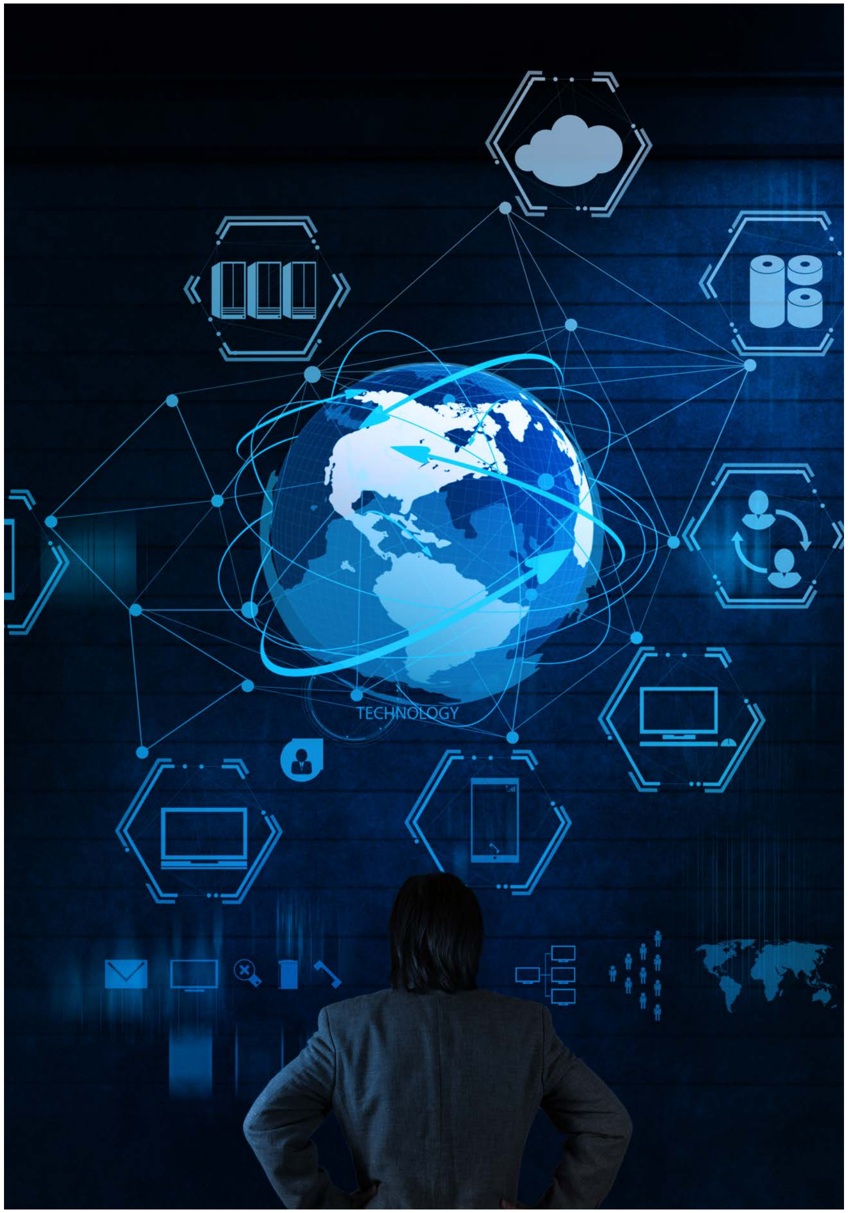
SMART MANUFACTURING
Beginning the Journey

POLYTRON



Introduction

The discussions surrounding the Industrial Internet of Things (IIoT) and Smart Manufacturing have become almost deafening over the last year. The mass of new technologies reaching the manufacturing floor such as wireless, cloud, connected enterprise, smart controllers, and other smart technology can seem confusing. Some manufacturers would prefer to tune-out the oversupply of new terminology, such as: advanced manufacturing enterprise; intelligent manufacturing systems; connected enterprise; smart manufacturing; industrial internet; digital manufacturing; etc., but the terms are less important than what they mean to describe. Let's cut through the jargon for a moment.

> *Manufacturers' success over the coming years will be comprised of connected, data-driven processes that combine innovative automation, interactive connectivity, sensing and control, with a transformed workforce.*

The message for manufacturers is that the Smart Manufacturing changes are on the horizon and are expected to accelerate quickly. Manufacturers need to start learning and planning now, so that as the speed of business increases, production keeps pace.

What Does "Smart Manufacturing Ready" Look Like on the Plant Floor?

The Smart Manufacturing-ready plant is fully-integrated, collaborative manufacturing systems that respond in real-time to meet changing demand and conditions. Production data is available on smartphones and tablets to view and control operations from anywhere, so you can have a bird's eye view of your entire operation, from procurement through finished inventory. Melding your manufacturing infrastructure with real-time data generated by your equipment will give your operations team the ability to make informed decisions at any given instant.

To achieve the benefits of Smart Manufacturing, manufacturers will need a clear set of architectural guidelines and products that tie together factory automation systems, enterprise applications, and the wider ecosystem of supplier and partner solutions. Key components include:

- Upgraded industrial network to allow for operational upgrades
- Open and scalable architectures for robust Industrial Ethernet and enterprise networks
- Standards-based Industrial IP Ethernet switching and security services
- New higher speed drives, controllers, sensors, etc. delivered on an industrial platform with scalable, secure, real-time performance
- Access to video, cameras, smarter controllers, data, and real-time feeds from HMIs, wireless handheld devices, and scoreboards
- Digital control systems with embedded, automated process controls, operator tools, and information systems, that are optimizing your plant operations and adding safety
- Asset management with predictive maintenance tools, statistical evaluation, and measurement to maximize plant reliability
- Smart sensors to detect anomalies and help avoid abnormal or devastating events
- Smart systems integrated within the industrial energy management system and externally to a smart grid for real-time energy optimization

Some of these upgrades are direct and more easily accomplished, others more complex and risky to operational performance. A thoughtful look at each of these items will help to develop a strategic plan. In most cases, interdependencies must be addressed before diving into an upgrade.

Obstacles You May Face

The current age of the majority of manufacturing facilities poses one of the greatest challenges to preparation for increased production speed and higher levels of automation and communication. In the U.S. alone, almost 75% of manufacturing facilities are over 20 years old. More than $65 billion worth of legacy automation assets are reaching the end of their lifecycle. This includes:

- Programmable Logic Controllers
- Variable Frequency Drives
- Distributed Control Systems
- Human Machine Interfaces
- Network hardware and software

The state of some manufacturing facilities is nearing the breaking point. With such a large investment at stake, there needs to be careful attention given to migration strategies that ensure the upcoming investment will meet manufacturer's present and future needs.

Manufacturing infrastructure technology has matured into a crucial business asset. New plants are being planned with specific IT requirements and objectives directed at the factory floor network design parameters. But what about older plants that have had to evolve technology over time? Chances are, these facilities have upgraded their IT in a "patchwork" fashion and the probability of significant downtime looms large, but revamping your plant's IT infrastructure is easier and more affordable than ever.

Is your industrial network hardware capable of handling future manufacturing needs with scalability and stability in mind?

Benefits and Risks of the Industrial Internet

According to the Global Risks for 2015 World Economic Forum Report, benefits and key business opportunities will be found in four major areas:

1. **Vastly improved operational efficiency** (e.g., improved uptime, asset utilization) through predictive maintenance and remote management
2. The emergence of an **outcome economy**, fueled by software-driven services; innovations in hardware; and the increased visibility into products, processes, customers and partners
3. New **connected plant**, coalescing around **software platforms** that blur traditional industry boundaries
4. **Collaboration between humans and machines**, which will result in unprecedented levels of productivity and more engaging work experiences [blended workforce — where it is no longer human vs machine, but human with machine to deliver outcomes that neither could produce alone]. This alone will require a focus on training.

And, with these benefits come an increased set of risks, such as:

- Investments needed for infrastructure
- Security frameworks to minimize vulnerability
- Higher skilled workforce
- Incompatibilities and obsolescence of aging assets
- Safety upgrades

Preparing The Plant Floor

Plant managers with existing lines and legacy systems often perceive major barriers to upgrading, such as cost, but the biggest investment manufacturers need to make isn't in hardware. Before technology is implemented, disparate teams of people need to work together. That means controls engineers need to be IT savvy and IT engineers also need to understand the needs of controls engineers to create the right networks and procedures. They need to share a common goal in creating a dynamic control system that maximizes efficiency and flexibility without sacrificing security, but how do aging facilities bridge the gap?

Company culture and processes need to adapt to the new climate. The former silos of automation need to be dissolved into a more harmonized production organization so that, troubleshooting, unscheduled downtime and production disruptions decrease.

Traditionally, IT personnel and controls engineers perform their jobs without much interaction, but as Ethernet technology improves and bandwidth increases, devices and sensors transmit much more information. Smarter decisions can be made in a much shorter timeframe, but this information is only actionable when it is in a cohesive system.

System-wide plans need to be created and implemented in parallel to ensure total plant compliance:

- Security platform and standards
- Infrastructure - network backbone standards
- Best Practices for automation
- Manufacturing Intelligence standards for high performance KPIs and decision-making

In the report by the Smart Manufacturing Leadership Coalition (SMLC), Implementing 21st Century Smart Manufacturing, states that while much progress and innovation in digital and communication platforms has been made, there are still many components of the Industrial Internet that will need to be addressed by manufacturers, software developers and OEMs, as the industry advances over the next 10 years. (Bold items are manufacturing components)

Ten actions have been identified as priorities by the SMLC:

1. Create community platforms (networks, software) for virtual plant enterprise
2. Develop next generation toolbox of software and computing architectures for manufacturing decision-making
3. **Integrate human factors and decisions into plant optimization software and user interfaces**
4. **Expand availability of energy decision tools (energy dashboards, automated data feedback systems, etc.) for multiple industries and diverse skill levels**
5. **Establish consistent, efficient data methods for all industries (data protocols and interfaces, communication standards)**
6. **Develop robust data collection frameworks (sensors/data fusion, machine and user interfaces, data recording and retrieval tools)**
7. **Optimize supply chain performance through common reporting (dashboards)**
8. Develop open platform software and hardware to integrate and transfer data between small and medium enterprises (SMEs) and original equipment manufacturers (OEMs)
9. Integrate product and manufacturing process models (software, networks, virtual and real-time simulations, data transfer systems)
10. **Enhance education and training to build workforce for Smart Manufacturing (training modules, curricula, design standards, learner interfaces)**

How many of these items have been initiated in your facility?

Workforce Readiness for the Industrial Internet of Things

The manufacturing workforce in the next few years is going to begin to see their environment shift into high tech mode. This will require the manufacturer to provide more precise and advanced access to technical and reference materials, at the point of use. The operators and technicians will need to have everything "at their fingertips" to operate both existing and new technology. Without this at-the-ready availability of technical and maintenance knowledge, along with new operating standards, operational efficiency may be hard to achieve.

With the exodus of the aging workforce in the next few years and new younger workers entering, it is going to be imperative that intuitive interactive guidance is provided for workforce success. The Smart Manufacturing workforce requires: technology and computer skills, problem solving skills, basic technical training and math skills.

Assessing the current state of workforce knowledge will help determine how to structure a program and tools that will support the plant employees for performance levels. Some of the first steps to consider are:

- Skills Set and Performance Matrix to establish task baseline
- Skill Assessment of current workforce to determine gaps
- Skills Gap Training Plan
- Training Documentation Development
- Training facilitation
- Training validation

Technology Transfer and Training delivery tools to ensure that your workforce is knowledgeable in the processes and procedures of upgraded or new operations include:

- Job Aids or placards at the point of use
- HMI embedded process documentation
- Near-field technology to deliver information when device is approached
- Wireless and handheld devices with knowledge-based data references
- Computer-based training aids with validation

A training plan that addresses easy-to-use tools to deliver the right information at the right place at the right time will ensure plant employees can effectively make decisions based on data and know at a glance how to efficiently deliver high operational performance.

A Real-World Scenario: Upgrading the Industrial Network

A global beverage manufacturer was having network performance and communication disruptions between factory floor assets. These disruptions were causing unplanned production losses due to network convergence timing issues.

The existing network was over 15 years old with an aging infrastructure of wiring and Ethernet. Although, new data requirements for plant reporting were initiated, the system had not been upgraded to keep up with the manufacturer's changing needs.

New components were continually being "bolted onto" the old infrastructure and it was close to collapsing. To further complicate matters, there was no in house expertise to upgrade the network.

Roadmap to Network Convergence

Polytron was engaged to evaluate and design a network architecture that focused on improving overall bandwidth utilization and efficiency across all manufacturing areas. The new network requirements were to; configure and install a reliable, expandable and robust infrastructure; and maximize the benefits of plant-to-business network convergence. It was going to take a new high performance copper and fiber system to meet and exceed the client's requirements for enterprise and industrial networking standards.

Following our proven Roadmap to Network Solutions, a network audit was conducted using diagnostics; a design plan was created; and a schedule was created for implementation. The Polytron team reviewed the design plan with the manufacturer's stakeholders for alignment.

Alignment with all stakeholder groups was crucial because the project touched every area of the plant. Support was needed from IT, all department managers, plant engineering, and control support technicians. The project would need to be invisible to plant operations with minimal disruptions. To accomplish this, the installation and network migration schedules had to be constantly adjusted to the plant's schedule. We determined that the network upgrade would include a change from the original Mesh Topology to a Star Topology. The new topology plan was to use Cisco switches along with Panduit fiber and copper solutions to provide a more reliable and flexible solution. Using these solution providers increased the manufacturer's technical resource support through the partner networks of Rockwell Automation, Cisco, and Panduit.

The Implementation

STEP 1 - The implementation began with the lowest risk area. The first step was to install and configure the new fiber infrastructure of the network, connecting the new infrastructure to the existing infrastructure. The installation was focused on replacing the existing Ethernet copper cabling and existing fiber optics cabling with a new cabling system that would support the updated topology and designed bandwidth. Validation was completed to ensure that the existing network could effectively communicate with assets on the new network before proceeding.

STEP 2 - The next step was to move all of the plant's industrial servers to the new infrastructure. The project team then tested and validated all communications with existing plant operations. This installation required the most resources from the facility's IT support group. Once validated and stable, it was time to migrate the other automation components and operational areas to the new network.

STEP 3 - The next several migration areas followed the operational flow of the plant. Strategically migrating each area formed a bell curve from low risk area to high risk and ended in a low risk area. Each area was validated in real-time against an agreed upon checklist and required 100% accuracy before moving to the next area.

STEP 4 - After completing the migration of each of the operational areas, the team conducted a Network Health Assessment. This step involved connecting to the core switch and running a number of tests, checking for any issue areas and/or communication disruptions. The updated network provided the desired performance results and delivered a system that is secure, sustainable, and scalable – eliminating network-related production downtime issues. The updated network also increased the plant's networking support structure and ease of maintenance, and introduced new technologies that can be used in future plant projects.

The FTC made 6 security recommendations for the Industrial Internet

1. Building security into devices at the beginning of the design process, not as an "afterthought" of that process;
2. Provide security training to employees, and ensure that security is managed at the appropriate level in an organization;
3. Make sure any outside service providers can provide "reasonable security" and that oversight mechanisms on them are in place;
4. Consider a "defense in-depth" strategy to provide multiple layers of security when a risk is identified;
5. Consider implementing procedures to keep unauthorized users from accessing a consumer's device, data, or personal information stored on a network ;
6. Monitor the full lifecycle of connected devices, and, "where feasible", provide security patches to mitigate known risks.

Conclusion

The change is coming and company competitiveness will depend on how well the plant is prepared for flexibility, speed, and effective decisions based on manufacturing and supply chain data.

Regardless of whether you call it Smart Manufacturing, Connected Enterprise, Industrial Internet of Things (IIoT), or Industry 4.0, preparing for change at the plant floor level calls for a holistic view of the plant with a 3D top down view of the whole plant. The plant environment is not unlike an ecosystem where everything is connected and interdependent – that environment exists now.

A plan for future readiness goes far beyond parts and pieces, and anything less creates silos of technology which fragment this holistic approach. For example, when controllers and drives reach end of life and are replaced, that action will most likely initiate changes such as:

- Plant network upgrades for increased wireless, improved Ethernet, and a bigger data highway
- Changes for the operation of equipment downstream
- Standardized code across all systems for faster system-wide updates and changes
- Greater access to data via historian collection and reporting
- Higher visibility into plant operations with scoreboards, intuitive HMIs, and handheld devices

Next generation plant operations require a plan that includes close collaboration between groups through formal and informal cross-training programs and creating cross-functional teams for a flexible organizational structure. The important part is defining the working relationship and making sure groups are collaborating.

Are you ready?

- Does end-of-life hardware and software run your plant floor decisions?
- Are you experiencing unscheduled downtime and productivity losses?
- Is your current network able to handle today's new smart technology?
- Do you have a plan for effectively using a higher volume of production data?
- How do you plan to increase production under the state of your current operation?
- What is the "view" of your plant for future readiness?

Successful readiness for the future calls for a thorough plan. A network assessment can detail small steps which can lead to major improvements in efficiency and help to create a realistic plan to get your plant ready for the future.

SMART MANUFACTURING

DEFINITIONS

Industrial Internet of Things (IIoT) - network of physical objects or things embedded with electronics, software, sensors and network connectivity to enable these objects to collect and exchange data - from supply to consumer**.**

Converged Plantwide Ethernet (CPwE) - **underlying architecture that provides the standard network services for control and information disciplines,** devices and equipment found in Industrial Automation and Control System (IACS) applications.

SMART MANUFACTURING (Industry 4.0 / Manufacturing 4.0) - the use of real-time data and technology when, where and in the forms that are needed by people and machines. It is **fully-integrated, collaborative manufacturing systems that respond in real time to meet changing demands and conditions in the plant**.

Digital Transformation - the profound and accelerating transformation of business activities, processes, competencies and models to f**ully leverage the changes and opportunities of digital technologies and their impact** across society in a strategic and prioritized way with present and future shifts in mind.

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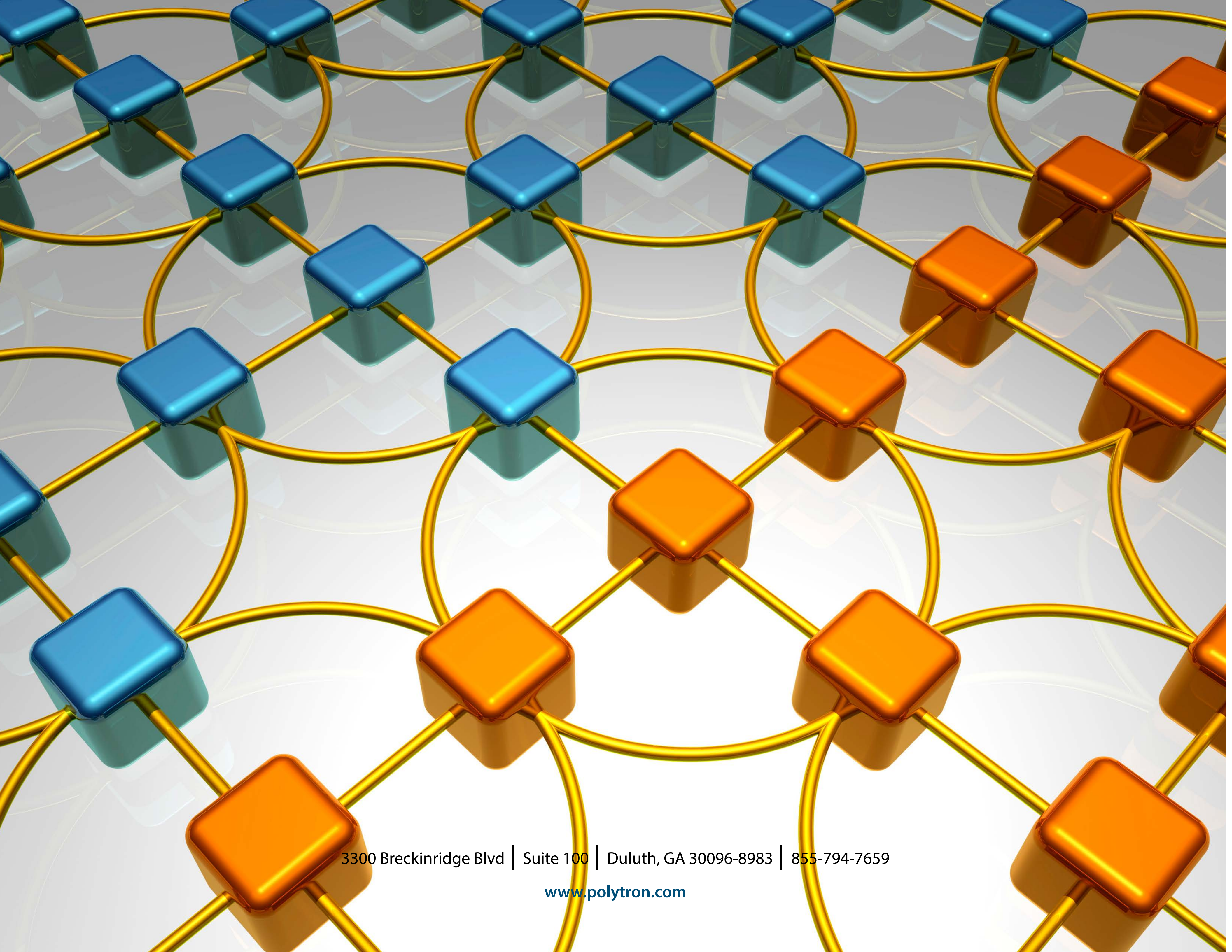

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