Interoperable City Platform and IES-City Framework

Sokwoo Rhee Associate Director for Cyber-Physical Systems Innovation Organized by National Institute of Standards and Technology

and our partner organizations

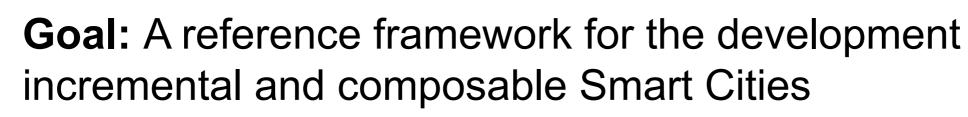
engineering laboratory



IoT-Enabled Smart City Framework

- Smart City technologies are being developed and deployed at a rapid pace.
- Many previous smart city deployments are custom solutions.
- A number of architectural design efforts are underway worldwide but have not yet converged.
- NIST and its partners are convening a public working group to distill a common set of architectural features from these architectural efforts and city stakeholders.







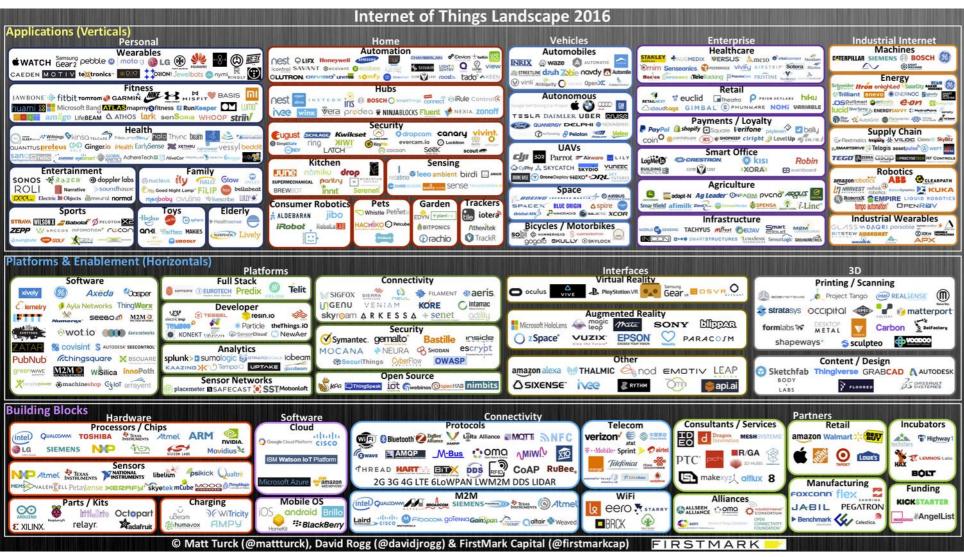


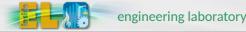
SIFIWARE



ANSI

The Challenge - Divergent CPS/IoT Technology Landscape



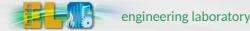




Global City Teams Challenge (GCTC) and IES-City Framework

Municipality

Market Driven: GCTC	 Action Clusters Super Clusters 	Assicution	Action Cluster Provider eccept Control Cluster Control	ter ter ter ter ter ter ter ter	GCTC SC3 2018
Technolog y Driven: IES-City Framework	 Application Analysis Technology Suite Analysis 				<form></form>





IES-City Framework Consists of:

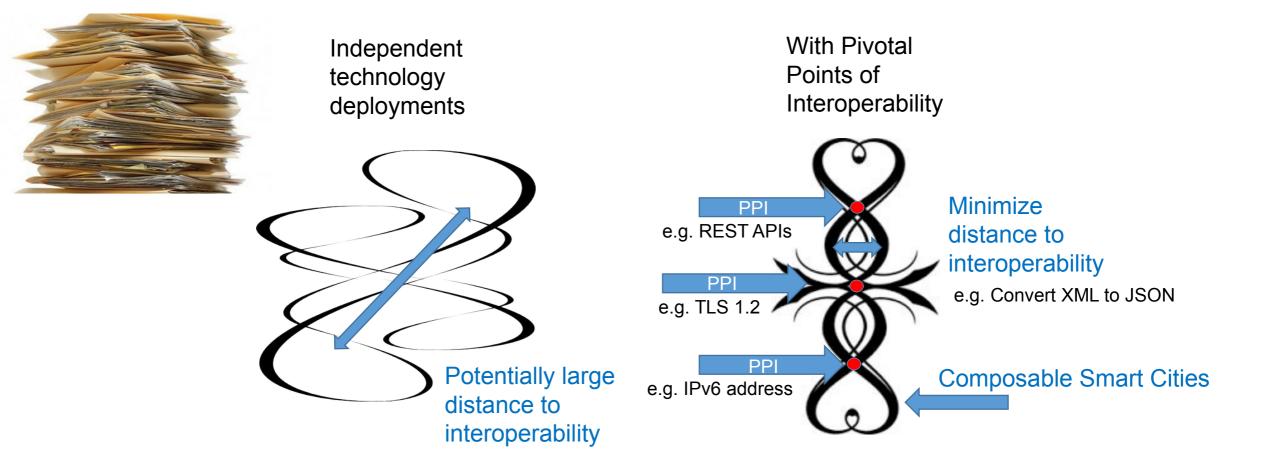
IES-City Framework Draft Release v20180208
A Consensus Framework
for Smart City
Architectures
IES-City Framework
(Internet-of-things Enabled Smart City Framework) Draft Release v20180208
This IES-City Framework is the product of an open, international public working group seeking to reduce the high cost of application integration through technical analyses of existing smart city applications and architectures. The Framework documents the findings of the authors and provides valuable tools that are based on the findings and that can lower barriers to an expanded smart city marketplace.
Currently, three primary barriers exist which inhibit widespread deployment of effective, powerful smart city solutions:
 Inadequate information and knowledge transfer: Most smart city deployments are based on custom systems which cannot exchange information with other cities, and therefore, are neither extensible nor cost-effective.
2. Diverse standards: Current architectural standardization efforts have not yet converged. This creates uncertainty among stakeholders[5]. There is a lack of consensus on both a common language/taxonomy and smart city architectural principles [67]. The result is that the many groups with smart city interests are likely to generate standards and practices that are divergent, perhaps even contradictory, which would not optimally serve the global smart city community.
 Poor scalability: A third barrier is the insufficient interoperability and scalability of underlying Internet of Things (IoT), and Cyber-Physical Systems (CPS) technologies that provide the foundation for many smart cities applications [51].
Additional barriers include lack of resources, clear principles for prioritization, and limited access to the necessary technical expertise and experience.
To lower these barriers, NIST and its partners, below, convened this international public working group to compare and distill a consensus language, taxonomy, and framework of common architectural features to enable smart city solutions that meet the needs of modern communities.
NET AND A CARSE AN

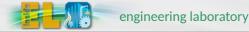
Set of Artifacts

	Application Framework Tool					
nput ease, choose the Category of your			anticipate and respond rapidly to a	emergencies and threats		
plication	Public safety, policy & Em.Res.		a improve safety and security within			
ease, choose the Sub-Category of	Flood monitoring and forecasting		ves		Example	
sur application		• h	andling emergency flooding conditi reparing for the flood-related disast			is for remotely alerting res nonitoring network
lease, select the reference ICT Level nultiple choice is possible)	application	_				
ease, select the reference Geo-	Ctv					
emains (multiple choice is possible)						
	Eaborate					
a Input Concerns Re						1.01
	and menter ()					
on Anthony level 100	avice, System, System of Sy) sterns)	1			
ee d'echnology level (De emiliethe dechnology lev Zone d'echnology lev Premi echnology so	tun kunst svice, System, System of Sy net (Device, System, System are description (text) ms (text – Encemarks, Field	stems) of System	(a)	h e Soluti	on Provided?	
ee d'achnology isval (Dy ens) athe Prend achnology isv Prend achnology so Rone of Concer Prenises)	nel (Device, System, System ape description (text)	stems) of System	(1)		on Provided?	
ee dischoology is vol (De englischer Roee dischoology iss Premi schnology iss Roee of Concer Premiant)	enderlan kont nel (Device, System, System ape description (text) ms (text – Ensegrise, Reld	stems) of System			on Provided?	
ee dischoology is vol (D) eendischoology is vol doee dischoology is Preestischoology is pre	enderlan kont nel (Device, System, System ape description (text) ms (text – Ensegrise, Reld	stems) of System		Caffill ci	walt	
ee d'admology level (Du enail duba- Zone d'admology level Parend admology so Dane of Conce Prentised) ant phy phy phy phy phy	enderlan kont nel (Device, System, System ape description (text) ms (text – Ensegrise, Reld	stems) of System			on Provided?	
ne d'admology lavet (p. 6 enail admol 2 anne d'admology lave Prend admology lave 2 anne of Concer Prend Lave 2 ann	endersteine heart nel (Device, System, System ges desergisien (vot) ms (tear – Enseyrise, Reld Aspect/Concern	stems) of System	-	Constr. pi	ava ^{nte} (*	
ee dischistinger weet (by eensel schistinger sone of Zoone dischistinger son Zoone dischistinger son Zoone dischistinger per sone fammel per s	enderland kennt nel (Device, System, System per description (text) ms (text – Enterprise, Rekt Aspect/Concern taution	stems) of System	T Ve	Constr we	atarti L	
ee distinisting level (by erral schenisting level) Saee dischensing level Saee dischensing van Saee dischensing van Saee dischensing van Saee dischensing van Premised) and phy collisional physical act communical	enderland kennt nel (Device, System, System per description (text) ms (text – Enterprise, Rekt Aspect/Concern taution	stems) of System	-	Constr. pi	ava ^{nte} (*	4.X.
ee d'admissinger level (by erral admissione en de Danne d'admissione en de Prend admissione en d'anne Prend admissione en d'anne physical et communical physical and communical Syntactic	endeden kont ape description (real) ma (from – finearite, field Aspect/Concern tastion	stems) of System	986 1985	Constr we	SANE .	
en distinistage level (by care d'activistage level pare d'activistage level pare d'activistage level pare d'activistage level pare d'activistage level president presiden	excitation levels ape description (tent) me (text - financiale, Reld Aspect/Concern testion tion	stems) of System	998 995 995 995 996 997 998 1	Constr we	NARE E	
ee distinisting weet (De engli ethnisting weet) (De Case e dischisiology law Dese e dischisiology law Dese et Conser- Prientland) phy col Faint phy col Faint phylicel and colematic Symtacki OSL-6 OSL-6	variation locat nel (Dontos, System, System ge description (van) me (trear – Ennergrise, Reld Aspect/Concern hartion tables tables treation	stems) of System	Vee Vee Ves Ves Ves Ves Ves	Constr we	SANE .	
en distinistage level (b) care d'activistage level Dane d'activistage level Dane d'activistage level Dane d'activistage level Dane d'activistage level premiano) ant physical en activista physical e	endedna kvat spe deseription (red) mr (trat – Graegaria, Field Aspect/Concern tuation tion : intersperability ppication : intersperability	stems) of System	V (46 (45 (45 (45 (46 (46 (46))))))))))))))))))))))))))))	Creation of the second	SANE .	
en of schrieburge (weet (De annal) schwieburge (weet (De Prenz)) schwieburge (we Benne of Concer- Prenz) schwieburge (we Prenz) schwieburge physical act confranctional) schwieburge generative oper	endedna kvat spe deseription (red) mr (trat – Graegaria, Field Aspect/Concern tuation tion : intersperability ppication : intersperability	stems) of System	v V98 V95 V95 V95 V96 v98 v98 v98 soc rest 3 V98	Constr we	un ^{gi}	87 19
ee distinisting feed (b) engli ethni bagy text Dare d'admissing fee Dare d'admissing fee Dare d'admissing fee Dare d'admissing president president president president companies	endednin kvat spe deseription (ved) me (tvar – finansike, Reld Aspect/Concern tion tion tion tion tion intersperability ppficulien immoperability solar	stems) of System	V (Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve Ve V	Creation of the second	SANE .	
See Celter Service See Celter Service Press Celter Service Press Celter Service Press Celter Conference Physical act communic Systems Systems Systems Systems Systems Service	endeterine Neutr (Elevis, System, System pe deception (not) Aspect/Concern taution tion intersperability optication intersperability main magant	stems) of System	v V98 V95 V95 V95 V96 v98 v98 v98 soc rest 3 V98	Creation of the second	tangti ta m m m	
Constructions share were likely used likely Case of Conservations Prevention of Conservations provide the state of Conservations provi	Aspect/Concern Aspect/Concern Nation Aspect/Concern Nation Concernsion Concern	stems) of System	v vys vs vs vs vs vs vs vs vs vs v	CARA WE WE	Hanti I	87 82 92 90 90 90 90 90
Sare d'extinations word (De mentification science of Care d'extinations of the Present extination of Concer- Presenters) and physical act confirmed of Physical act confirmed of Synthetic Odd - Synthetic Odd	endedine kont ape description (real) ma (four – finanzine, field Aspect/Concern tastion tion : manaperability pplication : innerspeciality sedon manapart etwork	stems) of System	V98 V95 V95 V95 V95 Soc mat 1 V98 Soc mat 2 V95 V95	CARA WE WE	NARE E	



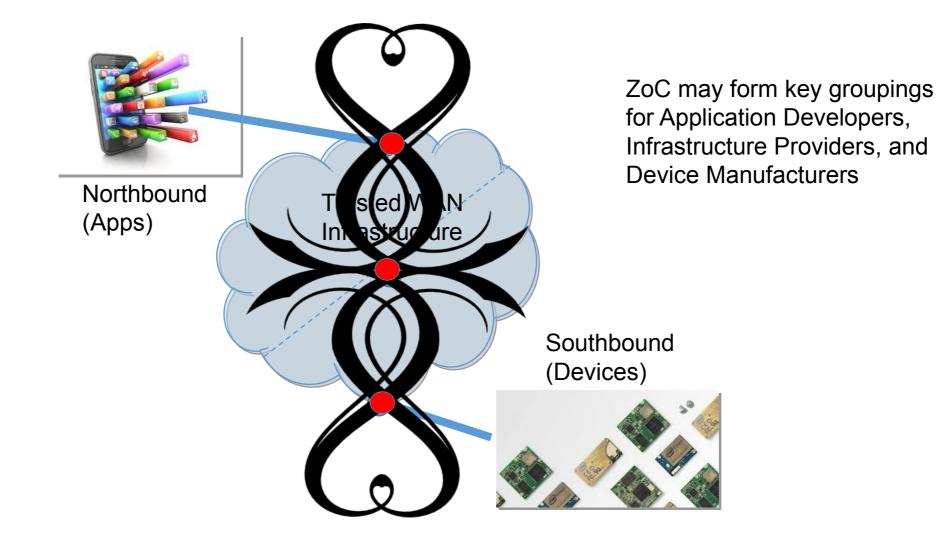
Pivotal Points of Interoperability (PPI)

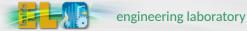






Zones of Concern (ZofC)







Technical Analyses Reviews

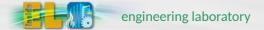




Do they address concerns?

Northbound ZofC



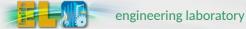




What solutions did they use?

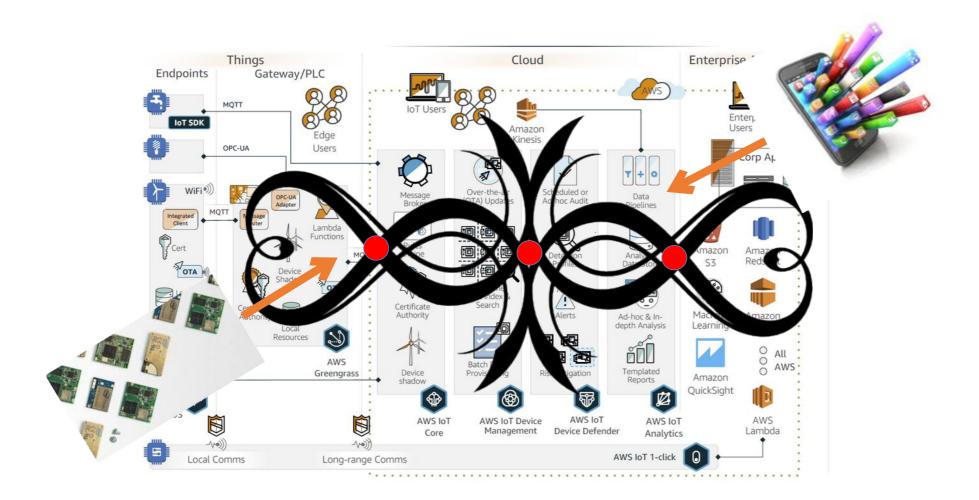
Northbound ZofC

			Extern	al References		
Aspect/Concern	ANS	CURIA	40 ¹⁵	FINARE	oneman	Openial
unctional				FIWARE NGSI (open source reference implementation: Orion Context Broker) combined with FIWARE IoT Agents (e.g., based on open source reference implementation: IDAS)		
physical actuation	https://aws.amazon.com/iot-core/ https://aws.amazon.com/greengrass/ https://aws.amazon.com/freertos/			FIWARE NGSI (open source reference implementation: Orion Context Broker)		xGSN
communication	https://aws.amazon.com/greengrass/ https://aws.amazon.com/freertos/					xGSN
Syntactic Interoperability			SOAP;REST			SSNO - URL
OSI-Application	https://docs.aws.amazon.com/iot/lat est/developerguide/topics.html	IETF HTTP, IETF FTP, NTCIP 2306	SOAP;REST			Data from sensors is acquired by XGSN using the virtual sensor concep
OSI-Presentation	https://docs.aws.amazon.com/iot/lat est/developerguide/topics.html	W3C XML, IETF GZIP	XML; JSON		W3C, Extensible Markup Language (XML) 1.0 W3C XMLSchemaP2: "W3C Recommendation (2004) IETF RFC 7159: "The JavaScript Object Notation (JSON) IETF RFC 2045: "Multipurpose Internet Mail Extensions (MIME) Part One	
Network Interoperability				FIWARE NGSI (open source reference		xGSN, LSM
OSI-Session	https://docs.aws.amazon.com/iot/iat est/developerguide/protocols.html	IETF TLS, DTLS			RFC 4566 - SDP: Session Description Protocol IETF RFC 5246: "The Transport Layer Security (TLS) Protocol Version 1.2" IETF RFC 6347: "Datagram Transport Layer Security Version 1.2"	
OSI-Transport	https://docs.aws.amazon.com/iot/lat est/developerguide/protocols.html	IETF TCP				
OSI-Network		IETF IPV6				
Basic Connectivity	https://aws.amazon.com/greengrass/ https://aws.amazon.com/freertos/					
OSI-Data Link						
OSI-Physical				FIWARE NGSI (open source reference implementation: Orion Context Broker)		
controllability	https://aws.amazon.com/greengrass/ https://aws.amazon.com/freertos/					



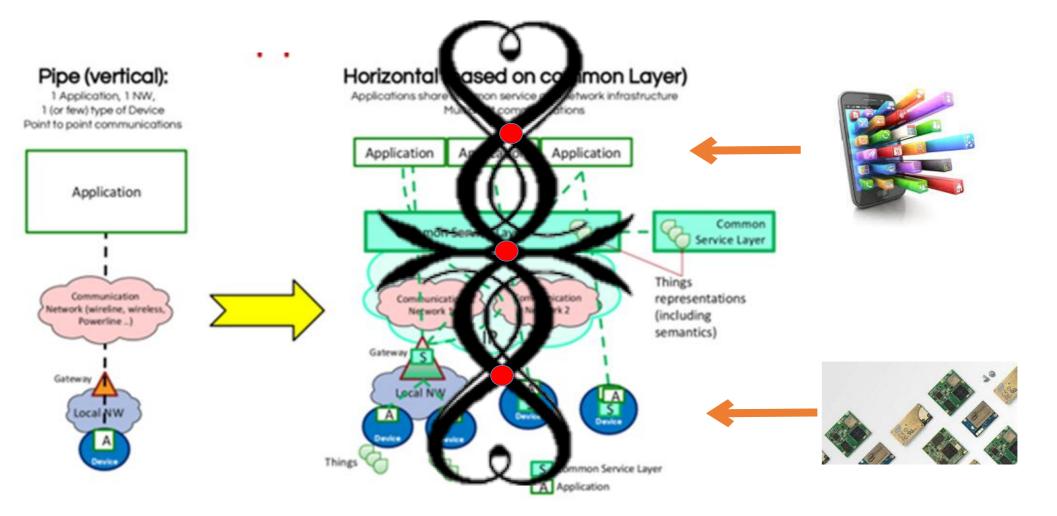


Insert examples of ZofC (Amazon Web Services)





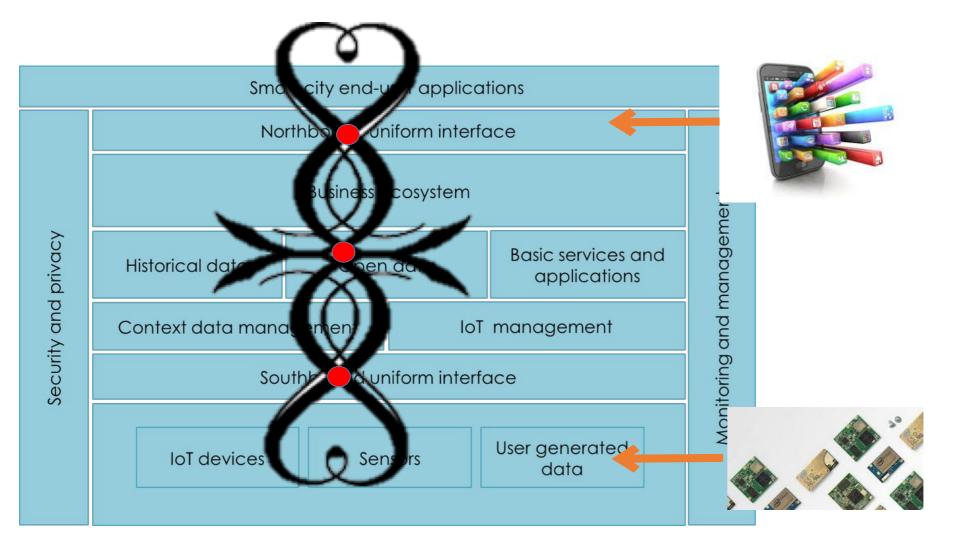
oneM2M ZofC

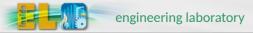




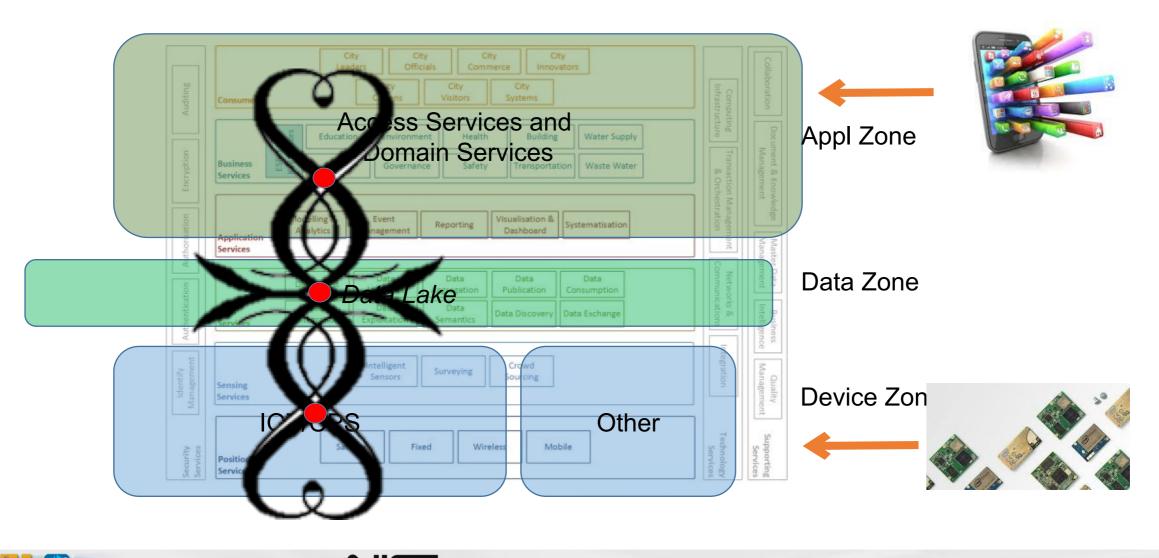


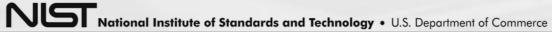
Synchonicity: ZofC





ESPRESSO ZofC





ApplicationFramework Tool





Smart City Application Framework

Objectives:

- Evaluating a list of cases that they are implementing in order to better manage their resources and deliver services to their citizenry.
- Identifying the needs and priorities of a city and assess on whether the city is ready from a technical point of view for absorbing "smarts".
- Measuring the benefits that can be expected from the solutions evaluated and/or determine whether the goals (benefits) have been accomplished



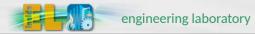


Dimension	Description
Breadth: List of applications and related metrics	It consists of both a framework (metrics + tool) for evaluating the breadth (elaborated on the basis of existing models) and the list of evaluated applications
Readiness: A framework for assessing City's Readiness	A List of Metrics + a tool to Assess the Readiness of Cities to Absorb Smart City Applications (elaborated on the basis of existing maturity models)
Benefits: A Framework to Measure Benefits	Metrics + tool for measuring benefits that can be derived from Assimilated Applications
engineering laboratory	ds and Technology • U.S. Department of Commerce

Evaluate Breadth

Objectives:

- Definition of an approach for evaluating the breadth of applications: this approach will be developed starting from some existing models
- Definition of a framework for evaluating the breadth of applications: practically this framework will be a software tool, based on the defined evaluation approach.



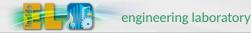


List of Requi	rements for the following kin	d of Smart City applications (Built Environme	ent/ Smart Building)
Aspect	Concern	Abstract requirements	Specific implementation requirements
Functional	Actuation	- to control building energy systems	 actuation capabilities smart devices
	Communication	- capacity to exchange information internal to the system	 Home management systems Sensor network
	Functionality	 energy management alarm management fault detection and diagnosis 	 Automation and real-time analytics integration with utilities and city infrastructure
	Controllability	- to remotely control/access to the systems	 Internet connection remote control software
	Performance	- to provide feedback in time to act	 fast and reliable network real-time systems
	Physical context	 to detect presence of people 	- sensors (motion, presence,)
	Sensing	 to detect presence of people persistent communications to elaborate data received from home energy systems capacity to analyse and elaborate received data and make decisions 	 sensors persistent communications technologies decision support systems
	Monitorability		List of no quinom on to for Smart
Human	Usability	 to provide human readable, unambiguous and aggregated data 	List of requirements for Smart Building application, involving the
			data level for geo-domain

engineering laboratory

Evaluate Readiness

- •A comprehensive and easy-to-use tool for cities to make a quick and prudent decision to identify and deploy smart city applications.
- Concise set of metrics and indicators to measure progress.
- •Allow a quick, high-level readiness assessment that can be followed up with a much more robust and long-term assessment process.
- Assist policymakers in prioritizing actions (i.e. procurement, indirectly highlighting most pressing needs, etc.)
- •Assist stakeholders in determining, at a first pass, whether a city has an existing infrastructure that will make applications to integrate.
- •Once a smart city project is engaged, more detailed analytical tool may be needed to aid in the specification and implementation process





List of Readiness Parameters for	the following kind of Smart Ci	ity applications	Example of set of a complete
Category:	Built environment		readiness table for a particular
Sub-Category:	Smart Home		sub-category
			sub-cutegol y
Strategic Intent	Technology	Readiness parameters	S
Data	Open data/information platform	- Current sources of c	open data from government services
ICT Infrastructure/Technologies	Internet network	 Substantial percentage of households with internet access Availability of fixed broadband subscriptions 	
	Broadcasting		
	Sensors networks	5	rs network infrastructure age of smart phones and tablets
	Computer/laptop		
Governance & Service Delivery Models	Integrated management center		
	Emergency response		
	Services deliveries	•	of public services and systems es to support persons with specific needs - nd affordability
Stakeholder Engagement	Citizen Education	- Availability of educat applications	tion program for citizens on smart city
	Web portal/mobile apps/online services	compliant to disabled	ops are universally accessible (also persons)(support) ims for online citizen engagement

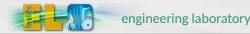




Evaluate Benefits

Objectives:

- Assist cities to parameterize the necessary investment of public resources for a smart city designation.
- Evaluate benefits for deploying possible technologies for all involved stakeholders public sector (city government), private sector (enterprises/private firms) and citizenry.
- Optimize the usage of available capacity and resources to maximize benefits to all.
- Instead of striving for physical growth, it is important that cities start to measure how wisely they consume resources, and how well they maintain high quality of life, and how smart they are enable economic prosperity and social equability and environmental sound.





Domains	Categories	Sub-categories
	Economic Benefits	IntegrationBenefit categories and subcategories for publicEmploymentsubcategories for publicLeverage of private funding Prosperitygector (please see more detailed metrics in the document)Cost savingdetailed metrics in the document)Economic resiliencyhetailed metrics in the document)
Public Sector	Environmental Benefits	Energy Conservation Water Conservation Waste reduction Raw Materials conservation Environmental Quality Ecology System Protection Natural Hazard Prevention
	Social Benefits	Public Service Governance Equitability Attraction





Applications Case Studies

Wireless water meter: New York City's Automated Meter Reading (AMR) system consists of 817000 individual water meters all over the city. Each of them is connected to a low-power radio transmitter that sends water readings to rooftop receivers in a certain frequency. The receivers transmit the data to a Network Operations Center using a secure citywide telecommunication network. Customers can view their water usage data and pay bills online. Thus, saved over \$3 million per year by avoiding manual meter readings.

Category/Subcategory: Built Environment / Smart Home **Readiness: Benefits:**

- Substantial percentage of households with internet access
- Current sources of open data from government services
- Substantial percentage of smart phones and tablets
- 24/7 ICT Services
- Information security of public services and systems

engineering laboratory

- Decrease cost in serving citizens
- Decrease cost in paying for utility, includes electricity, natural gas and water, etc.
- Reduce residential water consumption
- Increase residential wastewater recycling and reuse
- Promote business development and increase revenue opportunities
- Reduce operation and management cost



<u>City Open Data Platform:</u> The London Datastore was one of the first platforms in the world to publish open data and make it public accessible. This Datastore receives over 30,000 visits a month and more than 450 transport app has been created using open data. This encourages the development of products new business model, and creation of better, more cost effective, services for all Londoners.

Category/Subcategory: Socio-economic development / E-Governance

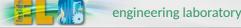
Readiness:

- Current sources of open data from government services
- Availability of online city information
- Substantial percentage of households with internet access
- High City coverage with 3G enabled mobile network
- Substantial percentage of smart phones and tablets
- Use of Integrated Management & Command Centre
- Availability of online city feedback
 mechanisms
- Government access to cloud services
- Adult Literacy Rate High percentage of households with at least one family member who is digitally literate
- Most web portals/Apps are universally accessible

WEATHER STATION (CASA)	WEATHER (METAR)	Forecast (Google)
Web Web Guists Direction Towershatung Raw Pressure Foncest Secto Guists Direction Towershatung Humony Raw Pressure Foncest 17.6 mph 12 mph S.† 11.8 °C 72% 0.8 min 991.2 mbar Cloudy	London City Airport Mostly cloudy SW at 9 10 C	Thu Fri Sat Sun
Tube Line Stratus (TFL) IS Bite Stratus (TFL) IS Determine Control Pert Supported (more) One Marco Strates Output Determine Control Control	Air QUALITY (DEFRA) 1750 1 - Low Oxone NO2 SO2 PMoc PMoc 10 - V High Oxone NO2 SO2 PMoc PMoc 10 - V High 3 1 1 1 1 Mayldone Rd 2 3 1 2 2 N Konsington 3 1 1 1 N/z Gelder Counter (CASA) I I I I I	Moop (LSE MAPPINESS) Slightly unhappier two the key term warage for here River Level (PLA) Tower Pler
W & E Osod Server COO DLR Good Server 24h 20h 16h 12h 6h 6000	counts per minute	metres at 09:54
A Picture Of Me When I Was Bakerloo Line #Thet Ramos Rupert Murdoch Embankment	hingis Charles Taylor #IfIHad	MyWay Joanna Lumley Sergio
A Picture Of Me When I Was Bakerloo Line #Theti	TWITTER: LONDON UNIVERSITIES	MyWay Joanna Lumley Sergio

Benefits:

- Improve economic integration
- Provide public-private-partnership opportunities
- Promote local GDP Growth
- Improve public service deliveries
- Improve decision-making process and operation efficiency of governance entity within one department or across others
- Reduce cost in governance operation and maintenance
- Decrease cost in serving citizens
- Enhance governance transparency
- Reduce duplication of city effort from different departments with enhanced procurement process
- Improve social equitability
- Increase city's attraction to residents and visitors
- Provide opportunities to enhance public participation in public affairs or activities
- Enhance creativity of citizens
- Improve community connectivity
- Promote business development and increase revenue opportunities
- Engage and leverage Small and Medium Enterprises (SME) community
- Accelerate new business start-ups
- Incubate innovative technologies and accelerate new product disruptions



<u>Smart platform for data management</u>: City of Genoa, Italy uses FIWARE (fiware.org), a public, open-source platform that eases the development of Smart applications, to improve the process of collecting and processing environmental data from meteorological sensors (e.g. meteor-radar, rain gauge, hydrometric, etc.) coupled with existing geo-referential data about major infrastructures and exposed people. The data will be used to provide weather nowcasting for preventing hydrogeological risk, and providing mid/long-term forecasting to address the Climate Change risks related.

Category/Subcategory: Public Safety, policy & EM. Res/Prevention and managing of natural disasters



engineering laboratory

Readiness:

- Current sources of open data from government services
- Availability of online city information
- Substantial percentage of digital broadcasting network
- Availability of sensors network infrastructure
- Use of Integrated Management & Command Centre
- Centralized collaboration between emergency response, police, fire, water, power
- Availability of online city feedback mechanisms
- Government access to cloud services
- 24/7 ICT Services
- Availability of needed citizen centric services over Mobile Applications/website portal - require support to continuously provide value to users
- Most web portals/Apps are universally accessible (also compliant to disabled persons)(support)
- Substantial use of social media by the public sector **Benefits**:
- Reduce economic loss
- Decrease cost in serving citizens
- Protect the habitat for animals and other species
- Reduce the occurrence and impact of natural hazards or man-made disasters
- Enhance alert of natural hazard or man-made disaster
- Improve public safety and security via video surveillance, fire and smoke alarms and other ICT enabled devices.

Why is NIST interested in the City Platform Group?

- IES-City Framework provides a set of concepts and tools to aid stakeholders in understanding interoperability issues and lowering the barriers to integrating IoT and smart city features
- There is a technical methodology that simplifies comparing complex systems of technology currently deployed from different sources
- There is an Application Framework Tool that can speed initial studies on the potential for deploying technologies in cities and communities

Based on this philosophy, NIST intends to participate and support private-sector activities to accelerate creation and adoption of standard-based, interoperable smart city platforms and solution.

