Fast Lane
Consulting and Education Services Inc.

Enabling Digital Business (EDB)

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Executive Summary

Digitalization is the new buzzword, and digital solutions have become the platform for a new generation of Information Technology use cases, architectures and systems. Digital strategies and emerging digital technologies are the basis for disruptive IT innovations that will influence and guide enterprise planners and designers for many years to come. This white paper identifies and introduces the key framework technologies that will push us into the new digital era.

This whitepaper should be of interest to those with responsibility for planning and building digital businesses and those looking to create the enabling strategies. It is intended for service providers, IT partners/VARs and enterprise customers.

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Don Sheppard
White Paper

Introduction

Disruptive innovation in IT has changed the way we live, work and play. We hear more and more about the digital economy, digital government, digital business and about life in the digital fast lane. The insights of Don Tapscott in his 1996 book "The Digital Economy" have now become business as usual for many enterprises.

Expectations for digital technologies have never been greater nor increasing so quickly. Some observers believe that this digital era will solve the problems of climate change, global waste, illness and even over-population. This new era is starting to be called the Fourth Industrial Revolution; this was the feature topic at the Davos 2016 World Economic Forum.

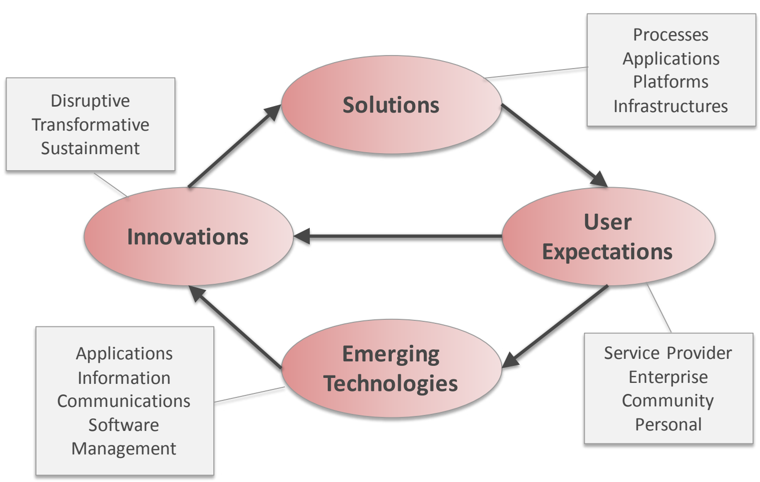
This white paper examines the 5 key technologies that provide the business models and technical frameworks for the new digital ecosystems. This white paper focuses on the "what" and "why" of each technology, leaving the deep dive into the components and methods for further reading and more in-depth training courses.

Digital Innovation

Disruptive innovation, a term first defined by Clayton Christensen in his 1997 book The Innovator's Dilemma, refers to a process by which a product or service initially takes root at the lower end of a market and then moves up market, eventually to displace the "old school" products or services.

While industry experts can debate what is truly disruptive, there is little doubt that emerging digital technologies are changing the world. This can be seen clearly in transportation with Uber becoming an alternative to licensed taxis and alternatives to hotel accommodations via Airbnb. Figure 1 illustrates a typical cycle of expectations, emerging technologies, innovations and solutions for the digital economy.

Figure 1: The Technology Innovation Cycle



Business, social and government services are all evolving to become cloud-first and digital-by-default.

Strategies for Digital Business

Gartner defines digital business as "the creation of new business designs by blurring the digital and physical worlds." An example of this can be found in financial services: ATMs (automated teller machines) and online banking do in fact blur the lines between physical (i.e., a human teller) and digital banking services.

Five important strategic directions are enabling and facilitating the IT transformation to the digital era:

1. Consumerization of IT

The Internet has turned multimedia communications into a consumer reality. Smartphones, wireless networks and public computing services are widely available and affordable. The boundaries between personal and corporate systems are also blurring with BYOD (Bring Your Own Device), self-serve shopping portals and corporate social networks.

2. Centralization of IT

Developing a system was traditionally a "bespoke" activity; systems were owned and operated corporately and used custom-built or highly customized applications. Cloud computing, on the other hand, centralizes IT by allowing multiple companies to share both the applications and the infrastructure. The Internet is one example of resources being shared by both social and corporate users.

3. Automation of IT

Automation includes various functions whose aim is to reduce the manual effort and delays involved in delivering digital systems. Some of the cloud computing characteristics depend on operations automation. Three typical features are subscription-based services, elastic service provision and consumption-based pricing.

4. Standardization of IT

Standards help to reduce the cost and complexity of developing and deploying new technologies. Standards include formal international standards, industry consortia and open source projects. OpenStack for cloud system control, Docker for application containerization and Linux for operating systems are examples of open source projects.

5. Usability of IT

The user experience is critical to digital business. Technologies such as virtual reality, machine learning, artificial intelligence, geolocation and adaptive devices all contribute to a much improved and more responsive user experience. Emerging technologies that are already producing big benefits include voice assistants, context awareness (location, environment, time, history, etc.), presence detection and learning.

Emerging Digital Technologies

Strictly speaking, most emerging technologies[1] are either partially overlapping or are inter-dependent. For the purposes of this white paper "emerging technologies" means products/technologies that as Geoffrey Moore described it, have "Crossed the Chasm" and are being used by early majority buyers. This would also include technologies that have moved past the Trough of Disillusionment in the Gartner Hype Cycle.

Figure 2 illustrates the elements of the digital technology landscape. These technologies are often referred to as the "fifth wave" of IT, with the previous waves being mainframes, minicomputers, personal computing and Web/Internet systems. This fifth wave also represents the IT industry's transformation from selling physical components to offering on-demand, shared, virtual services. In this whitepaper, we examine 5 digital frameworks that are the core of the digital transformation.

Figure 2: The Digital Technology Landscape

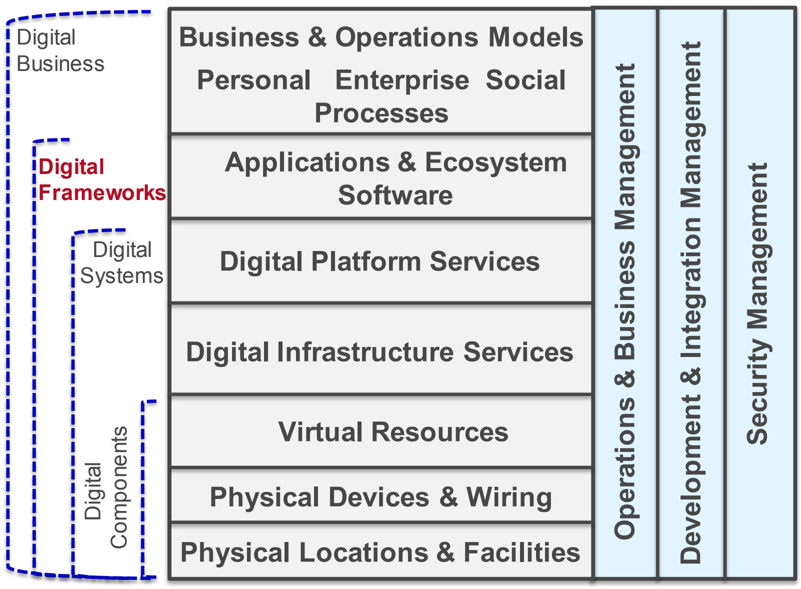


Figure 2 also shows why some technologies are called "cross cutting" as they are required at all the levels of the stack. These various management capabilities include operations, business, development, integration and security/ privacy. Security, which is a particularly important consideration for all emerging technologies, includes requirements ranging from heat sensors in data centers and biometric access controls to encryption algorithms for information transfer and storage.

We will now explore the top 5 technologies that are leading the digitalization of today's businesses.

Cloud Computing

1

The first emerging technology we will explore, cloud computing, is essentially a framework for delivering IT resources (primarily computing, storage and communications) and various types of software in the form of services.

Two fundamental concepts that cloud computing has pioneered (or perhaps just re-invented!) are:
• The provision of IT services by third party suppliers from off-premises data centers
• Sharing of services by multiple customers (now known as multi-tenancy)

Cloud computing has been defined in several well-accepted standards[2]. Although Cloud computing has its roots in server virtualization, the cloud era really began in 2006 with the announcement by Amazon of its Elastic Compute Cloud. Cloud-based systems currently available "off-the-shelf" are now being used by governments, large enterprises and start-up businesses worldwide. Despite the early adoption, the underpinning digital systems and components (see Figure 2) continue to evolve and change rapidly.

Cloud characteristics

Cloud computing, for practical purposes, is most easily defined by its distinguishing characteristics:

- **Broad network access:** Easy access from any location for a wide range of devices
- **Measured service:** Service use is monitored, controlled and reported with pay-as-you-go billing and on-demand elastic provisioning
- **Multi-tenancy:** Sharing of services, resources and facilities by multiple customers
- **On-demand self-service:** Automated service subscription and rapid provisioning with minimal human interaction
- **Rapid elasticity and scalability:** Dynamic matching of supply to demand
- **Resource pooling:** Resource sharing with dynamic assignment and reassignment of resources based on customer demand

Since there are no internationally adopted compliance standards for cloud computing, not every cloud service provider offers the same feature set. In the USA, programs such as FedRAMP define compliance requirements for Federal Government agencies.

Cloud configurations

A cloud system is said to be public if it is shareable by many customers and private if it is available to one customer only. Cloud systems can be owned by the customer or the service provider; they can be deployed in the provider's or the customer's premises; and independent clouds can be combined in various ways.

For example:

- **Hybrid cloud:** a combination of a public and a private cloud, typically a provider-owned public cloud connected to a customer's on-premises cloud
- **Legacy integration:** a cloud system interconnected to a non-cloud (legacy) system
- **Multi-cloud:** a combination of two or more provider-based clouds using cloud-to-cloud links (for example, Cisco's InterCloud Fabric)

Cloud services

Cloud computing offers the promise of on-demand IT-as-a-Service, delivered by third-party providers using their own resources and data centers.

The three basic categories of service are:

- **Infrastructure as a Service (IaaS):** storage, processing and communications, generally but not necessarily virtualized
- **Platform as a Service (PaaS):** software environments and tools for program development, testing, deployment and execution (AWS, Google and Rackspace are both IaaS and PaaS, for example)
- **Software as a Service (SaaS):** packaged applications provided on a shared or dedicated basis offering personal, social, enterprise or public services (Facebook and Salesforce, for example)

A wide range of use cases have been defined within these 3 broad categories including Disaster Recovery (DRaaS), Unified Communications (UCaaS), Database (DBaaS), Security (SecaaS) and Customer Resource Management (CRMaaS).

Cloud management and security

As is shown in figure 2, management of cloud operations, administration, service provisioning and security/privacy are also important parts of a complete cloud computing ecosystem. Cloud management can be bundled together with the services or offered on a standalone basis. Multi-cloud management is an emerging technology that facilitates management integration across multiple provider's systems.

The OpenStack software is a typical example of an enabling technology for cloud computing. The official OpenStack website states that: "OpenStack is a cloud operating system that controls large pools of compute, storage and networking resources throughout a data center, all managed through a dashboard that gives administrators control while empowering their users to provision resources through a web interface."

It can be argued that one of the most important cloud computing innovations is the automation of management for web-scale data centers.

The Internet of Things

2

The second emerging technology, the Internet of Things (IoT), is another framework technology. There are many current examples of IoT applications and Gartner predicts that by 2020 there may be as many as 26 Billion connected "things." IoT systems incorporate various emerging technologies such as cloud, wireless and big data, as well as more specialized IoT components such as local gateways/hubs and low-power sensors. Modernized electricity and factory operations systems are now being called the Industrial IoT (IIoT).

Definitions for IoT

No standard characteristics or specification for IoT exists as yet, although standardization has begun[3]. IoT represents a wide range of possible solutions, however, which makes creating a single vision for IoT difficult – there are some who believe it should even be called the Internet of Everything.

In the ISO/IEC report, IoT is defined as: "An infrastructure of interconnected objects, people, systems and information resources together with intelligent services to allow them to process information of the physical and the virtual world and react."

Gartner calls IoT "the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment." Gartner has determined that IoT is currently close to its peak of inflated expectations, but also estimates it will not reach its plateau of productivity (when it will become mainstream) for 5-10 years.

The scope and field of application for IoT is also a topic of debate. The ISO/IEC definition above covers more than physical things – this is sometimes called the Internet of Everything. A narrower definition restricts things to physical objects that include embedded communications capabilities and typically are not human interface devices (such as robots, factory machines or hydro switches).

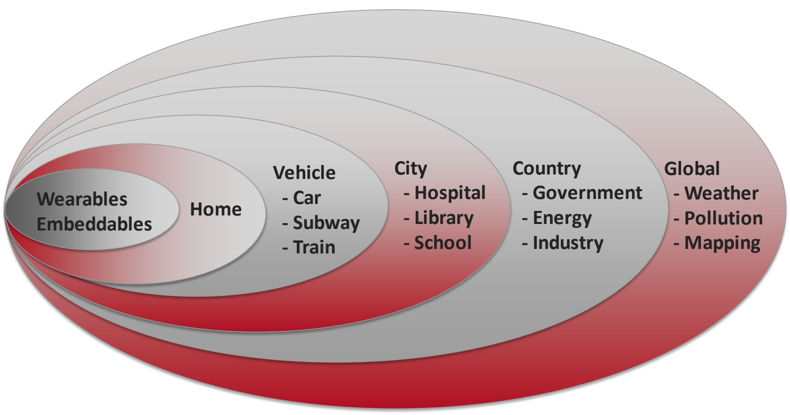
IoT characteristics

An important IoT distinguishing factor is the focus on non-human endpoints. The connected refrigerator is often used as an example in which human interaction is not the primary goal. The IoT list of "things" generally excludes interpersonal communications (such as email) and systems for business-to-consumer (online banking and shopping). IoT systems share many of the cloud computing characteristics (see the previous section) but also add other characteristics to the mix:

- Large numbers of low power devices (such as sensors) of different types that can benefit from distributed pre-processing and local hubs
- Unrestricted forms of digital multimedia data – voice, data, image, sensor, video, etc. – and multiple modes of interaction including latency sensitive applications
- Increased security and privacy sensitivity (accessing home systems or breaching connected cars, for example)

Most IoT systems are likely to be cloud-based with wireless Internet access, but these technologies are not mandatory. IoT systems will generate large volumes of data and are likely to move some of the processing and storage functions closer to the endpoint devices. The IoT World Forum Reference Model includes a layer for "edge computing." This has also been called a data aggregator layer, and also referred to as Fog Computing. The large volumes of data that can be collected will qualify as "big data" for purposes of database management, analytics and artificial intelligence.

Figure 3: IoT Application Domains



IoT application domains

Figure 3 illustrates a number of "smart" environments in which IoT applications (as well as social and communications services) are starting to change the way we live and work.

IoT systems can be divided into four general application domains (although the boundaries are not rigid – drones, for example, would be widely used):

1. Personal/Home/Vehicle

Personal IoT includes applications and objects associated with individuals (or perhaps families) including health monitoring, sensors in clothes, smart assistive devices and alarms. A variety of possibilities exist for smart homes and vehicles including connected entertainment, environmental controls, access and security, and smart appliances. Smart car applications range from failure sensing and maintenance to driverless cars. Related services include automatic software updates (including for smartphones and watches), service notices, tracking and reporting.

2. City/Community

IoT for smart cities, municipalities and communities include applications for fire and police, roads and transportation, hospitals, schools, libraries, parks, parking, etc. Traffic management and green environment are emerging areas. Communities could include shopping centers, apartment buildings and stadiums.

3. Enterprise

Enterprise systems can be divided into commercial and industrial IoT. Business IoT includes smart buildings and offices, most retail applications, supply chain support services, RFid functionality, payment services and other possibilities. IoT “things” may over time be extended to include objects such as contracts and currency (e.g. bitcoins).

4. National/International

Public service IoT would include a wide range of IoT systems associated with state, country and global government sectors. Examples include electric power operations, water control systems, emergency management systems, weather and climate tracking, pollution and disease monitoring, etc. Many government systems for health, natural resources, education, open data, etc. could also be public IoT services.

IoT Services

No single set of service defines IoT for all domains. However, a number of specific features will be included in any practical IoT system, including:

- Support for low-power, low function devices (things, objects) as well as human interfaces
- Mass data collection, storage, filtering and pre-processing
- Networking and interoperability both locally and over wide areas
- Service discovery, orchestration and integration
- Storage and processing (the same as for cloud computing - infrastructure, platform and common applications)
- Analytics, user intelligence and big data processing of data (both realtime and historical)
- Security and privacy for users, data, functions and business processes
- Management of operations, administration, maintenance and provisioning

Needless to say, since these features cover most of the technology landscape (see Figure 2) IoT is often viewed as an extension of cloud computing.

3 Social Networking & Collaboration

Communication among people, especially email, was one of the Internet’s original applications. Over time this has expanded to include voice and video over IP, multimedia conferencing, text and voice messaging, small message services, personal broadcasting, presence services, shared calendars and others. Social networking is already widely used and can no longer be called an emerging technology. Facebook (introduced in 2004), YouTube (2005), Twitter (2006), LinkedIn (2002) and Pinterest (2010) are household names with many millions of subscribers. Social networking and the interpersonal Internet could be called the “Internet of People.”

Social networks often bundle multiple services (such as content posting and instant messaging) into a common ecosystem that has a unified user interface. Various communications styles are used including realtime, near realtime, store-and-forward, streams (e.g., the Facebook wall) and “bulletin board” (e.g. LinkedIn Pulse and Web sites).

Social networking and collaboration share many characteristics in common with cloud computing. In fact, the underlying support platforms for these are quite similar to Software-as-a-Service (e.g., easy to subscribe, provider hosted, open standards, etc.) and they are clearly multi-tenant. Most Internet services use an online subscription process, and there is little or no delay between subscribing and having access to the services. Currently this is a competitive market with little or no interoperability. Convergence and convenience are receiving significant attention from product developers, as is security and privacy.

Big Data & Analytics

4

The popular term “Big Data” is another elusive framework that is hard to pin down. The term itself refers both to the massive volumes of data that are being generated and to the modern technologies being used for storing the data and extracting insights and intelligence.

A 2014 ISO/IEC JTC1 report proposes the following: “Big Data is a data set(s) with characteristics (e.g. volume, velocity, variety, variability, veracity, etc.) that for a particular problem domain at a given point in time cannot be efficiently processed using current/existing/established/traditional technologies and techniques in order to extract value.”

Gartner uses the following definition for big data: “Big data is high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation.”

The characteristics often associated with Big Data are (it ranges from 3 to 7 “V”s in the literature):

- **Volume:** the amount of data to be processed should be larger than traditional databases can handle and this changes over time, but is usually in multiples of terabytes
- **Velocity:** the rate at which the data are created, stored, analyzed and visualized
- **Variety:** the wide range of relational and non-relational data and document formats including structured, semi-structured and unstructured
- **Variability:** represents the changeability of one or more of the other characteristics
- **Veracity:** the trustworthiness, applicability, noise, bias, abnormality and other quality properties of the data
- **Visualization:** the various readable and accessible ways that data can be presented
- **Value:** value of the actual data that is collected, of the Big Data industry overall, and of the derived data that is obtained by processing the source data

The key functions of a Big Data Analytics ecosystem are:

1. Data collection and pre-processing

Useful data can come from anywhere, at any time and in any form. Large scale data sets will often be associated with public cloud applications, social networks, and/or IoT and it will be aggregated from millions of users. Data sources can include (but by no means is restricted to) identity data, time data, location data (maps and coordinates), event data, sensor data, message tag data, meta data, historical data and open government data. Much of the data may need to be converted and formatted for easier use or for correlation with related data.

2. Very large scale storage and databases

Big Data is concerned with enabling systems to emulate physical reality. Continuous monitoring, rather than just samples or subsets will often be required. Correlation among data sources will provide context, improve decision relevance and detect anomalies and perturbations. Apache Hadoop, an open source project is one example of a system for storing and processing big data.

3. Analysis tools and techniques

Big Data analytics enables organizations to analyze data, either in batch mode or as a stream of data, in search of valuable information and insights. Apache Spark, another open source project is an application framework for doing highly iterative analysis that scales to large volumes of data.

4. Visualization and presentation of the data

A key part of any Big Data system is presenting results in a meaningful way for people to gain knowledge and insight. Data visualization helps to communicate information clearly and effectively through graphical means.

Big Data application areas include healthcare, national security, traffic control, energy management, telecommunications, IT security, financial services and weather. The goal of Big Data is to derive value from the data collected in such a way that it can be trusted. Enterprises can realize value from:

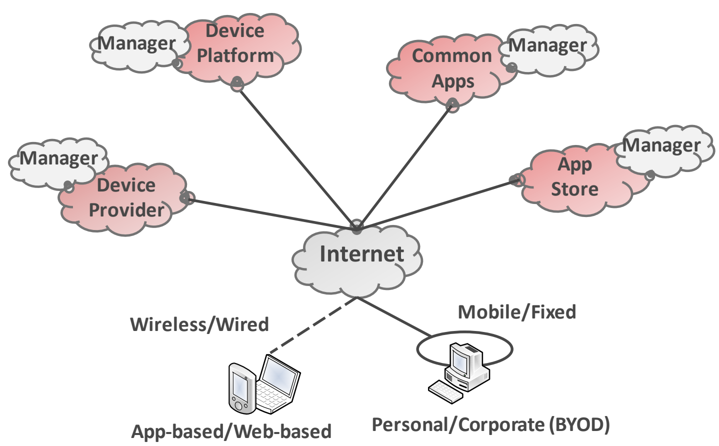
- **Insights:** discovery of deeper, more timely insights by including more data sources in the analyses
- **Productivity:** improve decision-making efficiency and effectiveness by having more information
- **Automation:** applications and control systems that can adapt and adjust to data received from smart sensors
- **Prediction:** forecasting events based on comparing statistics of similar devices (e.g., device maintenance or security)
- **Speed:** rapid processing to yield faster, more relevant responses to business opportunities, threats and challenges

The underlying assumption of Big Data is that traditional databases are not up to the task of managing very large quantities of data. What makes a data set big, however, is a moving target that changes over time. Applications and algorithms that are considered to be in the realm of Big Data today will be standard practice in the future.

5 Mobility

Mobility is yet another framework technology – it goes beyond simply wireless communications to include the ecosystem support for moveable smart devices including device support, applications and connectivity. Figure 4 illustrates the various digital system technologies that are part of a complete mobility environment.

Figure 4: The Mobility Ecosystem



The most familiar example of a mobile ecosystem is the smartphone, but the range of solutions will expand with IoT solutions (such as connected vehicles and embedded sensors). The following are typical components of a mobility ecosystem:

Device hardware

Mobile system hardware ranges from basic smartphones and tablets to cars and embedded sensors; the manufacturer may connect to the device for purposes of owner registration, updates and fixes, and potentially for security and tracking; the level of access to the device is a current hot topic in the industry.

Wireless communications links

Connectivity with mobile devices can be provided via WiFi or cellular data, which would currently include 4G, 4G LTE, and Advanced LTE; emerging communication technologies include 5G, which is expected to be deployed over the next 5 years.

Operating platform

The operating system and software platform for the device may be supplied by the manufacturer or a third party provider. Since this software will be subject to periodic fixes, updates and enhancements it will connect to one or more service providers. For many devices, this will be automatic (after all, very few owners of a refrigerator will spend time looking for updated IoT software).

Common applications

Basic smartphone functionality includes email, text messaging, telephony, intelligent assistants, support for sensors, etc.; these too will evolve over time and must be supportable through interactions with providers.

Application stores

Many wireless devices will support a wide range of optional applications that would be available from an app store (e.g., collaboration services); these may also be subject to frequent updates and changes.

Today, much of the mobility ecosystem is user-controlled and essentially a manual task. For example, updates to iPhone software comes from Apple, third party applications and updates are downloaded from Apple's App Store, and wireless access is offered by a national carrier. Updates and changes are initiated by the user. While the idea of "mobility" is conceptually simple, a full mobility ecosystem can be quite complicated when differences due to suppliers, competition, location and technology are taken into account. Universal mobile connectivity is a key goal for the 20+ Billion IoT devices and 6+ Billion smartphones that will be attached to the Internet by 2020.

The Promise of Digital Business

The ultimate promise of digital technology is more productive economies within a better, more livable and more sustainable world. Many possibilities for achieving this promise exist in health care, education, entertainment, transportation, safety and protection, public sector and agriculture to name a few.

Digital innovation depends on achieving the transformation to the digital society and to digital business. One of the most fundamental pre-requisites is high quality education and training, preferably from qualified organizations, for both the technical and social aspects of the various emerging technologies.

About the Author

Don Sheppard P.Eng. is a Senior Consultant with ConCon Management Services of Toronto, Ontario. He has been an advisor and consultant to public and private sector enterprises for more than thirty years. Don has also participated actively in the development of ISO standards including The OSI Reference Model and the Cloud Computing Reference Architecture. Don has written numerous whitepapers and seminars and is an active blogger at IT World Canada.

To view Fast Lane's full Enabling Digital Business portfolio please visit:
http://www.fastlaneus.com/enabling-digital-business

Notes/References

1. The Oxford dictionary defines the word “technology” as: the application of scientific knowledge for practical purposes, especially in industry.

2. The NIST describes cloud computing in Special Publication 800-145 and Special Publication 500-292. ISO/IEC 17788:2014 (Information technology - Cloud computing - Overview and vocabulary) and ISO/IEC 17789:2014 (Information technology - Cloud computing - Reference architecture).

3. The NIST recently published a draft “Framework for Cyber-Physical Systems” which defines cyber-physical systems as: “Cyber-physical systems (CPS) are smart systems that include co-engineered interacting networks of physical and computational components.”

ISO/IEC JTC1 is also beginning to develop standards for IoT. They have a report on IoT and recently established Working Group 10 to focus on standards for IoT. ISO is currently developing ISO/IEC 30141, entitled “Information technology - Internet of Things - Reference Architecture.”

In the ITU-T SG20 is focused on “IoT and its applications including smart cities and communities.” Recommendation Y.2060 provides an overview of the Internet of things (IoT). It clarifies the concept and scope of IoT, identifies the fundamental characteristics and high-level requirements of IoT and describes an IoT reference model.