Standards Development in the Internet of Things

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Introduction

While the Internet of Things (IoT) does not have a single, widely-accepted definition, it can be described as a growing set of objects, or "things," that might include tags, sensors, and a variety of devices that interact with each other and with distributed software applications. IoT is the application domain of Machine to Machine (M2M) communications, which provides the plumbing that enables the IoT ecosystem.[1] The IoT will comprise tens to hundreds of billions of heterogeneous and pervasive objects.[2] These objects will have limited capacity, be uniquely addressable, and become increasingly intelligent and autonomous.

Today's IoT industry is in its infancy, with proprietary vertical silos using multiple communication stacks that are tightly coupled and embedded along with nonstandard constrained devices.[3] This currently prevents devices and objects in the IoT from communicating with one another across multiple and diverse platforms. Industry Standards groups are working to provide a cohesive set of standards to enable global M2M interoperability for the IoT. De facto standards will encourage companies to make more significant investments in the IoT and will spur its growth. Until then, for several years, M2M applications will remain limited to proprietary implementations with incomplete value chains and will lack interoperable cross-market applications. Over the next three to five years, standards development and adoption will lead toward industry evolution and maturity.

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[1] Eric N. Barnhart, P.E. and Charles A. Bokath, "Considerations for Machine-to-Machine Communications Architecture and Security Standardization", http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6156367 (2012).

[2] Constantine A. Valhouli, "The Internet of things: Networked objects and smart devices", The Hammersmith Group, http://thehammersmithgroup.com/images/reports/networked_objects.pdf, (2010).

[3] Stuart Revell, "Machine to Machine Communications (M2M) Challenges and opportunities", https://connect.innovateuk.org/documents/3077922/3726367/IoT+Challenges,%20final+paper,%20April+2013.pdf/38cc8448-6f8f-4f54-b8fd-3babed877d1a, (2013)

Industry Investment in the Internet of Things

'C-level' executives eagerly anticipate getting a slice of the projected $14.4 trillion global market,[4] but often find M2M adoption challenging in the current landscape. According to executives, the greatest accelerant to IoT investments are broadly adopted interoperable standards that result in a well-connected value chain.[5] Without a well-connected value chain, companies are unable to produce sustainable business models that can support the forecasted revenue opportunities. Other considerations like competing interests across industry participants and protection of intellectual property also are complicating development of IoT. Additionally, thus far corporations have been unable to find within today's fragmented IoT market quick wins that might boost confidence in M2M platform solutions and spur more investment in IoT technologies. As a result, while global corporations' investments are spurring innovations in M2M and IoT, they have been limited while standards are being developed and the promises of savings and efficiencies may be far off. When companies invest, they need to convince several layers of management that an investment proposal makes sense, which has slowed sales cycles.[6]

Global Standardization for the Internet of Things

Standardization is the accelerant that lowers operating and capital expenses, speeds up time to market, and simplifies application development.[7] The IoT market requires strong industry standards to promote long-term technology investments.[8] Standards are the building blocks that allow different elements within the IoT to evolve and innovate while maintaining interoperability and service delivery.

In Standards Development Organizations (SDOs), typical development cycles have many steps, including Initiating, Mobilizing the Workgroup, Drafting the Standard, Balloting the Standard,

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[4] Joseph Bradley, Joel Barbier, Doug Handler, "Embracing the Internet of Everything To Capture your share of $14.4 Trillion", http://www.cisco.com/web/about/ac79/docs/innov/IoE_Economy.pdf#page=1, 2013, Cisco.

[5] Value chains are the building block components within a vertical application that cohesively link devices, data networks, platforms and applications creating an end to end interoperable IoT solution.

[6] David Wood, "Breakthroughs with M2M: moving beyond the false starts", http://dw2blog.com/2013/05/18/breakthroughs-with-m2m-moving-beyond-the-false-starts, 2013.

[7] Eric Klein, "M2M and the Importance of Standards", http://www.vdcresearch.com/maw/13_EMOB_MAW_View_July_M2MStandards_EK_1.pdf, 2013, VDC Research.

[8] Emmanuel Darmoius and Omar Elloumi, "M2M Communications: A Systems Approach", (Wiley; 1 edition April 30, 2012) .

and Gaining Final Approval. Under ideal circumstances, this multi-step process takes approximately 12 to 18 months, though in a difficult standards cycle, it can take as long as 48 months.[9]

Devices in the IoT are often constrained in memory, processing capacity, and size. Just as important, IoT devices will vary in capacity depending on their vertical applications. These constraints and capacity variabilities generate more potential requirements and options for standards. SDOs must consider stakeholders' differing opinions on these requirements and options, which makes IoT standard-setting uniquely more time consuming than it is for other standards processes.[10]

Presently, many organizations have a direct or indirect interest in M2M standardization.[11] Participants in standardization review processes work very hard to accommodate different industry sectors' competing requests, agendas, and goals, but the industry is still currently fragmented.[12]

To address the fragmentation, seven global regional SDOs have partnered to create a unified global standards body, oneM2M, that is designed to drive global acceptance of the technology.[13] However, oneM2M is not slated to deliver a first release of a limited M2M technical specification until late 2014.[14]

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[9] "Develop Standards", http://standards.ieee.org/develop/process.html, IEEE-SA

[10] For instance, working groups such as the Internet Engineering Task Force (IETF) are introducing new protocols that attempt to solve the constrained issue in networking. New companies, such as Jasper, are working on providing efficient data transit capabilities through AT&T's network. Software companies are creating platforms to interoperate with various networking technologies. Enhanced Service Delivery Platform (SDP) organizations, such as the ALLSEEN Alliance and M2M Industry Working Group, need to interoperate with the multitude of application protocols based on capabilities of the device.

[11] "GSC MSTF preliminary list of global organizations, groups, associations and other entities with a direct or indirect interest in machine-to-machine (M2M) standardization", http://www.tiaonline.org/standards/mstf/documents/Global_M2M_Standardization_Task_Force-M2M_Activity_Mapping_GSC-16_Report_Halifax_rev2_0.pdf, October, 2011.

[12] Mike Bushong, "More on Open: Standards", http://www.plexxi.com/2013/06/more-on-open-standards/#sthash.KGs995bL.dpbs, 2013, Plexxi Inc.

[13] Eric Klein, "M2M and the Importance of Standards", http://www.vdcresearch.com/maw/13_EMOB_MAW_View_July_M2MStandards_EK_1.pdf, 2013, VDC Research.

[14] "oneM2M WI-0003 Roles and Focus Areas", http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CC4QFjAA&url=ftp%3A%2F%2Fftp.onem2m.org%2FWork%2520Programme%2FWI0003%2FoneM2M-WI-0003-VocabPrinciples-

In addition to oneM2M, other SDOs,[15] industry working groups,[16] and government agencies[17] are working on and publishing their own updates on multiple proprietary architectures, security schemes, and communication protocols. Dozens of other organizations are creating new or adapting proposed standards based on their own interests or geographic technical or legal requirements.[18] Global industry has the resources and motivation to work through the complexities, but it will take time.

Development of Inter-Standards Middleware

Although the establishment of standards is necessary for market acceleration, true interoperability will be realized through middleware (inter-standards "glue") that fills the gaps between standards that do not fully meet the needs of the market.[19] After the standards have been defined, IoT platform vendors will need to develop middleware to create interoperability between each of the technologies defined by SDO-ratified standards. The development of middleware will add as much as 18 to 24 months to the standards development cycles.

V1_2.DOC&ei=n_LKUvamIZC_kQeTtIDACQ&usg=AFQjCNFk_UsX-DlvzLOShPQ339Tn-Kqxbg&sig2=gkYhkOFGp62N5nHqNaktQA&bvm=bv.58187178,d.eW0, 2013, oneM2M Work Programme.

[15] Examples include Internet Engineering Task Force; Association of Computing Machinery (ACM); Third Generation Partnership Project 2 (3GPP2); Inter-American Telecommunication Commission; Internet Protocol for smart object communications (IPSO); Organization for the Advancement of Structured Information Standards; Open DeviceNet Vendors Association; and Open Services Gateway Initiative (OSGi).

[16] Examples include M2M Industry Working Group (M2MIWG); ALLSEEN Alliance; Open Services Gateway Initiative (OSGi) Alliance; SIM Alliance; Zigbee Alliance; Continua Alliance; and Weightless Special Interest Group.

[17] Examples include U.S. National Institute of Standards and Technology (NIST); U.S. National Science Foundation (NSF); ICT Standards Advisory Council of Canada (ISACC); Administration of Quality Supervision, Inspection & Quarantine of the People's Republic of China (AQSIQ); and International Organization for Standardization (ISO).

[18] Examples of other organizations include International Telecommunications Union (ITU); M2M Standardization Task Force *(*MSTF); Internet Protocol for Smart Object Communications (IPSO); Telecommunications Industry Association (TIA); CDMA Development Group (CDG); GSM Association (GSMA); Open Mobile Alliance (OMA); Institute of Electrical and Electronics Engineers (IEEE); Association of Radio Industries and Businesses (ARIB); Alliance for Telecommunications Industry Solutions (ATIS); and China Communication Standardization Association (CCSA)

[19]Sean Horan "4 Reasons to Justify M2M Middleware Solutions", http://networkingexchangeblog.att.com/enterprise-business/4-reasons-to-justify-m2m-middleware-solutions/, 2012, AT&T.

Realization of Value Chains and the IoT Ecosystem

The creation of standards promotes the development of IoT value chains; value chains provide functional components or building blocks that when combined with middleware enable a cohesive, end-to-end M2M solution.[20] Five key segments of a value chain – devices, network, delivery platform, applications, and customers – provide critical services that need to interoperate across the segments' functional lines in a standard process.[21] Although standards provide the bedrock to interconnect the segments, cross-industry efforts will be needed to connect all the segments of a value chain and allow companies to support IoT and address every day, real-world scenarios. A connected value chain will enable vertical markets to grow and flourish. When the vertical markets are able to *interoperate* across industries' horizontal market segments, then a global IoT ecosystem can be established.[22]

Conclusion

Today's connected devices operate in proprietary technology silos. Development of standards and middleware will drive greater investment in the IoT. A realistic horizon for cross-sector interoperable standards and middleware in the global IoT ecosystem is three to five years.

[20] Emerson, Bob, "M2M: the Internet of 50 Billion Devices", http://m2m.com/servlet/JiveServlet/downloadBody/1043-102-1-1033/M2M_Magazine_The_internet_of_50_billion_devices.pdf#page=1, 2012, M2M Magazine.

[21] David Escandon , "A QNX Neutrino Primer of Embedded Designers, Part One" http://www.arrownac.com/solutions-applications/embedded/eblog/?q=node/58, 2013, Arrownac Inc.

[22] A vertical market is a set of services that are available to M2M applications within one industry segment that satisfy one or all the components of the IoT value chain. Two examples would be *Asset Tracking* and *Automotive Vehicle-Vehicle*, which are services that incorporate diagnostic, location and monitoring systems. A horizontal market is a coherent framework that is valid across a large variety of business domains, networks, and devices; it is a set of technologies, architectures, and processes that will interoperate across market segments.

ABOUT

Besides starting and operating Blind Tiger Communications, Chuck Bokath is a Senior Research Engineer at the Information and Communications Laboratory at the Georgia Tech Research Institute, working largely in the cyber-security and commercial wireless industries. Mr. Bokath has 25 years experience in the wireless telecom, forensics and security industries. Mr. Bokath has been interviewed and has spoken as a subject matter expert on privacy, exploitation, cyber-security within the commercial mobile wireless industry in numerous seminars, tradeshows, newspapers, and radio programs, including the New York Times, CBS Radio, and CNN.

Mr. Bokath is the Cyber-security Chair of the North American Standards Body, TIA, and has authored several standards for the Machine to Machine ecosystem within that organization. Mr. Bokath has entered security contributions to the oneM2M global standards development organizations, which are currently pending adoption. Additional standards work includes member of the North American TIA delegation to the Global Standards Delegation, member of the Georgia Tech M2M Delegation to ITU M2M Focus Group, and expert contributor for creation of the Java Wireless Messaging Standard (JSR-120).

Mr. Bokath founded Blind Tiger Communications to solve a problem in the majority of the nation's prisons: smuggling and use of illicit use of mobile devices to threaten, launder money, and continue operate unlawful businesses inside prison walls. Mr. Bokath has used his intimate knowledge in the cyber security and wireless industries to create Mobile Soap - a wireless managed access system to detect, defeat, and collect data from these illicit mobile devices.