IMTS 2022:
11 KEY TAKEAWAYS

Critical Insights for the Industrial
& Manufacturing Sector

A MESSAGE FROM OUR CHIEF RESEARCH OFFICER

Stuart Carlaw
Chief Research Officer

IMTS 2022 was a very different event compared to IMTS 2018. A rather obvious statement given the intervening COVID-19 years and ongoing macro issues associated with war in Ukraine, energy costs, and global inflationary pressures. However, the tea leaves our analysts read at the event signal a community that is robust, is beginning to truly embrace digital transformation as a force multiplier, and is setting itself up for a changing world.

So, what does that mean in terms of tangibles? There were several clear trends that were evident in most conversations. The most prominent of these was the issue of labor shortages. The overspill from COVID-19 shutdowns and the trend to reshoring means that the biggest risk to productivity in many instances is the availability of skilled workers. This is driving companies toward technology as a stopgap that could turn permanent. Key technology beneficiaries are the robotics industry in the form of cobots, which were near enough prominent on every other stand at the show, and to a lesser degree the longer-term prospect of Autonomous Mobile Robots (AMRs). At the other end of the scale, it was interesting to see typically conservative industries such as grinding and finishing looking at replacing human capital-intensive low-skilled processes with automated operations.

The second major trend seen at the show was that of a more realistic and practical attitude about technology implementation. The focus was much more on the quick wins from low-hanging fruit rather than long-term visionary ideas. Limited, targeted implementation built around clearly ring fenced and structured projects with definable Return on Investment (ROI) parameters were very evident with projects spanning from reduced parts and inventory scanning to improved in-line part inspection and machine tending. The message received was that ROI for digital transformation projects is now measured in the 6 to 8-month window and that simple projects attuned to "where the rubber meets the road" is the sweet spot for digital transformation success.

The third major trend to pay attention to is that the market landscape and hierarchical structure is changing. The easiest part to see is that there are now significant differences in the submarkets within the wider community in terms of their appetite and velocity toward digital transformation. The differences between process and discrete industries were profound and even within these broad categories, there are spectrums of differing adoption levels. You cannot view an automotive story the same as a Fast-Moving Consumer Goods (FMCG) story. This means that as a supplier, one must be nimble, identify the key success criteria that are common, and indulge in deep understanding of the very specific market peculiarities of each defined regional and market segment.

The second consideration regarding the landscape has to do with the supplier community. The prevalence and influence of new market entrants in new market segments, such as Nokia and Amazon Web Services (AWS), was clear to see. They are now part of an increasingly disparate supplier ecosystem that is sometimes creating conflicting technology messages and approaches that risk slowing digital transformation, rather than speeding it up. Two things spring to the fore. First, the market, at some point, will coalesce around commercially-driven multi-company partnerships that will be afforded the gravity of scale. Second, the message to the supplier industry is to focus on solving problems, simplifying the equation, and speaking the language of the customer.

Lastly, it was evident that companies attending IMTS exhibited a very different set of priorities from those at Hannover Messe.   Sustainability and energy consumption were one of the foremost contemporary issues at Hannover Messe. Although a consideration, they were much less of an issue and much more of a long-term consideration at IMTS. This could be largely attributed to the differences in energy policy and exposure to the Ukraine war between the two regions, but also the evolving pressures of labor shortage that have emerged in the period between the two shows.

In summary, digital transformation is gathering pace. No matter the trend that is driving the need for change, it is happening. The dominant trends might change and differ, but the underlying benefits of digitization that afford the flexibility to address future issues at the same time as addressing real world issues of today will mean that any investment now will likely bear future unseen benefits in addition to immediate impact. The train is still in the station, but is preparing to leave. Time to board!

Stuart Carlaw
Chief Research Officer
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ANALYST

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1 ADDITIVE MANUFACTURING

Additive Manufacturing (AM) had a major presence, and, in some ways, it had its own home in the West Hall. The location itself was far enough from the rest of the show to feel like it was on its own, yet sticking with the machine builder/maker theme, there's no doubt this section had enough chutzpah to command some serious space. The entryway was guarded by industry stalwarts HP, Stratasys, and 3D Systems and behind them newer entrants like Desktop Metal. HP had a major unveiling of MetalJet, the company's flagship production AM workhorse first debuted in 2018. The most notable changes are the addition of HP-branded peripheral equipment for all parts of the process except sintering (i.e., pre-and post-production stations à la Desktop Metal), which many manufacturers will already have. These changes follow the great consolidation in the metal binder jetting market, resulting from Desktop Metal picking up ExOne (unicorn picking up the incumbent) and the acquisition of Digital Metal by Markforged, which also had a massive booth presence and is on somewhat of an acquisition spree (recently scooped Teton Simulation).

Stratasys is the other notable mention. If there is one company going all in on production polymer AM, it is Stratasys. In many ways, the company is in the midst of completely transforming from a 3D printing company to an AM solutions provider, an important distinction that alludes to manufacturing production versus prototyping. Already, Stratasys provides a diverse mix of options for polymers, has more than doubled down on software as a strategic differentiator, and is starting to open its ecosystem in terms of partners and materials. The company's GrabCAD software was cited by an executive at another firm as a standout for updates and innovation.
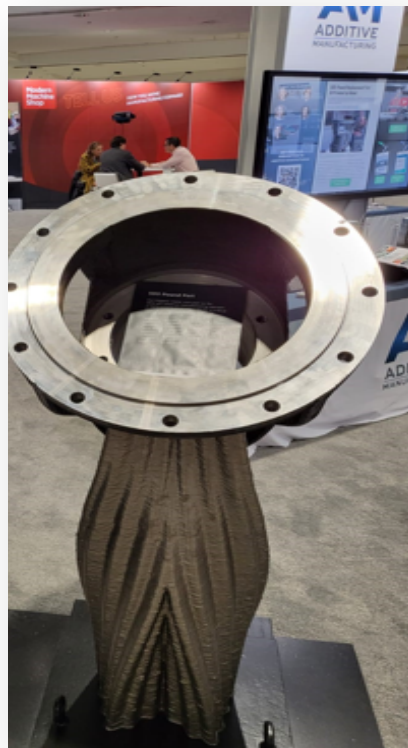
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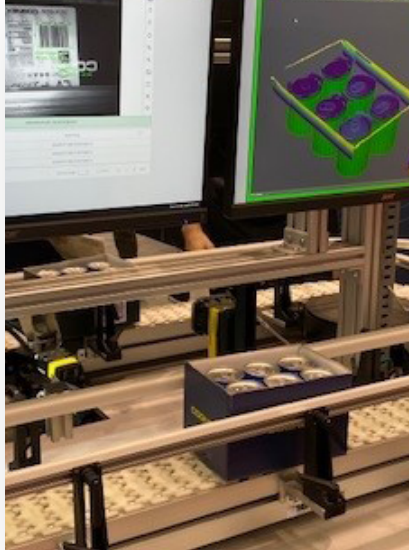
AI in action

2 ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) was certainly present at IMTS 2022, though more in the form of talks, seminars, and presentations than on the floor. To be sure, smart manufacturing is a very real trend and there were various applications on display, not least in smart sensors, cameras, and the like, with vendors such as Vooban and the Advanced Robotics for Manufacturing (ARM) Institute showcasing its solutions at their IMTS booths. But some the most interesting developments in AI at IMTS involved the speaker sessions and talks, where some of the topics under discussion included *Critical Initiatives in Artificial Intelligence and Machine Learning for Manufacturing*, *Design Process With Generative Design Powered by A*I, and *Enabling Predictive Maintenance with AI and Machine Learning (ML)*. In addition there was a Live Lab, sponsored by AMT and ASME, where various demonstrations on 5G, Augmented Reality (AR)/Virtual Reality (VR), AI, automation and robotics, ML, and modeling simulation were put forward.

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Boston Dynamics robot, Spot, used to automate data capture and inspection

3 AUGMENTED REALITY

AR-based solutions, while not deployed at mass scale yet, can play a part in meeting the challenge of labor shortages. Head gear with embedded AR solutions enable users to receive instructions and verify that tasks have been completed throughout their shift. Trumpf has incorporated the devices in their go-to-market strategy. The company gives away the head gear as part of its machine sales. This is because customers can use the devices for receiving remote advice as if an engineer is in the building; reducing the need for support engineers to visit customer sites.

Still, digital transformation is yet to reach all corners of the market with sensor and equipment vendors not necessarily enabling the data they collect to feed software and analytical applications. This kind of disconnect risks Industry 4.0 being a collection of capabilities, rather than enabling a seamless flow of data that support operations; both manufacturers and suppliers would benefit from improvements in this area in time for the next IMTS.

4 DIGITAL TWINS

Manufacturers not only want to control their operations, but they also want to optimize their lines for maximizing productivity with digital twins considered an important method for doing so. However, some suppliers are promoting digital twins that are little more than a static digital representation of machines, rather than a virtual representation that can simulate operational changes. After being much heralded at IMTS 2018, suppliers need to refrain from "twin washing" and distinguish between solutions that are digital replicas and those that virtualize their operations.

5 GENERATIVE DESIGN

Generative design was another much-vaunted technology in 2018, but in 2022, it remained a niche focus for the likes of Autodesk and nTopology. There were some interesting examples of AI-driven design on both suppliers' stands, but for the time being at least, enthusiasm for the technology will remain in the aerospace and transportation verticals.

ANALYST

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Research Director

6 INDUSTRIAL SOFTWARE

Industry 4.0-focused companies started to tout wholistic solutions versus discrete products, but these conversations were almost solely relegated to the Hannover Messe USA portion of IMTS. Here, and at Hannover Messe Germany, we saw end-to-end demonstrations of solutions from companies like Autodesk, Dassault Systèmes, Hexagon, and Siemens. Attendees also witnessed the smaller, yet still sizeable presence of AWS, which hosted partners including GE, SKF, Telit, and Tulip (which also had its own booth). While Siemens is historically the largest booth at Hannover Messe in Germany, it is far from the largest at IMTS. That said, there were several inconspicuous absences, such as Rockwell Automation (although Plex was there), and, interestingly, PTC did not have a dedicated booth, despite many of its peers, partners, and competitors at the show.

Microsoft (Azure) and Google (Google Cloud Platform (GCP)) were another double miss at IMTS. Their absence was at best surprising, if not inconsistent with their investment in the German edition of Hannover Messe. These companies—especially AWS—are a fertile ground for exposure for technology companies selling into manufacturing. Manufacturing solutions providers should look to partner with AWS, Azure, and GCP for industry events like Hannover Messe and IMTS. In the future, this could include connectivity at one end (i.e., 5G network providers such as Nokia and Ericsson) and actual machine builders at the other (i.e., ABB, John Deere, Mazak, Stratasys). The 2-year runway between IMTS editions leaves ample room for change between shows.

ANALYST

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*Automation—
a key element in
use with this
industrial robot*

AI is expected to deliver process optimization

7 LABOR SHORTAGE SOLUTIONS

While the focus for many exhibitors across the many halls in McCormick Place was signing contracts for machine tools or demonstrating the capabilities of their robots, in the hall hosting Hannover USA the talk was about digitally enhancing manufacturing facilities. The driver for doing so was consistent across nearly all the booths—labor shortages.

Labor shortages took several forms. Technology suppliers reported that their customers are unable to recruit enough staff to fulfill tasks and so are looking to automate processes to fill the void. But the technology suppliers themselves are also struggling to recruit enough digitally-savvy individuals, especially data scientists, to help them develop and deliver their solutions to customers. Some firms were optimistic their recruitment challenges will lessen as big tech firms freeze hiring and make redundancies considering the economic climate. While AI is perceived to be a key technology to deliver process optimization and digitally transform operations, the takeaway from the show is that it will take longer than many hope.

Pressure for digital transformation to deliver will intensify with many people stating that payback periods are shortening to just a handful of months, rather than 1 year to 18 months. Automation continues to be critical priority for firms and now cobots are a key enabling tool with the payback often being immediate as a deployment can alleviate pressures of labor shortages straightaway.

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8 MACHINE BUILDERS

Machine Builders were out in full force. IMTS as a show is traditionally machine builder focused, so it is fair and understandable to see just that: machine builders. However, as large and expansive as this year's show was, there were more halls that could have been filled; not necessarily with more of the same, but with peripheral equipment that factories may need for a cohesive product—components other than what can be machined, such as wire harnesses and upholstery. But overall, and importantly, IMTS evidenced the deep heritage of silos and fragmentation in industrial technology markets.

The largest problems identified were price volatility, productivity, and labor/talent-related. However, one of the most notable differences among the base in Chicago versus Hannover Messe in Germany was the posture toward sustainability. In Germany, the sustainability moniker couldn't be missed. In the United States, sustainability as a topic was scarcely found outside of the Hannover Messe USA pavilion.

Instead, the focus in the North and South Halls was on traditional industrial automation, comparatively more awareness around the benefits of digitalization and digitally-enabled solutions, but still very much traditional industrial automation. One of the reasons is cost— U.S. energy costs are one-third of those in Europe, which means less of an impetus to adopt renewables (for now). ABI Research believes this will change by the next edition of IMTS because U.S. machine builders and their customers will continue to struggle to attract talent without a more positive and proactive posture toward sustainability, and the regulatory environment may require it. Ultimately, the next generation of innovators and contributors want to work for companies that represent values that align with their own. This includes sustainability in no small way and was a sentiment shared among machine builders, robotics vendors, and manufacturing shoppers at the show with whom ABI Research spoke.

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Ingersoll Rand's large additive printer

9 ROBOTICS

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Robots were a common sight at IMTS 2022, though in a deceptively circumscribed fashion. They were everywhere, but mostly of one type. The big industrial players were certainly all at the event, most notably FANUC, KUKA, ABB, and Universal Robots, and with them a plethora of Collaborative Robots (cobots) of all shapes and kinds, the biggest and strongest FANUC's, the most compact and focused perhaps those of Universal Robots. It was the cobot that took center stage at IMTS 2022. In particular, Universal Robots unveiled its latest, the UR20 cobot, FANUC demoed some of its latest Selective Compliance Articulated Robot Arm (SCARA) robots, including the world's apparently strongest cobot, the CR-35iB robot, which has a 35 Kilogram (kg) payload, while ABB debuted some 30 new robots.

There were also plenty of robotic solutions and platforms, such as those put forward by vendors like Veo Robotics or Mech-Mind Robotics, which were typically showcased in machines manufactured by the aforementioned, as well as by vendors like Yaskawa, Kawasaki, and Mitsubishi, but it was still a cobot at the end of it all. This was also the case for augmented robots, namely those that came with 5G networking, machine vision, and AI processes of various kinds (e.g., smart sensors, edge AI computing, TinyML, and the like). OnRobot, in particular, released D:PLOY software, a deployment solution, which is claimed to be able to reduce the time to deploy a cobot by 80%.

In line with one of the main themes at IMTS 2022—automation—the cobot is possibly one of the best ways to help with the labor shortage, though whether this is the way to go about it remains to be seen, and deployment is not going to happen all that quickly. AMRs can also assist with this issue, but there was much less about mobile robots at IMTS, and this despite an impressive demonstration by Boston Dynamics and its well-known Spot robot. There were some solution providers for mobile robots at the event, often with some connection to AI in terms of navigation and object recognition, but OTTO Motors was one of the few proper AMR vendors around.

Heavy payload robotic arm from FANUC

10 SUPPLY CHAIN MANAGEMENT & LOGISTICS

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Despite there not being an abundance of solutions pertaining to warehousing or yard management, the lack of supply chain visibility seemed to be a major point that resonated with manufacturers at IMTS. With persistent labor market complications, port congestions, and end-to-end visibility being top concerns, AWS ran a session providing an overview of its supply chain and logistics strategy. It started with an overview of the digital supply chain strategy by discussing the underlying capabilities and providing guidance on how AWS services can be used to support the operation and forecasting of a digital supply chain. Nokia also ran a session discussing manufacturing and supply chain network issues and how private Long Term Evolution (LTE) and 5G could prove to be the answer with concise use cases that addressed very specific pain points. In addition, given how supply chain resiliency is one of the most important topics for manufacturers right now, Dassault Systèmes ran a session discussing how the right tools enable companies to adapt quickly and get ahead of the challenges.

Beyond this, there was a bit of focus on supply chain management at IMTS, with emphasis on visibility and organizational resiliency. With an abundance of manufacturing solution vendors across the exhibit floors, streamlining intralogistics within manufacturing as a way to mitigate supply chain disruption was the main theme with solutions pertaining to supply chain management. Some highlights are discussed below.

VISIBILITY AND AUTOMATION CONTROL DASHBOARDS

Digital solutions giant SAP showcased its Supply Chain Management (SAP SCM) software suite. The suite contained supply chain planning solutions that would enable a collaborative supply chain network through procurement and supply management. It also boasted predictive analytics, AI and ML capabilities that could allow for optimized inventory management. Similarly, the supply chain logistics aspect of the suite featured capabilities like warehouse and collaborative transportation management, yard management, track and trace, as well as sustainable load optimization. Similarly, IBM showcased its Supply Chain Control Tower platform that combined IBM's technology, AI-powered applications, and configuration capabilities for supply chain management. Usage of AI bots, the IoT, and semantic models for better supply chain planning and order management was the highlight here.

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WAREHOUSE AUTOMATION

When it came to warehouse automation, Automatic Storage/Retrieval Systems (AS/RS) stood out. Automation specialists like Mitsubishi Electric Automation, Agile Robotics, and AutoStore displayed their cube-based robotic picking AS/RS solutions. AutoStore's solution was particularly an interesting one, as it is the fastest order fulfillment system per square foot in the market, according to the company. With a global average availability of 99.6%, it is also one of the most efficient and reliable storage system in the world. Similarly, vendors like Kuka, Kawasaki Robotics, and Universal Robots displayed piece-picking robotic arms that could be used for complex order-picking and fulfillment applications. Veo Robotics was a unique vendor that focused on workplace safety. It featured Veo FreeMove, an advanced safety system for industrial and warehousing environments with human-robot collaboration. The system monitors the workplace in 3D and implements dynamic Speed and Separation Monitoring, enabling safe interaction between humans and robots. ClearPath Robotics' subsidiary OTTO Motors also featured impressive industrial-strength AMRs with throughput increase and workplace safety as its focus.

ON-DEMAND LABOR

Staffing complications and navigating through a tight labor market also was one of the issues that was often talked about. Beyond robotics complementing reduced labor to maintain steady operations, on-demand labor was one of the more unique solutions that particularly stuck out. Veryable was one of the companies that did this. Veryable is an on-demand marketplace for manufacturing, logistics, and warehousing labor. Its flexible labor solution connects businesses with high-quality workers at the click of a button, enabling higher productivity and a competitive edge.

XPlanar mover from Beckhoff Worldwide

11 WIRELESS CONNECTIVITY

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Wireless connectivity had an interestingly unpretentious stand at IMTS and Hannover Messe USA. Most exhibitors at IMTS kept praising fixed line connectivity as their most reliable solution and did not see the need to even think about mobilizing their production assets. Considering the fact that IMTS mainly targets a blue-collar audience dealing with particularly heavy production machinery (large robots or welding machines for example), putting these machines on a wireless communication infrastructure to be able to mobilize them is indeed a tough ask.

Therefore, interest in wireless connectivity was almost exclusively confined to the Hannover Messe USA part of the show, where a different patten became visible. Outside the booth of the "usual suspects" for both Wi-Fi and cellular connectivity at Hannover Messe USA (in the East Building of Chicago's McCormick Place convention center), exhibitors and attendees did not show interest in what connectivity technology they are deploying, as long as it provides satisfactory solutions that address key pain points. Convergence and coexistence of cellular and Wi-Fi connectivity should be the name of the game. The skyrocketing costs of production (due to current geopolitical events) threaten manufacturers' short- and medium-term profitability and survival in the market. Consequently, enterprise digitization projects face a radically shortened ROI expectation of well below 1 year (around 6 to 8 months depending on the industry). It should be in the best interest of both cellular connectivity and Wi-Fi vendors to combine forces and deliver on these challenging financial expectations.

Against this backdrop it was interesting—to say the least—to see old battle lines between Wi-Fi and specifically 5G reappearing. While telco infrastructure vendors and system integrators keep following the trend of cellular & Wi-Fi convergence, particularly Communication Service Providers (CSPs) continue to energize this artificial battle, as they focus their discussion not on what use-cases cellular connectivity can enable in addition to what is possible with Wi-Fi, but rather how cellular connectivity is nothing but a more efficient connectivity technology than Wi-Fi in its current form.

Private 5G network demonstration

CELLULAR CONNECTIVITY

The tough reality check for cellular connectivity in industrial and manufacturing continues. IMTS and Hannover Messe USA continued to manifest what became apparent when visiting the original Hannover Messe in Germany in April 2022: enterprise cellular continues to face a tough, but very important reality check when it comes to industrial applications. As the hype around fancy 5G-enabled extended reality and VR use cases seems to be over for the time being, cellular connectivity continues to be praised as a wireless infrastructure to transmit existing machine automation protocols. The 5G Alliance for Connected Industries (5G-ACIA) provided the booth space for partners within their existing testbed program: HMS Networks, ifak, NXP, and Radisys presented the use of 5G connectivity as a wireless interface for PROFINET and PROFIsafe communication. Similarly, Phoenix Contact showcased the transmission of PROFINET signals over 5G. Other than that, Zebra (which recently acquired robotics manufacturer Fetch) showcased its use of private cellular connectivity for Automated Guided Vehicles (AGVs) together with Ericsson. Compared to other connectivity technologies like Wi-Fi, cellular connectivity's compelling value mainly relies on providing robust handovers (which make mobility use cases easy to implement). Furthermore, cellular connectivity can cover particularly large areas more efficiently than current Wi-Fi solutions can. With Wi-Fi technology advancing as well, cellular connectivity will need to develop its value proposition further to remain relevant in the market.

Interestingly, leading industrial automation vendors have decided to leave their private cellular network product portfolio at home and leave the floor to the traditional telco industry. ABB and Siemens both decided to leave their industrial automation and communication portfolios at home, while others like Schneider Electric or Bosch were not even exhibiting.

Overall, soaring costs of production and—especially in the US—the persisting shortage of manual labor remain the most pressing issues for manufacturers and other industrial companies. While in theory, these are prime use cases for enterprise digitization enabled by private cellular connectivity, enterprises seemingly do not make this connection.

This is partly due to the ongoing bottleneck of availability of industrial-grade devices, particularly for 5G. Most of the important features for industrial enterprises (i.e., ultra-reliable low latency communication, full support for time sensitive networking, and massive machine type communication), require 5G capabilities that have been standardized in 3GPP's Release 16. Despite this release being frozen (which is telco language for completed), in the summer of 2020, industrial-grade devices compatible with this Release are expected to emerge only by the end of 2023 and reach scale in 2024. This means that enterprises will have to wait at least until 2024 to be able to utilize industrial-grade features like 99.999% availability and reliability of the network, end-to-end latencies of around 1 millisecond, and the connection of up to 1 million devices per square kilometer. As a result, enterprises' dissatisfaction with cellular connectivity turns into obliviousness toward connectivity technologies in general.

Meanwhile, telco infrastructure players have realized that their industry, so far, has overpromised and underdelivered, especially when it comes to 5G and they are working hard to catch up. While Nokia continues to follow a three-pronged go-to market strategy—directly to enterprises, through system integrators or CSPs—Ericsson begins to diversify and looks at channel partners outside the traditional telco landscape (like Zebra).

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INDUSTRIAL WI-FI

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Industrial Wi-Fi's relevance is reaffirmed, but the disconnect between Information Technology (IT) and Operational Technology (OT) persists. Even prior to stepping onto the show floor itself, a skim through the exhibitor list revealed an absence of all the IT heavyweights with strong portfolios of OT equipment, such as Cisco and Aruba—a stark reminder that the disconnect between the IT and OT domains has not been bridged since the last iteration of IMTS back in 2018. IT/OT separation continues to hinder the scalability of industrial Wi-Fi for OT, one of the technology's main drawbacks vis-à-vis cellular. This competition between Wi-Fi and cellular was a constant theme across all the connectivity vendors present, but the traditional fault lines (mobility, range, latency, interference, cost, etc.) were joined by new areas of differentiation, notably energy expenditures. The promise of energy savings made through transitions away from Access Point (AP)-heavy 802.11 toward AP-light cellular were touted by the likes of Ericsson, Verizon, and AT&T, with Verizon suggesting that a 500,000 ft warehouse requiring 49 Wi-Fi APs could be connected with just 10 private 5G APs. This comparison was with Wi-Fi 6 APs though, and was not accounting for Wi-Fi 7, which can support higher power (termed standard power), and thus greater range and higher performance. Standard power Wi-Fi 7 is possible through Automated Frequency Control (AFC), which in a system similar to that implemented for the Citizens Broadband Radio Service, ensures 6 GHz operation outdoors will not interfere with incumbents. There was a general agreement from factory automation manufacturers that standard power Wi-Fi 7 APs could be disruptive in certain verticals, such as warehouse environments straddling indoors and outdoors, especially as it will reduce the number of Wi-Fi APs required to service a given area, driving down hardware costs, and by extension, energy usage. Most of the vendors were coming from a North American perspective through, and while the Federal Communications Commission (FCC) has enabled standard power Wi-Fi outdoors with AFC, many other regions have not followed suit.

Yet despite the optimism expressed by exhibitor staff toward the potential of Wi-Fi 7's features, the protocol itself was nowhere to be seen at the show—a further reminder that the industrial sector lags several years behind traditional carpeted enterprise and residential when adopting the latest Wi-Fi standards. Indeed, several of the AGVs crisscrossing the trade show floor were still running on Wi-Fi 5, a standard that was released in 2013, and superseded by Wi-Fi 6 in 2018. More than anything, this signified that factories themselves are typically both slow, apprehensive, and cost sensitive when adopting new technologies. This same principle also applies to cellular, and factory automation manufacturers at IMTS were still confident that industrial Wi-Fi, the tried and tested technology that they have relied upon in the past, is still suited for most of the tasks they are faced with, outside of limited applications such as real-time 8K AR or VR. Given the confidence in industrial Wi-Fi expressed by the automation manufacturers, it is perhaps surprising that many vendors neglected their industrial Wi-Fi portfolios (Siemens, HMS Networks), and others were missing altogether (Moxa, Hirschmann). This may be a holdover from COVID-19, with the pandemic situation still unclear as potential exhibitors were gearing up for the show. Thus, we can expect the exhibitor list for IMTS 2024 to contain an expanded list of industrial Wi-Fi vendors, alongside more IT heavyweights staking a greater claim to the OT market.

MEET OUR ANALYSTS

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Ryan covers new and emerging transformative technologies, including Industry 4.0, digital transformation, and the Internet of Things (IoT). He currently leads the firm's manufacturing, industrial, and enterprise IoT research efforts.

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