Harnessing the IoT for Global Development

John Garrity
Policy Advisor | Global Technology Policy
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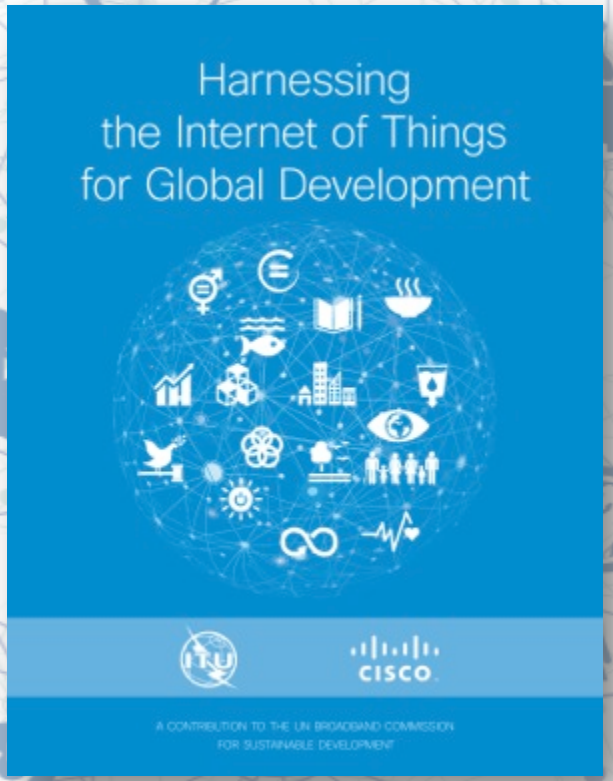
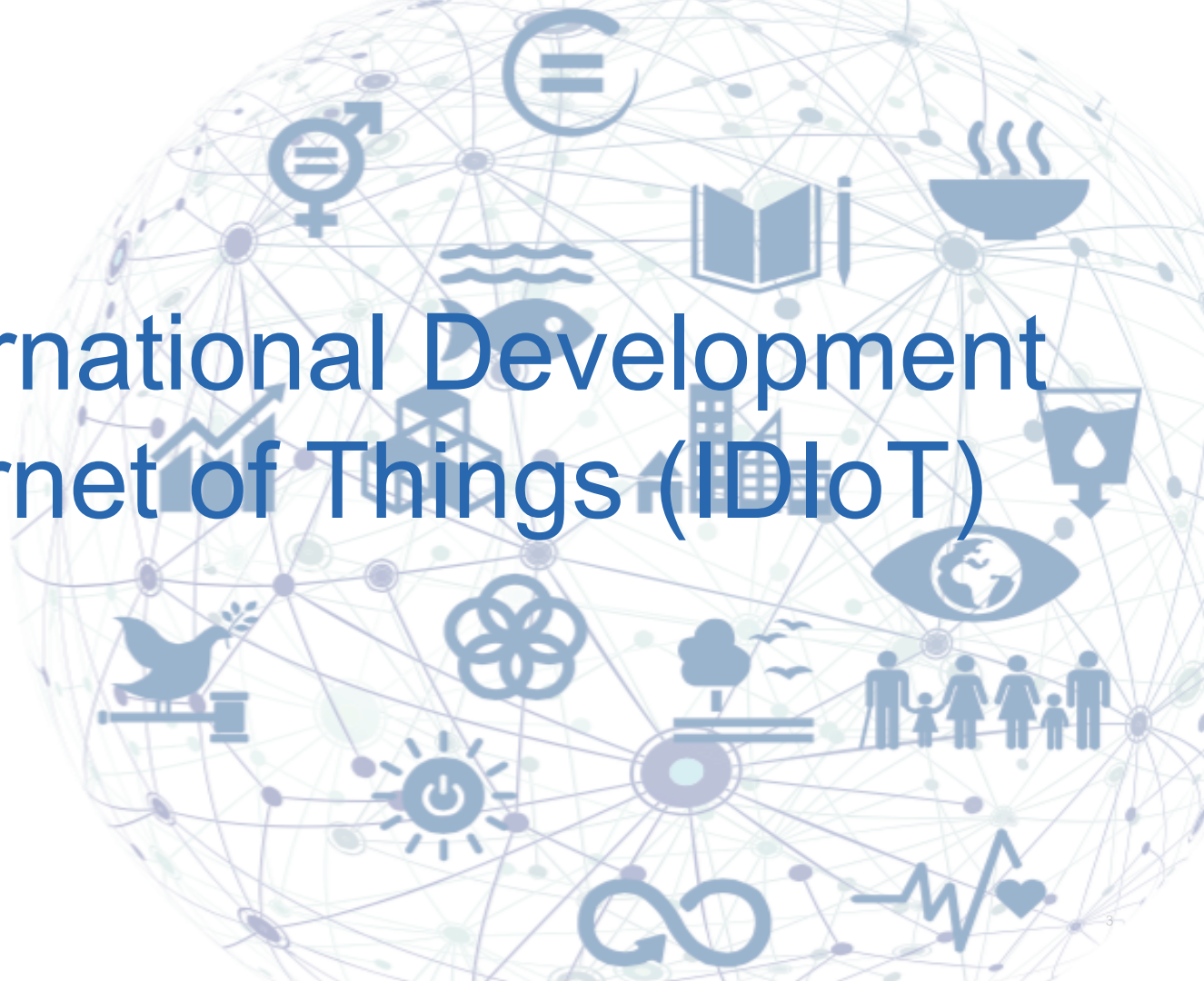
Harnessing the IoT for Global Development



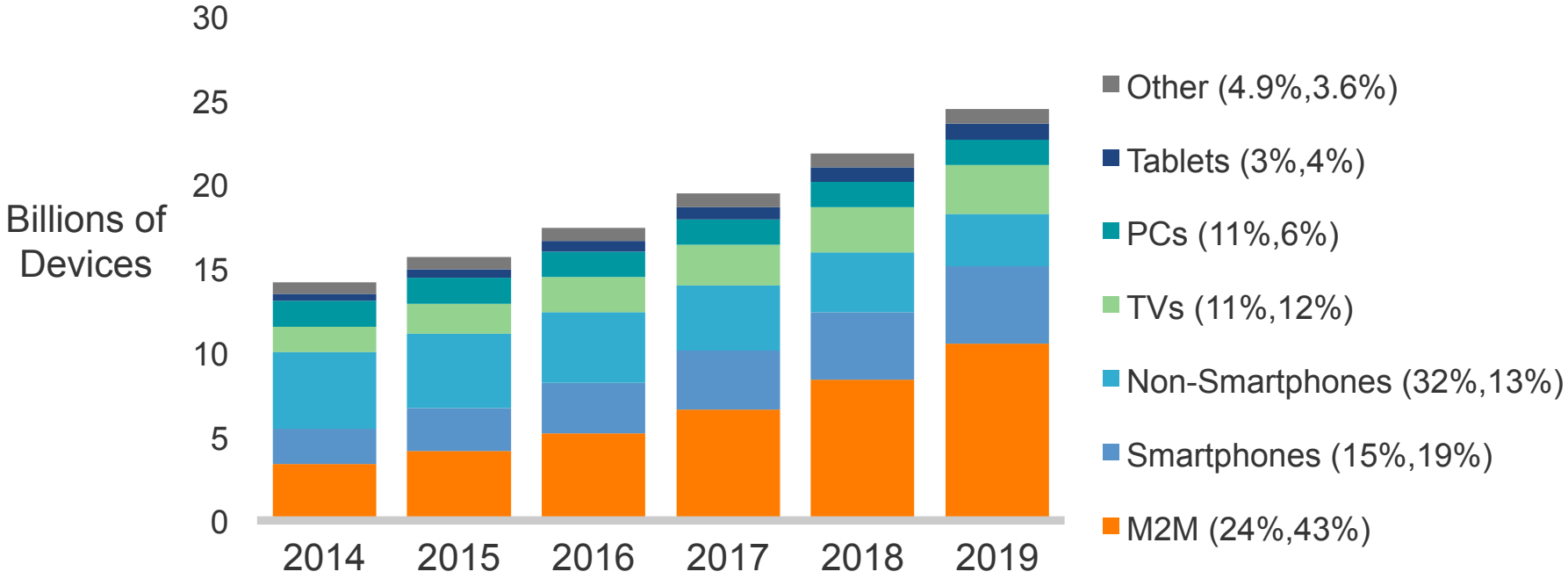
A Contribution to the UN Broadband Commission

NOT:
The International Development and Internet of Things (IDIoT) Report!



Worldwide Connected Device Growth

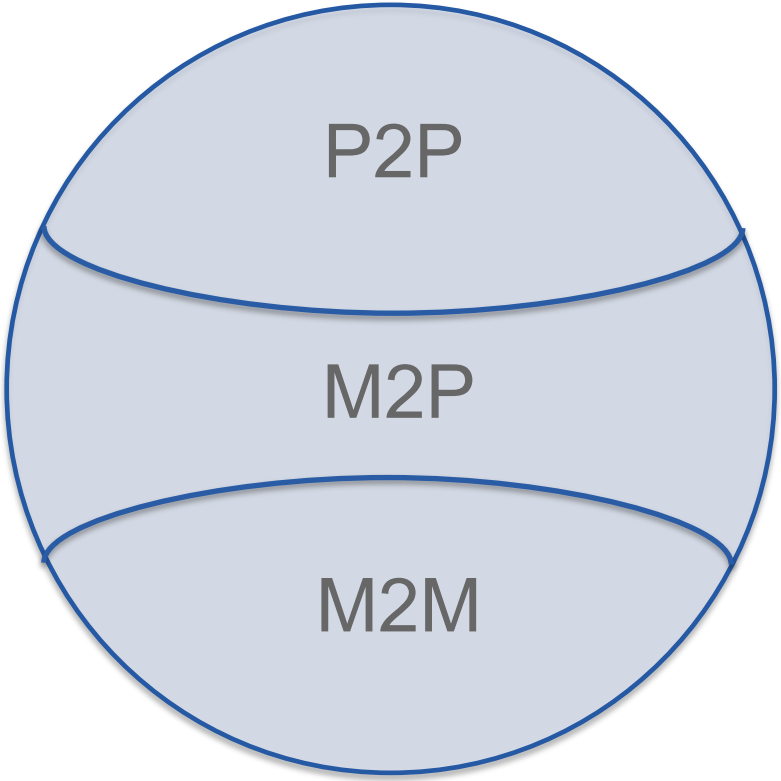
14.2bn in 2014 to 24.4bn by 2019



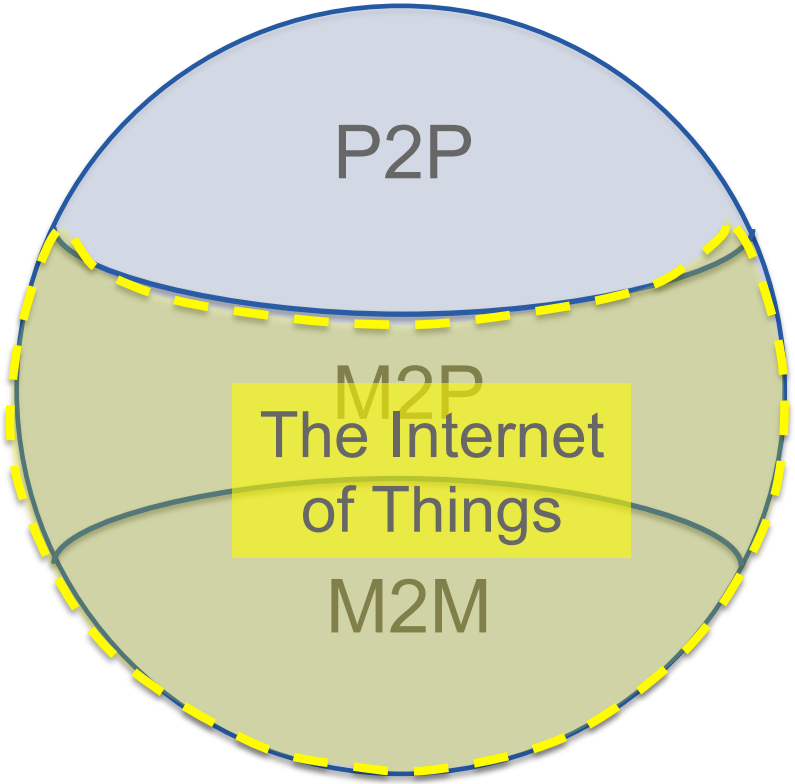
* Figures (n) refer to 2014, 2019 device share

Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

Defining the IoT



Defining the IoT



Macro Impacts of IoT

US $19 Trillion
(2014 – 2023)

$14.4 Trillion PRIVATE SECTOR

Includes Both Industry-specific and Horizontal Use Cases:

- Customer experience
- Innovation
- Employee productivity
- Supply chain
- Asset utilization

$4.6 Trillion PUBLIC SECTOR

Includes Cities, Agencies, and Verticals such as Healthcare, Education, Defense:

- Increased revenue
- Reduced cost
- Employee productivity
- Connected militarized defense
- Citizen experience

US $4 -11 Trillion/ Year
(by 2025)

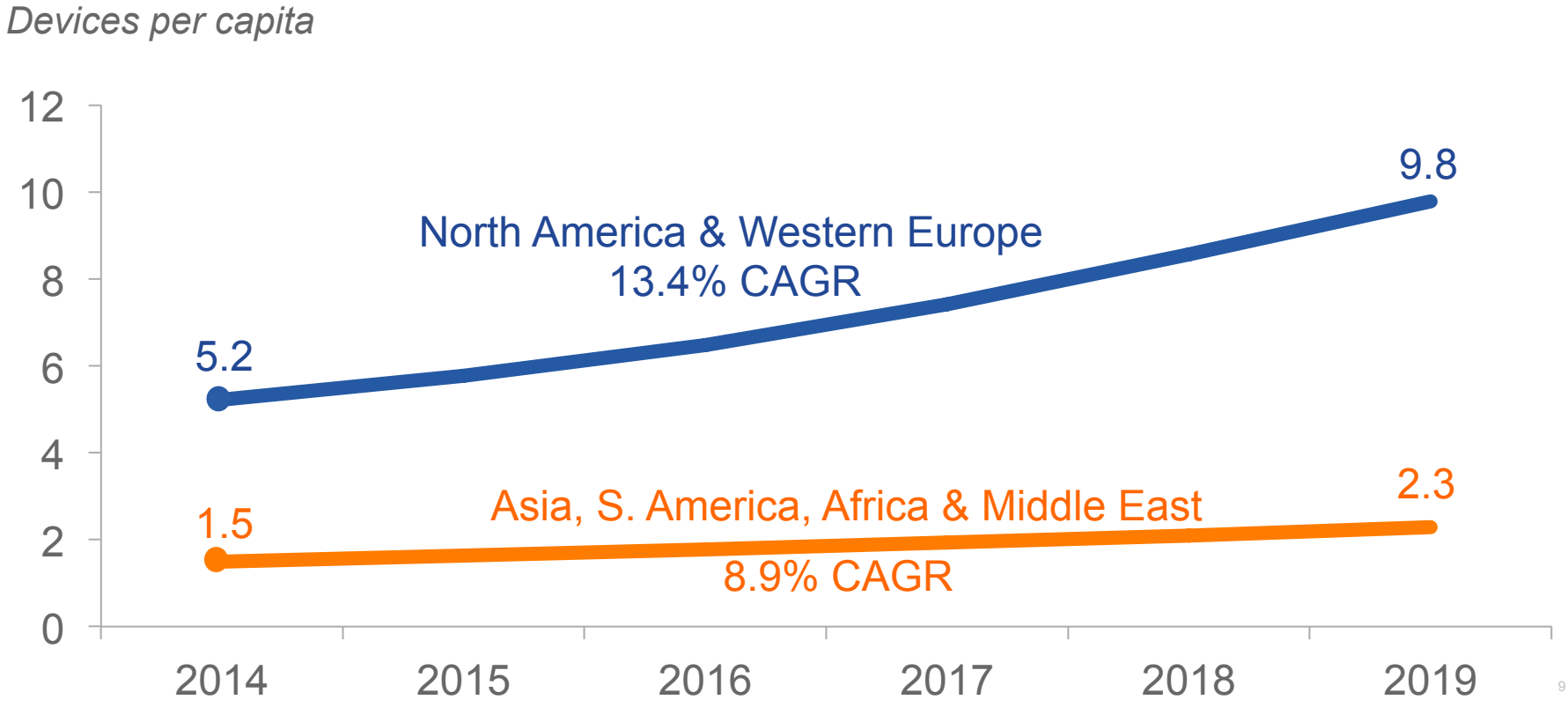
McKinsey&Company

Settings Where Value May Accrue

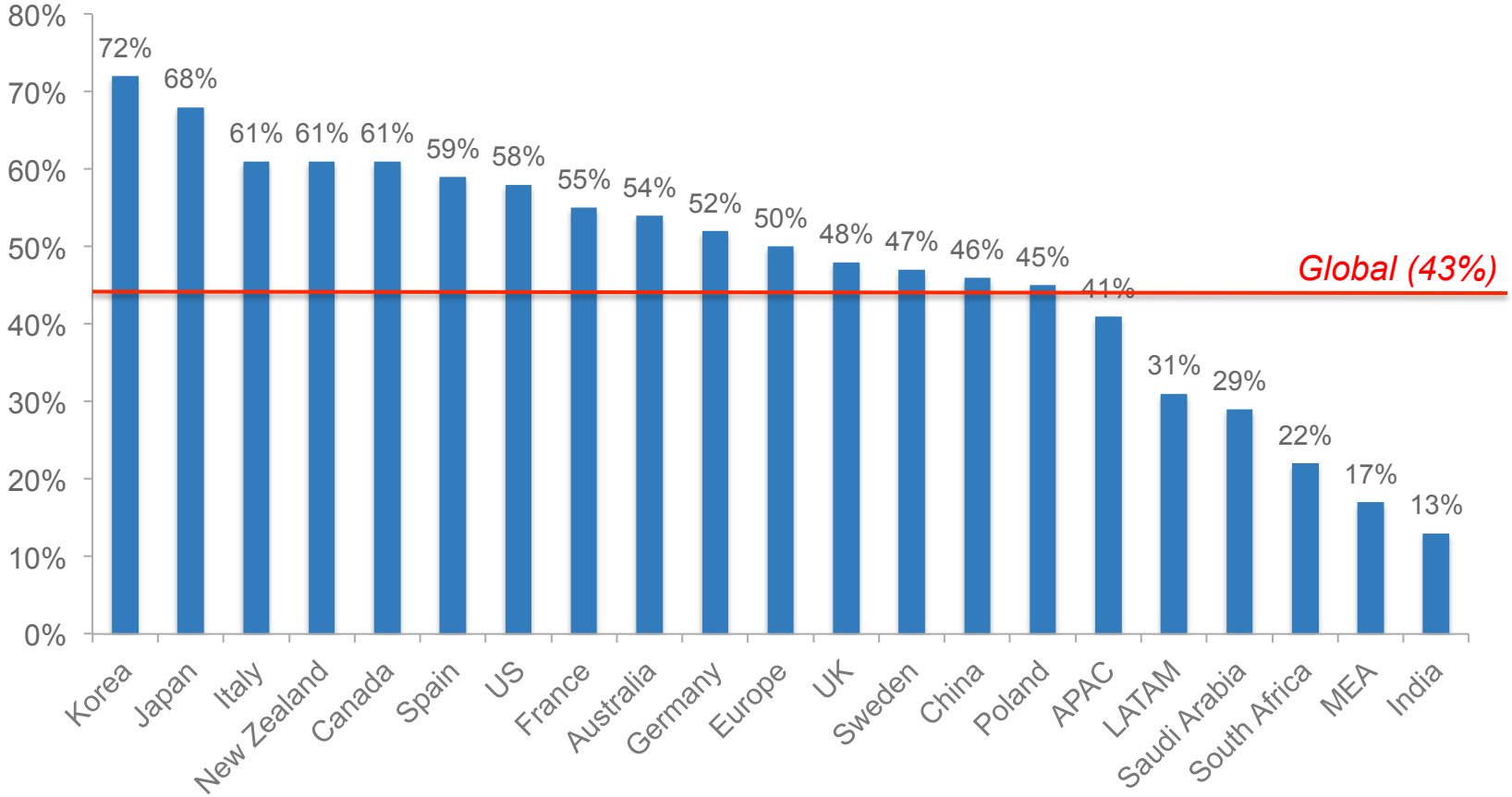
- Factories
- Cities
- Retail
- Construction
- Health & Wellness
- Vehicles
- Homes
- Offices

Growing Divide in Connected Devices

Growing Divide in Connected Devices



M2M Share of Devices (2019)

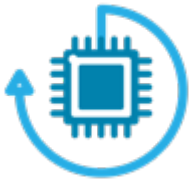


Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

Our research question:
Can the IoT play a role in ICT4D?

Factors Contributing to Emergence of IoT

Reduced cost of computing (including sensors)



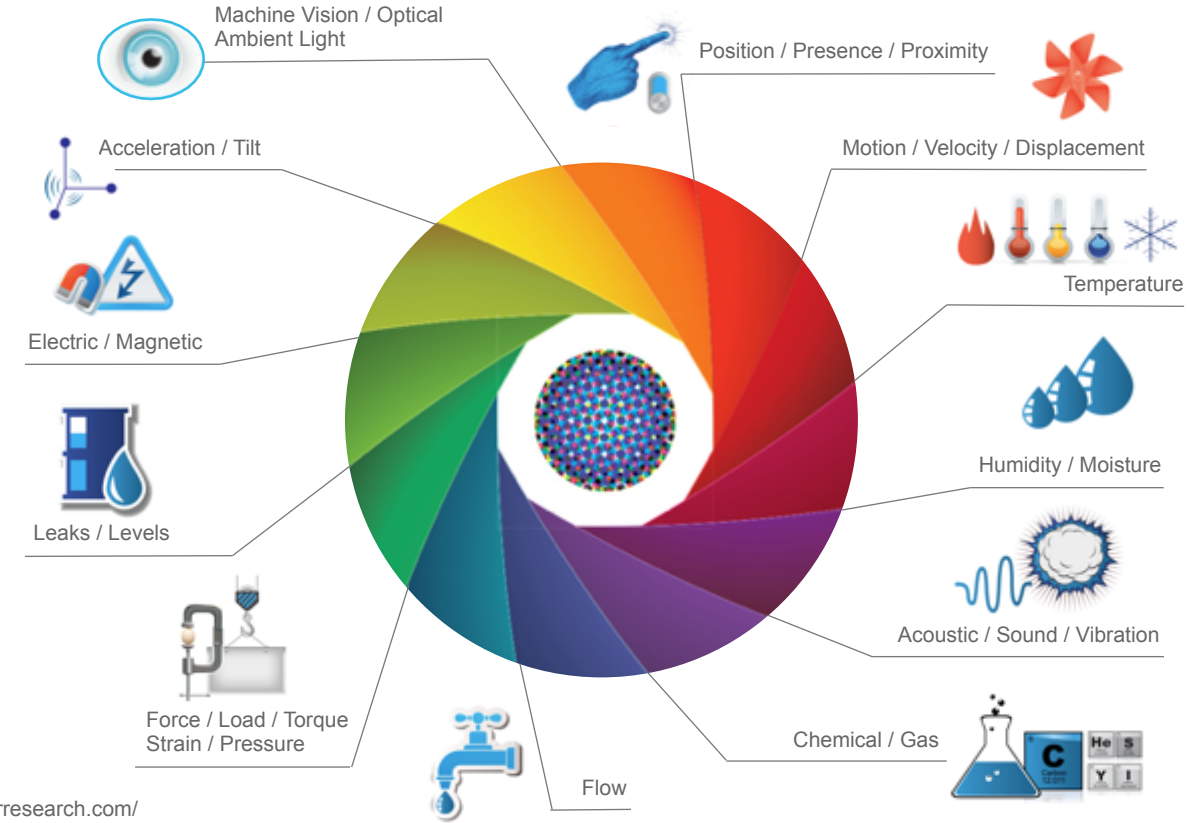
Growth of various wireless connectivity technologies

Expanded access to networks, especially in rural areas

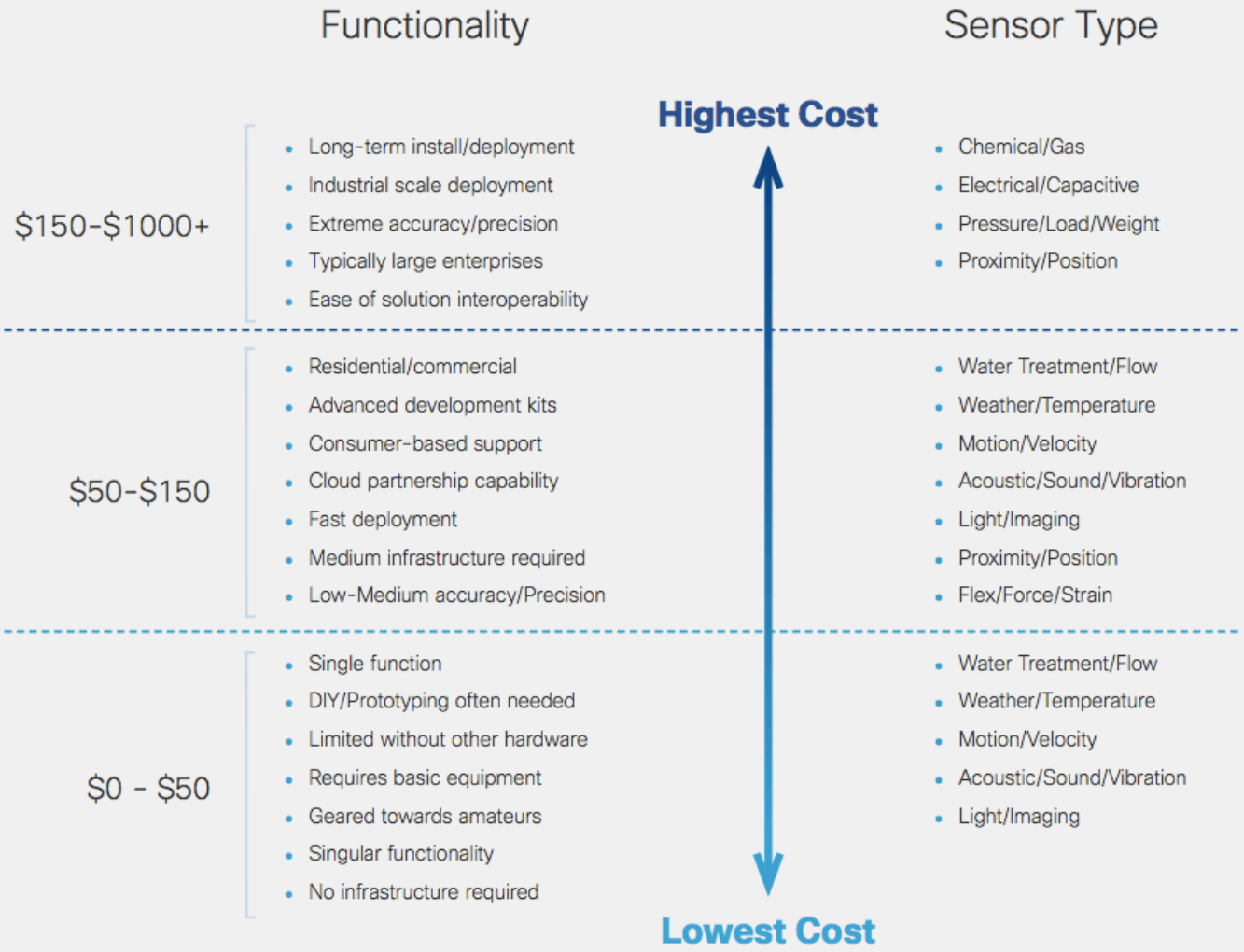
Growth in software development

12

Sensor measurement of …



http://harborresearch.com/


Functionality
Sensor Type
Highest Cost
$150-$1000+
Long-term install/deployment
Industrial scale deployment
Extreme accuracy/precision
Typically large enterprises
Ease of solution interoperability
Chemical/Gas
Electrical/Capacitive
Pressure/Load/Weight
Proximity/Position
$50-$150
Residential/commercial
Advanced development kits
Consumer-based support
Cloud partnership capability
Fast deployment
Medium infrastructure required
Low-Medium accuracy/Precision
Water Treatment/Flow
Weather/Temperature
Motion/Velocity
Acoustic/Sound/Vibration
Light/Imaging
Proximity/Position
Flex/Force/Strain
$0 - $50
Single function
DIY/Prototyping often needed
Limited without other hardware
Requires basic equipment
Geared towards amateurs
Singular functionality
No infrastructure required
Water Treatment/Flow
Weather/Temperature
Motion/Velocity
Acoustic/Sound/Vibration
Light/Imaging
Lowest Cost

Trade-offs in Connectivity Technologies

Wireless		
Personal Area Networks (WPAN)	Local Area Networks (WLAN)	Wide Area Networks (WWAN)
ANT+ Bluetooth 4.0 LE RFID NFC 802.11.4 ZigBee	Wi-Fi	LoRa Weightless Dash 7 WiMax 2G 3G 4G/ LTE

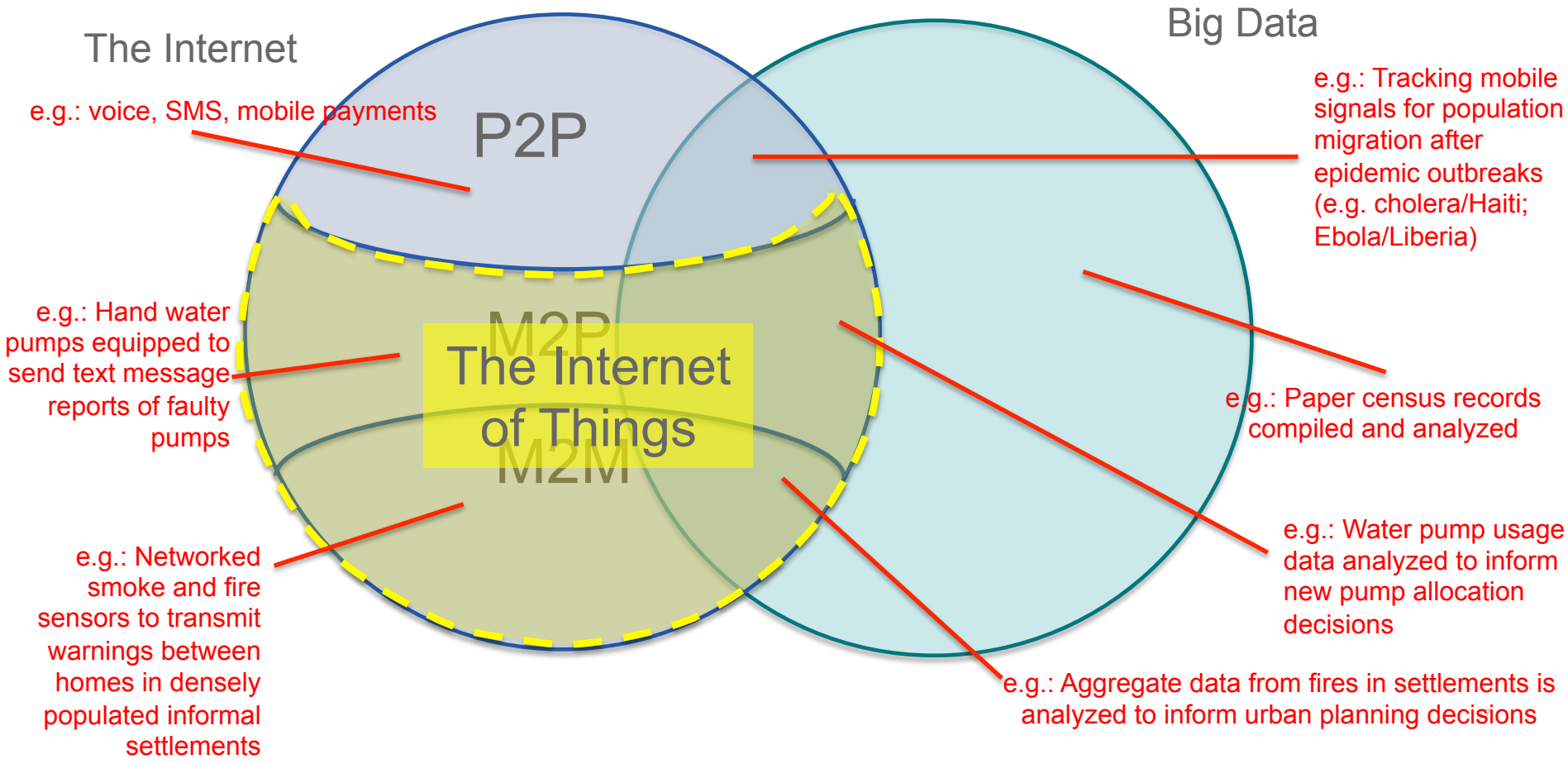
Range ■ short to long ■			
Bandwidth ■ narrow to broad ■			
Battery Life ■ short to long ■			

Note: non-exhaustive

Network Type	Technology Name	Max Range	Max Bandwidth/ Data Throughput	Operating Life (Battery)	Module Cost	Spectrum/ Operating Frequency	Spectrum License
WPAN	ANT+	30m	1 Mbps	Days	$1 - $15	2.4 GHz	unlicensed
	Bluetooth 4.0 LE	50m	24 Mbps	Hours	$1 - $15	2.4 GHz	unlicensed
	RFID	Passive: 10m Active: 100m	100 Kbps	Passive Tags: n/a Active Tags: years	Passive: <$1-$5 Active: $5-$25	120-150 kHz; 12.56 MHz, 433 MHz, ISM bands (868 MHz, 900 MHz), 2.5-5.8 GHz	unlicensed
	NFC	10cm	424 Kbps	n/a	<$1	13.56 MHz	unlicensed
	802.15.4g	200m	200 Kbps	Up to 4 years	$1-$15	2.4 GHz	unlicensed
	ZigBee	10-100 meters	250 Kbps	up to two years	$1 - $15	2.4GHz/ 900Mhz (915 MHz, 868 MHz)	unlicensed
WLAN	Wi-Fi	300m	250 Mbps (802.11n); 54 Mbps (802.11a/g); 11 Mbps (802.11b); 1Gbps (802.11ac)	4-8 hours(com) 50 hours (idle)	$10+	2.4GHz/5GHz	unlicensed
	Wi-Fi (802.11ah)	up to 1000m	100 kbps (802.11ah)			Sub-1 GHz ISM bands – Europe (863-868.6 MHz); Japan (950.8 MHz – 957.6 MHz); Korea (917-923.5 MHz); USA (902-928 MHz)	unlicensed
WWAN	LoRa	2-10 km	200Kbps	10-20 years (idle), 120 hours communicating	$1 - $15	ISM bands (868 MHz in Europe; 900 MHz in US)	unlicensed
	Weightless	2-10 km	200Kbps	10 years	$1 - $15	Weightless-N: ISM bands (868 MHz in Europe; 900 MHz in US); Weightless-W: TVWS	unlicensed
	Dash 7	2 km	200 Kbps	Up to 10 years	$1 - $15	433 Mhz	unlicensed
	WiMax	40 km (30 miles)	34 Mbps – 1 Gbps	Hours	$1- $15	No uniform global licensed spectrum but WiMAX forum published 3 licensed spectrum profiles: 2.3 GHz; 2.5 GHz; 3.5 GHz	licensed
	2G (GSM, GPRS, EDGE)	35 km	9.6 Kbps – 384 Kbps	4-8 hours (com) 36 days (idle)	$1 - $15	Global GSM bands	licensed
	3G (UTMS, HSPA)	up to 100km	384 Kbps – 10 Mbps	2-4 hours (com) 20 days (idle)	$35-$50	Various - licensed	licensed
	Cellular 4G/ LTE	up to 100km	3 Mbps – 100 Mbps	2-3 Hours (com) 12 days (idle)	$80-$120	Various - licensed	licensed

Note: non-exhaustive; work-in-progress

The IoT & Big Data – Development Examples



Development Areas Impacted

IoT4Climate Action: Mitigating Disaster Risk

The Problem

- Natural disasters, like the 2004 Indian Ocean tsunami, devastate communities all over the world.
- EM-DAT recorded 6,873 natural disasters worldwide between 1994 and 2013
- 1.35 million lives were claimed – about 68,000 lives on average each year.

IoT Intervention

- Early warning systems use kinetic sensors (measuring waves and water flow) are placed on the ocean floor and communicate data on potential tsunamis to disk buoys floating on the ocean surface via acoustic telemetry

IoT4Health: Improving the Vaccine ‘Cold-Chain’

The Problem

- One-fifth of children in developing countries go unvaccinated every year for preventable diseases
- Major cause is vaccine spoilage – most require storage between 2 and 8 degrees Celsius
- Over 200,000 cold storage units in place in developing countries – mostly monitored with pencil and paper

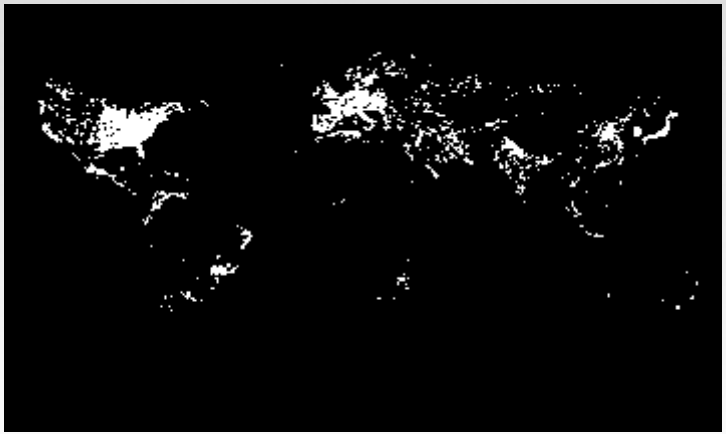
IoT Intervention

Connected Thermometers (Cellular)

- Cellular-enabled temperature sensor
- Remotely monitors vaccine and drug storage temperatures
- Measures temperature & location

IoT4Affordable & Clean Energy: Off-Grid PAYG

The Problem



- Electrification rates in Sub-Saharan Africa average 58% in urban areas and only 12% in rural areas.

IoT Intervention

- M-Kopa, a pay-as-you-go Energy Service Company (ESCO) for off-grid customers in Kenya, leverages machine-to-machine (M2M) technology to fulfill its mission of providing high-quality energy at an affordable rate to everyone.

IoT4Water & Sanitation: Improving Water Access

The Problem

- Roughly one million hand-pumps supply water to over 200 million rural water users across Africa
- But up to one third of all hand-pumps are not working at any given time
- 30-70% broken within two years

IoT Intervention

Connected Water Flow Sensors

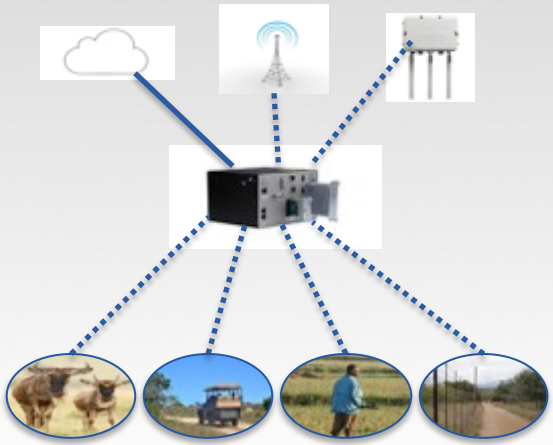
- Simple water sensors monitor water flow and usage
- SMS messages sent to municipal authorities, water service providers (and donor community if donor funded) when usage drops in order to accelerate repair times and reduce down time

IoT4Life on Land: Preventing Poaching

The Problem

- Big game poaching reaching tipping point in Africa
- 100,000 elephants killed in last 3 years for their tusks (estimated 25% of the species)
- Rhino poaching up 9300% from 2007 to 2014

IoT Intervention



- Securing wildlife park perimeters with sensors to detect presence of animals, vehicles, poachers (sensors: seismic, acoustic, thermal cameras...)
- Tagging animals for tracking

IoT4Climate Action: Enhancing Air Quality

The Problem

- The World Health Organization attributes one in eight deaths worldwide to polluted air
- Lung damage, heart disease, strokes, and cancer may all result from dirty air
- 600,000 people died in 2012 alone due to indoor air pollution in homes

IoT Intervention

- Air quality sensors to track pollutant levels
- Outdoor; in-door
- e.g. The Fresh Air in Benin project uses project aims to develop a network of sensors that will capture and send data every 20 minutes via GSM connectivity
- Indoor black carbon & CO2 sensors tracking cookstove pollution

IoT4Health: Responding to Epidemics

The Problem

- More than 3 million people die from vaccine-preventable diseases each year
- Approximately 1.5 million of these deaths are in children less than 5 years old.
- West Africa experienced the largest outbreak of Ebola in history in 2014, with a death toll of over 11,000

IoT Intervention

- USAID's STAMP2 / "Smart Band-Aid" remote monitoring of baseline vital rating — heart rate, temp and oxygen saturation -– and then measures all changes from the baseline

IoT4Agriculture & Livelihood: Feeding Communities

The Problem

- How will we feed 9 billion people by 2050?
- Greater weather condition variability
- Water shortages

IoT Intervention

- Soil moisture and nutrient sensors (e.g. tea plantations in Sri Lanka)
- RFID tags for livestock (Botswana, Senegal, Namibia)
- Localized weather stations (east Africa)

IoT4Education & Inclusion: Securing the Classroom

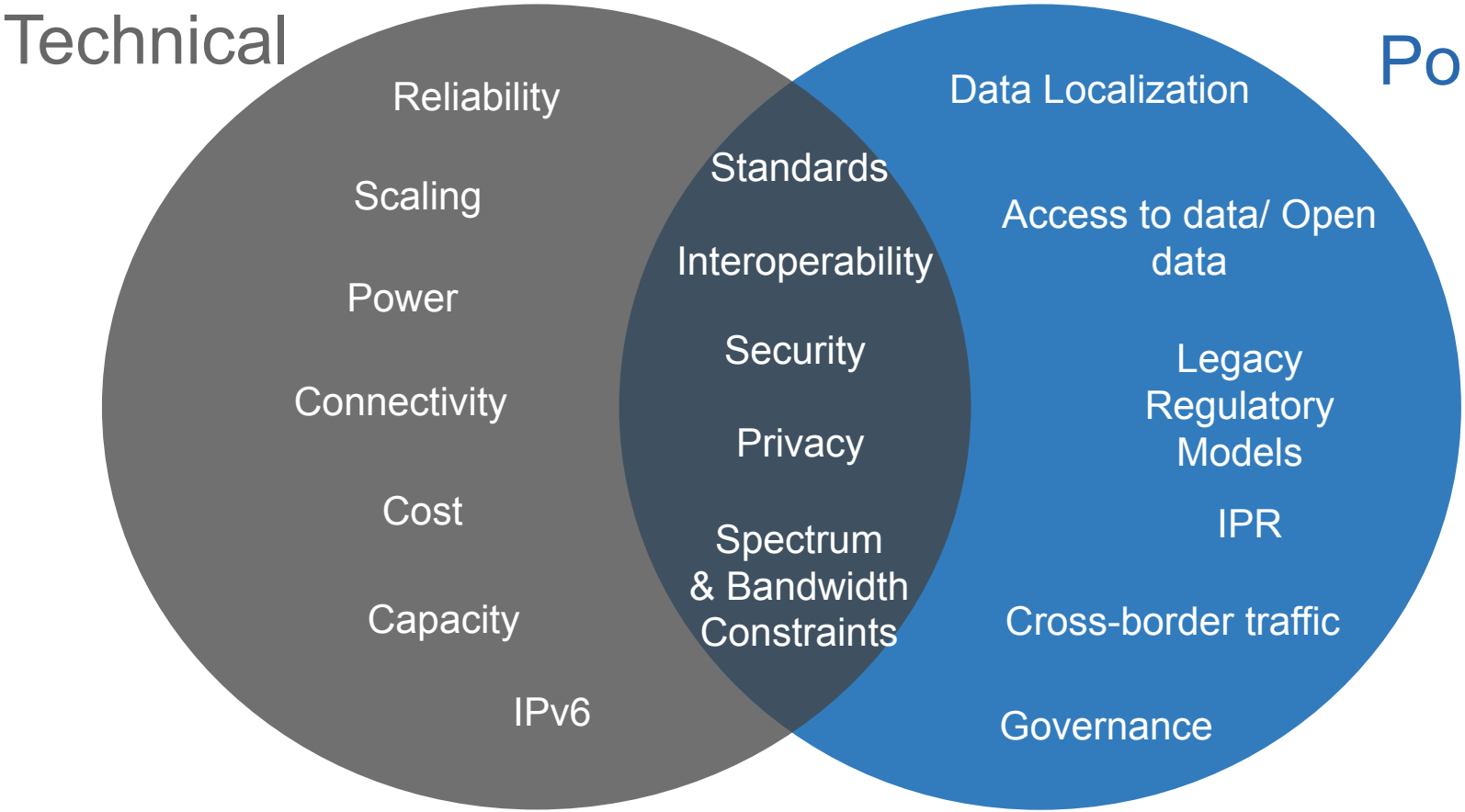
The Problem

- 58 million primary school-age children worldwide and 63 million adolescents of lower secondary school age have yet to gain access to education
- 793 million adults – almost 66% of whom are women – still lack basic reading and writing skills.

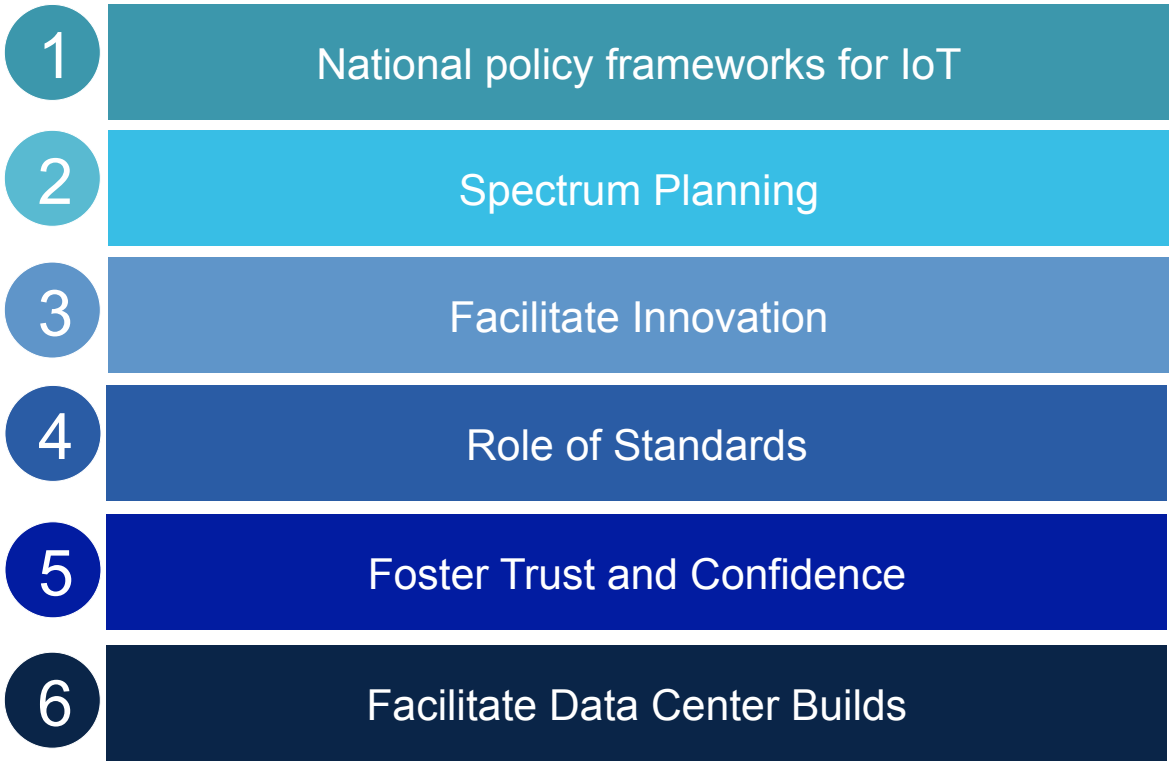
IoT Intervention

- Smart identity cards with biometric features for all public school students to improve service delivery (Nigeria)
- Biometric clocking device to improve teacher attendance in real-time (South Africa)

Challenges


Technical
Reliability
Scaling
Power
Connectivity
Cost
Capacity
IPv6
Standards
Interoperability
Security
Privacy
Spectrum & Bandwidth Constraints
Policy
Data Localization
Access to data/ Open data
Legacy Regulatory Models
IPR
Cross-border traffic
Governance

Recommendations (Policy)



SDG & IoT Table (Next Steps: Taxonomy/ Catalogue?)

Sector	SDG	Examples
Health, Water & Sanitation	SDG 3; SDG 6	Sensor- and SMS-enabled village water pumps (Rwanda, Kenya); GSM-connected refrigeration for vaccine delivery in the 'cold chain' (Global); sensor- enabled 'band aid' to monitor Ebola patients' ECG, heart rate, oxygen saturation, body temperature, respiratory rate and position, all remotely (West Africa); water stream gauge with sonar range sensor to monitor river flow and depth (Honduras); water flow sensors and motion detectors in latrines to monitor efficacy of hygiene training and intervention (Indonesia).
Agriculture & Livelihoods	SDG 1; SDG 8; SDG 2	Connected micro-weather stations improving localized weather data and provision of crop failure insurance (Kenya); low-cost mobile-controlled micro irrigation pumps (India); soil-monitoring sensors used to improve tea plantation production (Sri Lanka, Rwanda); RFID-based food supply testing and tracking system (India) and RFID based livestock programmes for tracking, theft prevention and vaccination records (Botswana, Senegal and Namibia).
Education	SDG 4	Smart identity cards with biometric features for all public school students to improve service delivery (Nigeria); biometric clocking device to improve teacher attendance in real-time (South Africa).
Environment & Conservation	SDG 12; SDG 13; SDG 14; SDG 15	Radio-based cloud-connected devices to identify and track the presence of illegal fishermen (Timor-Leste); air pollution sensors to monitor urban outdoor air pollution (Benin); acoustic sensors to monitor sea bird populations (global); sensors and connectivity to protect game park perimeters and track animals (Africa); connected unmanned aerial vehicles monitor national parks and connecting images from camera traps (UAE); acoustic sensors in tropical rainforests 'listening' for illegal logging (Indonesia).
Resiliency, Infrastructure and Energy	SDG 7; SDG 9; SDG 11	Networked fire/smoke alarms in high-density urban slums/ informal settlements (Kenya, South Africa); Connected buoys as part of the tsunami monitoring system (Indian Ocean); off-grid micro solar electricity systems for electricity for lower-income households (east Africa, India); connected black carbon- and use sensors to monitor cook stoves (Sudan); sensor-connected matatus (mini-buses) tracking velocity, acceleration, and braking to curb dangerous operation of public transportation (Kenya).
Governance & Human Rights	SDG 10; SDG 16	Retinal scans used for ATMs providing secure biometric cash assistance to displaced refugees (Jordan).
Cross-Cutting	SDG 5; SDG 17	

jogarrit@cisco.com