Connected Products for the Industrial World

By leveraging product-centric connected ecosystems, manufacturers can create new and more effective business models, advance operational excellence, and design and develop better products and services that align with customer needs and preferences.
Executive Summary

The Internet of Things (IoT) is getting a lot of attention from the industrial sector, particularly with advances in information and communications technology (ICT), the cross-pollination of talent in business, IT and consulting across industry sectors, and the growth of the knowledge economy. Devices instrumented to collect and transmit intelligence on user behavior and environmental conditions over IP networks have created vast opportunities to build connected ecosystems surrounding industrial products.

Based on a recent study by Cognizant’s Center for the Future of Work, the business-to-business industrial equipment space is among the most active areas for smart product development, with 58% of respondents saying their companies are already developing products. Smart packaging and consumer home devices are next, at 57% and 40%, respectively. Multiple industries are adopting different forms of connected solutions, with varying degrees of success. Although the opportunities and risks of these solutions are unique to each industry’s priorities and the business context, common underlying elements run across all of these connected initiatives.

This white paper explores the opportunities and challenges for organizations that want to adopt product-centric ecosystems, or what we call connected ecosystems. These ecosystems create business value by leveraging data value chains built around the concept of Code Halo™ thinking. In this context, meaning is derived and applied from the intersection of data generated by smart products, devices, processes, organizations, employees and consumers. Although this whitepaper is aimed at industrial applications in core sectors such as manufacturing and utilities, it also illustrates examples covering the industrial and consumer segments.
Connected Ecosystems and Products

Technology is driving change, as seen in the areas of sensorization, power management, connectivity, computing and interactive technologies (including visualization). Most connected ecosystems consist of four major elements (see Figure 1):

- **Hardware**: Hardware includes any device or system with some behavioral functionality and the ability to generate and transmit data. If the device is incapable of communicating, capabilities must be added to permit it to share data within a connected ecosystem. A low-power industrial motor with no local computing or communication capability is an example of a passive device that can become active (or smart) with the addition of a vibration-monitoring sensor with the ability to transmit data. At a broad level, the degree of device “smartness” is dependent on its sensory, data gathering, storage, local computing, decision-making and interaction capabilities. The best example of active hardware is the smartphone, with its built-in computing and communication capabilities, which can quickly be onboarded to an IP network.

Depending on the context, a device or product could be a sensor, a piece of heavy equipment or machinery, or a car (see Figure 2, next page).

### Anatomy of a Connected Ecosystem

<table>
<thead>
<tr>
<th>ADVANCEMENTS</th>
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<tbody>
<tr>
<td><strong>Hardware</strong></td>
</tr>
<tr>
<td>- Advancement in material sciences</td>
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<tr>
<td>- Miniaturization</td>
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<tr>
<td>- Reduced cost of embedded products</td>
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<tr>
<td>- Reduced form factor</td>
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<tr>
<td>- Better power management</td>
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<tr>
<td><strong>Network</strong></td>
</tr>
<tr>
<td>- Pervasive connectivity</td>
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<tr>
<td>- Lightweight protocols</td>
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<tr>
<td>- Interoperability</td>
</tr>
<tr>
<td>- Security mechanisms</td>
</tr>
<tr>
<td><strong>Data Management</strong></td>
</tr>
<tr>
<td>- Ability to manage 360-degree view of data</td>
</tr>
<tr>
<td>- In-memory databases</td>
</tr>
<tr>
<td>- Improved storage capacity</td>
</tr>
<tr>
<td>- Ever-reducing chip sizes</td>
</tr>
<tr>
<td><strong>Intelligence &amp; Interaction</strong></td>
</tr>
<tr>
<td>- Evolving analytics tools ecosystem</td>
</tr>
<tr>
<td>- Improvements in computing</td>
</tr>
<tr>
<td>- Multi-echelon intelligence</td>
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<tr>
<td>- Advanced interactive technologies</td>
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</table>

Figure 1
Network: Networks are pervasive, thanks to ever increasing advances in hardware footprint, open standards, interoperability and available bandwidth. Many wireless networks, such as 802.11, Bluetooth and Zigbee, are available in the consumer space, whereas commercial enterprises rely primarily on wired networks, such as Modbus, FFB, and HART. Over the last decade, industrial organizations have begun moving away from wired networks to reduce the miles of wires running across their plants, as well as ease of installation and maintenance. The industrial world was the first to embrace the machine-to-machine (M2M) phenomenon decades ago, and today’s IoT is a consumerized version of that. The scalability of a connected ecosystem within an enterprise and across an ecosystem is dependent on the network and data management strategy.

Data management: Industrial companies have a long history of managing machine data related to their people (usage), processes and products. The proliferation of IT systems is generating a huge repository of data, with multiple software applications creating data silos on the back end. Many companies are now trying to create connections between these silos to reflect the single version of a “true” state. There is also a movement away from traditional relational databases to big data-oriented and in-memory databases to store, analyze and make meaning of various data types (structured, unstructured and semi-structured). Consumers also struggle to manage their personal data in their social interactions.
everyday lives (digital images, music, application software, etc.). With the advent of the smart product economy, businesses must develop the ability to manage the scale and security of data. Both in the consumer and industrial contexts, the data management strategy will dictate the success of a connected ecosystem.

- **Intelligence and user interaction**: Visualization is the first stage of contextualized intelligence, while artificial intelligence-based decision systems are the last. Multiple software applications are available to address the needs of both visualization and business intelligence. Analytical and statistical tools such as R, Matlab, SPSS and SAS are commonly used for simulation, modeling and optimization, and for creating algorithms to address different types of intelligence requirements, but no single tool is a fit across different business contexts. The challenge lies in selecting the right tools or creating an overarching tools ecosystem with common data access and integration layers. Such solutions are evolving, as organizations establish dedicated data labs to generate insights into their business, ranging from product design and manufacturing to after-sales services.

### Device Code Halos and the Four Dimensions of Business Value

Across industries, the lifecycles of products, manufacturing assets and fulfillment are tightly coupled, generating various forms of data when active (smart) devices across these lifecycles interact within a connected ecosystem. Such data typically contains a multitude of information regarding product design, process, usage, operating environment, maintenance history and customer preferences, along with resource consumption. We call this swirling field of data (real-time or historical) a device Code Halo.

With devices at the center of the connected ecosystems, the resulting Code Halos act as the seeds of the data value chain (DVC). A connected ecosystem based on smartly designed DVCs can help businesses derive value along four dimensions (see Figure 3):

#### Operational Improvement

Operational improvement – one of the most common value dimensions – includes opportunities that address the traditional goals of cheaper, better and faster, with the objective of creating highly efficient operations and processes. Large distributed-asset-based industries, such as rail and utilities, are moving toward integrated proactive asset management frameworks, making use of the enhanced capabilities of networking and centralized data processing. A better understanding of asset condition and deterioration, using both historical and operational data, will bolster more proactive and predictive asset maintenance and renewal, compared with today’s reactive/fixed approach.
Quick Take

Applying Code Halo Thinking to Oil Exploration

We recently helped an oil and gas major improve its drilling system. The improved system has enhanced drilling efficiency, and reduced tool downtime by monitoring vibrations of the tool string, and predicting failure of the drilling motor.

The system consumes surface data to analyze downhole performance and develop a dynamic model to identify and segregate harsh drilling spots. The system leverages data generated by the interaction of the drilling system, drilling operator and drilling column. The model takes into account drilling torque, rotation per minute (RPM), differential pressure, hydrostatic pressure, weight on bit (WoB), length of the drilling strings and resonance frequency, among other factors to support smarter operator decisions.

As a result, the client expects to reduce drilling time by 5%, totalling $1 million per year in savings per rig.

In cold chain logistics, several factors — such as ambient conditions, product metabolism and driving behavior (door opening/closing patterns, harsh driving), controller tuning, loading conditions and vehicle health index — have a significant impact on operational expenditures (e.g., fuel and maintenance), quality (e.g., temperature variance) and service (e.g., SLA, quality on arrival). Such vehicles with “digital” reefers (refrigeration unit) act as nodes on a network and help achieve fleet and workforce effectiveness.

Other areas, such as facility management and infrastructure businesses (e.g., airports), are examining holistic ways to reduce operational costs beyond complying with green regulations (noise, energy and carbon footprint) by optimizing around processes and systems halos. To create an enhanced ecosystem, such solutions must also extend data from external climatic conditions, internal ambient conditions, available headroom, passenger preferences (through personal Code Halos) and asset health and usage patterns.

Industrial OEMs are installing sensing gear to monitor the installed base of equipment and maximize return on assets (RoA) by developing remote service monitoring frameworks that overlay a set of monitoring, analytical and intervention services. Such solutions enhance the serviceability and reliability of industrial equipment, while reducing the total cost of ownership (TCO) of the assets.
Product Innovation

Capturing the voice of customers and businesses across the product lifecycle can substantially help improve product design and performance. Companies can enhance existing product designs by including or removing specific features, tweaking designs if they can understand usage patterns, perform parts rationalization and predict performance, etc.

Product Code Halos can help detect failure patterns at an early stage. Data-driven models can predict the likelihood of component or product failure by capturing performance degradation over time. Further, equipment manufacturers can track performance of their installed products to develop meaningful insights about product performance and failure events, leading to improved product design.

Pharmaceuticals companies are exploring frameworks that define the optimal manufacturing process for new products (golden recipes, SOPs) by integrating data from different phases, such as R&D, engineering, manufacturing and maintenance to boost new product success. The objective is to analyze data to predict yield, quality, deviation and process reliability to achieve seamless commercialization of a drug or active product ingredient.

Customer Experience

Customer preference and personalization is becoming pivotal to market differentiation and business success. From customized cars to customized healthcare, businesses are leveraging technology to offer personalized products and services to new-age demanding customers.
Auto OEMs are exploring ways to differentiate brands by creating mashups of data from vehicle and infotainment, enterprise and social content to create uniquely personalized customer experiences. Retailers and other businesses in the fashion industry are among the earliest adopters of this approach, with certain customers showing interest in creating their own apparel, as well as designing their own shoes and accessories. Some retailers offer enhanced experiences that include personalized advertising based on customer profiles and the products they are looking at.

This type of customer engagement can be created by using a variety of digital layouts, such as display boards, kiosks and smartphones. Brand owners can monitor retail chain traffic using cameras and motion sensors to collect demographic information and dwelling time in various parts of the store to optimize product placement and stocking patterns.

New Business Models

This dimension refers to “servitization” opportunities and new business models based on connected products, in which businesses create knowledge-based service offerings around their existing product portfolio.

Fast-moving consumer goods (FMCG) companies are exploring the ability to exchange data with smart vending machines fitted with embedded sensors that can communicate using 2G/3G/LTE networks (in turn creating new revenue streams for telcos) to supplement their existing revenues from the vending network. These companies also expect to earn additional revenues through digital signage and third-party coupons/vouchers. Smart machines can exchange vending Code Halos in real-time, including the number and type of drinks consumed, machine health, ambient conditions and heat leakage. Stakeholders can develop meaningful insights from the machine operations, demand patterns and impact of promotional campaigns. A proactive maintenance and spare parts strategy could be effectively woven around an integrated network of devices.

Additionally, taxi cab businesses are leveraging dynamic pricing models to maximize profits and improve operational efficiency (e.g., vehicle utilization). This has been enabled by creating an ecosystem of devices and optimizing supply-demand dynamics.

Smart metering in the utilities industry is another example where billing can be optimized by evaluating usage patterns. Insurers are also experimenting with usage-based insurance (UBI), configuring insurance premiums based on users’ driving patterns (personal Code Halo) and data collected from the automobile’s telematics device. Popular UBI products, such as “manage how you drive” (MHYD) and “pay as you drive” (PAYD), allow insurance companies to offer discounts to customers based on their driving behaviors. Companies offer discounts of up to 30% based on driving behaviors, and customers can save 10% to 15% on their premiums. MeterMile, a U.S.-based car insurance company, charges customers for the actual miles driven, offering scalable pricing for both high- and low-frequency drivers.
Challenges with Connected Ecosystems

All four of these dimensions present their fair share of challenges. Figure 4 maps the most common challenges faced while exploring the opportunities available to a given business value dimension, along with their severity.

Connected Ecosystems: Opportunities, Challenges

<table>
<thead>
<tr>
<th>DIMENSIONS</th>
<th>CHALLENGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Business Model</td>
<td>Creation of new knowledge-based service lines and new business models.</td>
</tr>
<tr>
<td>Operational Improvement</td>
<td>Business process improvement to reduce the cost of creating and serving offerings.</td>
</tr>
<tr>
<td>Customer Experience</td>
<td>Customized products and services to command premium pricing and brand loyalty.</td>
</tr>
<tr>
<td>Product Innovation</td>
<td>Capturing VOCs across the product value chain to improve/introduce features.</td>
</tr>
</tbody>
</table>

Figure 4

Entitlement Management: Who Owns What?

A connected ecosystem creates a data value chain between a device and the intelligent system. An entity (i.e., a company or individual) can own either a part or the entirety of the DVC, depending on ecosystem factors such as the stakeholders, business value and technology involved. A wearable device connected to an athlete to monitor key parameters such as sweat and heartbeat is an example of a DVC owned by an individual, who can determine what data to transmit, the transmission network (depending on the device), where to store the data and what kind of decisions to be made.

Not all consumer-oriented ecosystems provide full control of the DVC to the end customer. For example, in the communications space, multiple stakeholders, such as smartphone manufacturers and app developers, own most of the DVC. These stakeholders also own the data management (gathered from thousands of devices sold), and sometimes even have control over what data needs to be gathered from the phone (ideally with the consumer’s consent), and generate intelligence based on the gathered data. In contrast, a telecom carrier owns the network infrastructure, along with data around network statistics, usage, diagnostics, etc.

A similar example is that of a “connected” vehicle, where an OEM manufactures the device (a car), and telecom carriers and app developers capture most of the
user’s data, as well as manage it. Although auto OEMs see value in the captured data, they don’t necessarily own the data. However, applications based on data mashups from diverse sources can help auto OEMs create brand differentiation by applying advanced analytics.

Market segmentation mapped to demographic needs can become the basis for deciding on a new feature introduction program. However, data ownership coupled with customer reluctance to pay an additional premium for these digital features has stifled the potential of what can be achieved in terms of consumer profiling and catering to the specifics. (To learn more, read our white papers “Exploring the Connected Car” and “The New Auto Insurance Ecosystem: Telematics, Mobility and the Connected Car.”)

For industrial applications, examples of partial or full ownership of DVCs are emerging, in which a machine or device is already installed at a customer’s premises and functions in tandem with upstream and downstream processes and systems.

Industrial customers maintain strict control over the data leaving their ecosystems, whether it’s device data, process data or product data, and they have varied requirements for governance and security compliance. For example, a process control system (provided by a third-party vendor) running in a refinery is a smart device that can communicate on a network and make real-time decisions. The program running on the control system (CS) is specific to the process and has a certain IP attached to it. Thus, the CS handles both product and process data. Essentially, the refinery owns the process data, the network and the data management, and it makes business decisions based on the data. The CS vendor can plug into the refinery’s network (not the plant network) and gather specific data to analyze the performance of the CS (i.e., product data). The vendor can have limited access to the DVC.

Ownership of the DVC is a function of many parameters. Because ecosystem designers must manage the entitlement of the data, ecosystem integration is key, especially to create new business models and enhance the customer experience.

**Monetization Strategy: Business Lags Behind the Technology**

This is the most puzzling piece of the entire connected story. Technology advancements have led to a plethora of devices, networks, data management systems and software applications, creating opportunities for device interaction of many types. As a result, businesses are looking to generate value from different interactions, such as how a driver drives a vehicle, how a machinist uses a machine, how a reefer’s performance impacts packaged product metabolism, etc. But imagine if your microwave and refrigerator were sensorized, onboarded to a network and able to speak with one another; should a customer pay more for these products, and if so, how much more? Just two intelligent devices talking to each other is not enough – context and understanding of customer value is key.

Industrial businesses are complementing their existing product portfolios with solutions and services to generate greater value. As Figure 5 (next page) shows, adoption of a connected ecosystem varies depending on where the products fit in the product/services continuum. Leveraging a connected ecosystem to monetize services and create new business models is especially challenging for the businesses positioned on the extreme left of the product/service continuum. The movement
toward the right side of the continuum (toward pure services) is what is known as servitization.

Although the movement to the right is not new for many industries, connected ecosystems have accelerated the trend. Servitization is here to stay, with new business models evolving due to the following key factors:

- Opportunities for recurring revenues.
- Relatively low Cap-Ex.
- Shrinking margins for pure products.

However, it is still challenging to create new revenue models and services based on a connected ecosystem. The reasons include:

- **Evolving customer KPIs and needs:**
  - It is difficult to make a case for tangible, sustainable advantage with the help of a connected ecosystem. Customers are asking for specific recommendations around their businesses; mere reports and insights are not enough.
  - Customers want businesses to invest in and prove the case for connected ecosystems. Output-based models are gaining in popularity, along with co-investment; we see companies being willing to pay to participate in the ecosystem only if they see business value emanating from it.

- **Lack of understanding of the product’s ecosystem in the installed base.**
  Product ecosystems can include both upstream and downstream processes and systems, the environment in which the product operates, its overall impact on the process, external factors that create process performance bottlenecks, the workforce that manages and operates the product, the cost incurred by the customer to procure the product, third-parties servicing the product, consumables procured during normal operations, issues with configurations and settings, standard operating procedures followed while using the product, and the product’s resource consumption. Gathering such data from the ecosystem is a significant challenge, which makes the device’s “smartness” all the more critical.

### Churning the Revenue Model

A connected ecosystem typically represents the following types of revenue opportunities (or a combination thereof):

<table>
<thead>
<tr>
<th>PURE PRODUCTS</th>
<th>SOLUTIONS</th>
<th>PURE SERVICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Examples: Component manufacturers, textile, pulp &amp; paper, metals &amp; mining, etc.</td>
<td>Industry Examples: Automotive, consumer goods, industrial, etc.</td>
<td>Industry Examples: Engineering services, consulting</td>
</tr>
<tr>
<td>Linear margins, commoditized products</td>
<td>Non-linear margins, differentiation via solutions</td>
<td>Varied, difficult to differentiate</td>
</tr>
</tbody>
</table>

**Figure 5**
• **Traditional product revenue**: Premium pricing for the smart product.

• **Service-based revenue**: Revenue driven by services around the products and pure services. This can include knowledge-based service revenue (advisory services, reports, data as a service), dynamic pricing models and usage-based models.

• **Product usage-based/leasing models**: Unit pricing (per pound, per pack, per hour, etc.).

Designing a win-win business model requires significant collaborative efforts with clients and business partners. Successful revenue models often involve co-investment and co-piloting with customers.

As Figure 6 reveals, the aim is to realize any of the aforementioned revenue types by reaching the prescribed state. A major challenge is validating the customer value proposition offered by the connected ecosystem.

**Security and Privacy**

The heterogeneous and dynamic nature of the connectivity required between devices, systems and end-users gives rise to several security challenges, whether at the device, communication protocol or application level. In the connected car scenario, in-vehicle applications need to secure the information exchange between ECUs/onboard/telematics devices and user devices. Around-the-vehicle applications need to handle vehicle-to-vehicle (V2V) security, and outside-the-vehicle applications need to handle vehicle infrastructure (V2I) security.

**Defining the Revenue Model**

**New Product/Service Offerings**

Example: A newly launched car with demographically-specific connected features.

1. **PLAN**
   - Identify a business-critical product line/plan for a new product.
   - Develop a strategy around the data value chain and connected ecosystem.

2. **PILOT**
   - Define commercialization roadmap.
   - Develop pricing & engagement model (outcome-based, usage-based, gainsharing model etc.).

3. **PRESCRIBE**
   - Develop pricing & engagement model (outcome-based, usage-based, gainsharing model etc.).

4. **PROLIFERATE**
   - Proliferate the offerings.

**Enhancing Product/Service Offerings**

Example: Monitoring an installed packaging machine and moving to a performance-based business model.

1. **PLAN**
   - On-board an anchor customer.
   - Identify a business-critical active device/product line.
   - Device and data integration.

2. **PILOT**
   - Gather ecosystem data.
   - Develop hypothesis.
   - Conduct a pilot and confirm the enhanced value/benefits.

3. **PRESCRIBE**
   - Define commercialization roadmap.
   - Develop pricing & engagement model (outcome-based, usage-based, gainsharing model etc.).

4. **PROLIFERATE**
   - Proliferate the offerings.
Securing the communication at the protocol level requires that bandwidth, power supply, processing capabilities and security features are balanced. Security and privacy need to be addressed for all the data that is captured, stored, processed and accessed across the technology chain and by different stakeholders. For example, trust needs to be established for connected infrastructure components (e.g., resolution, authorization or certification authority) and actors within the network (service invokers and providers), as does the accountability for actions performed through the connected network and privacy for data handled by the infrastructure.

Governance, risk and compliance policies help businesses use appropriate frameworks to identify risk, assess vulnerabilities, design and implement controls, manage incidents and design forensic measures across the technology chain. Additionally, the management of residual risk, testing and updates form essential processes that need to be followed for designing resilient and connected solutions.

Technology Selection

Technological advances ensure that information is made available within the connected network on an anywhere/anytime basis to authorized users so that proactive decisions and actions can be made. However, businesses are struggling to keep pace with rapid technology change and thus want to build enterprise-wide architectures that can handle scale, interoperability, security and obsolescence seamlessly.

The connected network DVC primarily comprises hardware devices (sensors, controllers and gateways), communication protocols, device and data management platforms and analytical tools. Given the plethora of choices and lack of standards, selecting and “standardizing” these elements is a significant challenge. For example, hardware selection is based on performance and interface analysis, depending on factors such as I/O volume, latency, local processing and storage requirements. Communication protocols are primarily selected on the basis of bandwidth, latency, data footprint and security requirements. The selection of device and data management platforms depends on scalability, flexibility, ease of device management and client-side application support, whereas the choice of analytical tools is driven mainly by domain considerations and the mathematical skills required to consume the data.

Choosing the right technology depends on a combination of the maturity level of the connected infrastructure, perceived customer value and business model selected.

Going Forward

Fast-changing technology is disrupting the industrial and consumer spaces. Customers are now more aware and critical of the products they use, and businesses are increasingly aware of the opportunities posed by connected ecosystems to boost efficiencies and establish a closer, more engaged relationship with customers and their needs.

Adopting a connected ecosystem requires significant collaboration across the organization, and because of the enterprise-wide impact, these initiatives should be driven by executive leadership. A central, cross-functional entity should own the connected agenda.
Organizations must also understand the business requirements – their own KPIs and that of their customers – the technology maturity of all ecosystem players, and the market dynamics that define and inform the connected roadmap. In addition, we suggest the following:

- **Customer awareness**: Businesses must generate insights around customer processes and how their products and services are being used. For industrial businesses, it is imperative to co-innovate with customers to realize the potential of connected ecosystems.

- **Dimension identification**: Businesses must identify value along the four dimensions described in this whitepaper, and extract results from at least one.

- **Monetization**: Filters must be applied to prioritize strategic initiatives that advance the business agenda in terms of revenues and profitability.

- **Business ecosystem creation**: A winning partner ecosystem depends on ownership of the DVC and fulfillment of required technology elements. Onboarding the right customers and partners will be critical to success.

- **Minimum viable product (MVP), models and culture**: Businesses will need to invest in new technologies and platforms and re-engineer current processes and products as required by all partners in the initiative. Given the inevitable business and operating model changes needed, a mindset shift is a must. Workforces will be challenged to embrace new technology platforms and a digital approach to engaging with customers and internal stakeholders.

*Note: Code Halo™ is a trademark of Cognizant Technology Solutions.*
Footnotes


3. Sensorization refers to the process of adding/enabling multiple sensors within a system/device to capture the data of interest around the device and its surroundings.

4. FFB (Foundation Fieldbus) is is an all-digital, serial, two-way communications system that serves as the base-level network in a plant or factory automation environment.

5. HART (Highly Addressable Remote Transducer Protocol) is an early implementation of Fieldbus.

6. Servitization refers to the inclusion and delivery of a service component to the existing product portfolio to enhance the overall value of offerings for customers.


8. Ibid.

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