IOT STANDARDS

IoT Standards will look at different segments of the IoT market as it relates to implementation and use of standards. Each column will select a particular vertical, and lay out the relevant standards and technologies that affect the evolving IoT hyperspace. The pace of the columns will start broadly with the vision of narrowing the subject of subsequent articles toward more specific applications of standards, whether in the development, application, test, or commissioning of IoT technologies.

Introduction

The emergence of disruptive technologies like Internet of Things, 5G, Artificial Intelligence, Machine Learning, Blockchain & Quantum Computing has already begun profoundly reshaping our lives, our interactions, and our lived environments. As adoption of these technologies becomes widespread, they are likely to play a substantial independent role in society's energy consumption and environmental impact. Following the conclusion of the COP26 climate conference, private organizations and governments alike are stepping up their promises to combat climate change, bringing to bear a mix of public policy and innovative technologies to address one of our era's defining challenges. In this context there is a strong interplay between IoT and Smart Cities to make cities carbon neutral, sustainable, resilient and citizen friendly. However, to enable seamless sharing of information/data across diverse and heterogenous city systems, the stakeholders need to adopt systems approach in developing the Digital Infrastructure Architecture and system standards to provide comprehensive yet granular interoperability.

Mentor's Musings on Standardization Interplay between Smart Cities and Internet of Things

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Internet of Things

"IoT," a concept that originally sounded like something out of sci-fi movie – the "Internet of Things" – is, in fact, a reality, and one that is bound to become even more widespread. From being considered as one of the most Disruptive Technologies in the early years of the last decade to coming on the verge of becoming one of the most Profound Technologies by weaving into the fabric of everyday life until it becomes indistinguishable from it... Since its advent more than a decade & a half back, the IoT paradigm has crossed through different phases of the famous Gartner Hype Curve, and has truly come of age... and it would be apt to see what the IoT 2.0 is, or could be all about, today...

Internet of Things is all about "heterogeneous" and "aware" devices interacting to simplify people's life in some way or the other. The Heterogeneity of the IoT paradigm has made it imperative to have a fresh look at the prevalent architectures & frameworks of the ICT Infrastructure being deployed or being developed. The extensive work done by various global SDOs in recent years has very comprehensively defined the framework & roadmap for future ICT/digital Infrastructures. However, the new paradigm of "Internet of Things" has given rise to a new aspect of the way human, machines and things are going to communicate with each other in the very near future.

The IoT value chain is perhaps the most diverse and complicated value chain of any industry or consortium that exists in the world. In fact, the gold rush to IoT is so pervasive that if you combine much of the value chain of most industry trade associations, standards bodies, the ecosystem partners of trade associations and standards bodies, and then add in the different technology providers feeding those industries, you get close to understanding the scope of the task. In this absolutely heterogeneous scenario, coming up with common harmonized standards is a major hurdle. Hence, in spite of so much hype and even genuine potential, the IoT paradigm has not proliferated in a true sense to its desired potential. Bringing the "Internet of Things" to life requires a comprehensive systems approach, inclusive of intelligent processing and sensing technology, connectivity, software and services, along with a leading ecosystem of partners. We need to see acceleration and a maturing of common standards, more cross-sector collaboration and creative approaches to business models....

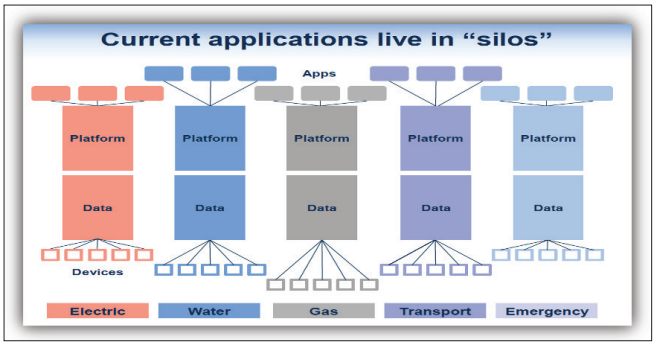
Smart Cities

Sustainable development of any Nation depends on the development of sustainable cities, which can only be achieved through the wide-reaching roll out of integrated, scalable, resilient & sustainable city/community solutions. Sustainable, smart cities and communities will contribute to sustainable development and resilience, through soundly based decision making, and the adoption of both a long and a short-term perspective. Cities face a whole set of challenges providing for the needs of its residents — CITIZENS. The first challenge is to provide for the many needs of their residents. People come to cities and stay there because they believe that by living there, they will have their needs met. The needs of residents, of course, vary in importance. There are many basic needs that a city must provide, not simply about survival, but also those that are required to provide the citizen with a reasonable quality of life.

To make cities and our planet earth "Smart & Sustainable" all the initiatives are extensively leveraging ICT (Information & Communication Technologies) solutions to manage various aspects of O & M of any infrastructure and services. While, intervention of ICT tools can help achieve major enhancement in operational efficiency and optimisation in the Energy Consumption & Environment Contamination including but not limiting to Green House Gasses Emission; the Carbon Footprint of the ICT Infrastructure itself needs to be kept in Check. In the gold rush of getting buildings and cities certified as Green/Sustainable, a plethora of IoT, SCADA and Automation systems are being added. In any Smart Building or Smart City, every service & utility is being automated and being re-enforced with ICT backbone to monitor and control its operation in a most optimized manner. While the attending benefits of ICT backbone for any service/utility are quite commendable, yet there is little focus to optimize the design and carbon footprint of the ICT infrastructure itself.

The imperatives of building a sustainable and secure planet have given rise to new paradigms like green movement, DC power, renewables, microgrids, networking devices, network & cyber security, smart homes, smart buildings, smart grids and smart cities. All these shifting and rising paradigms are ultimately converging into the new & much larger paradigm of "unified and secure" Digital Infrastructure.

But, true convergence is still eluding the evolved citizens of Today's Super industrial Society, because of lack of harmonized



Current applications live in silos.

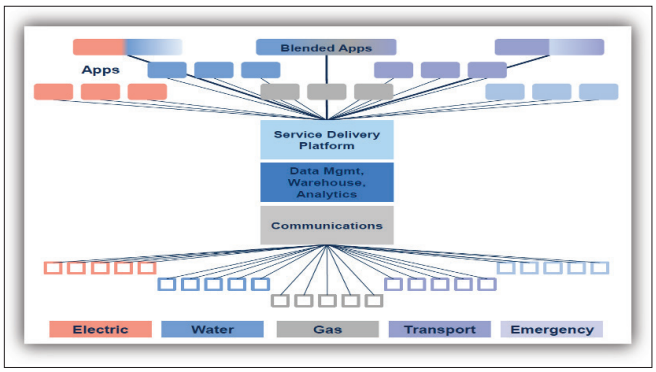
standards in the respective ecosystems of Smart Homes, Smart Buildings, Smart Grid and Smart Cities. The smart nodes of one network cannot talk to smart nodes of the other networks. Multitude of "proprietary systems/solutions," or "systems/solutions with very limited interoperability" are being deployed in each application areas for today's Home Automation, Building Automation, Industrial Automation or even the Infrastructure Automation needs of the society. This is definitely going to ensure that we shall not be able to derive the maximum benefits of these Technologies, whatsoever due to lack of interoperability among these complementary systems/solutions...

Consider the following:

- Smart cities development & deployments announced without any groundwork on preparedness of the stakeholders and the ecosystem...
- In a smart city, multiple utilities are going to leverage and deploy similar technologies & solutions to improve the operational efficiency
- The technological trends in "smart Homes," "Smart Buildings," "Smart Grid" "Smart Water" "Smart Transport" and "Smart Cities" are being considered and pursued in isolation from each other, by the respective stakeholders. This is in spite of the fact that they form a very tightly interwoven and homogenous confluence of similar technologies being applied in different domains for a common cause of making our planet earth "smart-n-green."
- There is no common framework and architecture defined for the various physical infrastructures to be deployed in the proposed smart cities to work in an integrated, harmonized and optimized manner...
- Since, there is NO standardization or Harmonization groundwork undertaken to cater to the physical infrastructure's comprehensive and heterogeneous needs of the smart cities, most of the systems & solutions deployed shall have to be procured which are based on respective vendors' proprietary technologies with limited or NO interoperability with system/solution components from other vendors.
- Each city shall always be dependent on the respective vendors throughout the lifecycle of such systems/solutions for their Operation & Maintenance, and more so for their up gradation...
- Lack of harmonized standards in the respective "SILOED" ecosystems of the Digital Infrastructure shall ensure that the smart nodes of one network cannot talk to smart nodes of the other networks.
- Thus, Data sharing amongst the multiple stakeholders of a smart city shall be a major challenge.
- In fact, there is a recursive cycle to the data in a Smart City. Information that is generated, is information that is consumed, which in turn adds to the information generated, which becomes information used again.

The Rationale

All sectors in the infrastructure domain are influenced by the unified ICT backbone paradigm. However, a common infrastructure pool enables the creation of an interconnected and truly homogenous system with seamless communication between Services. Coordination, collaboration and harmonization can be better implemented by the effective use of standards based open, common and shareable, information and communication technologies.



A converged common ICT infrastructure pool.

The disconnect amongst technological trends being pursued by the stakeholders of the now homogenous smart infrastructure needs to be bridged without any further delay to maintain the Lifecycle Cost/TCO (total cost of ownership) of these individual components within viable economic thresholds.

In this context, we need to redefine our individual perspectives of smart grid, smart building and smart cities. Now, it is imperative for them to work in close harmony with each other to enable & achieve the homogenous functioning of the smart infrastructure in any given geographical territory. To optimize the resources and costs, we need to design and deploy a "Unified & Secure" common ICT backbone for all the different components of the smart infrastructure. This shall need to be capable of comprehensively catering to the individual stakeholders' independent applications and use cases like smart grid, smart water, smart health, smart transportation, smart street lighting and or smart buildings.

Whatever architectures and frameworks we design that provide overseeing guidelines to the stakeholders of respective components and layers of the overall smart infrastructure paradigm; yet it is imperative to work on the finest granularity of each component and layer for standardization, as well as, harmonization, and ensuring the interoperability among various similar components addressing different applications at semantic as well as syntactic levels. Further the standards being adopted for the smart homes or smart buildings deployments must be harmonized with standards in all other relevant ecosystems and integrated smart infrastructure paradigms. There is a need to create and suggest frameworks to achieve the Interoperability among all the devices & layers at every interface in the networks, be it a smart home network, a smart building network, a smart city/community network or the smart grid network that shall enable the stakeholders to prepare a set of detailed standards based specifications to cater to specific/defined/fixed use cases followed by development of a Compliance Testing Framework.

The Importance of Standards

We consider that the development and widespread acceptance of smart city related standards play an essential part in enabling

the achievement of a futuristic vision for cities. However:

- Smart Cities globally are being deployed and are evolving at pace without standards. This is likely to significantly reduce the potential of benefits being realised at scale.
- Technical solution standards are being developed by industry and are generally developed in silos in isolation from international Standards Development Organisations. Examples include:
  –Internet of Things face the addition of "gateways" and limited use of "APIs" to interoperate with each other and with Operational Technology (OT) and IP networks. This leads to increasing complexity and cost that can inhibit Smart Cities adoption at scale.
  –Data Exchanges lack standards to aggregate data in credible open formats that can be tied to Smart Cities indicators aligned to UN SDG's that also secure and protect citizen privacy.
  –AI used to generate insights and controls at scale for Smart Cities are not transparent as many of the major platform providers are not providing researchers with access to proprietary code. This may lead to unintended bias in system operations.
- The challenge practitioners face is to create an effective structure to support a community of experts across broad ecosystem over interests from technology manufacturers, software developers, urban & infrastructure planners, city data scientists, engineers and cyber security professional, city leaders and citizens to develop practices and create a community of thought leaders (our audience).
- Access to timely and relevant intelligence for standards development via government, academia and research, industry associations and/or analysts such as Gartner is limited by access to volunteer resources and limited funds.
- Smart Cities are complex, this is reflected in the difficulty reaching agreement on definitions related to methodologies and reference architectures.

"The irony is that Standards & even SDOs are not at the forefront of Solution designers, developers, providers, deployers or users' minds."

There are misconceptions on what standards are for, and, the case for the use of standards has not been made. Most researchers, design engineers and even startups argue that **standards block innovation**. Liberalization and markets have a lot of great virtues, but they cannot create their own conditions of existence, they **must be designed**! Truly speaking, a consumer focus is also missing in the global standardization movement. It is important to remember that standardization is a tool and not an end in itself.

IoT in Smart Cities

Homogeneous Communication Architecture Imperative for the Heterogeneous Applications Environment

"OneM2M" is one such initiative that has attempted to address this problem. However, their efforts are limited to the Common Service Layer only. Their philosophy keeps the Infrastructure at a very abstract level. The user and/or web interfaces are defined relatively in an explicit manner in line with the WEB Paradigm under constrained environment. But, on the sensor or field devices side of the network, interfaces are defined on the API (Application Programming Interface) paradigm, which on the face of it look quite logical and appropriate; yet when you try to implement them on diverse sensors or field devices from different vendors even for the same applications/use cases, you start getting the feel of challenges of API based approach of Interoperability. Exposing your Data to the ecosystem stakeholder for consumption through APIs is relatively quite simple, however, consuming Data from plethora of heterogeneous devices through APIs turns out to be an entirely different ballgame. In the API based consumption into a common framework interoperability scenario, you still have to have each API tested against the respective API's Compliance Test Tools (which also need to be first developed and accepted by the respective stakeholders) for each use case and/or application, which in some cases turns out to be more cumbersome than defining an "end to end" unified protocol and Data Models.

A Case in Point

Each application ecosystem like smart home, smart building, smart street lighting and smart grid have, over the years, developed their own respective sets of standards and last mile communication protocols. Even some ecosystems like smart grid and smart home have got multiple sets of standards and protocols being advocated as the most appropriate for their respective applications. Unfortunately, all these initiatives, protocols and standards go against the tenet of the unified and harmonized paradigm of the Smart Infrastructure.

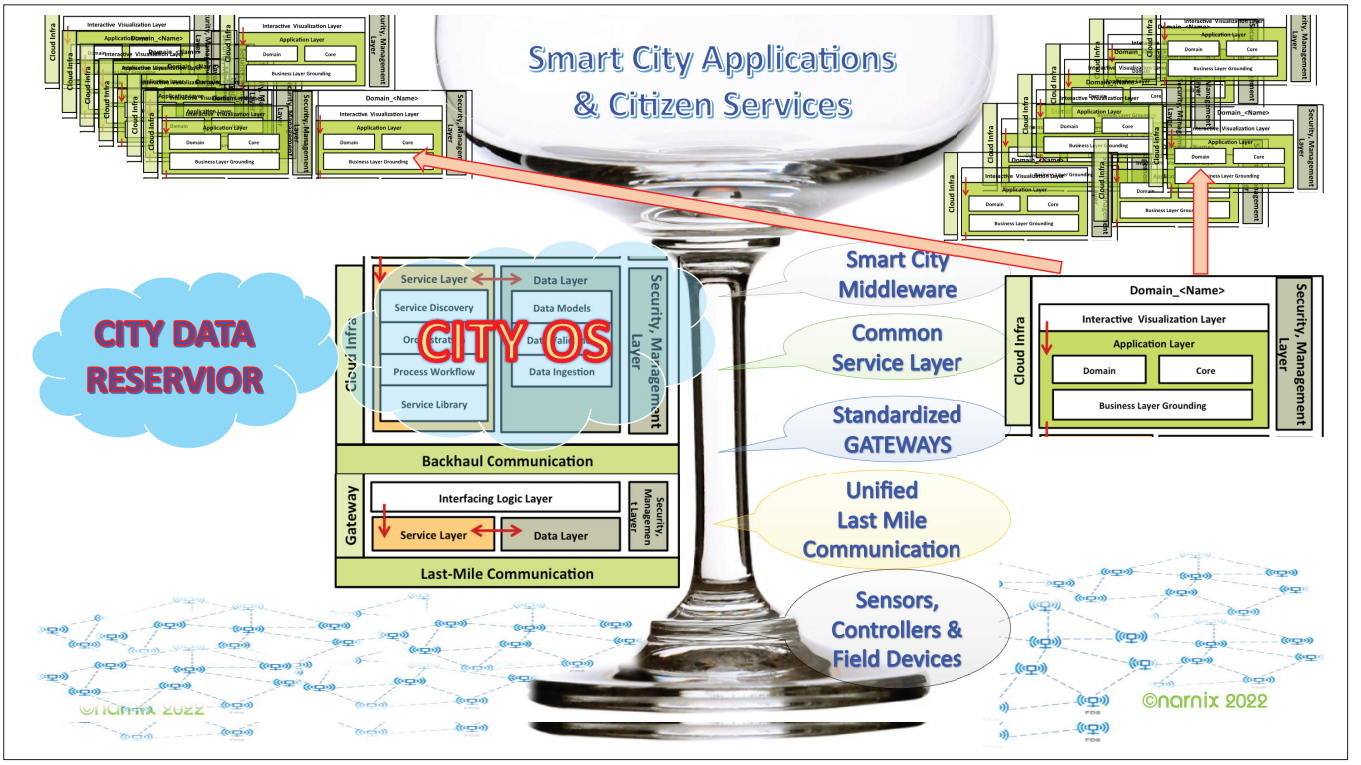
Consider the following — in a smart city, a Data Concentrator Unit/Gateway is installed at a main square of a city, with RF range of 100 meters radius. Does it make sense to dedicate this DCU/Gateway for only one application like Smart Street Lighting only? Should we not leverage this DCU/Gateway to communicate with all kind of sensors or smart "monitoring and/or control" nodes within a radius of 100 meters irrespective of their applications or use cases, and collect the data from them and send it to the cloud/server, where the data is segregated on the basis of their applications or use cases and forwarded to the respective stakeholders/databases? The importance of a sound & vibrant unified ICT backbone in making the concept of any smart city cannot be underscored.

Another Case in Point

At the lower layer of smart nodes themselves, take an example of the electricity energy Meter. Earlier, there used to be a single Stakeholder of the Data from the Energy Meter; and that was - the 'Utility' supplying the Electricity, and that also, only because the utility needed the data, so that it could raise the bill against each consumer in accordance to the individual energy consumption. Today, the same 'energy meter' has three different stakeholders of the data from it: First is still the Utility, as it still needs to raise the bill. Second stakeholder is the consumer. Today, each consumer wants to monitor his own energy consumption and its pattern to manage his energy bill or even devise his energy efficiency strategy. Third stakeholder is the Building Energy Management System, be it a residential or commercial building (unless of course, if the consumer is living in an Independent Villa etc.). The BEMS needs the data from each consumer's energy meter to understand and thus manage and cater to the changing needs of each consumer efficiently, and reliably.

Incidentally, all these three ecosystems have evolved in a Silo mode, and developed and adopted different communication technologies and protocols. The utilities have adopted DLMS or ANSI Tables as its Data Exchange Standard. Home Automation ecosystem uses ZigBee, Zwave, Thread or KNX technologies and protocols, and the building automation or management ecosystem has been using MODBUS as its communication & Data Exchange platform.

So, shall a consumer deploy three different meters to share information with the three stakeholders? Or, a consumer shall put three communication modules on a single meter to share the data individually with each stakeholder? Neither is a truly viable solution. Thus, there is a dire need to harmonize the communication technologies and protocols, as well as, data exchange



Classic saucer champagne glass architecture model.

formats to share the energy meter data with multiple stakeholders. There are numerous such use cases in every application domain of the smart Infrastructure deployments. If the standardization, harmonization and interoperability aspects of the critical information and communication infrastructure are not addressed immediately, then we shall end up investing many times more on implementing the current initiatives of the governments, which shall become redundant in next few years, when (and if) the stakeholders of all the various ecosystems come up with the harmonized and interoperable standards, needing reinvestment of taxpayers money to revamp the infrastructures.

The Imperative

Smart projects are often connected to other aspects of infrastructure, and should be thought of as large systems of systems, the success of which relies on the optimization of all the sub-systems that support it. Some of the earliest deployments of smart infrastructure have proven to be not so smart. Most deployments have failed to identify dependencies or interactions with adjacent systems, impacting overall performance and restricting functionality.

Such a systems level approach in design and standardization is likely to not only enable newer and better services, but also allow far greater synergies and cost-effective deployments, reducing the lifecycle (total) cost of ownership of any Infrastructure, be it the grid, a home, a building or even a city, with attendant environmental benefits, including carbon reductions. There is a need to focus on the creation of a secure, standardized and open infrastructure model for the delivery of services. The concept combines standards-based, end-to-end software with a converged smart infrastructure gateway/DCU design to establish a common, open framework for secured service delivery and management.

"A "box" (or service gateway) built on such a platform can consolidate boxes from utilities and/or multiple service providers into a single, unified BOX that can support multiple service providers and utilities. In wake of the proliferation of "IoT," a new paradigm of "Fog Computing," and now "Edge Computing" beyond the "Cloud Computing" are evolving rapidly. In this paradigm where the storage and intelligence moves from the "cloud" to the "edge" the standardization, harmonization and the interoperability take a pivotal role for operational efficiency of the "Smart Infrastructure."

Classic Saucer Champagne Glass Architecture Model

The evolved Comprehensively Unified ICT Architecture can be modelled as a "Classic Saucer Champagne Glass" with a wide Flat Bottom Base depicting the multitude of Field Devices & sensors etc. The Saucer Shaped Bowl on the Top depicting being filled with an ever-increasing spectrum of City Applications and Citizens' Services.

The Long Stem depicts all the Common Layers viz.: the Unified Last Mile Communication, Common Standardized Gateways (application or Vertical Agnostic), Common Service layer representing the Common Service Functions in the Gateways on the Edge, as well as, in the Cloud... and the Smart City Middleware & City Data Reservoir in the Cloud.

It is the "Long Stem" of the "Champagne Glass Model" instead of the Short & Narrow Neck in the "Hourglass Model" that brings the comprehensive harmonization, standardization & interoperability in the Architecture leading to optimization in operational efficiency & Life Cycle Cost of the ICT Infrastructure in any Smart City.

This Architecture Model, beyond reducing significantly, the CAPEX, OPEX & Carbon Footprint of the Digital Infrastructure, enables a unified & well architected Infrastructure that can be easily designed to be comprehensively Resilient & Cyber Secure.

Further, the Gateways and the Common Service Layer at the Edge and the City OS, City Data Reservoir at the Cloud need to be designed to be elastic, scalable and resilient with Disastor Recovery capabilities and smooth migration from one cloud platform to another seamlessly.

The major focus must be to develop & deploy such a unified, harmonized and yet standards based Comprehensive ICT Infrastructure, including the "end to end last mile communication protocol" defining explicitly and comprehensively layer by layer, frame by frame with complete interoperability, be it at the network, semantic or at syntactic level. It is hoped that if such a solution could be developed, it could be used as a reference framework for development of standards in the field unified communication for "Smart City" and "Smart Infrastructure."

Biography

N. Kishor Narang (kishor@narnix.com) is a technology consultant, mentor, and design architect in electrical, electronics, and ICT with over 40 years of professional experience in education, research, design, and consulting. He has over 30 years of hardcore research, design, and development experience in fields as diverse as industrial engineering, power and energy engineering, IT, telecommunications, medical devices, and environmental engineering. Professionally, he is an electronics design engineer practicing design and development across a wide spectrum of products, systems, and solutions through his own independent design house, NARNIX, since 1981. For the last 10 years, he has been deeply involved in standardization in the electrical, electronics, communications, and information technology domains with a focus on identifying gaps in standards to bring harmonization through standardized interfaces to ensure end-to-end Interoperability. He has been leading national standardization initiatives at BIS, the Indian national standards development organization, in smart cities, smart manufacturing, smart energy, and active assisted living as the Chairman of the Smart Infrastructure Sectional Committee LITD 28, along with contributing to multiple other SDOs and initiatives. Globally, he is Vice Chair-Strategy and Project Leader of two international standards in IEC SyC Smart Cities, a Co-Editor of the ISO/IEC JTC1/WG 11 Four Standards, and a member of the Steering Committee of OCEANIS, beyond proactive contributions in many committees in global SDOs.