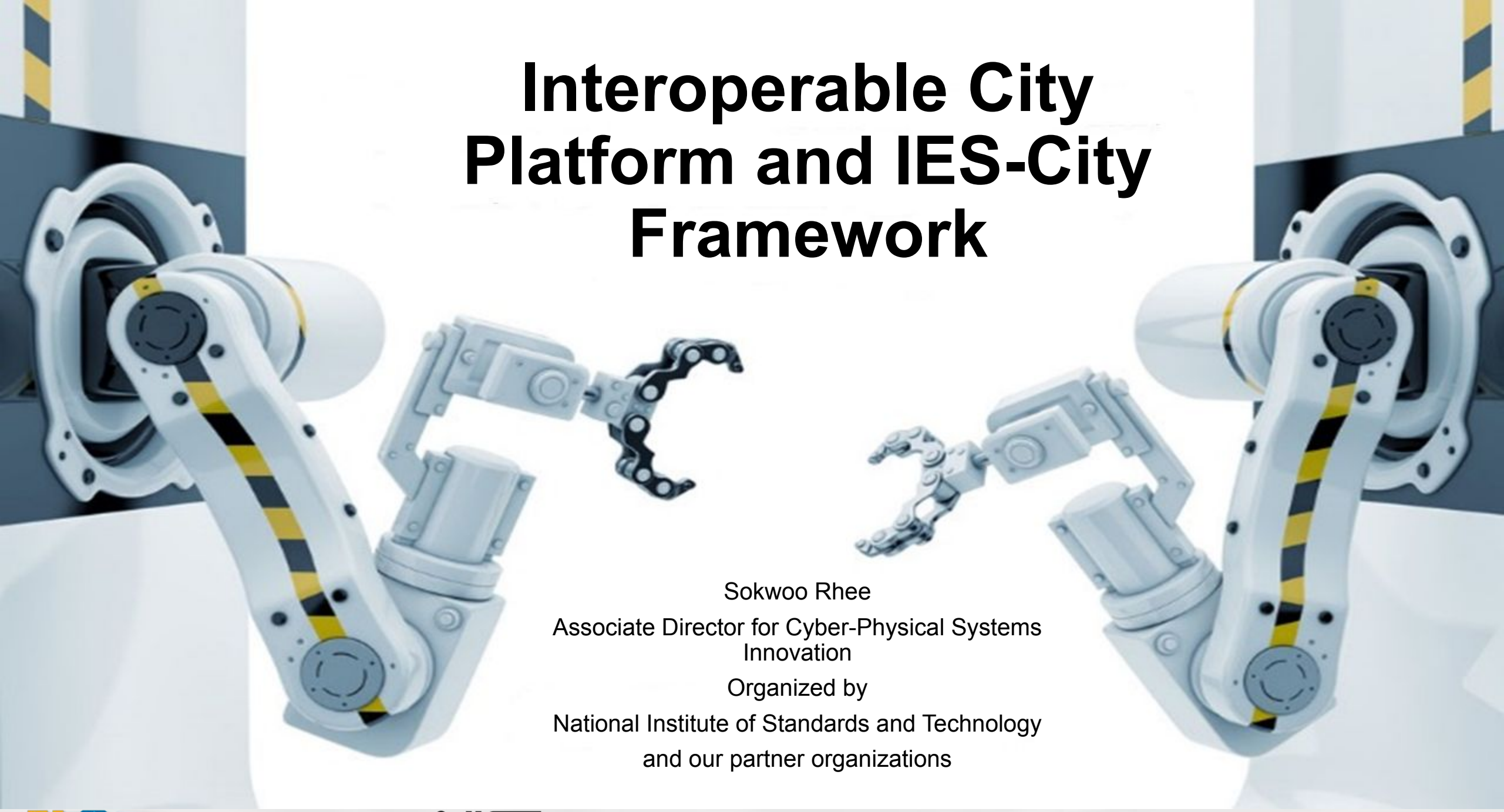
Interoperable City Platform and IES-City Framework



Sokwoo Rhee

Associate Director for Cyber-Physical Systems Innovation

Organized by

National Institute of Standards and Technology

and our partner organizations

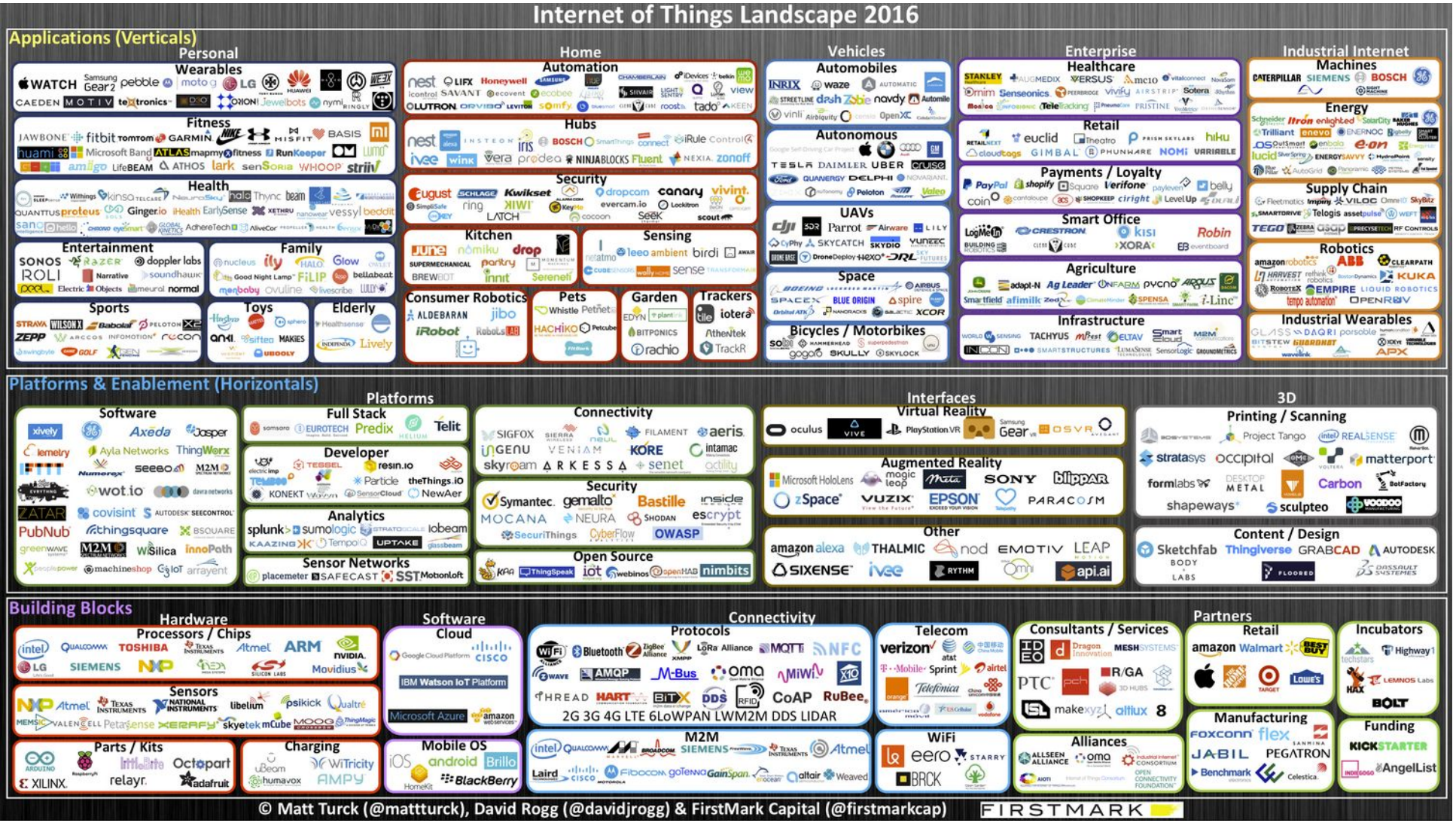
IoT-Enabled Smart City Framework

- 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.

FIWARE MSIP NIST National Institute of Standards and Technology U.S. Department of Commerce ETSI World Class Standards ANSI U.S. Green Building Council USGBC ENEA Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile TIA Advancing Global Communications

Goal: A reference framework for the development incremental and composable Smart Cities

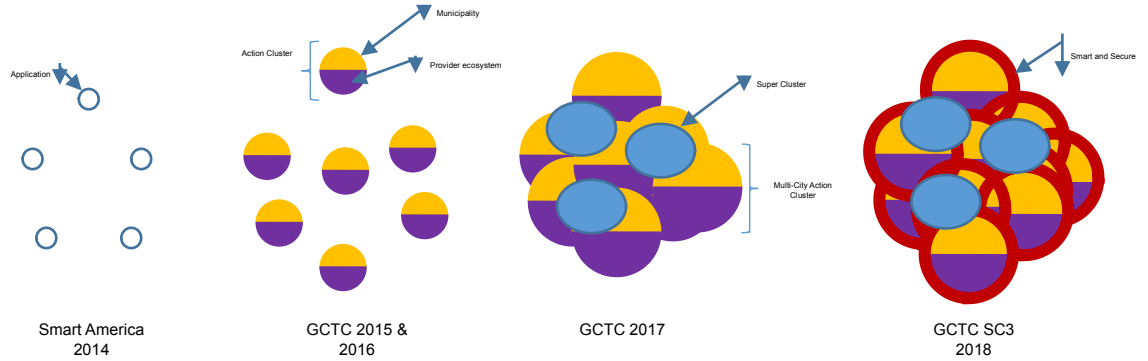
The Challenge - Divergent CPS/IoT Technology Landscape



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

Market Driven: GCTC

- Action Clusters
- Super Clusters

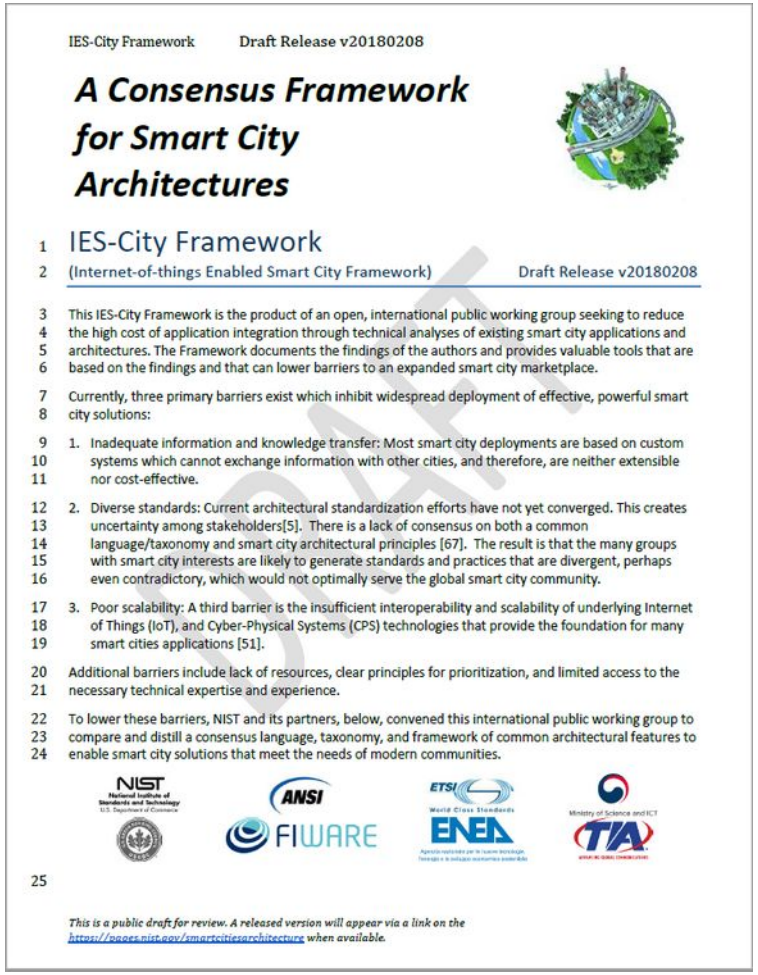


Technology Driven: IES-City Framework

- Application Analysis
- Technology Suite Analysis

IES-City Framework Consists of:

A Framework Document



IES-City Framework Draft Release v20180208

A Consensus Framework for Smart City Architectures

1 IES-City Framework

2 (Internet-of-things Enabled Smart City Framework) Draft Release v20180208

3 This IES-City Framework is the product of an open, international public working group seeking to reduce
4 the high cost of application integration through technical analyses of existing smart city applications and
5 architectures. The Framework documents the findings of the authors and provides valuable tools that are
6 based on the findings and that can lower barriers to an expanded smart city marketplace.

7 Currently, three primary barriers exist which inhibit widespread deployment of effective, powerful smart
8 city solutions:

9 1. Inadequate information and knowledge transfer: Most smart city deployments are based on custom
10 systems which cannot exchange information with other cities, and therefore, are neither extensible
11 nor cost-effective.

12 2. Diverse standards: Current architectural standardization efforts have not yet converged. This creates
13 uncertainty among stakeholders[5]. There is a lack of consensus on both a common
14 language/taxonomy and smart city architectural principles [67]. The result is that the many groups
15 with smart city interests are likely to generate standards and practices that are divergent, perhaps
16 even contradictory, which would not optimally serve the global smart city community.

17 3. Poor scalability: A third barrier is the insufficient interoperability and scalability of underlying Internet
18 of Things (IoT), and Cyber-Physical Systems (CPS) technologies that provide the foundation for many
19 smart cities applications [51].

20 Additional barriers include lack of resources, clear principles for prioritization, and limited access to the
21 necessary technical expertise and experience.

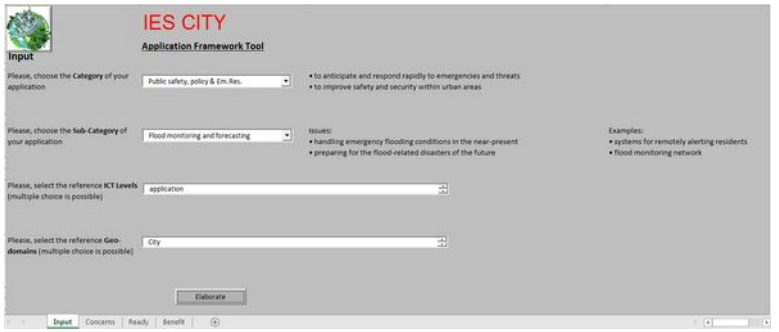
22 To lower these barriers, NIST and its partners, below, convened this international public working group to
23 compare and distill a consensus language, taxonomy, and framework of common architectural features to
24 enable smart city solutions that meet the needs of modern communities.

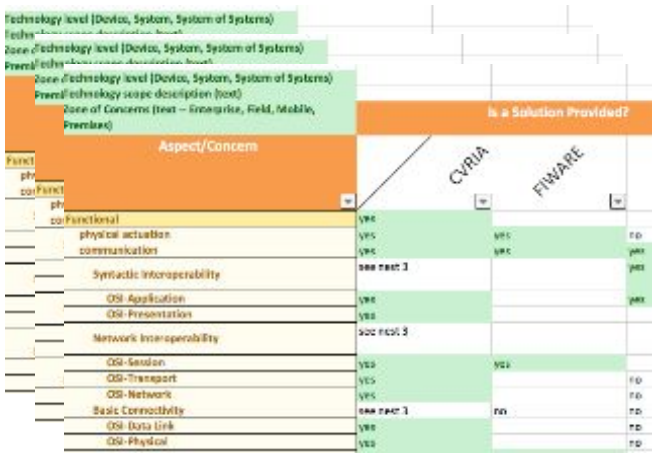
25

This is a public draft for review. A released version will appear via a link on the https://pages.nist.gov/smartcitiesarchitecture when available.

DRAFT

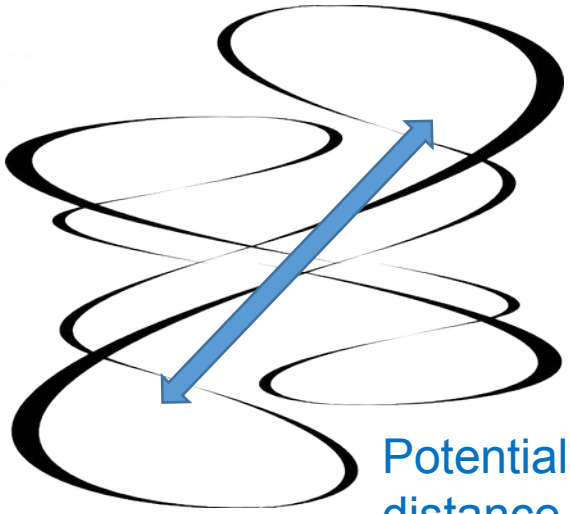
Set of Artifacts





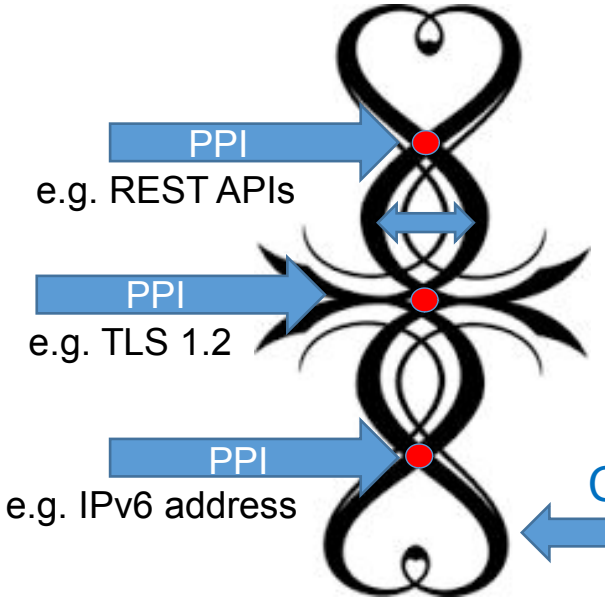
Pivotal Points of Interoperability (PPI)

Independent technology deployments



Potentially large distance to interoperability

With Pivotal Points of Interoperability

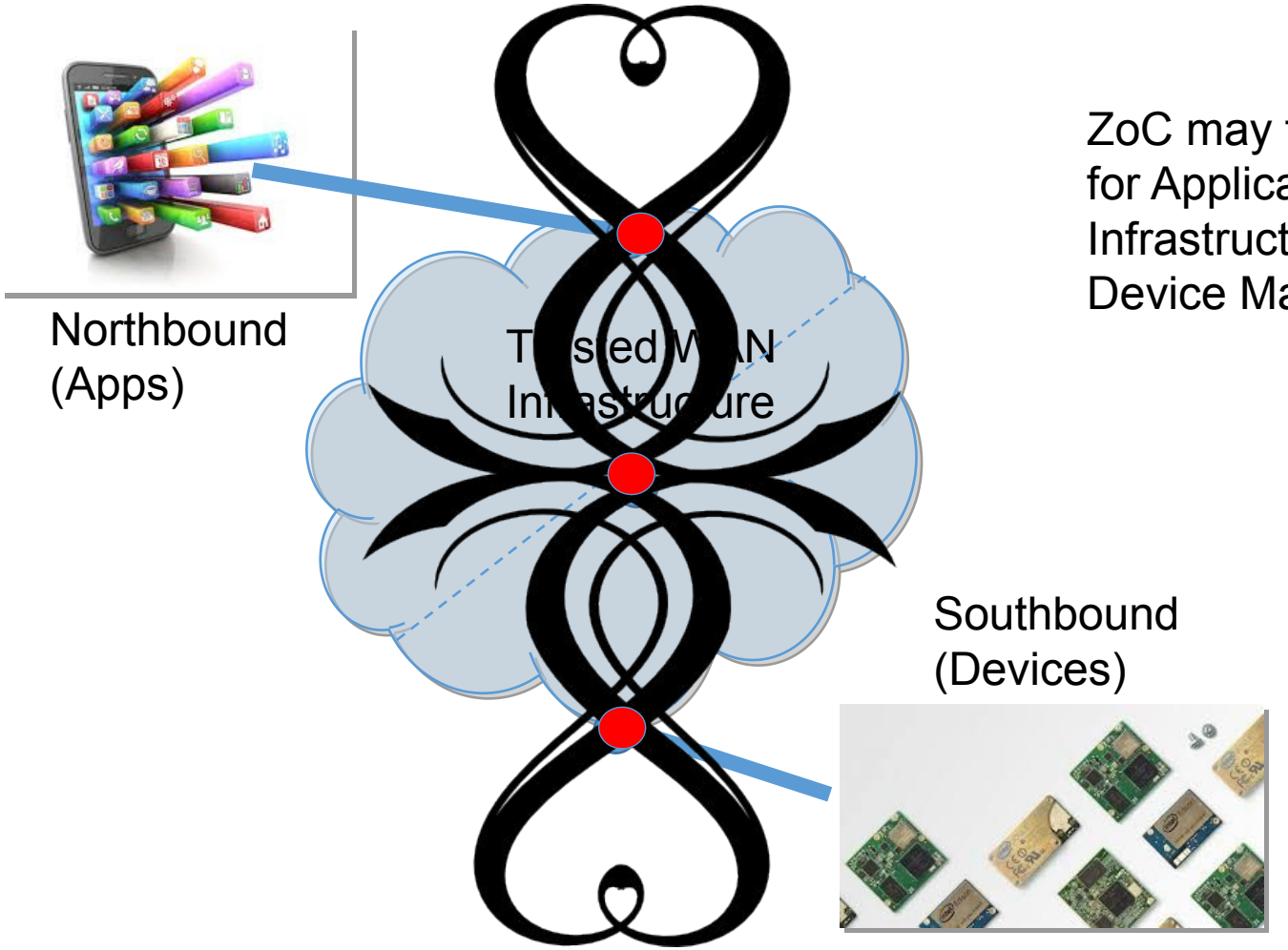


Minimize distance to interoperability

e.g. Convert XML to JSON

Composable Smart Cities

Zones of Concern (ZofC)



ZoC may form key groupings for Application Developers, Infrastructure Providers, and Device Manufacturers

Technical Analyses Reviews

Do they address concerns?

Northbound ZofC

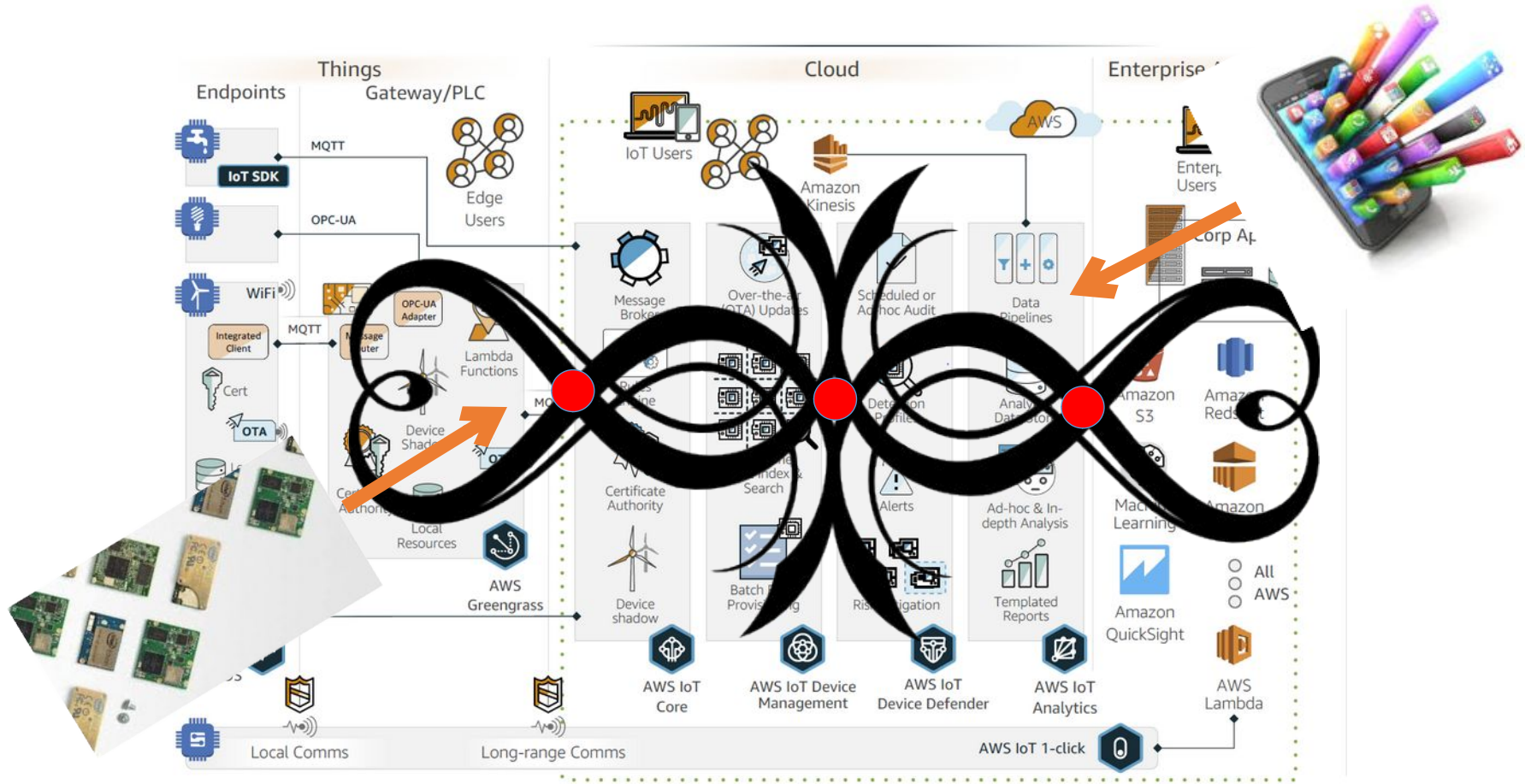
Aspect/Concern	Is a Solution Provided?					
	AWS	CVRIA	E015	FIWARE	oneM2M	OpenIoT
Functional		no		yes	yes	
physical actuation	yes	see below	no	yes	yes	no
communication	yes	see below	yes		yes	yes
Syntactic Interoperability		yes	yes		not applicable	yes
OSI-Application	yes	no	yes		yes	yes
OSI-Presentation	yes	see below	yes		yes	no
Network Interoperability		yes	no	yes	not applicable	
OSI-Session	yes	yes	no		yes	no
OSI-Transport	yes	yes	no		yes	no
OSI-Network		see below	no	yes	yes	no
Basic Connectivity	yes	yes	no		not applicable	no
OSI-Data Link	no	yes	no		yes	no

What solutions did they use?

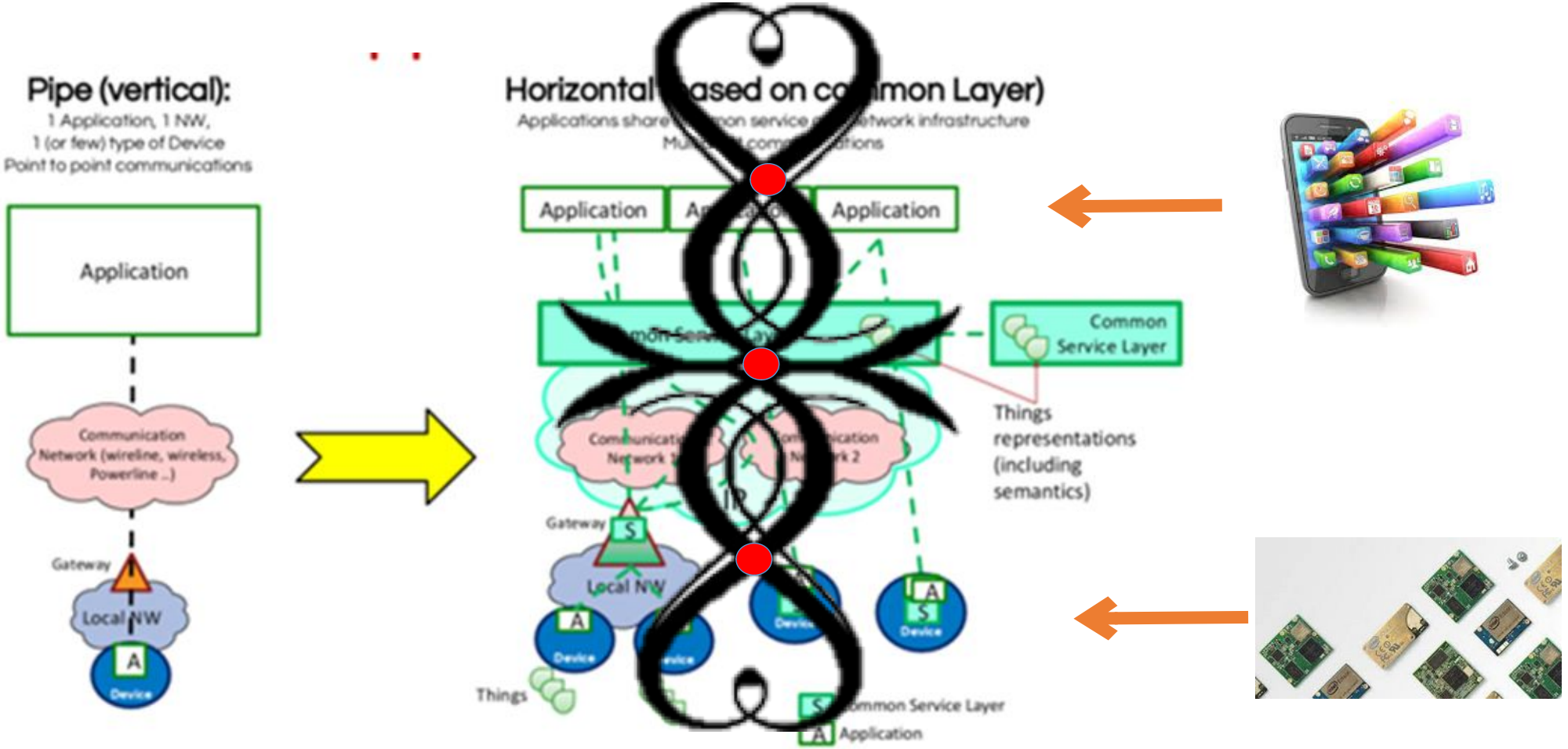
Northbound ZofC

Aspect/Concern	External References					
	AWS	CVRIA	E015	FIWARE	oneM2M	OpenIoT
Functional				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/latest/developerguide/topics.html	IETF HTTP, IETF FTP, NTCIP 2306	SOAP;REST			Data from sensors is acquired by XGSN using the virtual sensor concept
OSI-Presentation	https://docs.aws.amazon.com/iot/latest/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/latest/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/latest/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/					

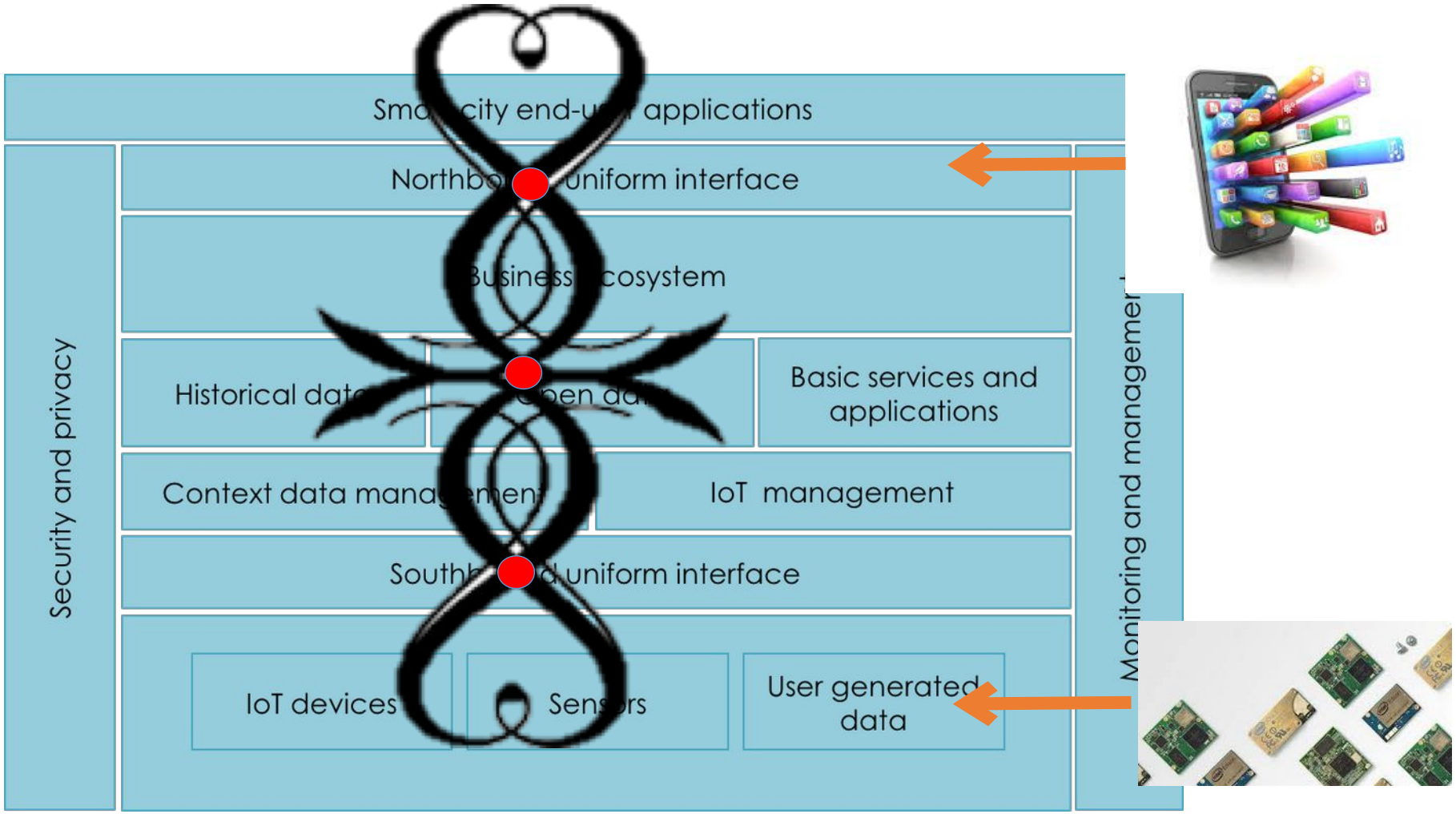
Insert examples of ZofC (Amazon Web Services)



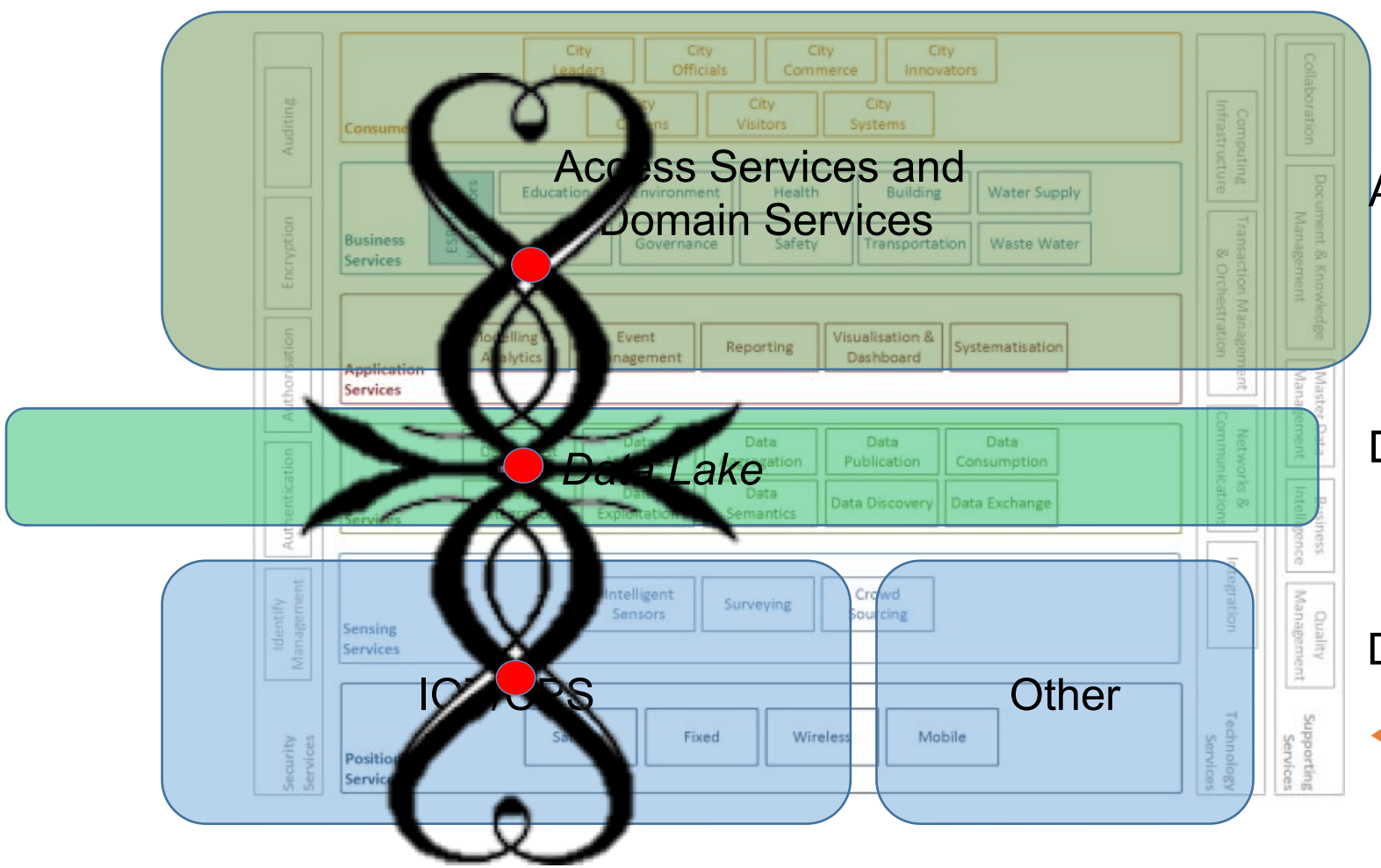
oneM2M ZofC


Pipe (vertical):
1 Application, 1 NW,
1 (or few) type of Device
Point to point communications
Application
Communication Network (wireline, wireless, Powerline ..)
Gateway
Local NW
A
Device
Horizontal
Application
Application
Common Service Layer
Things representations (including semantics)
Gateway
S
Local NW
A
Device
Things
Application

Synchonicity: ZofC



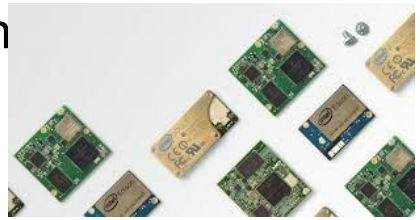
ESPRESSO ZofC



Appl Zone

Data Zone

Device Zon



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

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 Requirements for the following kind of Smart City applications (Built Environment/ 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		
Human	Usability	- to provide human readable, unambiguous and aggregated data	

List of requirements for Smart Building application, involving the data level for geo-domain

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 City applications

Category: Built environment

Sub-Category: Smart Home

Example of set of a complete readiness table for a particular sub-category

Strategic Intent	Technology	Readiness parameters
Data	Open data/information platform	- Current sources of 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	- Availability of sensors network infrastructure - Substantial percentage of smart phones and tablets
	Computer/laptop	
Governance & Service Delivery Models	Integrated management center	
	Emergency response	
	Services deliveries	- 24/7 ICT Services - Information security of public services and systems - Availability of services to support persons with specific needs - regardless of ability and affordability
Stakeholder Engagement	Citizen Education	- Availability of education program for citizens on smart city applications
	Web portal/mobile apps/online services	- Most web portals/Apps are universally accessible (also compliant to disabled persons)(support) - Availability of programs 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
Public Sector	Economic Benefits	Integration
		Employment
		Leverage of private funding
		Prosperity
		Cost saving
		Economic resiliency
		Pricing
	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

Benefit categories and subcategories for public sector (please see more detailed metrics in the document)

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:

- 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

Benefits:

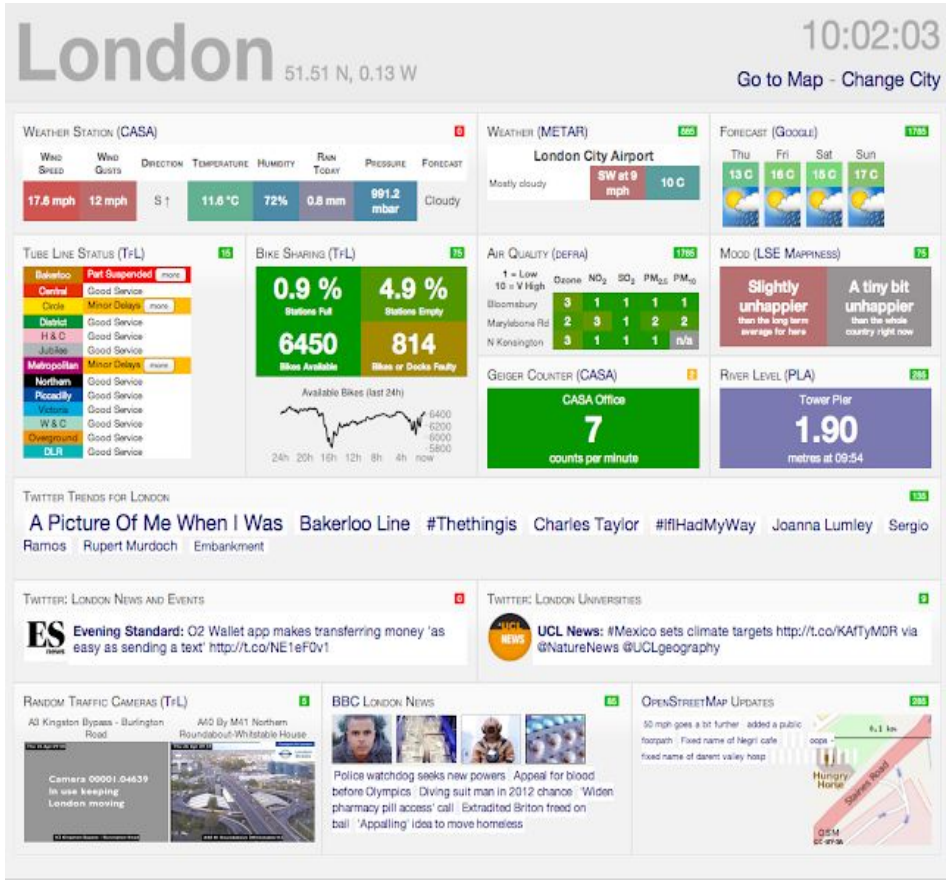
- Decrease cost in serving citizens
- Decrease cost in paying for utility, includes electricity, natural gas and water, etc.
- Reduce residential water consumption
- Increase residential wastewater recycling and reuse
- Promote business development and increase revenue opportunities
- Reduce operation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

City Open Data Platform: 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



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

Smart platform for data management: 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

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.