Request for Public Comment (RFC) on the Benefits, Challenges, and Potential Roles for the Government in Fostering the Advancement of the Internet of Things

GS1US Submission

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THE GLOBAL LANGUAGE
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Request for Public Comment on the Benefits, Challenges, and Potential Roles for the Government in Fostering the Advancement of the Internet of Things

A RESPONSE TO THE NATIONAL TELECOMMUNICTIONS AND INFORMATION ADMINISTRATION (NTIA)

GS1 US would like to thank the National Telecommunications and Information Administration (NTIA) and the US Department of Commerce (DOC) for the opportunity to respond to the Request for Public Comment on benefits, challenges, and potential roles for the government in fostering the advancement of the Internet of Things (IoT).

GS1 US & the IoT

The Internet of Things (IoT) is the concept of many objects, smart devices, machines, consumers, patients and services being increasingly connected to solve problems in new and more effective ways. The vision behind the concept is that increased connectivity will facilitate automation, visibility and access to services. The IoT promises to enable humans to improve their quality of life and to enable commercial companies and governmental organizations to increase the efficiency of supplying goods and services to levels never reached before in history.

The IoT is not any single, specific new technology. The IoT is here now and has actually been around us for many years. The roots of the GS1 system, born in the early 1970s started with a unique identifier for consumer goods represented in a machine readable form. This simple technology enabled users to connect products with services. The initial offering transformed the way retail stores managed their checkout operations. Forty-five years later the very same technology is the core enabler for an ever increasing range of services offered to consumers to find information about products, to buy them or to compare price and delivery conditions.

In the late 1990s, The Auto-ID Center at the Massachusetts Institute of Technology (MIT) developed the Electronic Product Code (EPC) concept. They coined the term "Internet of Things", which envisioned things connected to object-specific data on the Internet using an EPC as a unique identity for a specific thing. In 2003, GS1 assumed responsibility for this work by developing EPC standards and by helping to drive implementation of the concept to address real-world business needs.

The architecture of any IoT implementation must ensure that any object can be seamlessly identified across industries and domains, and that data can be exchanged in an interoperable, unambiguous, and scalable manner.

Different identifiers are needed for different purposes. Broadly speaking one can distinguish two main categories of identification requirements:

1) Object Identifiers, which are used for uniquely and persistently identifying physical and virtual objects. The GS1 standards meet this requirement perfectly.

2) Communication identifiers, which are used to identify uniquely devices in the scope of communications with other devices, including internet-based communications. Typical examples include IPv4 and IPv6 IP addresses.

GS1's "Global Language of Business" connects the physical and digital worlds, laying the foundation for the IoT. The unique identification of objects, assets, locations, etc. (things) and automatic data capture, powered by GS1 barcodes and EPC/RFID, enables interoperability and is a key requirement for the IoT. The very same identifier that has been utilized in traditional commerce at the point of sale for over 40 years is now being used in digital commerce by companies like Amazon, eBay, and Google, The IoT is driving increased connectivity of "things" – which leads to massive data collection. Seamless, trusted sharing of "big data" is enabled by GS1 standards. Data quality is more important than ever and GS1 standards provide the foundation for accurate, sharable, searchable and linkable data.

How GS1 Standards can support the IoT

GS1 US is a global voluntary consensus standards body serving more than 300,000 businesses across 25 industries. We provide support services, tools, education, and training on the GS1 System of Standards. We lead industry initiatives in Apparel and General Merchandise, Foodservice, Healthcare, and Retail Grocery. We connect communities through events and online forums. GS1 Standards are the global language of business—a language for identifying, capturing, and sharing information about products, business locations, and more; automatically and accurately, so that anyone who wants that information can understand it, no matter who or where they are.

GS1 has long experience in issuing identification and managing reference data in an international setting. In many IoT scenarios, products are communicating with one another in a variety of ways. GS1 standards provide the foundation for product identification and are therefore an important component of many IoT applications, particularly in the retail and home environments. By using the open identification standards already in use globally and governed by industry, there is no need to develop new systems of identification. We have sponsored research related to identification and the IoT at the Auto ID Labs at the University of Cambridge (United Kingdom), Fudan University (China), KAIST (South Korea), Keio University (Japan), Massachusetts Institute of Technology (USA), University of St. Gallen/ETH Zurich (Switzerland),and the University of Adelaide (Australia).

GS1's standards for identification and electronic commerce are the most widely accepted standards of their kind in the world. Consumers are familiar with GS1's GTIN or Global Trade Item Number (known as the Universal Product Code or U.P.C. in North America, and the European Article Numbering code or EAN elsewhere in the world), which appears on the labels of consumer products in 150 countries around the world. Less visible to consumers, but equally important, are GS1's identifiers for legal entity identification (the GLN) which are an integral part of electronic commerce messaging between trading partners around the world.

Since its founding nearly 40 years ago, GS1 has grown to include 2 million end user organizations worldwide who participate in GS1 through 111 country-based Member Organizations. Through the work of its end user members, GS1 sets standards for identification of physical products, legal entities, and electronic messaging that are used in twenty-five different segments of the global economy. GS1 has issued over 40 million product identifiers and 1.5 million legal entity identifiers to date. GS1's Global Data Synchronization Network (GDSN) today manages reference data for over 20 million product identifiers across 150 countries. The underlying standards are developed by the participating end user member companies, with GS1 providing facilitation of the process.

Global Standards

The GS1 System is an integrated suite of open global standards that provide supply-chain visibility through the accurate identification, capture, and sharing of information regarding products, locations, assets, and services.

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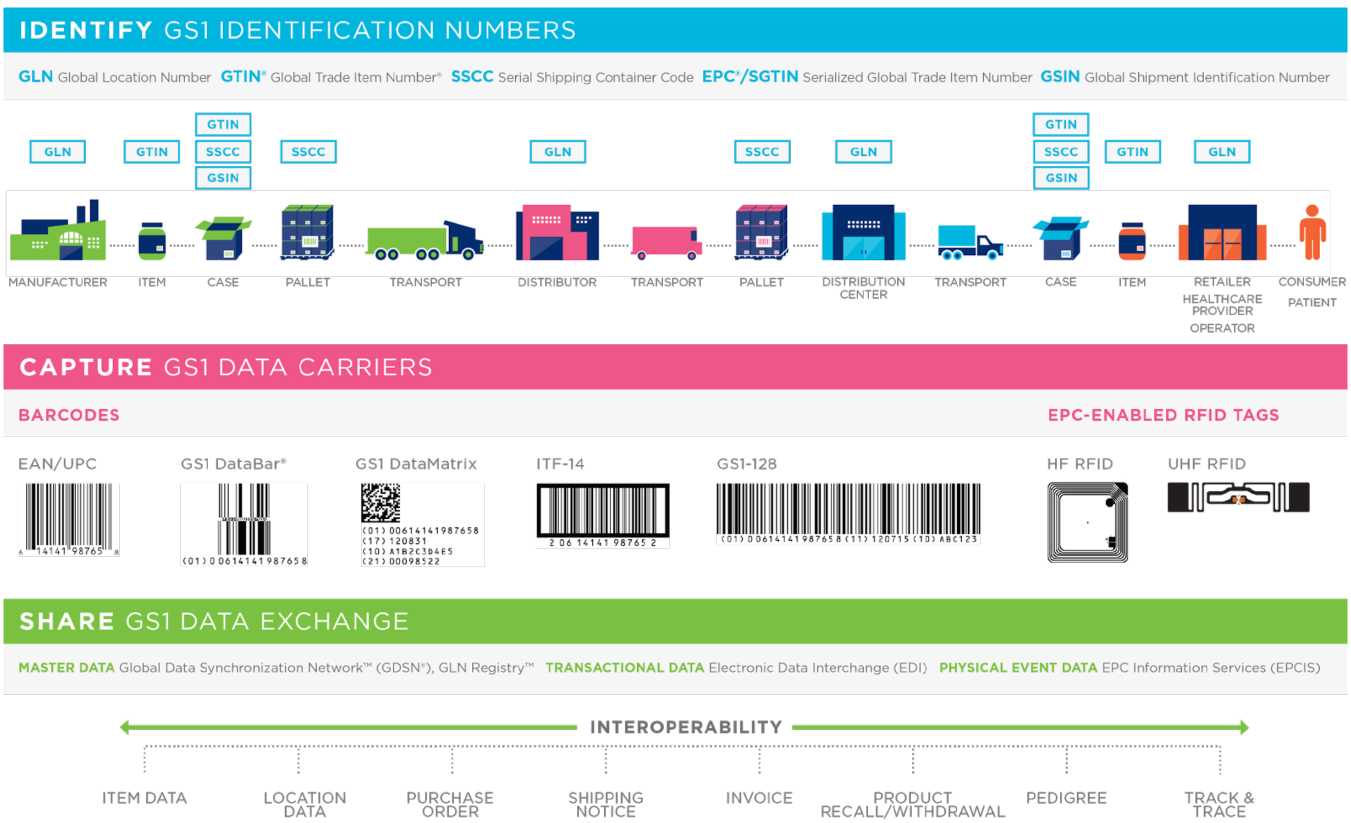
Using GS1 Identification Numbers, companies and organizations around the world are able to globally and uniquely identify physical things like commercial products, locations, assets, and logistic units as well as logical things like corporations or a service relationship between distributor and operator. When this powerful identification system is combined with the Global Data Synchronization Network (GDSN), the connection is made between these physical or logical things and the information the supply chain needs about them.

GS1 Identification Numbers provide the link between a product and the information pertaining to it. When a company assigns a GS1 Identification Number to a product, they define a set of standardized information about the product (e.g., size, weight, location, etc.). The GS1 System specifies standardized information for products, such as core data like selling unit and product dimensions. Standardized information about commercial entities includes core data like location information about a warehouse or restaurant. Once defined by the company, the standardized product information can be stored and shared with trading partners.



GS1 provides solutions for identifying “things” and for connecting the identifiers to the Internet. The GS1 standards for identification provide the means to identify real-world entities so that they may be the subject of electronic information that is stored and/or communicated by end users. The GS1 identification standards include unique identifiers (called GS1 identification keys), which may be used by an information system to refer unambiguously to a real-world entity such as a trade item, logistics unit, physical location, document, service relationship or other entity.

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GS1 standards provide the means to automatically identify, capture, and share data that is carried directly on physical objects, bridging the world of physical things and the world of electronic information. The growth of the IoT will require persistent identifiers for everything that needs to be accessed and monitored. The GS1 identification system is designed in a generic way that makes it suitable for virtually any IoT application that connects things.

Identify: Globally Unique Identification

The GS1 System provides globally accepted identification numbers to provide a common language for communicating information from company to company. The GS1 Identification Number for products is the Global Trade Item Number (GTIN). For decades, the GTIN has facilitated the sharing and communication of product information among supply-chain partners. Moreover, it has provided the foundation for innovative improvements in supply-chain management for many American industries, including the impressive and well documented advances in the retail and grocery industries directly attributable to their adoption and implementation of GTINs in particular and the GS1 System in general.

Capture Product Information

The GS1 System uses approved barcode symbologies and EPC-enabled RFID tags to encode GS1 Identification Numbers that uniquely identify products, trade items, logistic units, locations, assets, and service relations worldwide.

Share Product Information

The GS1 System provides a standardized approach for sharing different types of information including: **Master** data providing descriptive attributes of items; **Transaction** data consisting of business transactions exchanged between two parties; **Visibility event** data tracking objects in the supply chain

A growing set of IoT applications will lead to an increasing demand for accessing and sharing data ubiquitously. Companies can implement one method or a combination of all three depending on what information they want to capture and share with trading partners and other interested parties.

Response to General Questions

1. Are the challenges and opportunities arising from IoT similar to those that governments and societies have previously addressed with existing technologies, or are they different, and if so, how?

GS1 US understands firsthand the difficulties in developing and introducing new technologies. For example, few people remember the swirl of controversy that surrounded the introduction of the barcode in retail settings. While now ubiquitous, like the IoT, at it's introduction, the bar code was hard for consumers to understand and there was widespread opposition to its use. Today, it is difficult to imagine a world without the benefits of barcodes, such as faster checkouts and the lower prices enabled by improved supply chain management. The changes implemented in the business world with relation to the barcode had far reaching implications which continue to benefit industry today. An entire ecosystem based on the identification of goods and the associated management of such information has led to complete business and supply chain transformation. We see the same development process for the IoT in retail and consumer environments.

Controversies such as those involving the introduction of barcodes in the 1970s have helped GS1 to understand the importance of broadly inclusive processes in developing appropriate and responsible policies. As an organization devoted to the development of standards that allow for global interoperability, we are convinced of the importance of requiring interoperability in the public policy domain.

a. What are the novel technological challenges presented by IoT relative to existing technological infrastructure and devices, if any? What makes them novel?

The IoT largely assumes access to reliable high speed internet, which is still lacking in more rural parts of the US. The need for infrastructure is not just in-store, but literally everywhere to ensure connectivity of IoT enabled devices. In order for the benefits of the IoT to become a reality, increased presence and reliability of internet infrastructure is needed. The fact remains that while much of the developed world enjoys easily available high speed wireless connectivity, many areas still do not.

According to a 2015 United Nations report, broadband internet is failing to reach billions of people living in the developing world, including 90% of those living in the poorest nations. The State of Broadband (http://www.broadbandcommission.org/Documents/reports/bb-annualreport2015.pdf), produced by the UN Broadband Commission also shows that 57% of the world's population, with no access to a broadband connection, is unable to leverage the economic and social benefits of the Internet.

Better access in-store and on the move not only allows consumers to interact with connected products, but also enables smart objects such as buildings, transportation vehicles, and data-collection and reporting centers to interact via the internet, providing services and system health monitoring undreamt of until now.

In addition to robust internet coverage, a method of communicating the relevant data is needed. That data must be represented accurately in many different iterations, be shareable and linkable. Given this degree of complexity and scale, it is essential that a common language for the capture and share of IoT related data, along with an agreed upon set of open, non-proprietary, standards be used. GS1 US believes that the IoT can leverage the existing common global language of business made possible through our identification, capture and share standards for product and location data.

b. What are the novel policy challenges presented by IoT relative to existing technology policy issues, if any? Why are they novel? Can existing policies and policy approaches address these new challenges, and if not, why?

Several novel policy challenges for consideration might include:

Environmental impact

With the exponential growth of connected peripheral devices that make up the IoT, consideration must be given to the environmental costs of fabrication and disposal of these devices. Can the government incentivize the development of environmentally benign manufacturing and disposal techniques for these devices and associated communication hardware?

Energy consumption issues

The peripheral connected devices; communication infrastructure, cloud data storage and analysis all require energy to function. As the number of sensors grow exponentially so too does the supporting hardware. Is the US national grid set up to meet this rising energy demand? If not, how far in the future will the energy budget no longer be balanced? Policy creation should include Department of Energy expertise to see how government can help meet this rising demand and what research and development efforts need to be prioritized.

Security and architectural issues

Security and architecture go hand in hand for developing a secure IoT. Many IoT eco-systems today are heterogeneous and there are no agreed upon best practices of implementing them. For example, a network of sensors communicating over Bluetooth may interface with another type of sensor system using unsecured Wi-Fi. Even if the Bluetooth network is secure, the loosely coupled nature of the connectivity makes the entire system only as strong as the weakest link – in this case the unsecured Wi-Fi.

Second, we strongly advocate for open standards that reflect the best architectural choices. Open architectures prevent the development of silo'ed eco-systems that don't work well together. Furthermore, they provide the crowd sourced scrutiny and consensus necessary for true security.

Test beds for bullet-proof design

The government is uniquely positioned to provide a test-bed in which to incubate and test various best practices for the IoT eco-system development. For example, the government could use one of the national parks to test various standards and architectures used to control sensors and actuators deployed in an environment. Companies could cooperate to control electronic signage, watering systems, cameras and so on — with an agency or an industrial committee chosen by the government monitoring emerging issues such as security, privacy, emerging practices and standards. Just like the internet was incubated and launched by ARPA's initiative to network computers in labs, academia and industry, so too can the government play a vital role in shaping the practical development of secure, scalable IoT systems.

c. What are the most significant new opportunities and/or benefits created by IoT, be they technological, policy, or economic?

The IoT will help businesses not only to increase their operational efficiency (e.g., by reducing waste in supply chains due to smarter cool chain monitoring), but also to ensure that the products we consume are safe, particularly in areas such as food and pharmaceuticals. IoT technologies help in the fight against counterfeiting and adulteration of products with automated collection and checking of traceability data that can be used to detect gaps and inconsistencies in the entire lifecycle of products. This allows for quickly detecting potential counterfeit products at the point of introduction into supply chains and preventing them from distribution further downstream and reaching consumers. Another example includes the use of technology for sustainability through monitoring our environment and automatically taking effective corrective action in order to reduce risks to our health. For example, sensors can be used to monitor air quality and be linked to traffic control systems that restrict or divert traffic flows if air pollution levels exceed a safe level.

The mega trend of the IoT of continuously merging the physical and digital worlds also affects consumers and their behavior. Smart phones are ubiquitously available and act as the medium for consumers to connect the physical and digital worlds. This brings the IoT into a personal context and empowers the consumer to leverage its benefits. What results is a shift from traditional "big data" thinking where companies own all the data to "consumer big data" where the consumer is able to establish and drive a dialogue with his peers, social network, brands, and retailers. The IoT has the potential to help consumers live healthier lives and enjoy smarter and faster decision-making to discover healthy and sustainable products more easily. It has the potential to increase the standard of living by adjusting our home environment automatically to our preferences, saving energy thanks to consumption feedback of smart meters and devices. It has the potential to help managing our lives better with automated tracking of spending in various dimensions (e.g., Co2 footprint, financial transaction, calories consumed, etc.) thanks to automated feedback and digital receipts.

2. The term "Internet of Things" and related concepts have been defined by multiple organizations, including parts of the U.S. Government such as NIST and the FTC, through policy briefs and reference architectures. [8] What definition(s) should we use in examining the IoT landscape and why? What is at stake in the differences between definitions of IoT? What are the strengths and limitations, if any, associated with these definitions?

There is no universally agreed upon IoT definition. Many bodies have independently designed their own interpretations. This is because the IoT is a concept rather than a specific technology and different organisations tend to define it from their perspective. Kevin Ashton, director at the time of the MIT Labs Auto-ID Center (partially funded by GS1 US,) coined the term "Internet of Things" (IoT). This term refers to a collection of technologies that enable existing Internet technologies and applications (including the World Wide Web) to interface more seamlessly with physical objects, locations, and processes happening in the real world, so that interactions in the physical world can be exchanged and used to remotely monitor operations and make them more efficient.

The Internet of Things is closely related to new technology paradigms such as pervasive computing and ubiquitous computing. A number of technologies contribute to enabling the vision of the Internet of Things. These include hardware technologies such as sensors and actuators, barcodes, radio-frequency identification (RFID) tags and readers, geolocation technologies such as GPS, as well as software technologies such as complex event processing, machine learning, machine vision technologies, data analysis, etc. While the term Internet of Things may be imperfect, it has captured public imagination everywhere. The term is sufficiently broad enough to incorporate the various iterations of related concepts under a more useful broad umbrella.

Regardless of terminology, the Internet of Things is rapidly becoming a reality, driven by the convergence of:

- Everyday use of digital connectivity and the Internet, leading to a natural expectation that all things will be "connected";
- The upwards trend in capability and the downwards trend in cost of microcontroller and communications technologies; and
- The proliferation of cloud-based data gathering, processing and dissemination platforms.

The effects of this are transformational for the implementation of systems, devices and technologies across the spectrum of application spaces – consumer/domestic, commercial, industrial, agricultural, medical, transportation and so on.

The IoT is founded on the digitalisation of the properties of things, the availability of electronic connectors on things and the ubiquitous internet communication infrastructure. We live in a global society in which citizens and products can easily move anywhere in the world within hours. Products and electronic devices are manufactured for the global marketplace. Individual citizens, typically carrying a number of electronic devices when traveling, increasingly expect connectivity to the Internet of Things wherever they go.

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Internet of Things technologies enable a much more granular view into operations in the real world. Each individual product instance can be tracked separately throughout the supply chain, allowing for access to information about its provenance, “from farm to fork” for food products, from raw ingredients and components to finished product and beyond.

The essential characteristics of IoT data are that it can contain very granular, real-time, geo-located signals about activity in the real world. This highly specific information provides for the opportunity to more efficiently balance supply and demand, whether in retail (replenishment in store and also across supply chains) or better use of transport resources (demand-responsive transport, on-demand car-pooling), or energy consumption within the home or workplace (e.g., through the use of smart meters). Fine-grained IoT traceability data can be used to make our supply chains more secure and to detect more effectively and eliminate counterfeit goods. IoT technology also includes network-connected sensors and remote processing of the data. This results in applications in healthcare and assisted living for the elderly, through the use of body sensors to remotely monitor vital signs, as well as intelligent medicine cabinets and other tools that ensure that patients take the correct dosage of medication at the prescribed times and conditions.

The impact of the IoT is progressive, impacting all sectors of trade and industry and has the potential to radically change the way companies operate. Most importantly, it has the potential to impact all individuals and the multitude of roles they fill.

4. Are there ways to divide or classify the IoT landscape to improve the precision with which public policy issues are discussed? If so, what are they, and what are the benefits or limitations of using such classifications? Examples of possible classifications of IoT could include: Consumer vs. industrial; public vs. private; device-to-device vs. human interfacing.

Evolution of Commerce

The evolution of online commerce has shifted the way business is transacted and classified in radical ways. The emergence of what GS1 US calls “The Commerce Graph” combines all of the commercial connections between products, people and places on electronic networks, including the Internet and other information exchange networks.

Today’s consumer is in the middle of a much more complicated network of businesses than ever before. Our physical and digital worlds have converged. Technology has enabled it, and consumer demand has fueled it. With each passing year, the marketing information presented to the consumer at that first moment of truth in the purchase decision is more and more likely to be digital.

For the IoT to properly function the digital representation of a product needs to be the same in potentially thousands of different places. And that digital representation needs to be updated in all locations at the same time. In addition, each of the players in the commerce graph must be able to effectively communicate with each other, regardless of their location in the world. Given the degrees of complexity and scale, it is essential that a common language and set of standards be used. It requires a common global language of business that GS1 US makes possible through identification, capture and share standards for product and location data.

As traditional commerce is increasingly altered by technology and the interconnectedness of the online age, the role of GS1 US has expanding beyond that of a standards organization dedicated to helping industry identify, capture, and share information about products and locations in the supply chain, to a true platform for commerce. Platform theory is all about the new ways of matching service and/or products with consumers and is the driving factor behind the success of companies such as Google, Amazon, and Uber.

The basic tenets of platform theory involve technology enabling value-creating interactions between producers & consumers, an open, participative infrastructure with clear governance, non-linear increase in value for each new user via network effects and leveraging a many-sided market. Examples include:

- Manufacturers, Brand owners, & Retailers
- Distributors & Operators
- Medical Devices & Healthcare Providers,
- Application Developers & Information Providers).

Platform theory with respect to the IoT is a natural application. The internet itself is the platform for which producers and consumers of all types interact in a data driven relationship to effect change in new ways. The concept of the IoT takes commerce and the idea of interaction beyond the human scale, even beyond machine to machine communication, and into the ether of products, objects, locations communicating information and then *acting* on that data independent of human intervention. Within the IoT, the classification of the "consumer" becomes much more fluid, no longer clearly defined as one party in any given transaction or with a singular goal. Both producers and consumers within the IoT can be other products, data capture & analysis facilities, replenishment services, buildings, internet and mobile applications, other platforms such as FaceBook or Google, and more traditional companies, governments, or end-consumers.

Classification

From transmitting information about the health quality of air in a smart-building based on current weather patterns, local emissions, and occupancy statistics to a central air handling management service; to transmitters fixed to public transportation keeping tabs on infrastructure status and traffic fluctuations, to an individual refrigerator ordering milk from a local grocer via a mobile application so that a parent doesn't have to make one more trip to the store, the IoT has many and diverse applications. There are many possibilities for reducing waste and energy resources in the supply chain when products can communicate autonomously to retailers that they need to be replaced.

A potential classification schema could involve a somewhat artificial separation of "supply-chain/behind the scenes" or "maintenance" activities versus "end-consumer" facing services. An example of maintenance oriented activities could be auto replenishment at the back of store level from warehouses when front of store systems alert that consumers are looking for more product. A purely consumer facing application would be more front and center in daily life such as a change in blood pressure medication being automatically sent to a consumer's home in response to an alert from an internet enabled wearable fitness tracking device. The basic concepts of supply and demand and transfer of the data are the same yet the actors and outcomes are very different.

The Need for a Flexible Model

Prematurely categorizing new technologies is often limiting potential because in the early stages of development we are unable to see the full potential and potential applications. For example, the advent of the World Wide Web (WWW) was classified into specific categories: being online, search, and email. These features have since merged across industrial, personal and business applications. If it had been determined that the WWW had to be considered differently for personal vs. business applications (as in France with Minitel), we would not have the seamless internet experience known today. Looking at specific technologies in a vacuum can result in public policies that limit creativity, opportunity and development. In the case of the Internet of Things, we should not create a new set of data management guidelines; rather good data principles should be applied across all technologies.

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As with any new technology, attempts to classify the various components into specific categories can quickly become complicated, given so many unknowns. An inherent limitation to the classification of any future technology or experience is that we are, necessarily, limited by what we know "today". This speaks to the need for a flexible model which allows for categorizing what we know or can predict, but also remaining open to the inevitable unexpected.

5. Please provide information on any current (or concluded) initiatives or research of significance that have examined or made important strides in understanding the IoT policy landscape. Why do you find this work to be significant?

The Auto-ID Labs are a network of seven academic research labs located all over the world that are working on many important research initiatives related to the IoT: http://autoidlabs.org/wordpress_website/

The Auto-ID Labs' work is important not only because it is part of world-renown engineering universities that have made key advances in "high tech", but also because meaningful debate on the future of the IoT cannot exclude other regions from the process. We would like to see government look at itself as a partner with industry and universities to drive IoT innovation.

In advancing the IoT policy landscape, GS1 has been actively engaged in the transatlantic and global dialogue. From 2009 to 2011, GS1 was the leader of an EU-funded project (gRiFS5) which explored the feasibility of coordinating IoT - related standardization activities on a global level. GS1 also participated in a second project aimed at raising awareness among industry and consumers about RFID technologies. Since 2010, the policy debate in the European Union Commission has broadened its scope to address a wide set of technologies, similar to RFID, that are generally referred to as the IoT. Here too, GS1 was an active member of the "IoT expert group" that supported the European Commission's work to identify emerging policy issues for the period 2010-2012. On a global level, GS1 was one of the founding members in 2011 of the Internet Governance Forum Dynamic Coalition on IoT7, a multi-stakeholder forum aimed at fostering dialogue between the public and private sector on policies to promote development of the IoT. We mention this work because we cannot stress too much the importance of global stakeholder and industry engagement.

Response to Technology Questions

6. What technological issues may hinder the development of IoT, if any?

a. Examples of possible technical issues could include:

i. Interoperability

There is a strong need for global standardization to reduce region-specific barriers to adoption. These measures also aid in avoiding mistakes made in numerous other areas such as the lack of harmonization on radio spectrum (frequency bands and protocols) for mobile phone traffic, the lack of global standards for mains, power sockets and plugs, and region-coding of DVDs. These type of regional divergence and proprietary standards hinder adoption by increasing cost and complexity for end-users.

We must encourage open discussion and global cooperation on the standardization required for successful implementation and usage of the Internet of Things. Significant progress has been made over the last 10 years through the efforts of the global GS1 community to develop freely available open standards for networked RFID, unique identification, and supply chain information exchange. These standards have been supported by commercial hardware and software implementations and open source initiatives such as the Fosstrak (https://fosstrak.github.io/) project.

The IoT is all about integrating multiple disciplines, e.g. sensors, RFID, networks, cloud, security, information technology, etc. These different technologies are largely standardised, but have been considered separately. A reference architecture is an essential foundation to enable integrating the diverse technologies into IoT applications.

The integration of multiple technologies in IoT applications requires a high-level of interoperability between the various components. This is a critical factor to enable IoT applications to develop and to proliferate. The stumbling blocks will not be the lack of standards but at the contrary the fact that too many standards are available, leading to difficult choices to be made when designing IoT applications. These difficulties may often be exacerbated by the defensive attitude of solution providers willing to protect their market and thus not necessarily motivated to adopt open standards and to pursue fully interoperable solutions. It is thus important that end users contemplating IoT applications to include the need for open standards and interoperability in their list of requirements.

iv. Availability of network infrastructure

IoT related architecture needs to ensure that any object can be seamlessly identified across industries and domains, and that data can be exchanged in an interoperable, unambiguous, and scalable manner. Today, these requirements are typically addressed with local, technology vendor-specific closed-loop schemes. Therefore, a critical factor in enabling the IoT will be the availability of global standards for identification, data capture, and sharing for hardware, software, and application infrastructure.

On the hardware level, the key driver is the on-going need for miniaturization and availability of low-cost labels, tags, and sensor networks with ever increasing computing power. These sensors represent the nerve endings of the IoT and enable things to act smarter than those that have not been tagged. Take, for instance, the problem of pervasive sensor design. In order for sensors to be pervasively deployed in an environment, they must be cost effective. Prices in microelectronics continue to drop every day, but we are still not at the point where it is economically viable to monitor the temperature of every frozen carton in the cold chain with a conventional wireless sensor. Imagine the possibilities if this depth of monitoring became cost efficient.

On the software level, new methods for collecting, aggregating, storing, interpreting, visualizing, and sharing the massive data sets generated by sensors are the future. Smart analytics are the key to leveraging the power of sensor data for businesses and consumers to derive actionable insights in the right context. In order to enable IoT analytics, global standards for linked open data are required to distribute this information in a machine- readable and interoperable way through the internet.

Software application developers will be able to leverage linked data to combine data from multiple sources in order to add contextual information. For example, open mapping data can be combined with geospatial data in web pages and real-time observation data from GPS, RFID, or scanned QR codes to build augmented reality applications. This will allow people to discover additional relevant information about their immediate surroundings, local businesses, local events, exhibitions, etc.

Last but not least, interfaces and user-driven standards for empowering consumers to leverage the IoT in a powerful way are required. While the IoT in principle is able to manage complex systems semi- or even fully-autonomously, users need tools to be involved for decision-making and control via their smart phones or personal computers.

v. Other

b. What can the government do, if anything, to help mitigate these technical issues? Where may government/private sector partnership be beneficial?

Government and private sector/industry can benefit significantly by partnering on the issues facing us in the IoT future. GS1 US urges government to leverage existing standards used by industry in the data identification, capture, and share standardization space. To create new standards would introduce a level of confusion into existing commerce systems that would all but guarantee the failure of the well-intentioned attempts to govern the IoT.

Additionally, in order to succeed, the IoT governance platform must be sufficiently open to allow value for all parties to be recognized. GS1 US believes strongly in the power of bringing representatives of all stakeholders to the table when discussing problems facing industry in order to encourage a wide array of perspectives and ultimately craft a sustainable solution which benefits all players. Only then will true engagement, adoption, and actual usage of any solution occur.

Response to Infrastructure Questions

8. How will IoT place demands on existing infrastructure architectures, business models, or stability?

Pervasive, mobile-accessible internet coverage is critical to the success of the IoT. This enables sensors or readers to easily transmit data to the cloud, from which monitoring authorities or the public could access them. In areas where Wi-Fi coverage is not an option, advances in power harvesting devices and batteries could be utilized to boost sensor communication range. Use might also be made of “data mules” to gather data from sensors outside the “read range.” For example, a reader mounted on a janitor’s cart would allow for the daily monitoring of short-range passive air quality sensors in all rooms of a building. Similarly, readers mounted underneath a railway engine could be used to periodically monitor concrete railroad ties for strain and cracks.

Information from sensors can also be used for monitoring perishable goods such as fresh food products, as well as public infrastructure such as bridges, tunnels etc. to look for signals that give an early warning of degradation, spoilage, or the need for maintenance or intervention. However, sensor data is much more complex than simple observation data when barcodes or RFID tags are read at different locations. Not only are there a wide variety of different properties that can be sensed (e.g., light levels, humidity, concentration of gases, vibrations), it is sometimes necessary to “smooth” the data in order to extract the most meaningful interpretations. To realize the goal of effective standards for seamless identification, capture, and sharing of information about physical objects and activities in the real world in an IoT, GS1 and the Auto-ID Labs are collaborating with established organizations including the Sensor Web enablement architecture from the open geospatial Consortium and the Semantic Sensor network activity within W3C.

Response to Economy Questions

13. What impact will the proliferation of IoT have on industrial practices, for example, advanced manufacturing, supply chains, or agriculture?

The proliferation of IoT related technologies and capabilities is already creating a major impact in many areas of current industrial practices. For example, enhanced sensor technology such as the ability to affix RFID tags to metal and liquid substances, waterproof RFID tags, and cold chain tag ability combined with dramatically falling RFID tag costs and cloud based track and trace platforms all work together to allow industry to capture and share real time information across value chains.

In the retail supply chain, mobile applications to trace product pedigree and validate authenticity claims combined with product and promotion information available to the consumer is revolutionizing the in-store and mobile shopping experience. Item level tagging allows for automated shelf availability, enhanced inventory accuracy and works to combat shoplifting. Cloud based point of sale (POS) systems provide instant sales information to the business while intelligent retail kiosks offer higher levels of customer satisfaction for the consumer.

In Food & Beverage supply chains, RFID tank management improves asset management and goods deliveries. RFID enabled wine cellar systems allow for cross border inventory tracking, regulatory compliance, and complete product visibility. From a consumer safety perspective, Hong Kong restaurants are employing RFID tags on sushi plates to ensure product freshness.

From a logistics perspective, the IoT is enhancing fleet management in air cargo terminals, beverage operations, and transportation systems. GPS based ePOD (electronic proof of delivery) is ensuring product deliveries, while e-lock applications are facilitating cross border logistics and risk assessments.

The GS1 Blue Number initiative with the United Nations gives an identification number to the very first link in the supply chain, farmers of small agricultural plots in emerging economies. This first step of identification gives access to the number of farmers in particular locations and their methods of production. We envision a future where monitoring devices linked to mobile communications will ease sustainability compliance and reporting by demonstrating compliance with national and international voluntary standards, as well as charting a path to improved performance. IoT applications will help these small farmers manage and communicate their sustainable supply chain commitments to consumers continents away.

a. What will be the benefits, if any?

The benefits of the IoT are as diverse as the applications but some of the overriding benefits include increased efficiencies for business, much greater access to and control over information about products, services, and experiences for consumers, and greater insight to and ability to influence in areas of regulatory interest for government.

b. What will be the challenges, if any?

Potential challenges are many including infrastructure challenges and data ownership issues. Additionally, as we have seen with the explosion of the internet and greater access for the consumer to information about products, services, and experiences they purchase and consume, the more access there is, the more information is required. At some point, the drive for more information and control begins to degrade the quality of the experience overall and inhibits business and government from effectively providing safe products in a sustainable way.

c. What role or actions should the Department of Commerce and, more generally, the federal government take in response to these challenges, if any?

The federal government can have a positive impact on both industry and the consumer by crafting policy that provides the information consumers are demanding that can be implemented in a structured, standardized process, enabling industry to comply in a sustainable way.

With the advent and entrenchment of IoT applications into our daily lives, these challenges will become commonplace. Government, industry, and consumers must work together to manage demands, expectations, and implementation of sustainable ways to meet the needs of all parties. Standardized data, attributes, and processes are critical to making the ongoing management of the IoT successful.

Response to Policy Issues Questions

***Policy Issues:* A growing dependence on embedded devices in all aspects of life raises questions about the confidentiality of personal data, the integrity of operations, and the availability and resiliency of critical services.**

17. How should the government address or respond to privacy concerns about IoT?

Any efforts to address privacy concerns should be technology neutral and should only focus on the principles for data use and in what context they should be applied. Government should not focus on the underlying devices or technology enabling those devices.

IoT technologies transcend political boundaries and will only deliver their true potential if policymakers are able to engage with all relevant stakeholders to identify a global framework of principles that can address societal expectations. International cooperation efforts offer convincing examples of how such principles could be developed. The World Summit on information Society organized by the UN and the ensuing Internet Governance Forum have not only significantly contributed to a better understanding of the opportunities and challenges of such a transformative technology but, perhaps even more significantly, have contributed to shaping innovative policy-making approaches. Established international platforms for regulatory cooperation would provide an ideal means to develop a truly global approach to the IoT. The Transatlantic Economic Council, the OECD, APEC, and ASEAN could lead international coordination where new standards are needed (e.g., in areas of privacy, confidentiality, and usage of data, etc.) as well as exploring innovative approaches to new radio spectrum allocation.

New regulation inevitably trails innovation and barely supports current business models. A principal based approach encourages innovation by allowing for a flexible response and accountability. GS1 has experience pulling all stakeholders together to develop principal based approaches. Examples include our work to develop global privacy guidelines for Electronic Product Code (EPC) RFID applications and a free Privacy Impact Assessment online tool. GS1 led the stakeholder group that developed a PIA tool that was endorsed by the European Union member states' privacy commissioners, the Article 29 Working Party. We also participated in the European Commission's RFID and IoT Expert Groups as part of our commitment to a transatlantic dialogue.

Response to International Engagement Questions

20. What factors should the Department consider in its international engagement in?

a. Standards and specification organizations?

Throughout the vast array of potential IoT applications, there is one common dependency – the integrity and usability of data. The data required is not just big data, but quality data, which must be accurate, complete, timely, and relevant in order to be of use to the consumer, trading partners and government.

Quality data is sharable and linkable, so that all the relevant and related information, such as images and reviews, can be aggregated for consumers, customers and patients. To be sharable and linkable, data must be globally standardized.

The changes coming with the world of the IoT are already disrupting the way companies do business. At GS1, we help industry leaders see opportunity in disruption and collaborate to deliver better outcomes for everyone in industry. This is where standards come in. When industry agrees on standards, they are free to invest more resources into understanding insights that create competitive advantage. We believe this benefit extends to all parties within the IoT space and we urge government parties to leverage the work already in play by industry to harness the power of data identification, capture, and use standards in the next wave of technology enabled commerce.

GS1's unique role is to bring communities together to create standards. We are a neutral not-for-profit that is inclusive and collaborative. Our organization is global but we have strong local footprints through our member organizations. GS1 standards are governed by users and designed to meet their unique needs.

GS1 & Other Organizations

GS1 enjoys strong working partnerships and alliances with a variety of trade associations, governmental organizations and standards bodies, including:

- AIM Global: The Association for Automatic Identification and Mobility
- ANSI
- HL7: Health Level 7
- ICCBBA: The International Council for Commonality in Blood Bank Automation
- ISBN: International Standard Book Number
- ISSN: International Standard Serial Number
- ISO: The International Organization for Standardization
- UN/CEFACT: The United Nations Centre for Trade Facilitation and Electronic Business
- WCO: The World Customs Organization
- WHO: The World Health Organization

GS1's working relationship with ISO, the International Organization for Standardization, is a particularly long and active one. ISO is the world's largest developer of standards. Headquartered in Geneva, it represents 158 national standard bodies: one per member country. A number of GS1 staff members participate actively in ISO standard development committees, or even serve as their Chair or secretariat.

GS1 is the secretariat for ISO/IEC JTC1/SC31 which handles bar code and RFID standards. In that role, GS1 also has a liaison to ISO TC68 which handles financial services standards. Within JTC1 GS1 has status as an "approved reference specification originator organization" (ARO) allowing ISO/IEC standards to incorporate GS1 standards by reference. GS1 is also approved to use the "PAS Process" which allows GS1 standards to be published as ISO/IEC standards through a simple approval process. There are several examples of GS1 standards that have been simultaneously published as ISO standards.

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Summary

As we look across the various needs and applications of the Internet of Things, there is one common need – the integrity and usability of data. It's not just about big data, it's about quality data – for the consumer, trading partners and government.

Quality data must be tied to a uniquely identified object, location, service, or idea. It must then be sharable and linkable, so that all the relevant and related information, such as images and reviews, transmissions from one product to another, real-time information such as traffic, infrastructure health, transportation related data, etc. can be aggregated and put into real use for applications, consumers, customers, patients, and government users. To be sharable and linkable, that data has to be standardized.

GS1 Standards provide unique identification of products, objects, locations, and services; capture of relevant information about the identified object, and a methodology for safe and efficient sharing of that quality data to all interested parties via a common vocabulary known as the global language of business. GS1 Standards are extensible across industries, providing a sustainable solution past the commercial sector, including such sectors as healthcare, industrial products and the defense industry. These standards and the associated processes and methodologies for communication of data are easily transferable into the burgeoning IoT space.

GS1 believes that its 40 years' experience in providing globally unique identification and its 10 years' experience in providing global registration and dissemination of reference data for over 13 million products, legal entities, and other business objects is directly applicable to NTIA's work in the future of the IoT.

Attachments

1. GS1 US Annual Overview (https://www.gs1us.org/about-gs1-us/corporate/annual-overview)
2. GS1 FTC IoT Submission (https://www.ftc.gov/policy/public-comments/initiative-484)

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About GS1

GS1® is a neutral, not-for-profit, global organization that develops and maintains the most widely-used supply chain standards system in the world. GS1 Standards improve the efficiency, safety, and visibility of supply chains across multiple sectors. With local Member Organizations in over 110 countries, GS1 engages with communities of trading partners, industry organizations, governments, and technology providers to understand and respond to their business needs through the adoption and implementation of global standards. GS1 is driven by over a million user companies, which execute more than six billion transactions daily in 150 countries using GS1 Standards.

About GS1 US

GS1 US is a not-for-profit member organization established over 35 years ago by the grocery industry to administer and manage Universal Product Codes, also known as U.P.C.'s. The U.P.C. remains one of the most successful standards in history – with billions of barcodes scanned daily worldwide. This method of identifying products and capturing product data has evolved into what is now known as the GS1 System, the world's most widely used supply chain standards, which include:

- globally-unique numbering formats (identification numbers) for identifying supply chain objects;
- barcodes and radio frequency identification (RFID) for capturing identification numbers; and
- data synchronization and electronic information exchange for sharing data.

GS1 US brings industry communities together to solve supply chain problems through the adoption and implementation of GS1 Standards. More than 300,000 businesses in 25 industries rely on GS1 US for trading partner collaboration and for maximizing the cost-effectiveness, speed, visibility, security and sustainability of their business processes using GS1 Standards. GS1 US also manages the United Nations Standard Products and Services Code® (UNSPSC®). Some of the world's largest corporations participate in our boards and work groups, motivated by the knowledge that GS1 Standards help their companies reduce costs and increase both the visibility and security of their supply chains.

GS1 US is not:

- a software provider
- a hardware provider
- a commercial solutions provider
- a technology company
- a government agency

GS1 US is a local member organization of GS1®, a global information standards organization that has been recognized as a voluntary, consensus standards body pursuant to OMB Circular A-119. GS1 has been accredited by the FDA as an Issuing Agency for the assignment of UDIs in the context of the U.S. FDA Unique Device Identification System, and GS1 US serves as the first point of contact for the FDA. In addition, GS1 US works with and actively supports numerous federal government entities, including:

Department of Agriculture (USDA)
Department of Commerce (DOC)
Department of Defense (DOD)
Department of Homeland Security (DHS)
Department of Justice (DOJ)
Department of State
Department of the Treasury (DOT)
Department of Veteran Affairs (VA)
Commodity Futures Trading Commission (CFTC)
Consumer Product Safety Commission (CPSC)
Customs & Border Protection (CBP)
Environmental Protection Agency (EPA)
Federal Communications Commission (FCC)
Federal Deposit Insurance Corporation (FDIC)
Federal Trade Commission (FTC)
Food and Drug Administration (FDA)
National Aeronautics & Space Administration (NASA)
Securities & Exchange Commission (SEC)
United States Postal Service (USPS)
National Institute of Standards & Technology (NIST)
United States Congress
United States Trade Representative (USTR)

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