In the framework of SESEI

In association with CII Confederation of Indian Industry

3rd Indo-European Conference on Standards and Emerging Technology

26th April, 2018 – New Delhi

UNIFYING & HARMONIZING THE "LAST-MILE" MADNESS IN M2M/IOT

Prasant Misra, Ph.D.

Member, BIS LITD 28 | Scientist, TCS R&I

Background and Setting the Context …

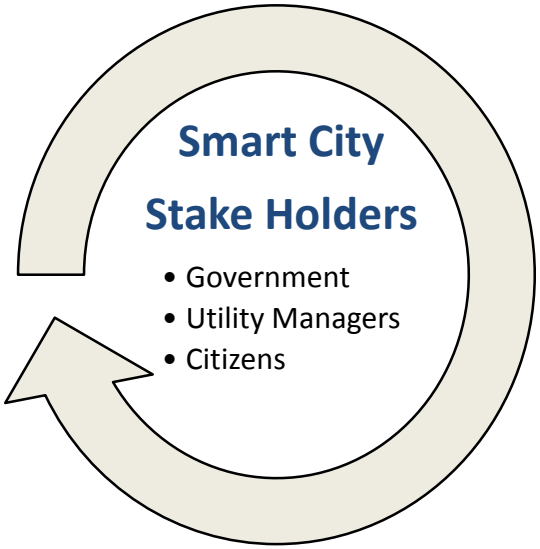
Smart City: Vision and Value Proposition

Vision:

- Urban development
- **Integrate** multiple (ICT and IoT) solutions in a **secure** manner to **effectively** and **efficiently manage** a city's assets, utilities, and infrastructure
  - City assets and utilities include, but not limited to: Electric grids, water distribution systems, transportation systems, communication infrastructure, waste treatment plants, commercial buildings, hospitals, homes and education centers, and other community services

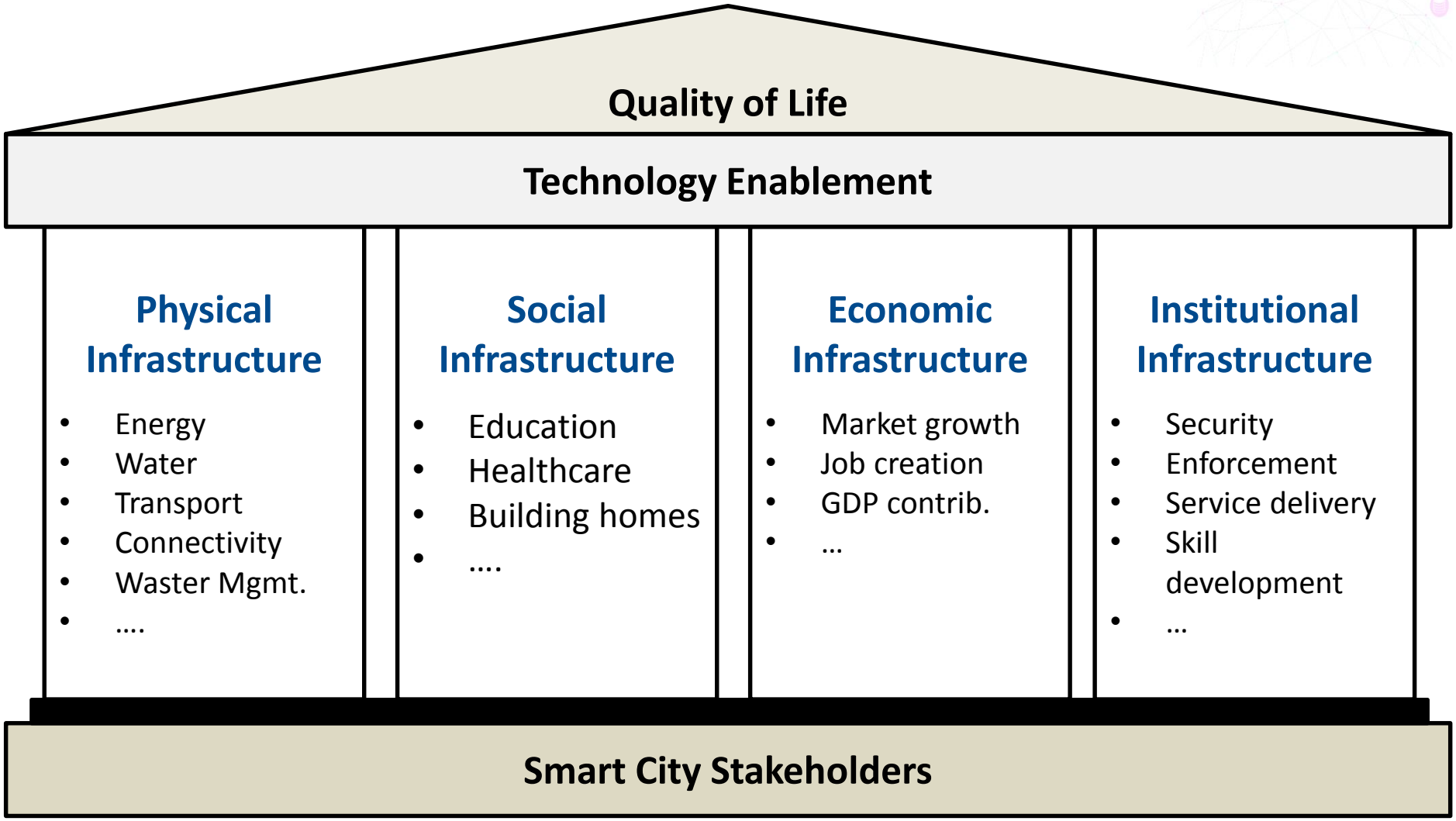
Value Proposition:

- Improve services and quality of life for

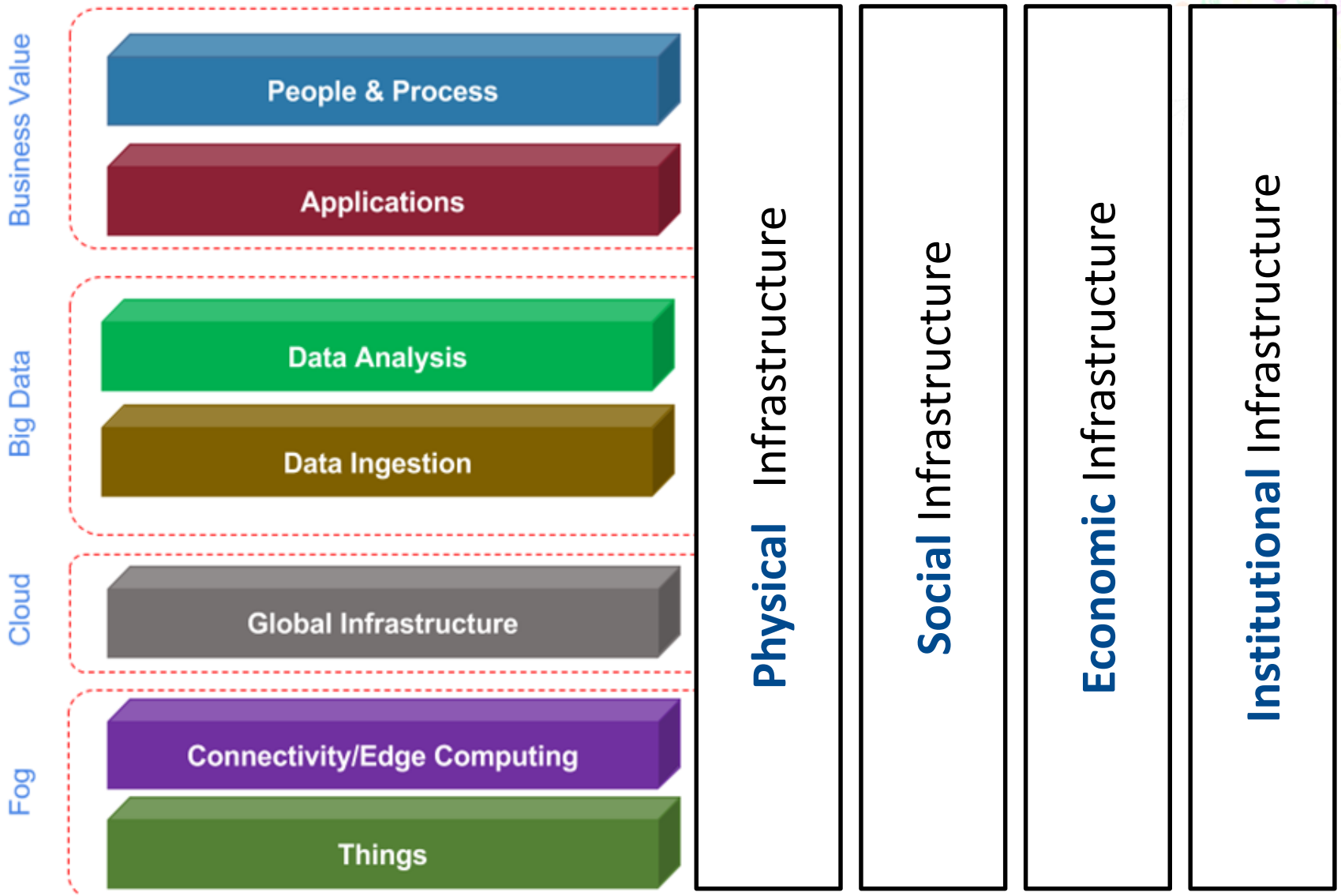


Smart City: Four Infrastructure Pillars to Comprehensive Development

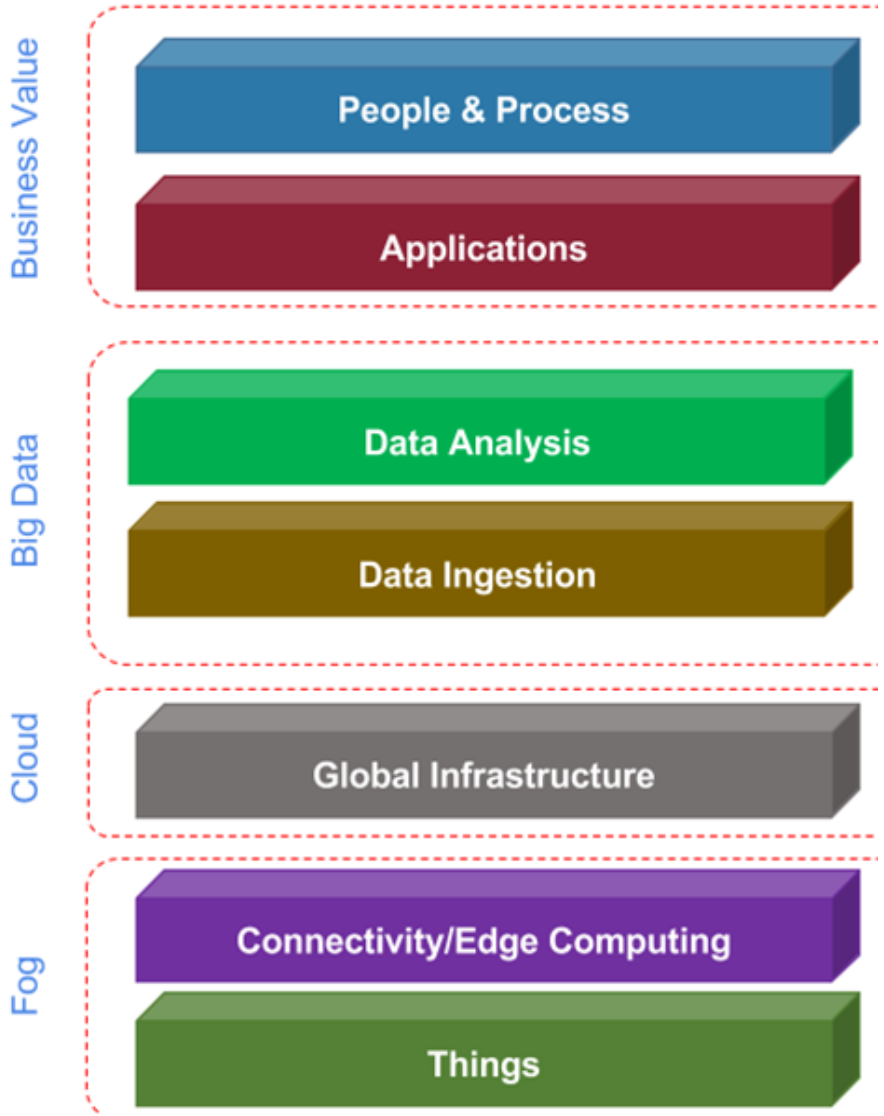
Smart Infrastructure is the **KEY** to Smart and Smarter Cities



Mapping the Smart Infrastructure Philosophy to High-level Functionality



Mapping the Smart Infrastructure Philosophy to High-level Functionality



Physical Infrastructure

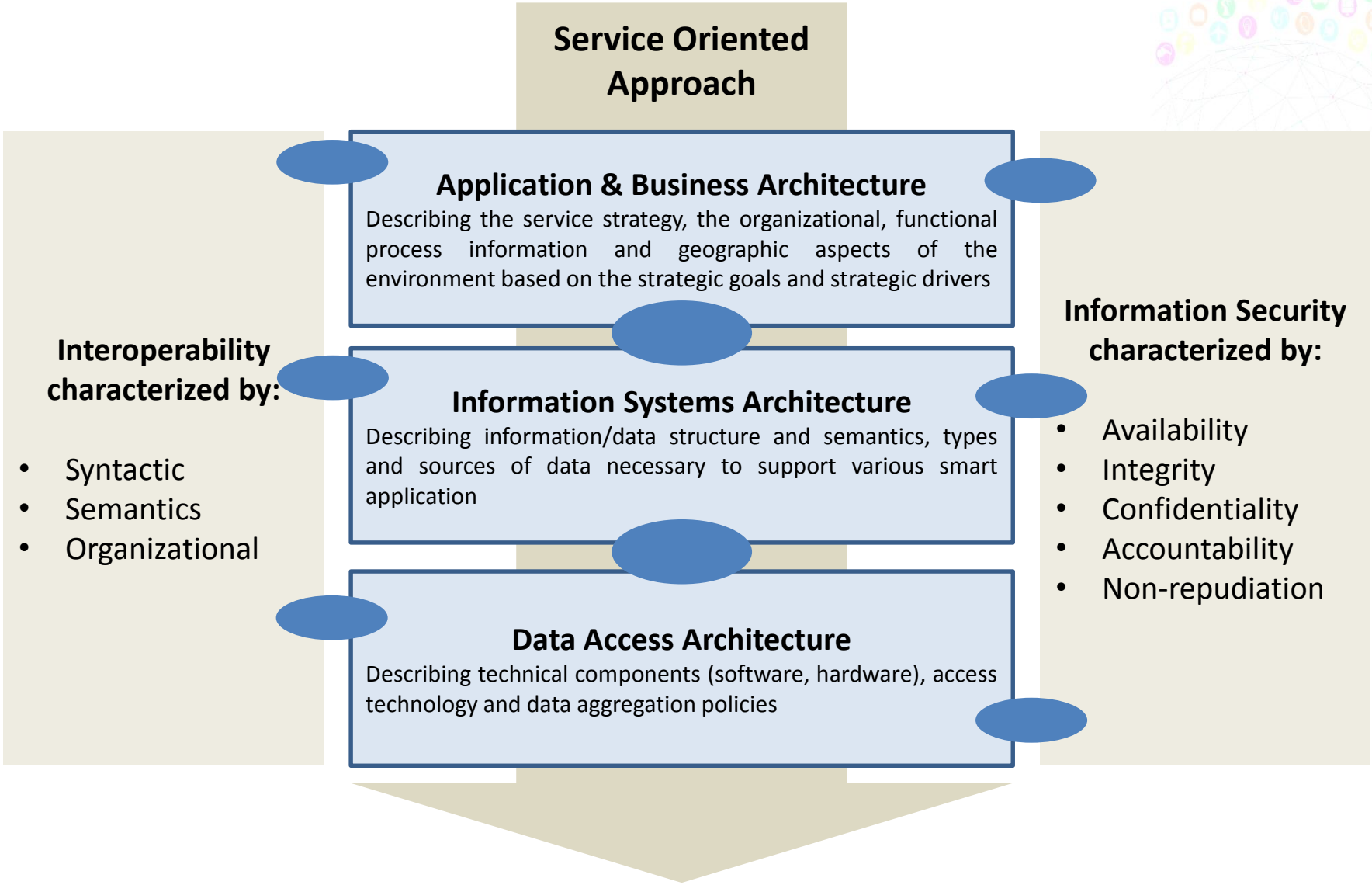
Social Infrastructure

Economic Infrastructure

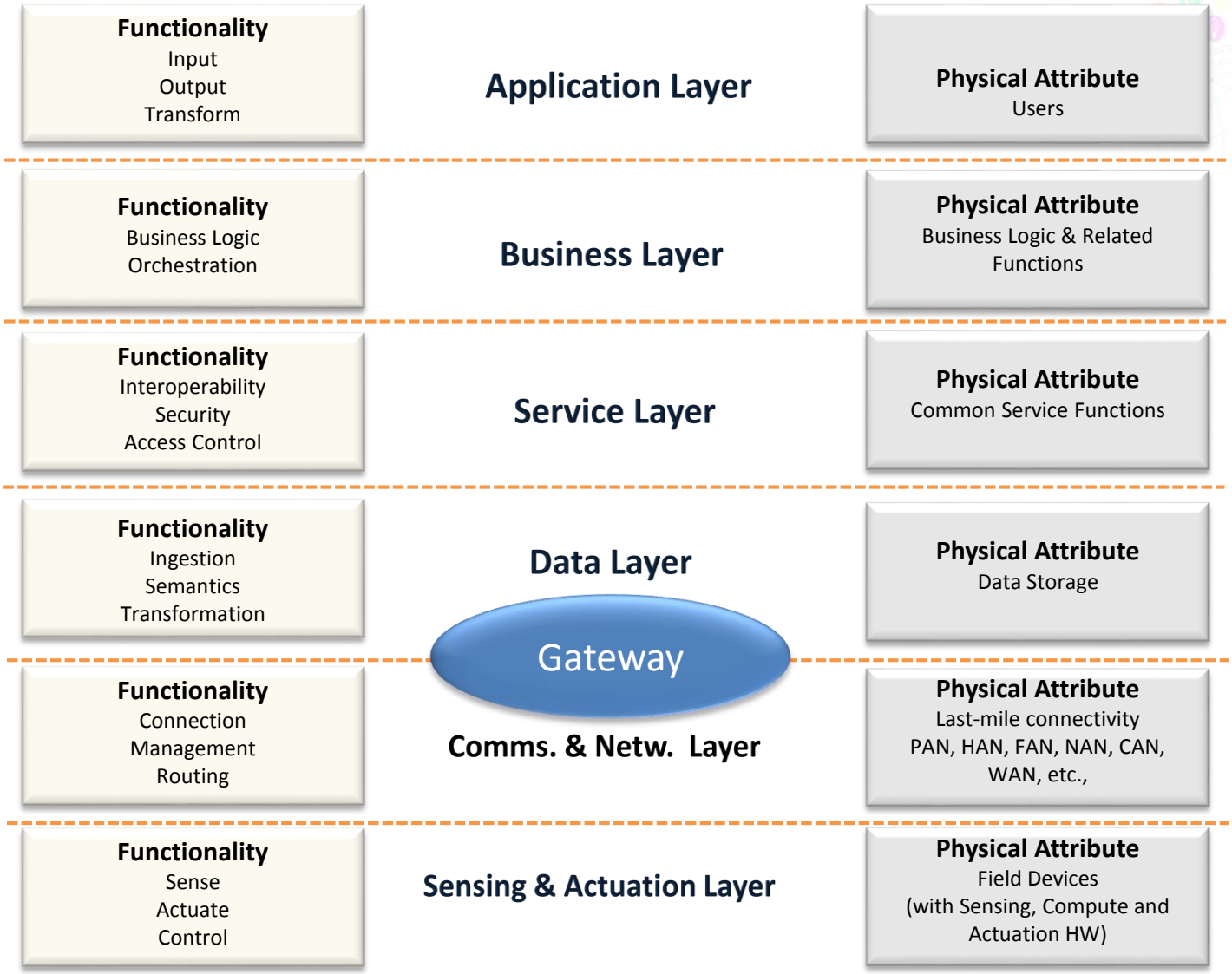
Institutional Infrastructure

The application needs **change** (as part of the users' requirement) to derive value from different infrastructure pillars, **but** the ICT and IoT **backbone the remains (or should remain) the SAME !!!**

Translating Smart Infra. High-level Functionality to Architecture Scheme

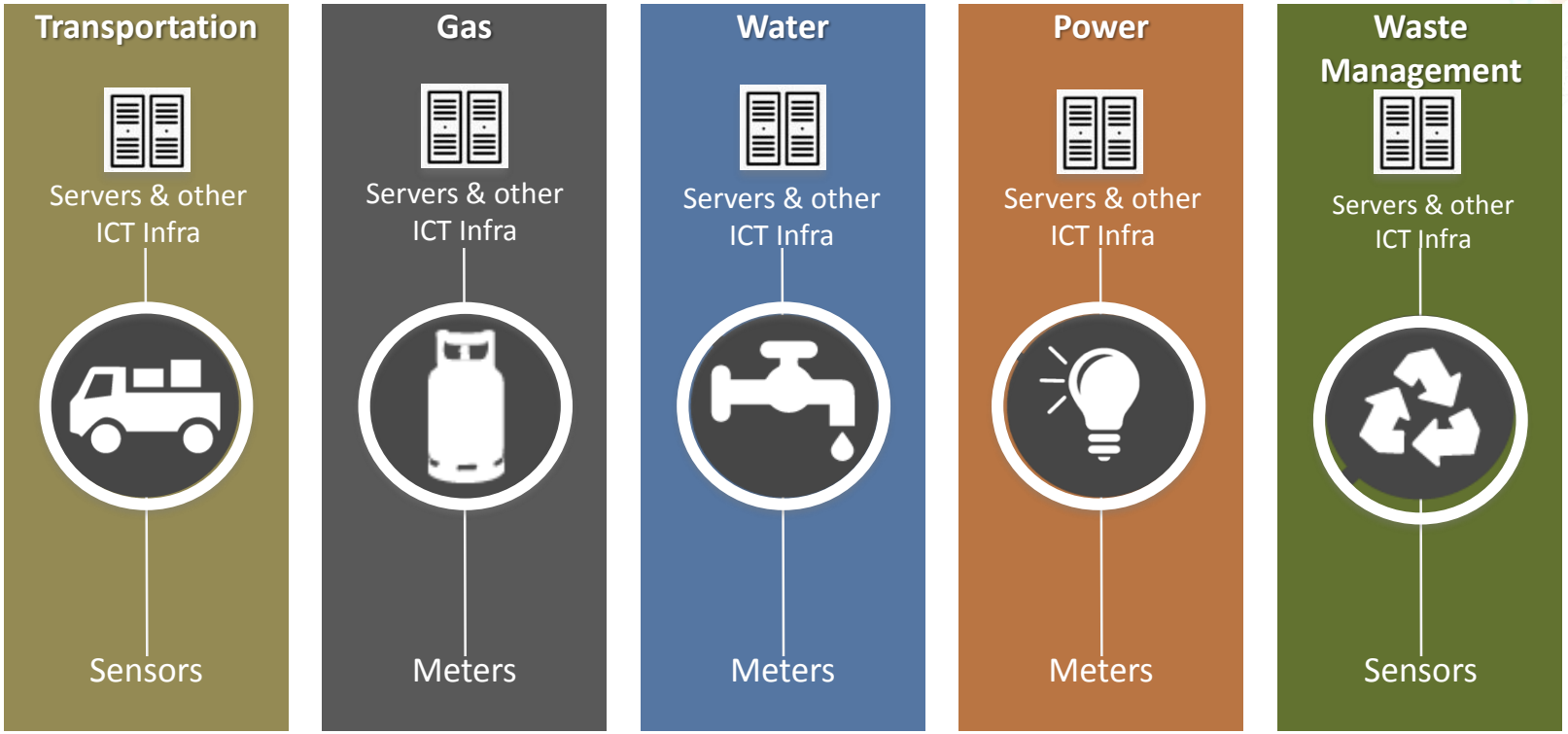


Translating the Smart Infra. Architecture Scheme to Technology Layers



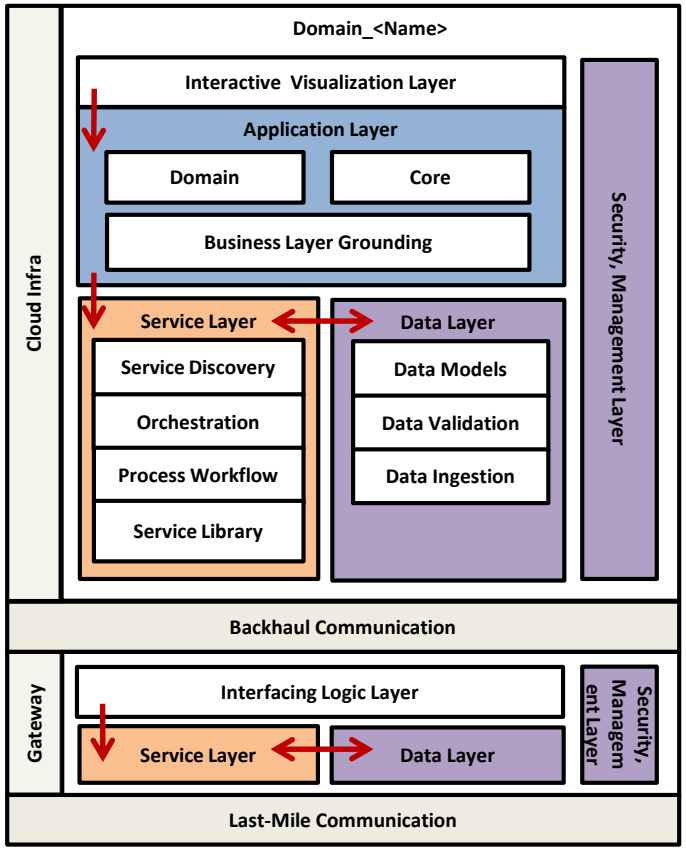
Our Current Approach, and Where do we stand NOW ?

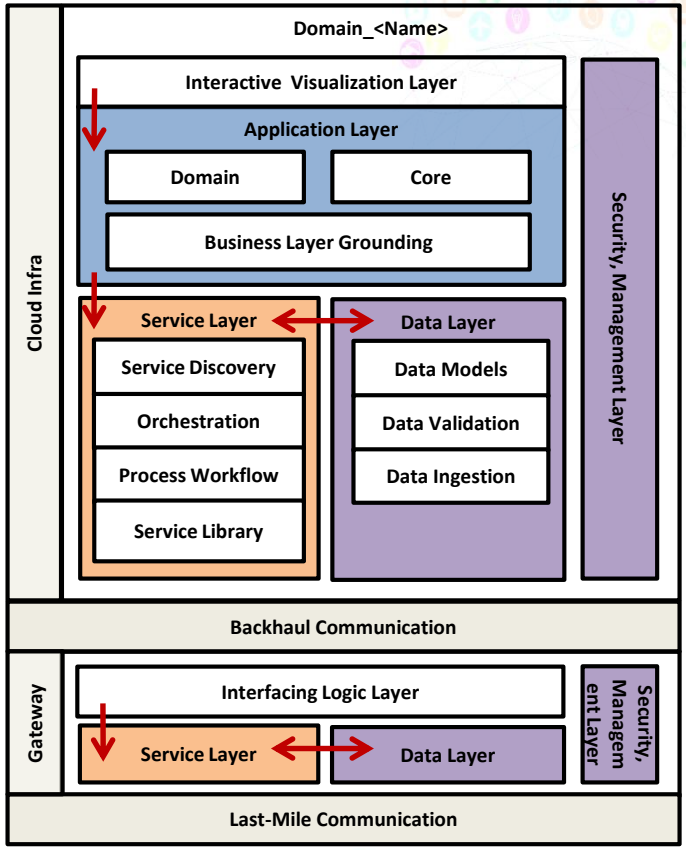
Smart Infrastructure for Smart Cities: Gaps

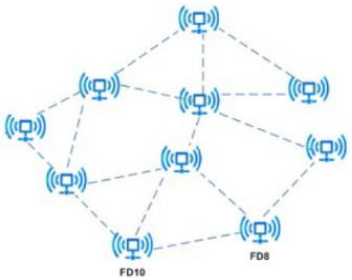


- **Closed & vertically Siloed solutions:** Available solutions **are extremely closed** with an **ecosystem that is highly locked-in by vendors**
- **Force fitting solutions developed for mature markets/advanced economies:** **May not be the right approach given** the requirements, constraints and challenges in India
- **Lack of interoperable, standards based solutions:** Existing "last-mile" technology space is a highly fragmented segment with **no common framework** for the various physical infrastructures to work in an integrated, harmonized and optimized manner

Functional Architecture: The Existing Siloed Manner of Operation

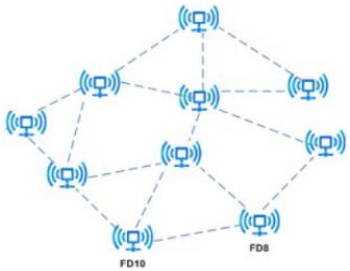






"Last-mile" Heterogeneity

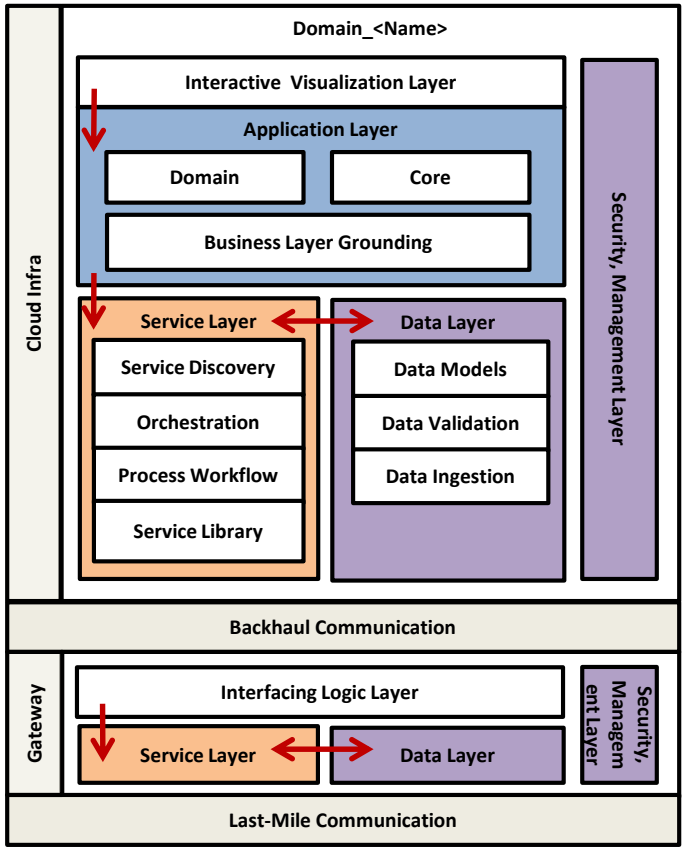
sensors, devices, communication primitives, network topology, data traffic patterns, etc.,



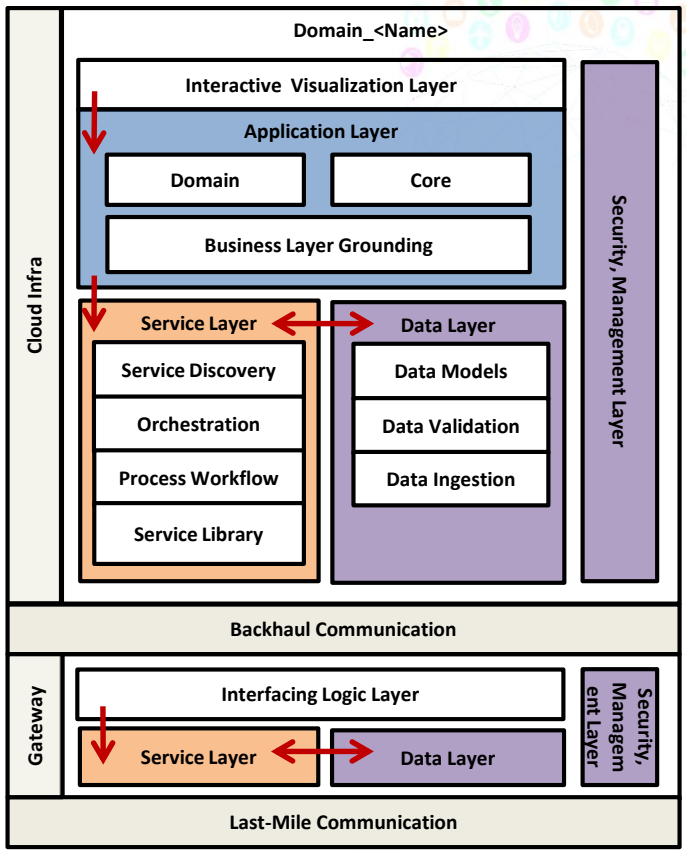
Our thought process going FORWARD …

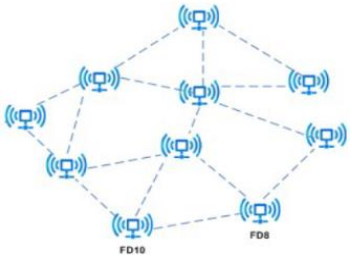
A secure, standardized and open infrastructure model for the delivery of smart infrastructure services will need **an common, integrated ICT backbone that encompasses an end-to-end system** with a converged and **unified "last-mile" communication-networking-data transfer protocol, smart infrastructure gateway design, and data semantics**.

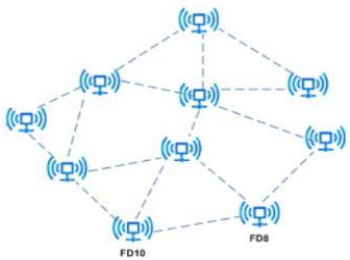
Functional Architecture: Harmonizing the "Last-mile" Madness



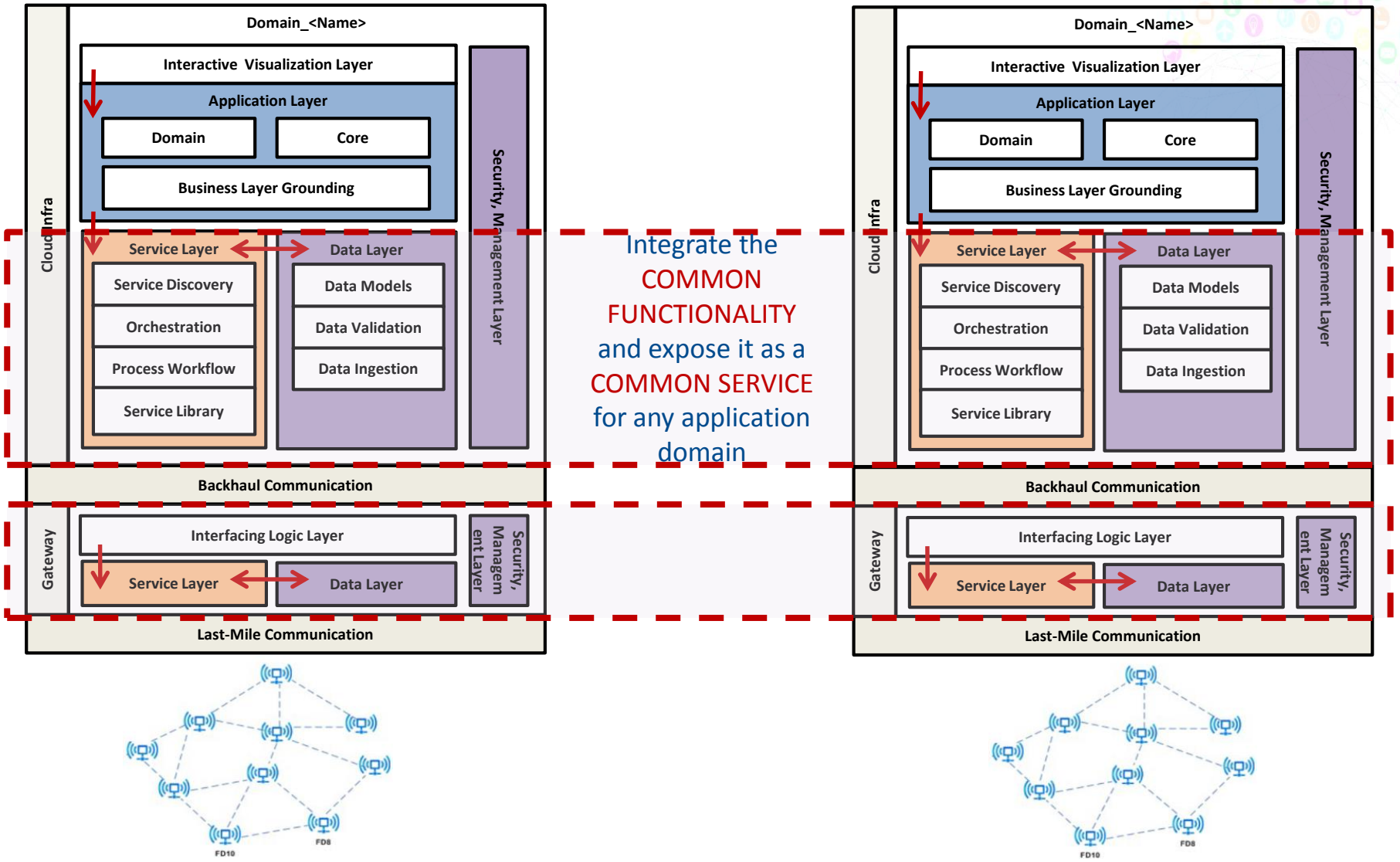
A unified "last-mile" communication-networking-data transfer stack, which will cross-function (and be interoperable) **irrespective** of their underlying physical layer technology



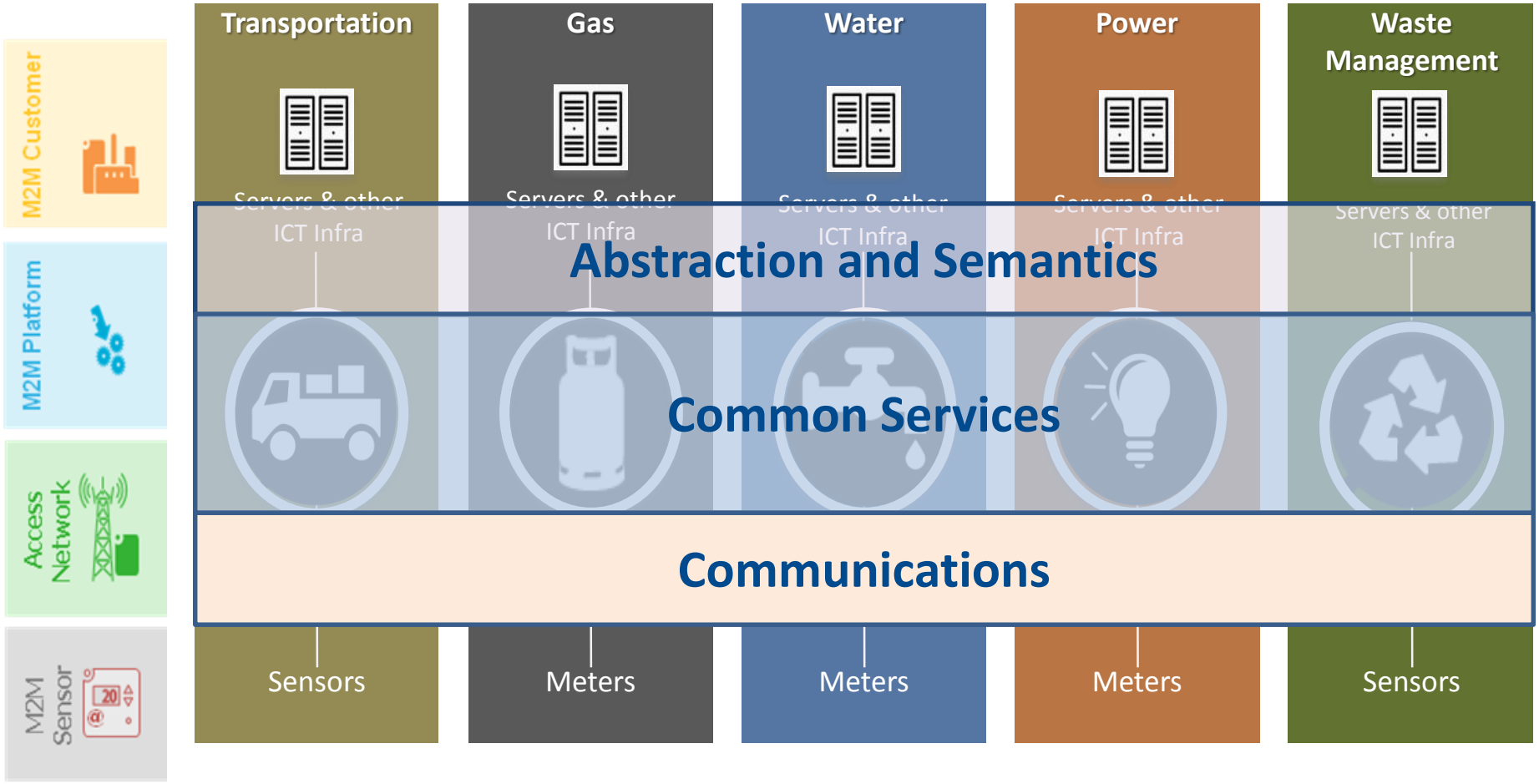




Functional Architecture: Harmonizing the "Last-mile" Madness



Functional Architecture: From Raw to Semantic Data



Unifying and Harmonizing the “Last-mile” Madness

(Popular) Short and Medium Range Low Power Wireless Technology

Technology	Standard Body	Frequency Band	Max Range	Max Data Rate	Max Power	Network Type
Bluetooth	Bluetooth SIG	2.4 GHz ISM	100 m	1-3 Mbps	1 W	WPAN
Bluetooth Smart	IoT Interconnect	2.4 GHz ISM	35 m	1 Mbps	10 mW	WPAN
ZigBee	IEEE 802.15.4, Zigbee Alliance	2.4 GHz ISM	160 m	250 Kbps	100 mW	Star, Mesh
Wi-Fi	IEEE 802.11 g/n/ac/ad	2.4/5/60 GHz	100 m	6-780 Mbps, 6 Gbps @ 60 GHz	1 W	Star, Mesh
Zwave	Zwave	908 MHz	30 m	100 Kbps	1 mW	Star, Mesh
ANT+	ANT Alliance	2.4 GHz	100 m	1 Mbps	1 mW	Star, Mesh
Rubee	IEEE 1902.1, IEEE 1902.2	131 kHz	5 m	1.2 Kbps	40-50 nW	P2P

Low Power Wide Area Networking Technology

Technology	Standards/ Governing Body	Freq	ge	Max Data Rate	Topology	Devices / Access Point
Weightless	-	Sub TV W	an)	200 bps – 100 Kbps, W: 1 Kbps – 10 Mbps	Star	Unlimited
LoraWAN	LoRa Alliance	43 MHz ISM		0.3 – 50 Kbps	Star	1 million
SigFox	SigFox	Ult	km (urban)	100 bps	Star	1 million
WiFi LowPower	IEEE P802.11ah	Sub	or)	150 - 340 kbps	Start, Tree	-
Dash7	Dash7 Alliance	43		9.6/56/167 Kbps	Star, Tree	-
LTE-Cat 0	3GPP R-13	Cel		200 kbps	Start	> 20,000
UMTS (3G), HSDPA / HSUPA	3GPP	Cel	h	0.73 - 56 Mbps	Star	Hundreds per cell

L6: APP (??)

L5: TRANSPORT (??)

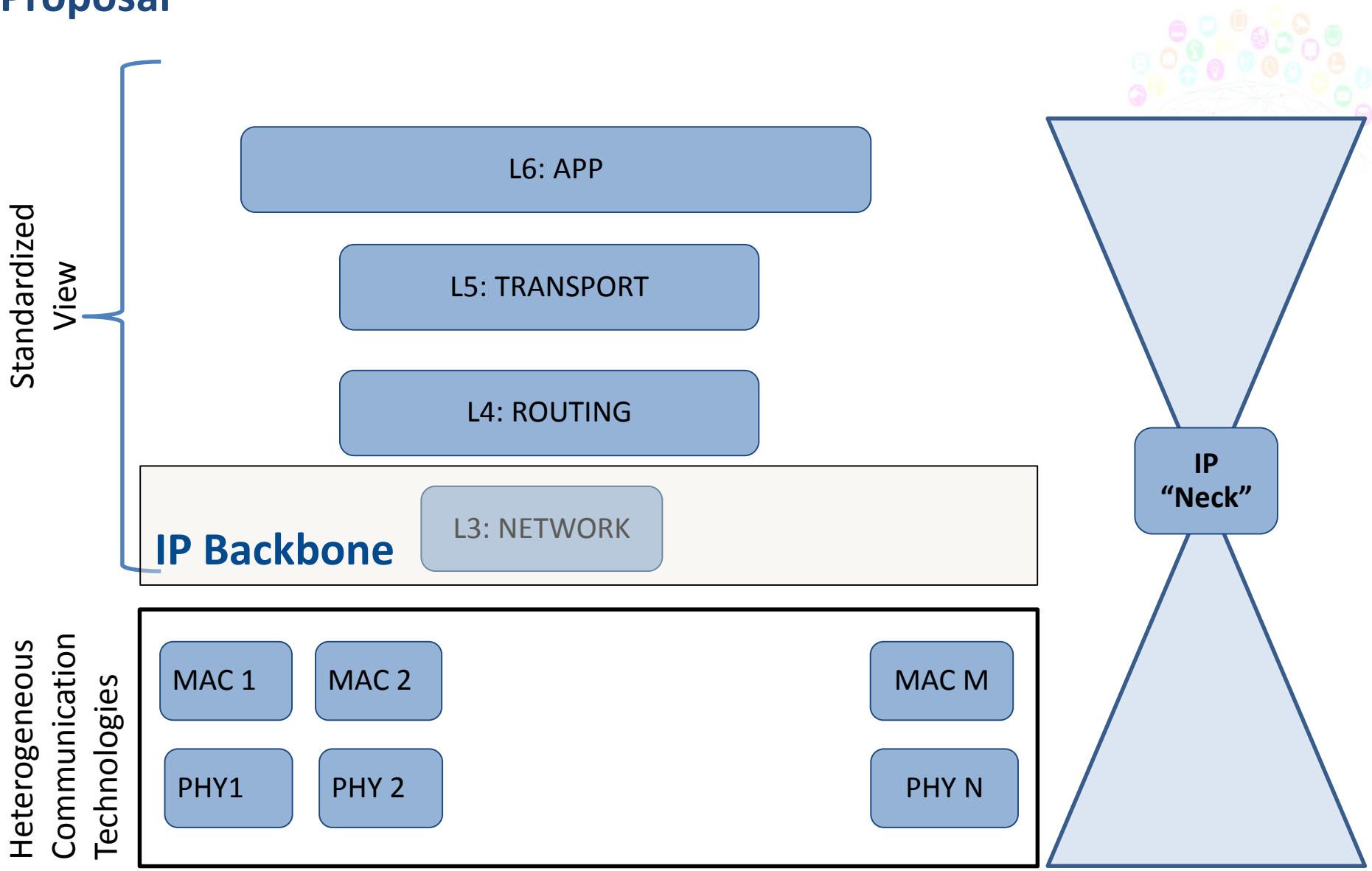
L4: ROUTING (??)

L3: NETWORK (??)

L2: MAC

L1: PHY

Proposal


Standardized View
L6: APP
L5: TRANSPORT
L4: ROUTING
L3: NETWORK
IP Backbone
Heterogeneous Communication Technologies
MAC 1
MAC 2
MAC M
PHY1
PHY 2
PHY N
IP "Neck"

An Illustrative Example …

Example of Existing Stacks using IEEE 802.15.4 as the PHY Layer

Application

Transport

Routing

Convergence / Adaptation

Zigbee Alliance	IEC	ISA	Microchip	IETF
Zigbee	WirelessHART	100.11a	MiWi	6LoWPAN

Non IP based Adapation

MAC

IEEE 802.15.4e

PHY

IEEE 802.15.4-2006
(868/915/2400MHz)

ZigBee
Control your world

IEC

ISA

MICROCHIP

IEEE

Example of Popular Field Device Stacks (IETF and Thread)

"Popular" IETF	Thread	IETF +6TiSCH
CoAP, CoAPs	Application	CoAP, CoAPs
UDP / DTLS	UDP / DTLS	UDP / DTLS
RPL	DV Routing	RPL
IP / IPSec	IP	IP / IPSec
6LoWPAN Adaptation	6LoWPAN Adaptation	6LoWPAN Adaptation
IEEE 802.15.4e	IEEE 802.15.4e	6TiSCH 6top
IEEE 802.15.4-2006	IEEE 802.15.4-2006	IEEE 802.15.4e (TSCH)
		IEEE 802.15.4-2006

E : prasant.misra@tcs.com

W: https://sites.google.com/site/prasantmisra
W: https://in.linkedin.com/in/prasantmisra