SMART SYSTEMS &
THE **INTERNET** *of* **THINGS**

the "front lines" of technology innovation

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Smart Systems and the Internet of Things are driven by a combination of:

1 **SENSORS** & ACTUATORS

2 **CONNECTIVITY**

3 **PEOPLE & PROCESSES**

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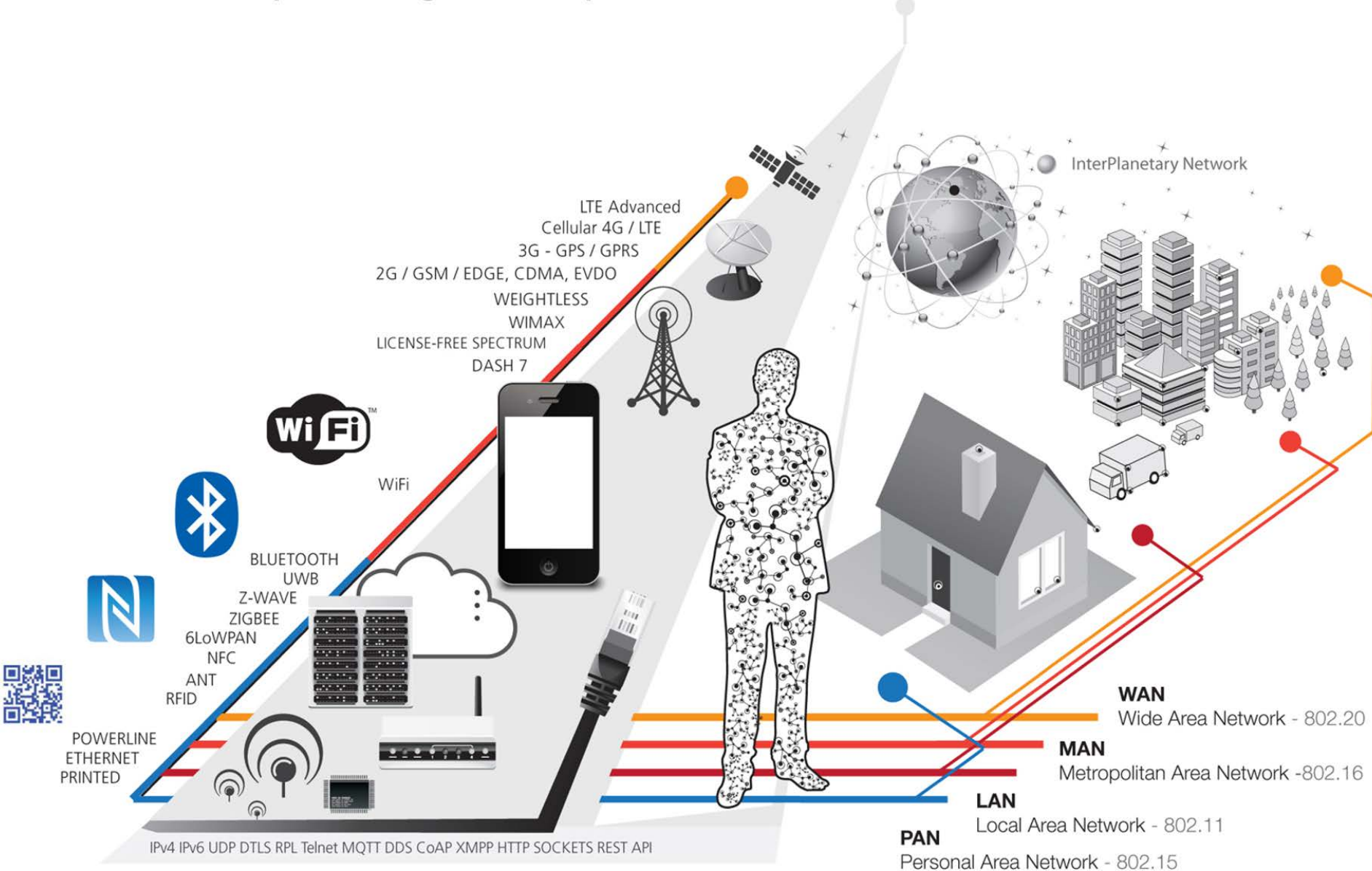
1 SENSORS & *ACTUATORS*

We are giving our world a digital nervous system. Location data using GPS sensors. Eyes and ears using cameras and microphones, along with sensory organs that can measure everything from temperature to pressure changes.

- Machine Vision / Optical Ambient Light
- Position / Presence / Proximity
- Acceleration / Tilt
- Motion / Velocity / Displacement
- Electric / Magnetic
- Temperature
- Leaks / Levels
- Humidity / Moisture
- Force / Load / Torque Strain / Pressure
- Acoustic / Sound / Vibration
- Flow
- Chemical / Gas
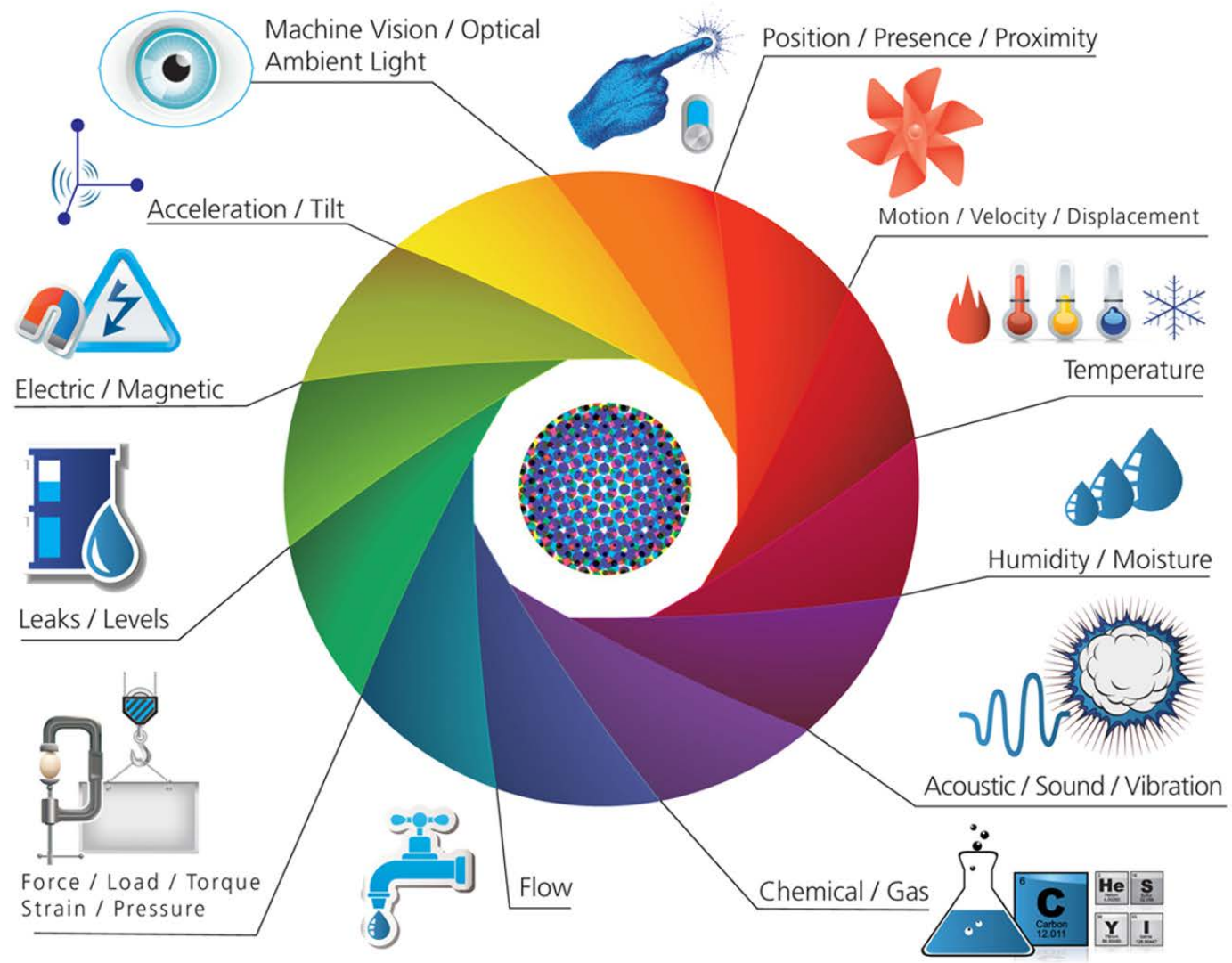
② CONNECTIVITY

These inputs are digitized and placed onto networks.

InterPlanetary Network

LTE Advanced
Cellular 4G / LTE
3G - GPS / GPRS
2G / GSM / EDGE, CDMA, EVDO
WEIGHTLESS
WIMAX
LICENSE-FREE SPECTRUM
DASH 7

WiFi

WiFi

BLUETOOTH
UWB
Z-WAVE
ZIGBEE
6LoWPAN
NFC
ANT
RFID

POWERLINE
ETHERNET
PRINTED

WAN
Wide Area Network - 802.20

MAN
Metropolitan Area Network -802.16

LAN
Local Area Network - 802.11

PAN
Personal Area Network - 802.15

IPv4 IPv6 UDP DTLS RPL Telnet MQTT DDS CoAP XMPP HTTP SOCKETS REST API

BICSI STANDARDS to make us "IoT Ready"

ANSI/NECA/BICSI 568-2006, *Standard for Installing Commercial Building Telecommunications Cabling*

- ✓ This standard also is intended to be used in describing a *"neat and workmanlike manner"*

ANSI/BICSI 005-2016, *Electronic Safety and Security (ESS) System Design and Implementation Best Practices*

- ✓ This standard continues to bridge the two worlds of security and communications

BICSI STANDARDS to make us "**IoT Ready**"

BICSI 006-2015, *Distributed Antenna System (DAS) Design and Implementation Best Practices*

✓ Design and installation of a standards-compliant, vendor-neutral DAS used for a wide range of applications, environments and locations

ANSI/BICSI 002-2014, *Data Center Design and Implementation Best Practices*

✓ This standard provides ample recommendations on the best methods of implementing a design to fulfill your needs

BICSI Subcommittee's enabling "**IoT Ready Status**"

Intelligent Buildings Subcommittee

Leadership

Todd W. Taylor, RCDD, NTS, OSP   ttaylor@bicsi.org

Mission Statement

The BICSI Standards Intelligent Building Subcommittee develops and maintains standards related to the implementation and integration of ICT systems for building systems that form an intelligent building or premise.

Subcommittee Activity

Document D035 - New Standard: Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises

BICSI Subcommittee's enabling "**IoT Ready Status**"

Wireless Systems Subcommittee

Leadership

Mike Patterson, RCDD, NTS   mike@physical-layer.com

Mission Statement

This subcommittee develops vendor-neutral standards and/or best practices standards and documents as needed for the design and installation of radio and other wireless systems. This subcommittee will also monitor existing codes and standards concerning radio and wireless systems and report on related activity.

Standards Published

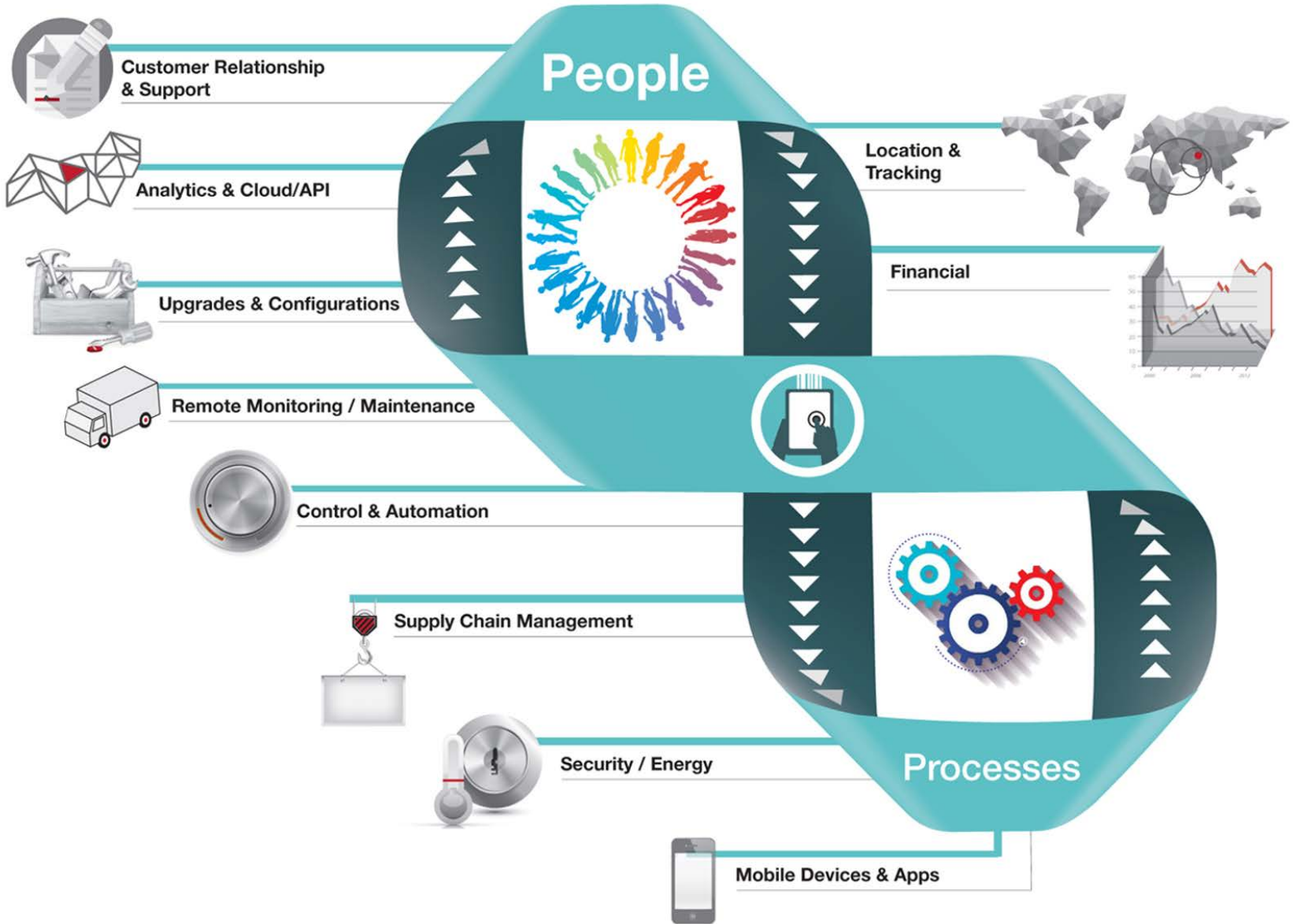ANSI/BICSI 006-2015, *Distributed Antenna System (DAS) Design and Installation*

Subcommittee Activity

Published BICSI International Standards Supplemental Information 2: Guide to Medical Grade Wireless Utility in September 2015.

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3 PEOPLE & *PROCESSES*

These networked inputs can then be combined into bi-directional systems that integrate data, people, processes and systems for better decision making.

People

Customer Relationship & Support

Analytics & Cloud/API

Upgrades & Configurations

Remote Monitoring / Maintenance

Control & Automation

Supply Chain Management

Security / Energy

Location & Tracking

Financial

Processes

Mobile Devices & Apps

The interactions between these

SENSORS + CONNECTIVITY + PEOPLE + PROCESSES

entities are creating new types
of smart applications and services.

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Starting with popular connected devices already on the market

SMART THERMOSTATS

nest

Save resources and money on your heating bills by adapting to your usage patterns and turning the temperature down when you're away from home.

CONNECTED CARS

CAR2GO

Tracked and rented using a smartphone. Car2Go also handles billing, parking and insurance automatically.

ACTIVITY TRACKERS

BASIS

Continuously capture heart rate patterns, activity levels, calorie expenditure and skin temperature on your wrist 24/7.

SMART OUTLETS

belkin

Remotely turn any device or appliance on or off. Track a device's energy usage and receive personalized notifications from your smartphone.

PARKING SENSORS

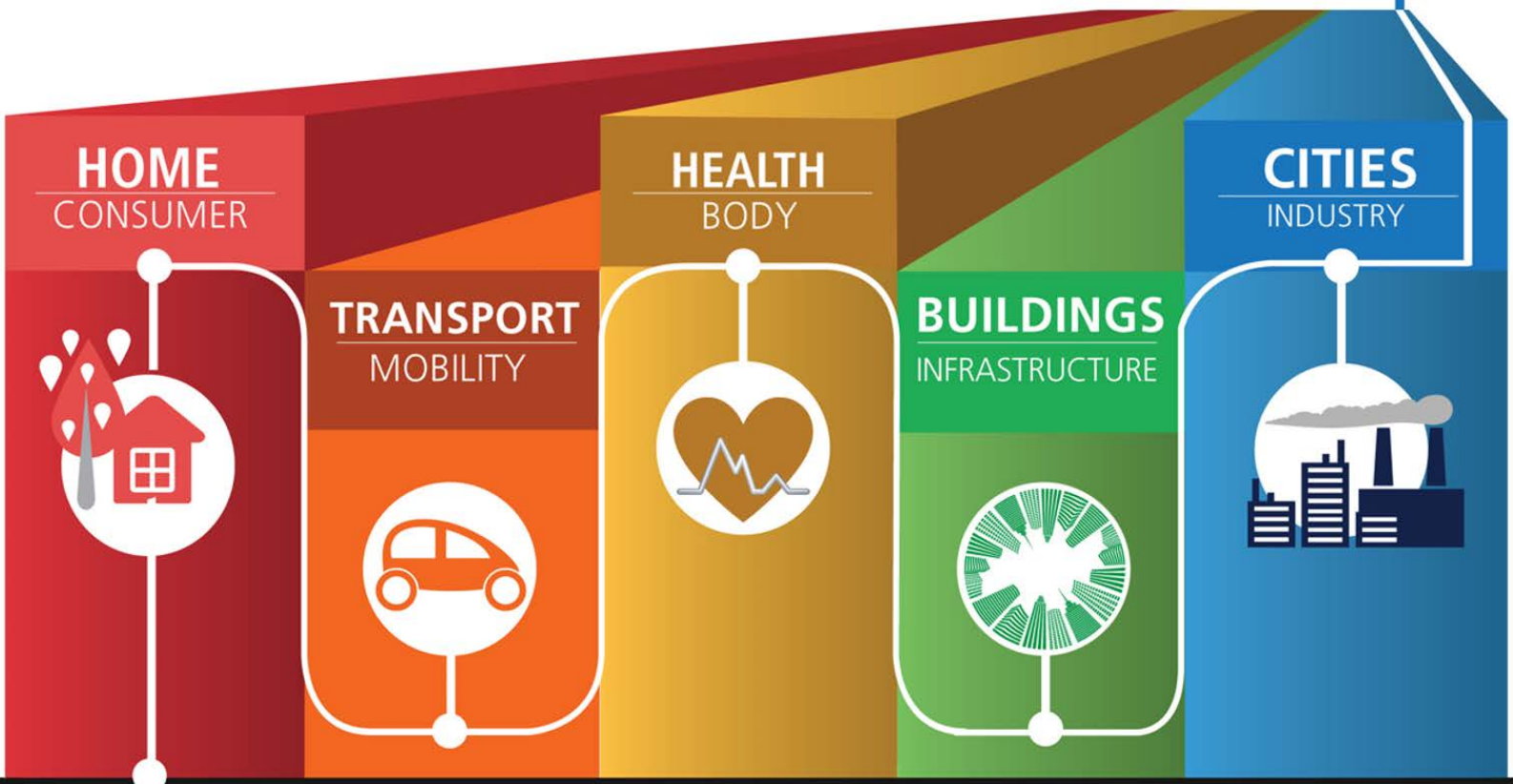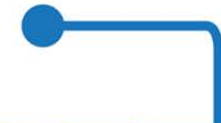STREETLINE
CONNECTING THE REAL WORLD

Using embedded street sensors, users can identify real-time availability of parking spaces on their phone. City officials can manage and price their resources based on actual use.

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And quickly advancing
TO ➤ DIVERSE APPLICATIONS

HOME
CONSUMER

TRANSPORT
MOBILITY

HEALTH
BODY

BUILDINGS
INFRASTRUCTURE

CITIES
INDUSTRY

Light bulbs	Traffic routing	Patient Care	HVAC	Electrical Distribution
Security	Telematics	Elderly Monitoring	Security	Maintenance
Pet Feeding	Package Monitoring	Remote Diagnostic	Lighting	Surveillance
Irrigation Controller	Smart Parking	Equipment Monitoring	Electrical	Signage
Smoke Alarm	Insurance Adjustments	Hospital Hygiene	Transit	Utilities / Smart Grid
Refrigerator	Supply Chain	Bio Wearables	Emergency Alerts	Emergency Services
Infotainment	Shipping	Food sensors	Structural Integrity	Waste Management
Washer / Dryer	Public Transport		Occupancy	
Stove	Airlines		Energy Credits	
Energy Monitoring	Trains			

Things get interesting when these connected devices and services start creating

COMPOUND APPLICATIONS

within their own verticals and across industries:
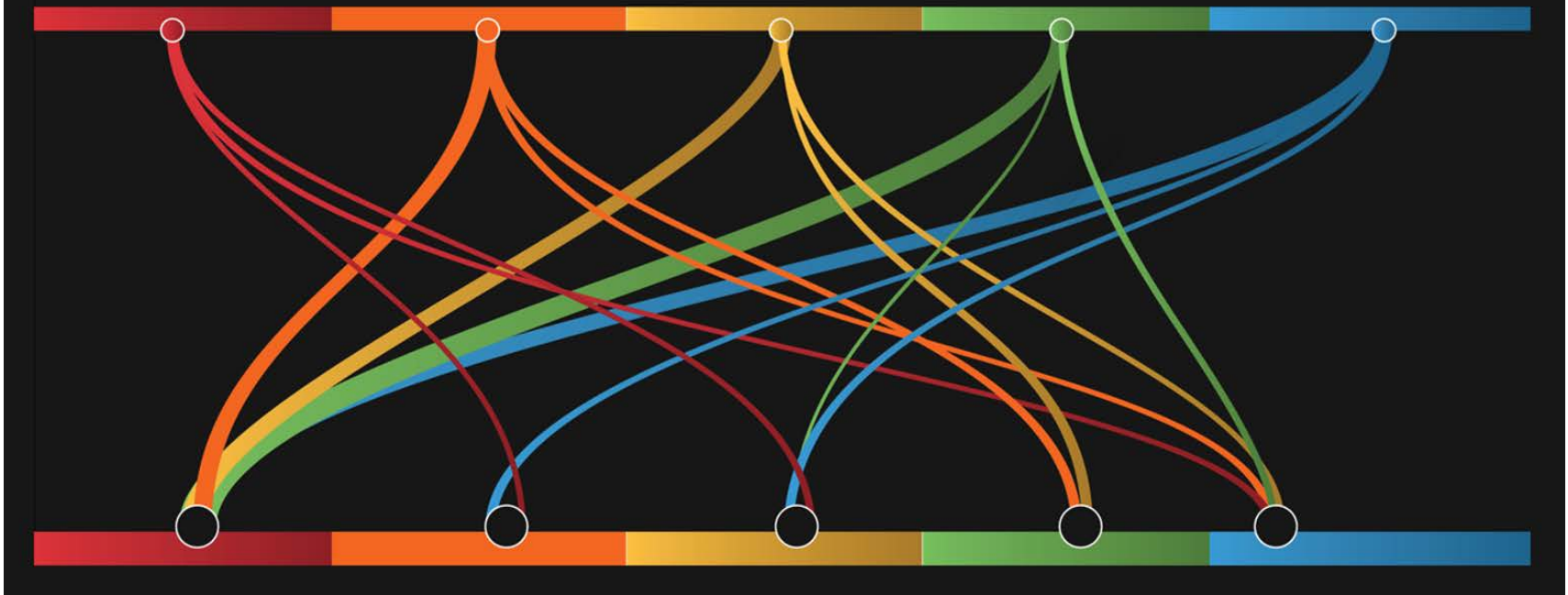
TRANSPORTATION + SMART CITIES

Sofia and her son Luis are on their way Downtown for an appointment.

Wireless sensors embedded in the parking lot help direct the car to an open spot in the city while also initiating the parking fee.

Using the cars's parking details the vehicle schedules a mobile mechanic to change the oil while the two are away for the afternoon.
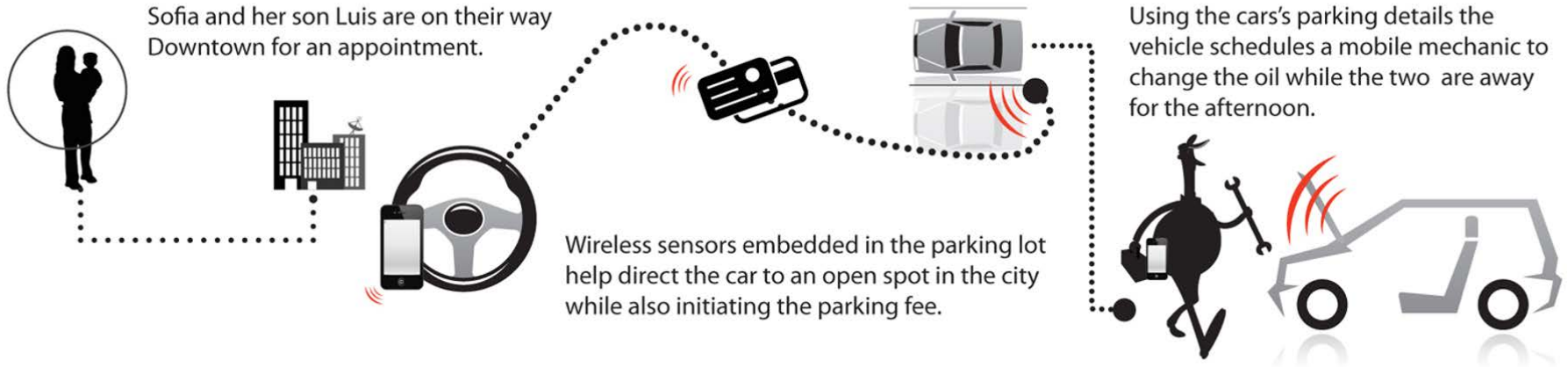
In Downtown San Francisco 20-30% of all traffic congestion is caused by people hunting for a parking spot.

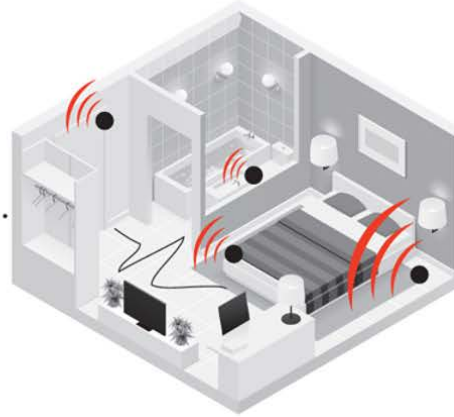- San Francisco Municipal Transportation Agency (SFMTA)

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HEALTHCARE + SMART HOME

Aging uncle Earl is still living isolated at his home and you are concerned about his safety.

Wireless sensors throughout his house help measure healthy activity levels, sleeping patterns and medication schedules.

Alerts are automatically sent to health care services and authorized family members if any abnormal activity is detected.

40 million adults age 65 and over will be living alone in the U.S, Canada and Europe.

- U.S. Department of Health and Human Services: Administration for Community Living (ACL)
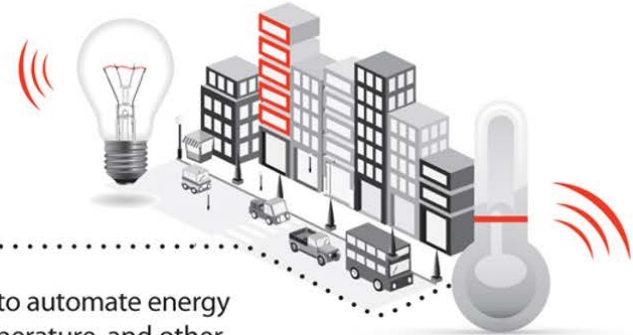
SMART BUILDINGS + MOBILITY

Anna is being pressured to reduce her company's expenses for their new corporate office.

After speaking with experts she decides to install sensors to automate energy usage according to building occupancy, people flow, temperature, and other ambient conditions -- improving the building's overall efficiency.

Energy used by commercial and industrial buildings in the US creates nearly 50% of our national emissions of greenhouse gases.

- United States Environmental Protection Agency

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Inevitably these integrations become more tightly coupled across time, location & services.

REAL-TIME SERVICE NETWORKS

- **Appliance Monitoring**
- **Predictive Maintenance**
- **Service Technician / CRM**
- **Waste Management / Recycling**

R Hotel Denver, *Industrial Washer #GHS40-2608*

Location: ID: *FC-RM #00243*
Manufacturer: *Appliance Park*
Louisville, KY ID: *#45205343*

Materials: *FC / SUS*
Sensor: *Vibration*
Connectivity: *Wireless LAN*

Connor, the Lead Maintenance Manager at the R Hotel in Denver, receives a sensor notification that the pump body O-ring #6 on washing machine #230243 is starting to fail in the housekeeping laundry room.

On his mobile, Connor prompts the machine to order a new part. This action triggers a bidding opportunity for local service technicians within the product's authorized maintenance network.

The request lays out:
- Pricing parameters
- Timing requirements
- Machine history
- Part specs
- Predictive sensor measurements & alerts

Tom from IA Appliances bids on the service request and receives a notification a few moments later that his bid was accepted.

Within 1.5 hours, a service technician from IA Appliances is on site (Using a temporary facility access code for the wireless door lock) to replace the water pump. Connor sends a brief note on the service quality and IA Appliances releases a bid request for the part's raw materials to local recycling centers.

DIGITAL FARM TO TABLE

- Farm & Livestock ID & Sensors
- Food packaging sensors
- Retail Supply Chain Monitoring
- Health Services
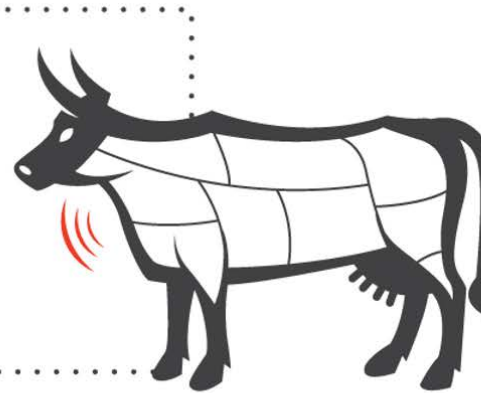
Cattle
AIN: 840 003 123 456 789

Location: ID: Braymeadow Farm *FR* #00285453543
Slaughterhouse ID: #45205343
Sensor: *Temperature, Accelerometer*
Connectivity: *RFID, NFC, WAN*

Maria and her daughter are picking up groceries for the week. Using packaging with printed sensors, the two can make sure the ground beef they are purchasing has never reached unsafe temperature levels while on the shelf or being transported.

The packaging also contains a QR code which they can use to query the cow's RFID tag and bring up its history:

- Where it was raised
- What it was fed
- Where it was slaughtered
- How it was transported
- Where it was packaged
- The last time it was inspected.

A week later the U.S. Department of Agriculture's Food Safety Service determines ground beef from originating from a regional packing company and sold at a neighboring store is contaminated with E. coli O157:H7. All packages from this distributer change their alert color and notification messages are sent to those shoppers that may have been impacted.

How large is the IoT Market?

In the not-too-distant future, hundreds of millions, then billions, of individuals and businesses with billions, then trillions, of smart, communicating devices will stretch the boundaries of current systems. Creating the potential to change the way we work, learn, entertain and innovate.
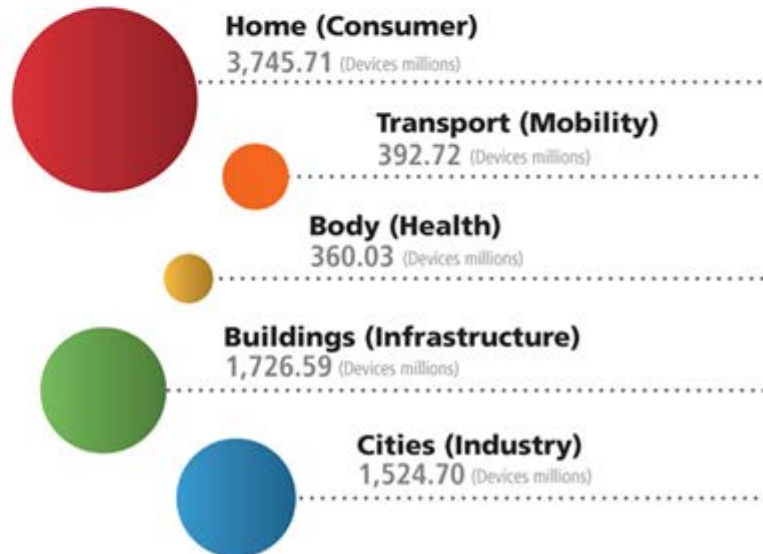
Connected Devices

In 2014 nearly **2 billion** connected devices

This number will grow to nearly **8 billion** devices for the year 2020
Not including mobile phones

Home (Consumer)
3,745.71 (Devices millions)

Transport (Mobility)
392.72 (Devices millions)

Body (Health)
360.03 (Devices millions)

Buildings (Infrastructure)
1,726.59 (Devices millions)

Cities (Industry)
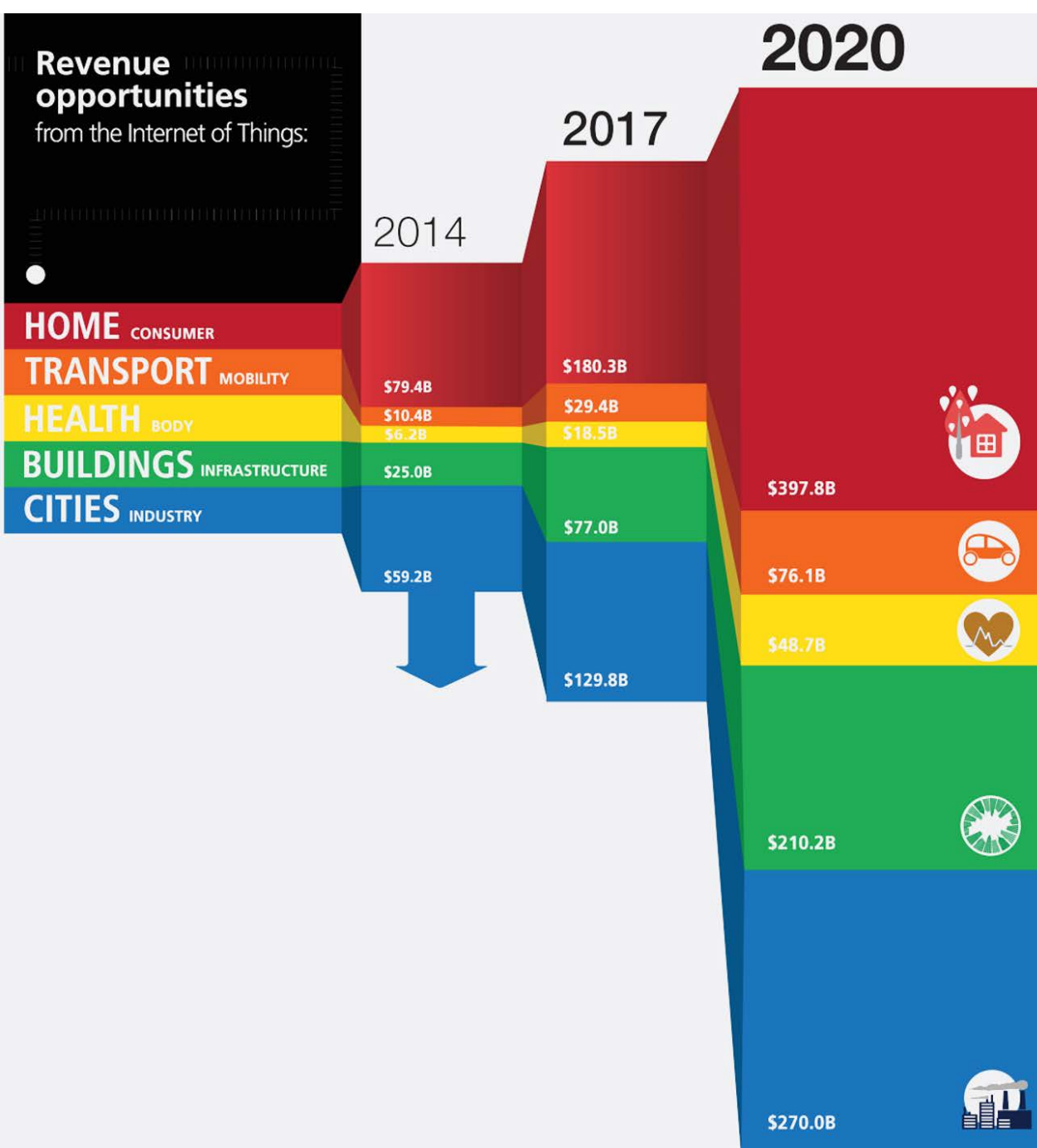1,524.70 (Devices millions)

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Business Impact

The implications of these trends are enormous. Vertically defined, stand-alone products and application markets will increasingly become a part of larger **networked "horizontal" systems**.
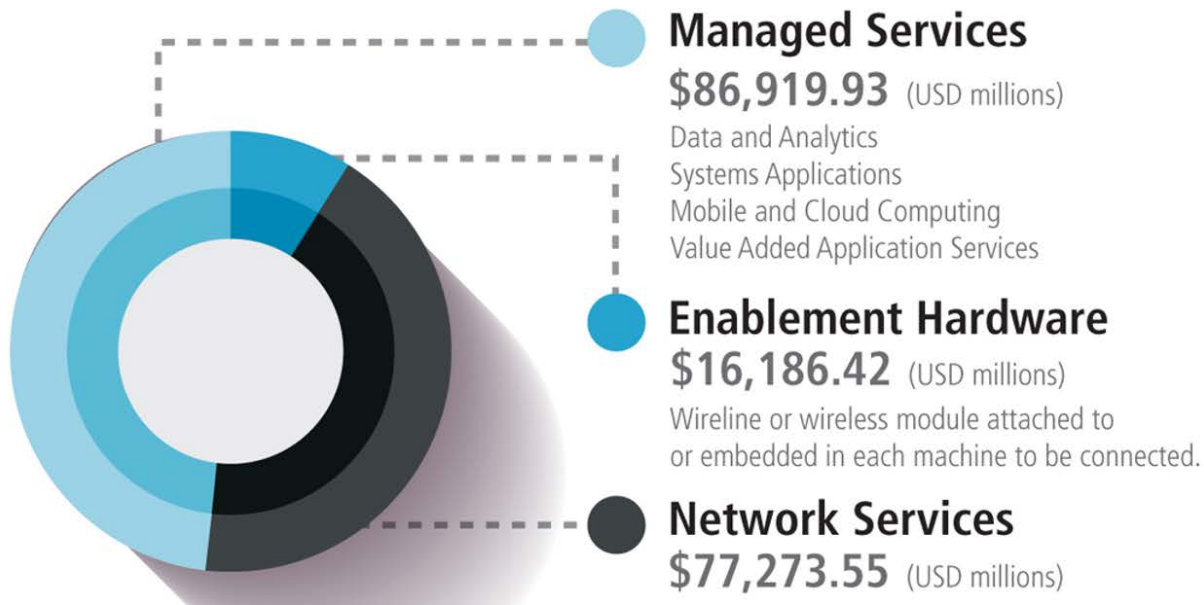
Revenue opportunities from the Internet of Things:

Category	2014	2017	2020
HOME CONSUMER	$79.4B	$180.3B	$397.8B
TRANSPORT MOBILITY	$10.4B	$29.4B	$76.1B
HEALTH BODY	$6.2B	$18.5B	$48.7B
BUILDINGS INFRASTRUCTURE	$25.0B	$77.0B	$210.2B
CITIES INDUSTRY	$59.2B	$129.8B	$270.0B

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2014

180+

Billion in Revenue
in 2014
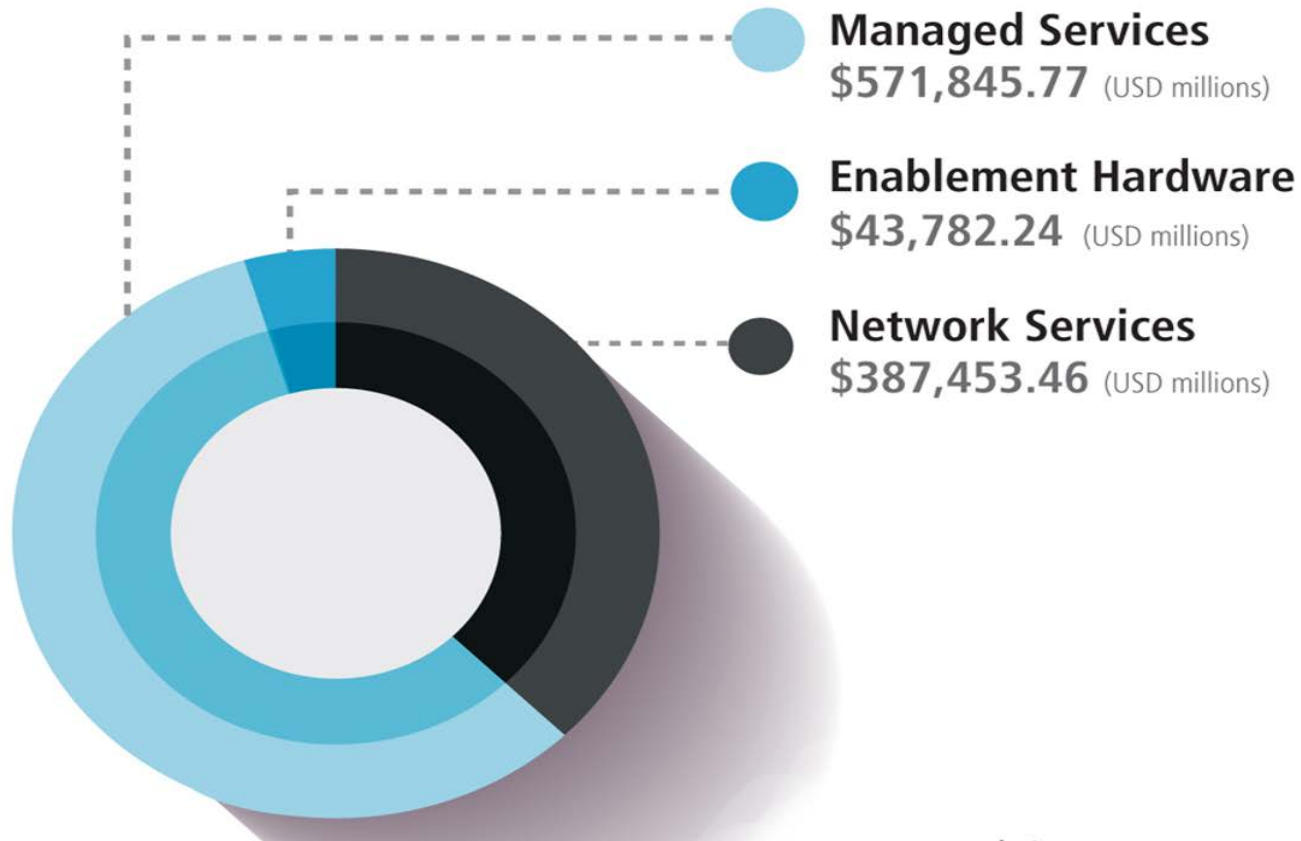
Managed Services
$86,919.93 (USD millions)
Data and Analytics
Systems Applications
Mobile and Cloud Computing
Value Added Application Services

Enablement Hardware
$16,186.42 (USD millions)
Wireline or wireless module attached to
or embedded in each machine to be connected.

Network Services
$77,273.55 (USD millions)

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2020

Managed Services
$571,845.77 (USD millions)

Enablement Hardware
$43,782.24 (USD millions)

Network Services
$387,453.46 (USD millions)

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Whether you are an individual, technology developer, or adopter of these technologies, the Internet of Things will stretch the boundaries of today's systems. **Are you prepared for the changes in the way we will learn, work, and innovate?**

INTERROGATIONS?