A IoT-Enabled Smart City Framework is needed to innovate Smart City ICT approach

Innovative approaches to Smart City: a shared smart cities framework can support informed policy- and decision-making and promote the emergent of a vibrant global market for smart city technologies

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No matter how Smart Cities will look like in the next future, no matter if their attitude will drive towards sustainability, resilience, workability, or whatever: currently there are two main barriers to effective and powerful smart cities solutions. First, many current smart city ICT deployments are based on custom system that are not interoperable, portable across cities, extensible, or cost effective. Second, a number of architectural design efforts are currently underway (e.g. ISO/IEC JTC1, IEC, IEE, ITU and consortia) but have not yet converged, creating uncertainty among stakeholders.

There is a lack of consensus on both a common language/taxonomy and smart city architectural principles. The result is that these groups are likely to generate standards outputs, including standards that are divergent, perhaps even contradictory, which does not serve the global smart city community well.

To remove these barriers, NIST and its partners (ANSI, FIWARE, ETSI, ENEA, MSIP) are convening an international public working group to compare and distil from these architectural efforts and city stakeholders a consensus framework of common architectural features to enable smart city solutions that meet the needs of modern communities.

Innovative approaches to Smart City

A smart city is a moniker that inspires a vision of a city where key components of infrastructure and services – environmental, emergency response, traffic and energy management to name a few – are integrated in such a way that features and applications can easily be combined with whatever capability existed before. Achieving that vision requires moving beyond many current applications in which the degree of integration of core subsystems within smart cities is often limited by patchworks of legacy and fixed solutions connected by custom integrations.

The most promising innovation in smart city RD&I programmes lies on how to distil a composable Smart City Framework. By the word "composable" it is intended that the continuous integration and improvement would be achieved through graceful addition of functions as opposed to wholesale replacement and retrofitting. Cities integrating each new capability should be able to simply acquire and add it to the existing infrastructure with a minimum of tailoring and reworking of existing component interface.

Cities and entrepreneurs worldwide seek to enable incrementally added "smart" to various aspects of city life regardless of which community of interest the components come from. And they do not want to wait to deploy these capabilities in anticipation of the arrival of some grand scheme. A desirable architecture would draw on the existing work to minimize the barriers to integrating criticalities as well as new and novel application to the benefit of citizens and city managers.

The recent progress of application in smart cities has been explosive. In just one example, this is evidenced by the large engagement achieved last year in NIST's Global City Teams Challenge (GCTC) (https://www.us-ignite.org/globalcityteams/).

There are many teams of implementers and cities pioneering applications all over the globe. There are also many consortia and standards organization developing architectures of various scopes appropriate for Smart City integrations. All these groups would benefit from the ability to work together through a common language and shared architectural principles.

As well as industry interest, governments have a keen desire to benefit from the efficient integration of "smart" into their cities. A recent report (IDC FutureScape: Worldwide Smart Cities) predicts that, by 2017, twenty of the world's largest countries will have in place prioritized national smart city policies and one third of medium and large cities worldwide will have developed a smart city roadmap. In the U.S., the Office of Science and Technology Policy recently announced a "Smart Cities Initiative to Tackle Challenges with Innovative Approaches" (www.whitehouse.gov/blog/2015/09/16/lunching-smart-cities-initiatve-tackle -city-challenges-innovative-approaches).

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Smart city as a growing market

Smart city is a growing market and a global one with significant competitiveness implications for both industry and municipalities.

A wide Consortium with NIST, as lead partner, and ANSI, ENEA, the Republic of Korea's Ministry of Science, ICT and Future Planning U.S, ETSI, the U.S. Green Building Council – USGBC, FIWARE, is coordinating this activity through its Cyber-Physical System programme, part of the NIST Engineering Laboratory, to pursue its responsibilities for assisting industry in the development of measurements, measurement methods, and basic measurement technologies; and assuring the compatibility of United States' measurement standards with those of other nations.

The activity builds on the work of two related NIST efforts – the Global City Teams Challenge (https://www.us-igite.otg/globalcityteams/), that encourages "action clusters" to form and collaborates to demonstrate technologies at city scale, and the CPS Framework (https://www.nist.gov/el/nist-release-draft-framewok-cyber-physical-system-developers.cfm), which provides for scientific underpinning of the description of the Internet of Things.

The activity will produce a streamlined architecture that emphasizes Pivotal Point of Interoperability or PPI (*If you standardize everything,*

you freeze out innovation. If you standardize nothing, you get non-interoperable clusters that are not easily integrated. The principle of Pivotal Points of Interoperability is to find consensus standardized interfaces that deal with composition of CPS without constraining innovation).

To determine these PPI it is necessary to review: analysis of current architectures; success stories about how seamless integrations and portability of application across cities were achieved; standards that support the modular integration of function at city scale; standards that support updates, publication and access to information coming from different sources describing what is going on in the city; best practices on how integrate PPIs into existing infrastructures; educational materials and tools that facilitate consumer/commercial understanding and usage of smart city capabilities and technologies.

The activity is ongoing, promoting inclusion of a wide range of public working groups such as smart cities leaders, administrators and planners; manufacturers of Internet of things and other smart city related components; academic studying the integrations of technologies into smart city designs; standard organization investigating and developing smart cities standards; industrial and commercial consortia developing smart cities platform and IoT specifications and designs; state and federal government; participants from around the globe.

ANSI's role is primarily outreach and awareness-raising to encourage technical experts to participate in the initiative and to use the working groups' output in subsequent standards activities in which ANSI plays a role as coordinator of the U.S. standardization system and U.S. member to international standards bodies.

ENEA's role is analysing (especially but not exclusively based on Italy) and elaborating specific aspects related to standards and smart cities (with a special focus on interoperability issues) as a contribution to the technical white paper. Moreover ENEA intends to coordinate a group of Italian Cities and Organizations participating in the Framework to promote and disseminate smart-city standards through events, projects and communication actions.

MSIP's (Ministry of Science, ICT and Future Planning) role is to provide its expertise gained from Korea IoT Cluster Projects such as Busan Global Smart City and Daegu Daily Healthcare Centre, which are facilitating convergence of various IoT services based on an International IoT/M2M Standard (one M2M) platform. In addition, as the government of South Korea, MSIP has the additional role of enabling numerous IoT businesses and start-up companies to build up profitable services and establishing IoT ecosystem with the smart city frameworks derived from its activity.

ETSI's technical groups such as SmartM2M and the global standards initiative one M2M, of which they are founding partners, are working on an IoT service platform specification that can be applied to Smart City scenarios. In addition, ETSI is active in various EU initiatives, such as AIOTI (the Alliance for Internet of Things Innovation), considering which technical specifications exist or would need to be developed to support the ICT technologies.

The U.S. Green Building Council (USGBC), along with Green Business Certification Inc. (GBCI – http://www.gbci.org/certification), is committed to a prosperous and sustainable future through cost-efficient and sustainable buildings, infrastructure, communities and cities. USGBC and GBCI will work toward their mission of market transformation and participation in this programme trough LEED and other key programmes, offering a credible measure to evaluate, compare, manage and improve the performance of urban systems through transformative actions that improve the quality of life and wellness of citizens.

The FIWARE initiative is targeted to boost the creation of an ecosystem around the FIWARE platform, which provides a rather simple yet powerful set of APIs (Application Programming Interfaces) that ease the development of Smart Application in multiple vertical sectors. FIWARE API specifications are public and royalty-free, supported by an open source implementation with the aim to contribute to the definition of a reference architectural framework for smart cities that it can help implement as open source and promote.

Use cases for Smart Cities

The use cases for Smart Cities analysis differ in scope and depth just as there is plenty of diversity in smart cities architectures such as Global City Teams overviews (http://www.us-ignite.org/globalcityteams/actioncluster/archive), i.e.:

Safe community Alert network (SCALE) in Montgomery County, MD

The Safe Community Alert network seeks to bring safety and security of connected devices to everyone, regardless of their financial means or technical savvy. This showcases a

new network of public safety with a diverse ecosystem of devices, standards and connectivity options. The SCALE network, currently being demonstrated in a senior living facility in Montgomery County Maryland, senses hazardous air and water factors as well as some facets of the physical health and well-being of resident volunteers. This real whorls test bed has deployed environmental sensors to detect a variety of factors including: smoke, carbon dioxide and monoxide, some toxic gases, humidity, temperature, particulates, and some forms of pollen. Sensors also detect water consumption and contaminants. The data complements information related to the health of a resident that comes from health devices such as blood glucose monitors, heart monitors and oxygen machines. It can even detect events such as falls, unauthorized access to sensitive areas, or a resident that has wandered off. Data collected from sensing of events goes to the SCALE platform where applications can then be built. The SCALE network contains a text message notification system, automatically initialises conference calls with family and care providers, dashboards for first responders and analytics for public health officials, all with affordable forms of technology and connectivity.

Managing Urban Air Quality: Chicago, IL

This project is investigating how cities might optimize air quality by managing the traffic flow, for instance, via schedules or temporary routing. This requires understanding of the spatial and temporal dynamics of urban air contaminants, particularly related to vehicle emissions, and the context of diverse weather, natural topology, and built forms of cities.

Coruna Smart City: Coruna, Spain

Coruna smart City Platform aims to improve environmental quality (noise, air quality), reduce greenhouse gas emissions through the Smart management of energy and traffic, and reduce consumption peaks in municipal infrastructure and buildings.

Smart Santander: Santander, Spain

Santander is one of the pioneers of IoT-nabled Smart Cities. With more than 15000 IoT devices deployed over the city, FIWARE is the platform providing access to real-time open data describing what is going on in the city. Part of this data comes from various verticals in the city, as traffic management, environmental control, public lighting management, noise and many more. Additionally, it comes directly from citizens using the "Pace of the City" application, trough which they report events related to the city context and provide data from their smartphone-embedded sensors. Last, but not least, it comes from devices embedded in the public bus fleet, parks and garden management fleet, a large number of taxis and intelligent "tags" deployed in shops, touristic points, public transport stops, etc.
All this real-time open data is made available to support the development of smart city applications.

Global Smart City Testbed: Busan, Korea

Busan Global Smart City Testbed project is an IoT-based Smart City building project having the goal to secure global references by developing an Open smart City Platform on which new commercialized urban services can be suggested and tested, demonstrate IoT-based promising urban services by building testbed in Haaeundae Busan for the realization of a sustainable city, and establish a governance for the operation of a smart city in order to vitalize a public self-sustainable ecosystem.