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Via Electronic Filing

Dr. Robert Bohn
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Re: Comments to NIST *U.S. Government Cloud Computing Technology Roadmap, Release 1.0 (SP 500-293)*, Volume I *(High-Priority Requirements to Further USG Agency Cloud Computing Adoption)* and II *(Useful Information for Cloud Adopters)*

Submission of TIA's *White Paper on Cloud Computing* for Inclusion into the NIST *U.S. Government Cloud Computing Technology Roadmap, Release 1.0 (SP 500-293)*.

Dear Dr. Bohn:

The Telecommunications Industry Association (TIA) hereby submits comment on the National Institute of Standards & Technology's (NIST) *U.S. Government Cloud Computing Technology Roadmap, Release 1.0 (SP 500-293)* (NIST Cloud Roadmap).[1] As described below, TIA strongly supports NIST efforts to help ensure that technical standards, guidance, and research work are focused on the most appropriate priorities, not only to NIST and the United States Government (USG) at large, but also to others who are building and deploying cloud technology. The effort underway by NIST is clearly critical in defining and shaping the general understanding of the cloud and its potential, and is consistent with the Administration's Federal Cloud Computing Strategy.[2] TIA particularly applauds the NIST request for input that "refine[s] the requirements and identif[ies] relevant work which is under way."[3] Gaining input from

[1] National Institute of Standards & Technology, *US Government Cloud Computing Technology Roadmap Release 1.0 (Draft)*, SP 500-293, Nov. 2011 (NIST Cloud Roadmap).

[2] Office of Management and Budget, U.S. Chief Information Officer, Federal Cloud Computing Strategy, Feb. 8, 2011, *available at* www.cio.gov/documents/Federal-Cloud-Computing-Strategy.pdf.

[3] NIST Cloud Roadmap at 10.

organizations already involved in cloud technology deployment through a transparent process that includes the opportunity for public comment will enable as efficient an implementation as possible for the USG in its continued effort to adopt cloud technologies and realize its benefits.

TIA represents a large number of information and communications technology (ICT) companies and organizations in standards, government affairs, and market intelligence. A major function of TIA is the writing and maintenance of voluntary industry standards and specifications, as well as the formulation of technical positions for presentation on behalf of the United States in certain international standards fora. TIA is accredited by American National Standards Institute (ANSI) to develop voluntary industry standards for a wide variety of telecommunications products and sponsors more than 70 standards formulating committees. These committees are made up of over 1,000 volunteer participants, including representatives from manufacturers of telecommunications equipment, service providers and end-users, including the government.

TIA is and has been a standards-setting organization (SSO) since its inception in 1988, and is one of the largest SSOs accredited by ANSI. TIA's standards development activities have both a national and global reach and impact. TIA is one of the founding partners, and also serves as Secretariat for, 3GPP2 (a consortium of five SSOs in the U.S., Japan, Korea, and China with more than 65 member companies) which is engaged in drafting future-oriented wireless communications standards.[4] TIA also is active in the formulation of United States positions on technical and policy issues, administering four International Secretariats and 16 U.S. Technical Advisory Groups (TAGs) to international technical standards committees at the International Electrotechnical Commission (IEC), and is the International Secretariat and US TAG Administrator for the International Organization for Standardization (ISO) Technical Committee (TC) 204 on Intelligent Transportation Systems

TIA’s members and others come to TIA to develop standards that promote efficiency and interoperability, enhancing industry collaboration to solve market-driven demands and customer needs. This enables access to new technologies and markets, helps diffuse innovative solutions across the industry while maintaining respect for intellectual property rights and supporting

[4] *See* 3GPP2, About 3GPP2, *available at* http://www.3gpp2.org/Public_html/Misc/AboutHome.cfm.

incentives for companies to further invest in related research and development (R&D). TIA's process also creates opportunities for further competition among differentiated implementations and products, which provides stimulus for more innovation and choice for customers and users. The member companies and other stakeholders participating in the efforts of these committees and sub-groups have produced more than 3,000 standards and technical papers that are used by companies and governments to produce interoperable products around the world.[5]

In the NIST Cloud Roadmap, NIST lists as its first "high priority" a requirement for "[i]nternational voluntary consensus-based interoperability, portability, and security standards (interoperability, portability, and security standards)."[6] TIA believes that through engagement in existing voluntary and consensus-based processes – which will naturally include detailed study to ensure that interoperability, portability and security (among other) concerns are fully addressed – the cloud goals of the USG can most effectively and resource-efficiently be realized. Through engagement in the standards development process, NIST (along with other USG representatives) and industry and other stakeholders will be able to collaborate and work together within the ANSI-approved processes to study issues critical to those engaged in the process, and resolve them in a streamlined and cost-efficient setting.

As detailed in the appended *TIA White Paper on Cloud Computing*,[7] an effort has recently been launched by TIA in the development of standards related to cloud adoption, and is directly relevant to NIST's efforts in this matter. The *TIA White Paper on Cloud Computing* investigates which TIA standards have potential interactions with clouds and proposes a strategy for acquiring the expertise to address interoperability issues between those standards and cloud standards. The various TIA committees[8] under consideration include TR-42 Telecommunications Cabling Systems, TR-45 Mobile and Personal Communications Systems Standards, TR-48 Vehicular

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[5] TIA standards are available from IHS Inc. *See* http://www.ihs.com/.

[6] NIST Cloud Roadmap at 11.

[7] TIA, *White Paper on Cloud Computing*, Aug. 18, 2011, *available at* http://www.tiaonline.org/standards/TIA_Cloud_Computing_White_Paper.pdf

[8] TIA publishes an annual report that includes the latest actions taken by each respective TIA engineering committee toward the development of standards for the advancement of global communications. *See* TIA, Standards & Technology Annual Report (September 2010), *available at* http://tiaonline.org/standards/about/documents/StarReport_09-10.pdf.

Telematics, TR-49 Healthcare ICT, TR-50 Smart Device Communications, and TR-51 Smart Utility Networks. These committees have the technical expertise relevant to their specific needs and are currently considering how products built to their standards will interact with cloud services, and thus how their standards will inter-operate with cloud standards. Pursuant to the NIST solicitation for information on work already underway, TIA has appended its *White Paper on Cloud Computing* to this submission for inclusion and/or reference in further drafts of the NIST Cloud Roadmap, and requests that NIST include any necessary references to it in any further drafts of the NIST Cloud Roadmap.

TIA therefore believes that it is critical that NIST and other USG representatives engage in the development of voluntary, consensus-based standards, and encourages such engagement as soon as possible. Aside from the benefits of engagement in an ANSI-accredited standardization process such as TIA's,[9] engagement by the USG (and NIST in particular) in the development of relevant standards will bolster the integrity of resulting standards, and result in increased adoption. This benefits all stakeholders involved in the standard development process, and would particularly benefit NIST in enabling widespread reliance on the priorities stated in its roadmap document. NIST will find that realizing each of its "high priorities" noted in the draft document will be more easily attained through engagement in such a standards development process.

For example, through engagement with TIA in the development of cloud standards, NIST could ensure that its priorities are reflected in crucial, widely-used standards such as TIA-942 (Telecommunications Infrastructure Standard for Data Centers). The purpose of this Standard is to provide requirements and guidelines for the design and installation of a data center or computer room. It is intended for use by designers who need a comprehensive understanding of the data center design including the facility planning, the cabling system, and the network design. The standard enables the data center design to be considered early in the building development

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[9] Such benefits include, but are not limited to: consensus must be reached by representatives from materially affected and interested parties, standards are required to undergo public reviews when any member of the public may submit comments, comments from the consensus body and public review commenters must be responded to in good faith, and an appeals process is required. *See* ANSI, *ANSI Essential Requirements: Due process requirements for American National Standards* (Jan. 2010), *available at* http://publicaa.ansi.org/sites/apdl/Documents/Standards%20Activities/American%20National%20Standards/Procedures,%20Guides,%20and%20Forms/2010%20ANSI%20Essential%20Requirements%20and%20Related/2010%20ANSI%20Essential%20Requirements.pdf.

process, contributing to the architectural considerations, by providing information that cuts across the multidisciplinary design efforts; promoting cooperation in the design and construction phases. Adequate planning during building construction or renovation is significantly less expensive and less disruptive than after the facility is operational. Data centers in particular can benefit from infrastructure that is planned in advance to support growth and changes in the computer systems that the data centers are designed to support. TIA-942 presents an infrastructure topology for accessing and connecting the respective elements in the various cabling system configurations currently found in the data center environment. In order to determine the performance requirements of a generic cabling system, various telecommunications services and applications are considered. In addition, this document addresses the floor layout topology related to achieving the proper balance between security, rack density and manageability. The standard specifies a generic telecommunications cabling system for the data center and related facilities whose primary function is information technology. Such application spaces may be dedicated to a private company or institution, or occupied by one or more service providers to host Internet connections, and data storage devices. We note that TIA-942 is just one of numerous opportunities of equal relevance that exist for NIST.

TIA also notes its support of NIST continuing to work closely within the Federal Risk and Authorization Management Program (FedRAMP) program[10] to continue to develop standardized, cross-agency procurement strategies to security assessment, authorization, and continuous monitoring for cloud products and services strategies for cloud computing, including for mobile telecommunications devices which support those services and accelerated upgrade cycles for hardware and software. The transparent and collaborative FedRAMP approach will aid agencies in minimizing service interruptions as well as increase productivity for federal employees working in the civilian, defense, and public safety fields, and will provide much-needed certainty for vendors in the cloud space, across Federal agencies.

[10] See http://www.cio.gov/modules/fedramp/demo.cfm.

TIA congratulates NIST on its work and progress in the cloud space, and the opportunity for comment in this matter. TIA believes that through (1) consideration of TIA's ongoing cloud standards efforts and (2) engagement in the standards development process, NIST, the USG, and adopters at large will most efficiently realize the benefits of cloud computing. We look forward to future engagement with NIST and other Federal agencies as cloud computing policies are formulated and implemented.

Respectfully submitted,

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

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Attached: TIA's *Cloud Computing White Paper*

White Paper on Cloud Computing

August 18, 2011

1. DOCUMENT USE

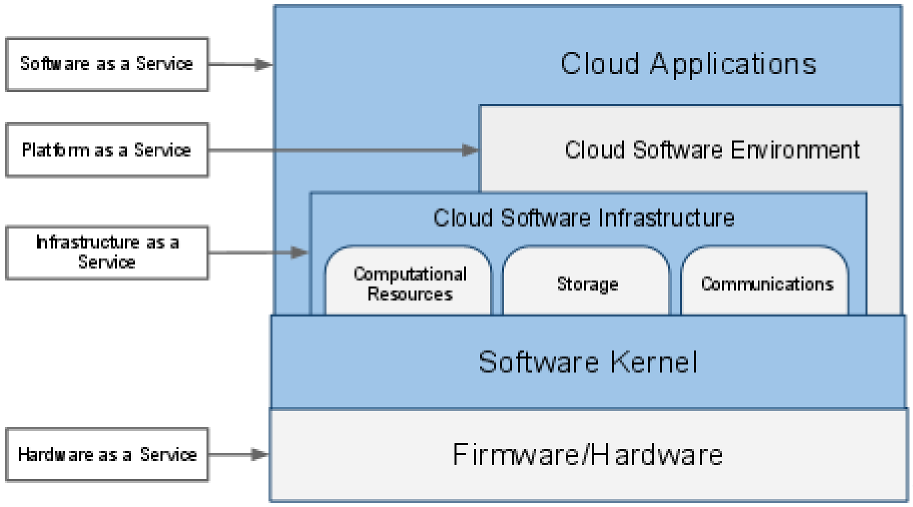
This White Paper investigates which TIA standards have potential interactions with clouds and proposes a strategy for acquiring the expertise to address interoperability issues between those standards and cloud standards. The various TIA committees under consideration include TR-42 Telecommunications Cabling Systems, TR-45 Mobile and Personal Communications Systems Standards, TR-48 Vehicular Telematics, TR-49 Healthcare ICT, TR-50 Smart Device Communications, and TR-51 Smart Utility Networks. Membership in these committees has the technical expertise relevant to their specific needs, but may not yet have considered how products built to their standards will interact with cloud services, and thus have not yet considered how their standards will inter-operate with cloud standards.

2. BACKGROUND

Cloud computing is a significant component of the new Web 2.0 world. As consumers and businesses have grown accustomed to networked services and applications, new standards/ specifications forums have been popping up throughout the communications industry, each focused on a particular aspect of cloud, covering topics across a broad spectrum, e.g., cloud security and privacy, hybrid clouds, corporate clouds, APIs, data centers. Additionally, the more traditional forums are getting involved, including IEEE, NIST, ISO, and ITU. Following the March ETSC meeting, it was determined that TIA should consider aspects of cloud standards that impinge upon other standards being developed in TIA, and the Cloud Computing Task Group (CCTG) was formed to initiate that task.

To address what it means for existing TIA standards to interact with cloud standards, we must first understand what the cloud is. Essentially, cloud computing is the use of resources (e.g., servers, data, applications) in the Internet. The end user does not have to 'own' enough processing power, storage capacity, applications to meet their needs, these resources can be 'rented' from a cloud provider on an as-needed basis and accessed from anywhere via an Internet connection. For example, in the consumer arena, we are seeing many new mobile cloud-based terminals hit the marketplace, such as smartphones, iPad tablets, and Chromebooks. These devices have limited storage capacity and limited access, their main function is to provide Internet access. In the network equipment manufacturing sector, we are seeing new M2M devices for smart metering and communications that will make use of cloud computing technologies. The expectation is that devices based on TIA standards for wireless telecommunications, vehicular telematics, smart devices, health care, etc. will evolve to utilize cloud resources, and thus standardized interactions between the existing standards and the cloud standards will become essential.

Figure 1: Cloud Service Structure



[1]

Based on current cloud experiences, and the work of other organizations on cloud standards, some key interoperability issues can be anticipated around security, reliability, privacy, QoS, accessibility, and manageability of cloud usage. While other groups are looking at these from a cloud centric viewpoint, TIA has the responsibility to address these for interactions between existing TIA standards and cloud standards. TIA standards have a history of providing a certain quality of service within the various technology arenas, maintaining this quality level when cloud is utilized depends on adequate requirements being defined for cloud interfaces. TIA committees need to develop an understanding of how systems based on their standards will utilize cloud services and take steps to address any interoperability issues that may emerge.

2.1 GLOSSARY

API	Application Programming Interface
CCTG	Cloud Computing Task Group
DaaS	Data as a Service
ECP	Engineering Committee Participants
ETSC	Emerging Technologies Subcommittee
IaaS	Infrastructure as a Service
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ITU	International Telecommunication Union
NIST	National Institute of Standards and Technology
M2M	Machine-to-Machine
PaaS	Platform as a Service

[1] UCSB/IBM, "Toward a Unified Ontology of cloud Computing", http://www.cs.ucsb.edu/~lyouseff/CCOntology/cloudOntology.pdf

QoS	Quality of Service
SaaS	Software as a Service
SDO	Standards Development Organization
SLA	Service Level Agreement
SMS	Short Message Service
TC	TIA Technical Committee
TIA	Telecommunications Industry Association
TR	TIA Engineering Committee

2.1.1 DEFINITIONS

These definitions apply for purposes of this document. Definitions of the same or similar terms may differ in other documents and in other uses.

Cloud: a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or cloud service provider interaction.

Cloud Bursts: Any kind of system failure in a cloud, e.g., loss of servers, loss of data, loss of access.

2.2 RELATED RESOURCES

The following documents provide additional information supporting the conclusions of this White Paper.

[1] National Institute of Standards and Technology, *NIST cloud Computing Standards Roadmap First Edition*, July 2011(http://collaborate.nist.gov/twiki-cloud-computing/pub/CloudComputing/StandardsRoadmap/NIST_CCSRWG_092_NIST_SP_500-291_Jul5.pdf)
[2] National Institute of Standards and Technology, *Draft cloud Computing Synopsis and Recommendations*, May 2011 (http://csrc.nist.gov/publications/drafts/800-146/Draft-NIST-SP800-146.pdf)
[3] SCOPE Alliance, *Telecom Grade cloud Computing v1.0*, 2011-05-03 (http://scope-alliance.org/sites/default/files/documents/cloudComputing_Scope_1.0.pdf)
[4] Storage Networking Industry Association, cloud *Data Management Interface v1.0*, April 12, 2010 (http://snia.cloudfour.com/sites/default/files/CDMI_SNIA_Architecture_v1.0.pdf)
[5] Alcatel-Lucent / Hewlett-Packard, *Strategic White Paper: cloud Ready Service Infrastructure for Communications Service Providers* (https://docs.google.com/viewer?a=v&pid=explorer&chrome=true&srcid=0Byq-WVq3Y4HEMGMzNmM4ZTItMmJkOS00ZmViLWIxMmMtOGIxNDkyYzA4Zjcw&hl=en_US)
[6] Huawei, *White Paper on Energy Efficiency and Carbon Reduction* (http://www.huawei.com/en/static/hw-076768.pdf)
[7] Nokia Siemens Networks, cloud *computing – Business Boost for Communications Industry* (http://www.nokiasiemensnetworks.com/sites/default/files/document/nsn_telco_cloud_white_paper_1_.pdf)
[8] Microsoft Global Foundation Services, *Securing Microsoft's cloud Infrastructure*, May 2009 (http://www.globalfoundationservices.com/security/documents/SecuringtheMScloudMay09.pdf)
[9] Alcatel-Lucent, *Secure cloud Computing with a Virtualized Network Infrastructure* (http://www.usenix.org/event/hotcloud10/tech/slides/hao.pdf)
[10] Cisco, cloud *Computing - Data Center Strategy, Architecture, and Solutions*, 2009 (http://www.cisco.com/web/strategy/docs/gov/CiscoCloudComputing_WP.pdf)

The CCTG has also created a spreadsheet providing additional information on cloud-related standards activities that are occurring globally as of the publication of this document (https://spreadsheets.google.com/spreadsheet/ccc?key=0Aiq-WVq3Y4HEdExMS1pTTmFYZl8xVUh1VHV6LXJTX2c&hl=en_US).

3 CLOUD USE CASES

This section provides use case examples showing how various TIA standards may interact with cloud services. The use cases take into account some of the known limitations and weaknesses of cloud computing, including reliability, privacy, security, QoS (Quality-of-Service), accessibility, and trust management issues and look at how interoperability standards come into play to address those weaknesses for systems based on TIA standards. The use cases also identify where TIA standards may need to be enhanced to take advantage of cloud based infrastructure, services, applications, and the general efficiencies that are provided by the cloud service model.

3.1 TELECOMMUNICATIONS CABLING SYSTEMS

In a move touted as creating momentum for open data center design standards, Facebook recently announced its plan to open-source its data center designs through the “Open Compute Project”[2]. However, it may not be an effective vehicle for lowering costs and increasing collaboration in the data center space. Following a series of articles, one comment suggested that, as specified, Facebook may be using a non-UL compliant DC in its designs. According to the Co-Chair of TIA TR-42.1.1, other potential pitfalls include non-compliance with related standards defined in TIA and IEEE, such as distance limitations for cabling systems. While sharing ideas on improving data center design can be useful to the industry, if it is not done within the context of an established and trusted standard, the end result may not meet the requirements.

For now, data center designers should design their telecommunications cabling systems, telecommunications pathways, and telecommunications spaces using TIA-942 Telecommunications Infrastructure for Data Centers to ensure that their data centers are manageable and have appropriate telecommunications cabling infrastructure to support the high-speed networking protocols that cloud computing utilizes. TR-42 will continue to evolve its standards to meet the changing needs introduced by cloud computing.

3.2 MOBILE AND PERSONAL COMMUNICATIONS SYSTEM STANDARDS

As part of a green initiative, a network operator may use a cloud based service to dynamically activate/de-activate network resources based on current demand. The service may require access to information about the operator’s subscribers such as location, subscribed QoS, subscribed service level, etc. in order to apply predictive algorithms about the current and potential resource demands in a given location at a specific time. Since the trust relationship between subscribers and their network operator is critical, the information must be provided in

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[2] Open Compute http://www.datacenterknowledge.com/archives/2011/04/07/facebook-unveils-custom-servers-facility-design/

an aggregate manner that does not identify specific subscribers but rather provides quantitative data elements that can be used to predict estimated load ranges within a specific time frame. In a business district, this information may be used to gradually ramp up resources as people get to work, perhaps deactivate a few as people leave for lunch, and significantly reduce active resources as people leave at the end of the day.

While TR-45 has recently completed a study on “Green communications,” work has not yet begun to address standardized solutions. As that work commences, thought should be given to cloud interactions in support of these types of applications.

3.3 VEHICULAR TELEMATICS

As vehicular telematics is being applied in new ways, such as remote monitoring of vehicle systems, automated driving assistance, vehicle safety communications, etc., interactions with cloud computing are already a reality. A simple Google search turns up several links to articles on the Microsoft/Toyota cloud-based vehicular telematics system. The system is planned for availability next year in Toyota’s electric and hybrid vehicles and will provide a comprehensive package for entertainment, telecommunications, GPS navigation, and energy management. Other links are found noting Hyundai’s receipt of awards for it’s cloud-based in car application planned for limited availability this fall, with broad availability by 2013. Their application provides service scheduling assistance, coaching on economic driving habits, remote lock/unlock, and other remote monitoring functions. These are only a few examples of the cloud-based capabilities for which TR-48 should consider interoperability issues in the standards they develop.

3.4 SMART DEVICE COMMUNICATIONS

A soda vending machine company may use a cloud based service to track inventory in its machines to allow it to better manage its distribution and delivery system. The vending machines would communicate with the service on a periodic basis, e.g., if a particular item reaches a threshold level, or on request, e.g., daily basis. The distributor could then access the service prior to loading delivery trucks to determine which items and how many of each need to be restocked on every delivery route. Having a cloud based service would allow the company to take advantage of shared resources managed by a third-party vendor, in order to grow or shrink their capacity based on real-time demand, without having to buy and manage additional hardware internally. Since the service is cloud based, there may be additional security measures needed on the communication between the soda machines and the service to prevent a competing soda machine vendor using the same cloud based service from getting access to the data sent from the machines. As TR-50 develops standards for smart device communications (and their work in the network layer aspects are adopted by the smart utility specification developed by TR-51), they will have the opportunity to be at the forefront of cloud interoperability standards.

3.5 SMART UTILITY NETWORKS

One can envision several different usages of cloud related to smart utilities, such as the storage of utilization records. Periodically, smart meters at the customer premises send information about utilization to the cloud, that is in charge of storing the data for utilization. An extension of this usage is the automatic generation of billing for this utilization that can also be done in the cloud. Another potential cloud use of the same stored data is in forecasting. This can help utilities understand traffic demands, by geography, or by topology, and better predict capacity needs. It also allows simulation of large systems with several nodes to predict grid stability under fault scenarios and overload conditions.

3.6 HEALTHCARE ICT

Interoperability standards could have helped mitigate the effects of Amazon's cloud burst on April 21, 2011 during which a person monitoring the vitals of heart patients placed a call for help on the Internet, because the loss of access to the cloud based service resulted in a loss of access to real-time patient information for an extended period of time[3]. In this life critical situation, if interoperability had been considered, there might have been a mechanism for the monitoring devices to detect the loss of access to the cloud and transfer to a backup system, potentially access to a duplicate service hosted separately, so that there would have been no disruption of service. A key element of considering interoperability is understanding the limitations of hosted clouds and finding ways to circumvent them in other domain standards. This issue has already become an area of prime focus for the *ANSI* Identity Theft Prevention and Identity Management Standards Panel (*IDSP*), which is assessing financial impact of the compromise of protected health information (PHI) to participants in the healthcare ecosystem.

4. POTENTIAL STANDARDS IMPACTS

This section provides specific examples of TIA standards or standards areas that can be enhanced to address interoperability with cloud infrastructure, applications, and services. These are not intended to be comprehensive, rather, they illustrate the need for further investigation into inter-working between TIA standards and cloud computing technologies.

4.1 TELECOMMUNICATIONS CABLING SYSTEMS (TR-42)

TR-42 has developed a number of standards that could be updated based on their interactions with cloud.

TR-42.1 Commercial Building Cabling: Section 8 of TIA-942 outlines various redundancy measures that can be taken to ensure service up-time within data centers, including redundant horizontal cabling, backbone cabling, access paths, and multiple Internet service providers for one center. One of the benefits of cloud computing services is that redundant data sets can be created, distributed, and accessed across large geographic areas. In fact, cloud service providers are already beginning to provide tiered access to their services based on varying levels of redundancy. Here is an excerpt from Amazon's Simple Storage Service web site:

> *"Reduced Redundancy Storage (RRS) is a new storage option within Amazon S3 that enables customers to reduce their costs by storing non-critical, reproducible data at lower levels of*

[3] Amazon Web Services, https://forums.aws.amazon.com/thread.jspa?threadID=65649.

redundancy than Amazon S3's standard storage. It provides a cost-effective, highly available solution for distributing or sharing content that is durably stored elsewhere, or for storing thumbnails, transcoded media, or other processed data that can be easily reproduced. The RRS option stores objects on multiple devices across multiple facilities, providing 400 times the durability of a typical disk drive, but does not replicate objects as many times as standard Amazon S3 storage, and thus is even more cost effective."

Language could be added to Section 8 of TIA-942 that would include redundancy measures by replicating data between data centers.

TIA-942 is currently undergoing revision to add support for very large data centers and containerized data centers that are utilized by some cloud data center service providers. The revision also includes updates to cabling media to support higher speed network protocols used for cloud computing.

TR-42.7 Next Generation Cabling: In April 2011, TR-42.7 approved a project to develop next generation balanced cabling for data transmission higher than 10Gbps. This work may form a recommendation for a new category of balanced twisted-pair telecommunications cabling and associated field testing requirements.

As data on cloud systems grows and requirements for data security/integrity become more stringent, there may be an increasing demand for active rather than passive network cables, that can prioritize or block certain data packets over others. However, this technology has not yet been standardized by any SDO, nor has it been applied to copper-based network cabling. TR-42.7 could assess the advantages and disadvantages of both active and passive network cabling in the discussions leading up to their next generation cabling standards.

TR-42.11 Optical Fiber Systems: has developed polarity schemes that use multi-fiber array connectors that will support 40 and 100 gigabit systems which will be used for cloud computing systems. TR-42.11 was also instrumental in development of new test criteria using the encircled flux metric and having that test criteria accepted in IEC and back-adopted into TIA.

TR-42.12 Optical Fiber and Cable: has standardized specifications for fiber suitable for manufacturing OM4 cabling that extends the reach of multimode solutions and thereby expands the utility of optical communications in enterprise and data center spaces at lower total cost than single-mode alternatives. OM4 cabling is now specified by IEEE 802.3 for Ethernet and INCITS T11 for Fibre Channel, two applications critical to cloud computing.

4.2 MOBILE AND PERSONAL COMMUNICATIONS SYSTEM STANDARDS (TR-45)

Mobile devices, such as smartphones and tablets, have both unique capabilities and limitations when compared to fixed computing devices. Some of the limitations, which depend on the specific device, may include energy efficiency, battery life, processing power, memory, bandwidth, screen size, data entry capabilities (keypad), and networking functionality. Added capabilities of smart devices include mobility, geo-location, availability (usually turned on and with the user), small size, and the inclusion of a variety of sensors (motion, orientation, etc.). The TR-45 air interface and network standards may need to be enhanced to allow cloud computing services and applications to adjust to the limitations of a specific mobile device and to take advantage of the added capabilities.

4.3 VEHICULAR TELEMATICS (TR-48)

TR-48 has been working with other TIA committees, national and international standards organizations, and other relevant entities to ensure the work on vehicular telematics are necessary and not duplicated. The most recent focus is on addressing the commonality of vehicular telematics related applications to improve the interoperability of varying platforms and systems. The work will lead to a common format for key elements/communication objects and make communications between the vehicles and the servers in cloud more efficiently. This work could be instrumental to ensure the success of the existing and new cloud based vehicular telematics applications.

4.4 SMART DEVICE COMMUNICATIONS (TR-50)

TR-50.1 Smart Device Communications (Requirements and Architecture) is currently developing the first in a series of standards (TIA-PN-4940-005) that will define the requirements for communications pertaining to the access-agnostic (e.g. PHY and MAC) monitoring and bi-directional communication of events and information between smart devices, applications, and/or networks. The standard includes a brief discussion of M2M applications and architecture, but this section could be expanded and focused around M2M between cloud-provisioned servers in a public, private, or hybrid cloud data center setup.

4.5 SMART UTILITY NETWORKS (TR-51)

TR-51 is developing a wireless Mesh L1 through L4 access technology to connect meters (electric, gas, water) to the utility's network access point/gateway. The standards developed will be network agnostic with the constraint of interoperating with an IP network, and thus suitable for enabling access to cloud computing infrastructure for data storage, management and processing. TR-51's mesh network standards will also seek to integrate with the TR-50 reference architecture technologies, at the lower levels of the networking stack.

It will be imperative that the communication is reliable and secure as the utilities environment must be reliable with respect to data integrity and vulnerability of the network to intrusion. Currently TR-51 is anticipating that security will be built in at the node and data center levels, but not directly across the mesh network. As the use of cloud systems grows across utilities, security requirements may grow to include specifications that require networks to differentiate between data meant for public, private, and hybrid cloud architectures.

4.6 GENERAL DOMESTIC CLOUD STANDARD GAPS

NIST has highlighted a number of areas in which SDO's should initiate new standardization work to bolster interoperability between cloud technologies, but many of them do not directly fit into the work streams of TIA's existing committees. NIST envisions the development of standards for providing guidelines on cloud service-level agreements and the quality of services, describing and discovering cloud service resources, metering and billing of service consumption and usage, identity provisioning and management across different networks and administrative domains, secure and efficient replication of identity and access policy information across systems, and standards that outline the policies, processes, and technical controls required to support security auditing, regulation, and law compliance needs.

5. CONCLUSION

Having analyzed several areas where TIA standards will interact with cloud computing systems in various forms, it is clear that interoperability issues will need to be addressed in TIA standards. Based on the research of the Cloud Computing Task Group, there is an immediate need for education on cloud computing.

The materials in the reference section provide an excellent overview of various cloud activities across the industry, many being implemented by TIA's member companies. The spreadsheet provides a brief synopsis each SDO's activities and links to each SDO's web site. The white paper illustrates current events where cloud computing is utilized in industries related to TIA standards. These scenarios highlight areas where a consideration of cloud issues within the TIA standards and interoperability specifications would mitigate real world cloud issues. The potential standards impacts section provides an introductory look at where there is potential cloud interaction with specific TIA standards.

Once TIA's leadership, committees, and divisions have an initial understanding of cloud technologies and the potential interactions with their existing standards, it will be helpful to increase cloud-knowledgeable participation and cloud related standards development within the association.

6 WHITE PAPER CONTRIBUTORS

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