates time-intensive steps that would otherwise set you back. You can leverage OEM Solutions' expertise in engineering, program management, global support and global secure supply chain. Or, solution builders seeking greater agility and flexibility from their own digital transformation efforts can take advantage of Dell

Technologies' new as-a-service offerings. OEM customers will also be reassured that Dell Technologies offerings utilize the latest technology from Intel.

Partner with Dell Technologies OEM Solutions to:

- Focus on your intellectual property and competitive differentiation by building solutions on Dell Technologies' next generation technology, services and support specific for OEMs.
- Bring technology to tough industrial environments with the broad range of ruggedized solutions.
- Simplify your edge to generate more value where speed matters.

- Enable analytics at the edge for smarter, faster and more cost-effective decision-making.
- Customize technology when standard off-the-shelf systems will not meet the need.
- Make customer transitions easier and less disruptive with long-life solutions.
- Protect sensitive data, infrastructure and operations.
- Replicate success at scale by leveraging a secure global supply chain and OEM support services.
- Access the latest Intel Xeon and Intel Core processors and other Intel-based technologies. ■

Find out more at
DellTechnologies.com/OEM/industrial

