IOT STANDARDS

IoT Standards Matters 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

Disruption is everywhere and the future is uncertain; no one knows what the world will look like even a decade from now. As we head into the future, we are surrounded by disruptive innovation. Whether it's Internet of Things, Artificial Intelligence, Driverless Cars, Space Exploration or Quantum Computing, tech-disruption will be driven as much by the methods and systems as it is by the devices we associate with tech disruption. From Automation to Sustainability, organizations are adapting to a whole new wave of consumer preferences. This pandemic has catapulted two diametrically opposite paradigms into the focus of the mankind: Digitalization and Sustainability.

Mentor's Musings on IoT, Environment and Standards Interplay...

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It's a small world. It's also an increasingly hot, crowded, and contentious one. The combined effect of climate change and society's impact on the earth is intensifying struggles over natural resources while also threatening our infrastructure, food systems and quality of life.

It is increasingly clear that today's environmental conditions are not sustainable. Over the past few decades, we have made huge progress fighting disease, poverty, and illiteracy. Now we must apply that same ingenuity to the problem of global warming and other consequences of human activity.

Confronting these challenges requires political will, as well as a new approach to business, one that puts human welfare on an equal footing with profits. It also calls for innovative technology. We are already starting to see how the Internet of Things (IoT), which connects everyday objects to the Internet, can help us transform our world (and **the Environment**) for the better.

IoT environmental monitoring applications usually use sensors to lend a hand in environmental protection by monitoring air or water quality, atmospheric or soil conditions, and can even include areas like monitoring the movements of wildlife and their habitats. The development of resource constrained devices connected to the Internet also means that other applications such as tsunami or earthquake early warning systems can also be reported and used by emergency services to provide effective aid.

An urban IoT can provide the means to monitor the quality of the air in crowded areas, parks, or fitness trails. The realization of such a service requires that air quality and pollution sensors be deployed across the city and the sensor data be made publicly available to citizens.

Due to the vast technological developments in the field of wireless communication technology, it has led to the emergence of many pollution monitoring sensors and wireless networks for monitoring and reporting pollution. From real time monitoring of water quality in the ocean through sensors connected to a buoy that send information via the GPRS network, to the monitoring of goods being shipped around the world, and smart power grids that create conditions for more rational production planning and consumption can all be achieved via microchips implanted in objects that communicate with each other.

IoT – Environmental Monitoring

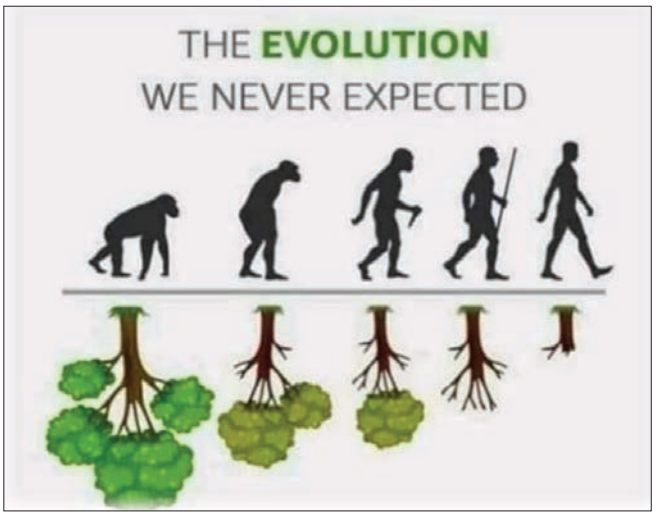
The applications of IoT in environmental monitoring are broad: environmental protection, extreme weather monitoring, water safety, endangered species protection, commercial farming, and more. In these applications, sensors detect and measure every type of environmental change.

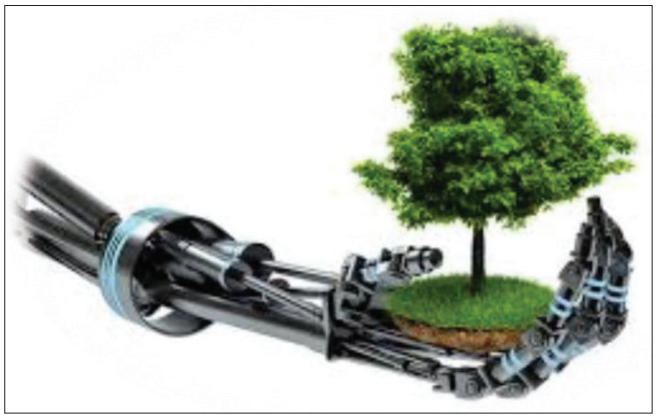
Air and Water Pollution: Current monitoring technology for air and water safety primarily uses manual labor along with advanced instruments, and lab processing. IoT improves on this technology by reducing the need for human labor, allowing frequent sampling, increasing the range of sampling and monitoring, allowing sophisticated testing on-site, and binding response efforts to detection systems. This allows us to prevent substantial contamination and related disasters.

Extreme Weather: Though powerful, advanced systems currently in use allow deep monitoring, they suffer from using broad instruments, such as radar and satellites, rather than more granular solutions. Their instruments for smaller details lack the same accurate targeting of stronger technology. New IoT advances promise more fine-grained data, better accuracy, and flexibility. Effective forecasting requires high detail and flexibility in range, instrument type, and deployment. This allows early detection and early responses to prevent loss of life and property.

Commercial Farming: Today's sophisticated commercial farms have exploited advanced technology and biotechnology for quite some time; however, IoT introduces more access to deeper automation and analysis. Much of commercial farming, like weather monitoring, suffers from a lack of precision and requires human labor around monitoring. Its automation also remains limited.

IoT allows operations to remove much of the human intervention in system function, farming analysis, and monitoring. Systems detect changes to crops, soil, environment, and more. They optimize standard processes through analysis of large, rich





data collections. They also prevent health hazards (e.g., e. coli) from happening and allow better control.

Smart Cities and the Environment

Internet of Things (IoT) has a large role to play in future of smart cities, which in turn are supposed to be environment friendly. Cities are major contributors to climate change, and some are already feeling its impact through rising sea levels and increasingly severe weather events. But cities are also great incubators for IoT-based systems that make urban life more attractive, such as fast, convenient transportation systems, safe street lighting and energy-efficient buildings. Along with advanced data analytics, IoT-enabled devices and sensors are helping us reduce air pollution in some of our world's biggest cities, improve agriculture and our food supply, and even detect and contain deadly viruses.

A citywide Wi-Fi and information network linked to sensors, software and a data analytics platform enables the city to provide smart water technology, automated street lighting, remote-controlled irrigation for parks and fountains, "on-demand" waste pickups, digital bus routes and smart parking meters. These IoT-enabled urban services dramatically reduce traffic jams and pollution, as well as water, light, and energy usage.

Cleaner air and water: The Internet of Things can help cities improve public health. Dirty air and water led to a staggering nine million deaths in 2015 alone, according to a recent study. Cities suffering from chronic pollution, such as Delhi and Beijing, are beginning to deploy sensor networks designed to alert residents when levels are dangerously high.

In London, where up to 9,000 deaths per year are attributed to air pollution, a company has been testing sensors that are distributed to bicycle couriers and a fleet of fuel-cell cars. The sensors, which transmit data to smartphones via Bluetooth, allow them to create real-time maps showing air pollution levels around the city.

In Oakland, California, an environmental sensing startup has created a highly detailed block-by-block map of air pollution, using a fleet of Google Street View vehicles carrying specialized sensors. By expanding this model across cities, networks of sensors could help policy makers identify and reduce pockets of pollution.

Can smart cities be scaled? A team of tech providers is developing IoT infrastructure for everything including culture, healthcare, energy, and travel to enable cities to become more sustainable while also providing a blueprint for others.

AI and IoT Blended: What It Is and Why It Matters?

Today's business world is changing with the adoption of IoT (Internet of Things). IoT is helping in prominently capturing a tremendous amount of data from multiple sources. However, wrapping around the multitude of data coming from countless IoT devices makes it complex to collect, process, and analyze the data.

Realizing the future and full potential of IoT devices will require an investment in new technologies. The convergence of AI (Artificial Intelligence) and IoT can redefine the way industries, business, and economies functions. AI enabled IoT creates intelligent machines that simulate smart behavior and support in decision making with little or no human intervention. While IoT deals with devices interacting using the internet, AI makes the devices learn from their data and experience.

The Artificial Intelligence of Things (AIoT) is the combination of Artificial Intelligence (AI) technologies with the Internet of Things (IoT) infrastructure to achieve more efficient IoT operations, improve human-machine interactions, and enhance data management and analytics. Combining these two streams benefits experts and non-experts alike. While IoT deals with devices interacting using the Internet, AI makes the devices learn from their data and experience.

The effects of climate change: Rising maximum temperatures; rising minimum temperatures; rising sea levels; higher ocean temperatures; an increase in heavy precipitation (heavy rain and hail); shrinking glaciers; thawing permafrost.

Impact of IoT on Sustainable Development

Environmental degradation is occurring all over the world. Land degradation, deforestation and desertification pose a growing threat to food security and water availability. Widespread loss of biological diversity is undermining the productive capacity of terrestrial and aquatic ecosystems. This reduces access to essential environmental goods and services, including vital ecological processes such as water purification, nutrient cycling, control of pollution and soil erosion. Environmental degradation exacerbates the frequency and impact of droughts, floods, forest fires, and other natural hazards.

The movement toward a more sustainable economy is gathering momentum. Consumers increasingly prefer to do business with companies that embrace sustainable practices, and more organizations are looking for ways to reduce the environmental impact of their operations. This "green" mindset is driving the development of new sustainability solutions, many of which utilize Internet of Things technologies (IoT).

Why are IoT sustainability solutions taking center stage? Underlying all these solutions is the fundamental concept of data analytics. Gathering data on business and operational activities, studying it for insights, and making decisions based on objective analysis are processes that have always been considered key to success. But today, the amount of information that can be collected thanks to the IoT has taken data-driven decision-making to the next level. A vast amount of data exists about every business, making it possible to derive greater insights than ever before. Add to that the machine learning capabilities employed by many IoT platforms, and you have a veritable ocean of actionable intelligence that businesses can use to improve processes and operate more sustainably.

The Internet of Things (IoT) is currently trending with its ever-expanding eco-system of digital sensors, appliances, and wearable smart devices. Like other sectors, the role of IoT in sustainable development and environment protection will be crucial in the coming years.

Already IoT is being leveraged in a multitude of applications linked to sustainable development such as buildings, water management, waste management, agriculture, wildlife, marine organisms, etc. ...

IoT and Sustainability: A Five-Pronged Approach

For any IoT sustainability solution to deliver insights, it must include the following:

1. A way to monitor the environment.

2. A way to measure the collected data.
3. A way to catalog the data.
4. Feedback loops and efficiency benchmarking.
5. An IoT analytics process that drives actionable insight.

The better your system of monitoring, measuring, and cataloging data, the better you will understand the story of your business, leading to actionable insights more quickly.

Will the Internet of Things Sacrifice or Save the Environment?

The internet of things (IoT), that ever-expanding ecosystem of digital sensors, home appliances and wearable smart devices, attracts its fair share of attention. Speculation is rife on how the 25 bn-odd (and counting) "things" will improve the quality of life, streamline business operations, and ultimately fuel economic benefits to the tune of up to $11tn per year by 2025.

Less often considered is the **cost to the environment** of such a vast network of devices. With the full extent of the IoT far from being realized, even experts are divided on whether it will spell doom or salvation for the environment. One thing that experts can agree on is that we should not wait around to find out.

We've got to think about the potential limitations on it due to power consumption, the use of rare earth elements, all of that, from day one. Some devices will power themselves, but the more complex will contribute to the world's huge data storage energy bill. How energy hungry the IoT will be largely depends on the types of devices deployed and what they will be doing.

It is easy to foresee an ecosystem of increasingly complex and energy-hungry devices emerging. Devices using video surveillance are a good example. Not only will these devices require mains power to function, but they will also contribute significantly to the growth in data coursing through the Internet's veins. According to one of the visual networking indices, an ongoing survey of data-consumption trends, Internet video surveillance traffic almost doubled between 2014 and 2015 and was set to increase **tenfold** by 2020.

The problem of energy consumption will be a pernicious one. "These technologies on a device-by-device basis, or even a house-by-house basis, are not a significant additional contribution to overall power consumption." However, multiply that across any country and "that's going to boil down to another power station or another two power stations."

AI for Sustainability: A Paradox!

AI as a BIG Hype, is a reality that scientists who worked on it for last four decades never ever thought of or envisaged. It is terrifying, scary and chilling. It is like riding the Tiger: will we ever be able to get off safely? Or tame the tiger?

To top it all, AI is NOW being leveraged to bring sustainability in different aspects forgetting the extensive energy it consumes, in turn increasing GHG emissions and carbon footprint it adds to anything, when you apply AI to any product, system or solution. **Is it NOT a PARADOX**???

Creating an AI can be five times worse for the planet than a car: Training artificial intelligence is an energy intensive process. New estimates suggest that the carbon footprint of training a single AI is as much as 284 tons of carbon dioxide equivalent, five times the lifetime emissions of an average car.

Learning from Our Past Mistakes: History Always Repeats Itself

Past failures to consider environmental consequences early have been costly:

- Semiconductor industry (metals, solvents).
- Synthetic chemicals (PCB, DDT, Freon).
- Applications of natural compounds (chlorine, asbestos).
- Transportation, energy (air pollution, global warming, nuclear wastes).

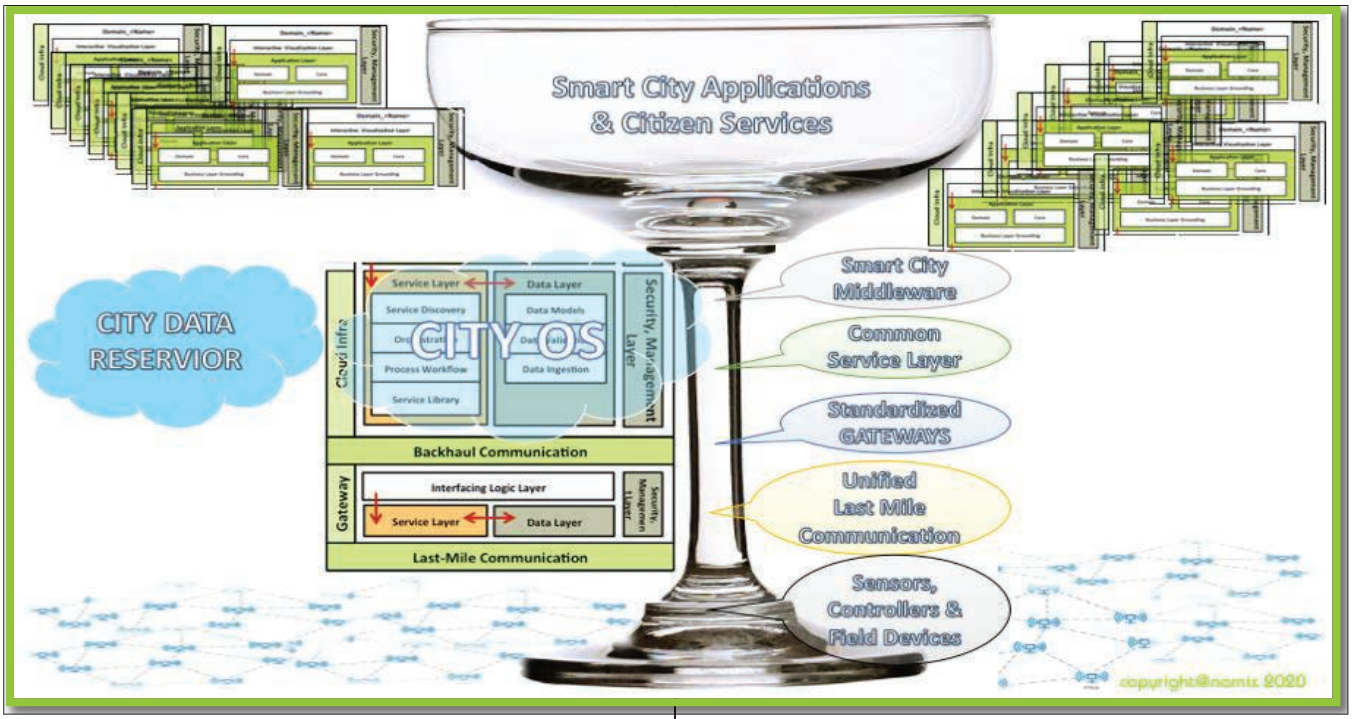
Internet of Things (IoT) and Artificial Intelligence (AI) technologies can help us fight climate change, but they also come at a cost to the planet. To truly benefit from the technology's climate solutions, we also need a better understanding of IoT's and AI's growing carbon footprint. IoT and AI need to be developed and deployed so it can meet society's needs and protect the environment by saving more energy than it expends.

To make sure that IoT and AI is used to help, and not hinder, our society, it is time to merge the two big debates of today. One is on **Digital Transformation** and the other is on **Sustainable Development**, and in particular the Environment. If we use the former to save the latter, I think we will have made the best.

Standards Matter

And this is where **STANDARDS** can really help. There is a plethora of standards to help us develop most optimized, energy efficient and environment friendly products, systems, solutions and even services. We also have sustainability standards, frameworks and metrices to measure the extent of sustainability, circularity and carbon footprint of any product, service and/or organization itself. Reinforcing the focus on the role of standards in protecting the environment, the theme of World Standards Day 2020 was "Protecting the Planet with Standards."

Innovation and technology development are accelerating. Strategic plans and roadmaps are needed to help ensure that the market is suitably served with best practices that are pertinent to the goals and context of this very large market. Standards support our need to balance agility, openness, and security in a fast-moving environment. Standards provide us with a reliable platform from which we can innovate, differentiate, and scale up our technology development. They help us control essential security and integrate the right level of interop-



Classic saucer champagne glass architecture model.

erability. Standards help ensure cyber security in ICT and IoT systems.

The world has never been as competitive as today, yet cooperation is a must to deliver solutions for increasingly complex systems. No technical committee and no standards organization can single handedly develop all the Standards that are needed. We all need to work together.

Given the scale, moving forward cannot be successfully, efficiently, and swiftly accomplished without standards. The role of standards to help steer and shape this journey is vital. Standards provide a foundation to support innovation. Standards capture tacit best practices and standards set regulatory compliance requirements.

However, 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 chains 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.

The extensive work done by various global SDOs has very comprehensively defined the frameworks and roadmap for future Information and Communications Technology (ICT) Infrastructure. However, the new paradigm of Internet of Things has given rise to a new aspect of the way humans, machines and things are going to communicate with each other in the very near future. Internet of Things is all about "heterogeneous" and "aware" devices interacting to simplify people's lives in some way. The heterogeneity of the IoT paradigm has made it imperative to have a fresh look at the prevalent architectures and frameworks of the ICT Infrastructure being deployed or being developed.

Also, true convergence is still eluding the evolved citizens of today's super industrial society, because of a lack of harmonized standards in the respective ecosystems of smart homes, smart buildings, smart grid, and smart cities. The smart nodes of one network cannot talk to the smart nodes of the other networks. Multitudes of "proprietary systems/solutions," or "systems/solutions with very limited interoperability" are being deployed in each application area 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 will not be able to derive the maximum benefits of these technologies, whatsoever.

The multiplicity of technologies and their convergence in many new and emerging markets, however, particularly those involving large-scale infrastructure, demand a top-down approach to standardization starting at the system or system-architecture rather than at the product level. Therefore, the systemic approach in standardization work can define and strengthen the systems approach throughout the technical community to ensure that highly complex market sectors can be properly addressed and supported. It promotes an increased co-operation with many other standards-developing organizations and relevant non-standards bodies needed on an international level. Further, standardization needs to be inclusive, top down and bottom up; a new hybrid model with a comprehensive approach is needed.

The architectures and frameworks that we design for the different digital infrastructures provide only high level guidelines to the stakeholders of different layers and components. To achieve comprehensive interoperability, it is imperative to work on the finest granularity of each component and layer for standardization, as well as harmonization, and ensure the interoperability among various similar components addressing different applications at the semantic, as well as syntactic levels. Further, the standards being adopted for smart home or smart building deployments must be harmonized with standards in all other relevant ecosystems like smart grids and smart cities and integrated digital infrastructure paradigms. **There is a need to create and suggest frameworks to achieve interoperability**

among all the devices and 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 compliance testing frameworks.

Sustainability (environmental concerns) of any IoT system can also be addressed through technical standards and system standards beyond the management standards (frameworks, metrices) mentioned above. However, there is vital gap in this area. We need more architectural and interoperability standards to bring a comprehensive optimization in the carbon footprint of any IoT Solution.

Two such examples are the most recent standards on "Unified Digital Infrastructure — ICT Reference Architecture" in India for Smart Cities: IS 18000 UDI-ICT RA and IS 18010 UDI-ULMCPS RA.

In these standards, the evolved Comprehensively Unified ICT Architecture has been modelled as a "Classic Saucer Champagne Glass" with a wide flat bottom base depicting the multitude of field and IoT devices and 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**, as well as in the **cloud**, and the smart city middleware and city data reservoir in the cloud. It is the "long stem" of the "champagne glass model" instead of the short and narrow neck in the "hourglass model" that brings the comprehensive harmonization, standardization and interoperability in the architecture leading to optimization in operational efficiency and life cycle cost of the ICT infrastructure in any smart city.

Beyond reducing significantly the CAPEX and OPEX of the digital infrastructure, a unified and well architected infrastructure is designed to be comprehensively secure and resilient. However, the real motivation behind this architecture modelling was to reduce the **carbon footprint** of the **digital infrastructure** being deployed in smart cities across the globe using IoT solutions for comprehensive monitoring of the diverse applications and services. Pilots have demonstrated that adopting such a reference architecture can bring down the carbon footprint of the digital infrastructure for the utilities and civic services in a city to 20 to 25 percent of the carbon footprint using the prevalent architectures.

Conclusion

It has been observed that the technologies developed by human beings in the last two to three centuries have had a major impact on the earth's climate and our nature's equilibrium. Some believe that we have reached a point of no return. This can have a huge impact on life on earth, especially on the human species. However, while technology has been responsible for most of it, technology also seems to have solutions for it.

This pandemic has catapulted two diametrically opposite paradigms into the focus of mankind: digitalization and sustainability. And while the global pandemic will leave a permanent scar for many people, communities, and businesses, it does offer us a once-in-a-generation opportunity to reset our collective thinking, pivot in new directions, and build back better. During 2020, through our collective pandemic response, we saw the impossible made possible, now it is time to accelerate this momentum. To make sure that IoT and AI is used to help, and not hinder, our society, it is time to merge the two big debates of today. One is on **digital transformation** and the other is on **sustainable development**, and in particular the **environment**. If we use the former to save the latter, I think we will have made the best.

We humans need to radically change our relationship, not just with the planet, but with the objects with which we fill our lives. **We need to change how we think about technology and innovation. Rather than allowing technological advancement to steer our narratives, innovation and technology should help us build bridges between the worlds we inhabit now and the ones we imagine for tomorrow**.

Biographies

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 (SDO), 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 in 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.

John K. Zhao is an expert on the Internet of Things, edge/fog computing, and Internet security. He received his B.A.Sc. (Hon.) degree in engineering Sscience and M.A.Sc. degree in electrical engineering from the University of Toronto, and later S.M. and Ph.D. degrees in computer science from Harvard University. He is currently the Director of the Intelligent Edge/Fog Computing Research Center and the CTO of the Center of Industry Accelerator and Patent Strategy of National Chiao Tung University in Taiwan. He is also the Founding Chair of the IEEE Standard Working Group on Fog Computing and Networking Architecture Framework and the Founding Vice-Chair of the IEEE Standard Committee on Edge/Fog/Cloud Communication with IoT and Big Data. He is deeply involved in the technology development and promotion of Industrial IoT. As a leader in the Industrial Internet Consortium, he serves as Co-Chair of their Security Working Group, Distributed Computing Task Group, and China Regional Team. Before returning to Asia, he was a Senior Member of Technical Staff and then a Principal Member of Technical Staff in the Information Security Department of BBN Technologies, the pioneer of packet-switching ARPANet. While at BBN, he also served as the principal investigator of four DARPA projects on Mobile IP, Internet Security Policy Management, and Information Assurance Formal Models.