Get Ready for the "Pervasive Computing" Era
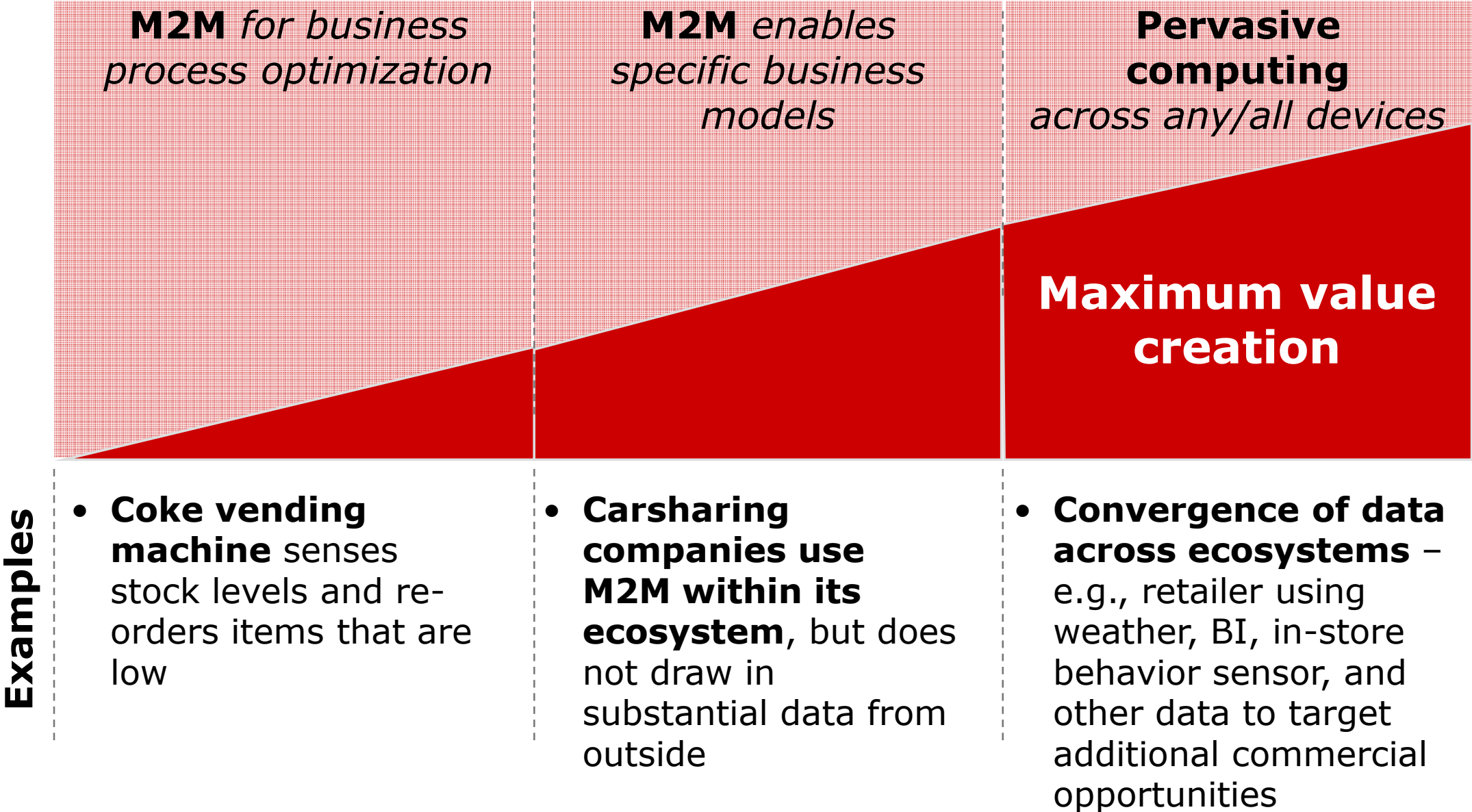
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What is Pervasive Computing: builds on machine-to-machine (M2M/IoT) and the Internet of People (IoP)

*"Pervasive Computing" =
Internet of People + Internet of Things*

and comprises every electronic system that is processing data and is connected to and communicating over the Internet with or without end-user inputs"
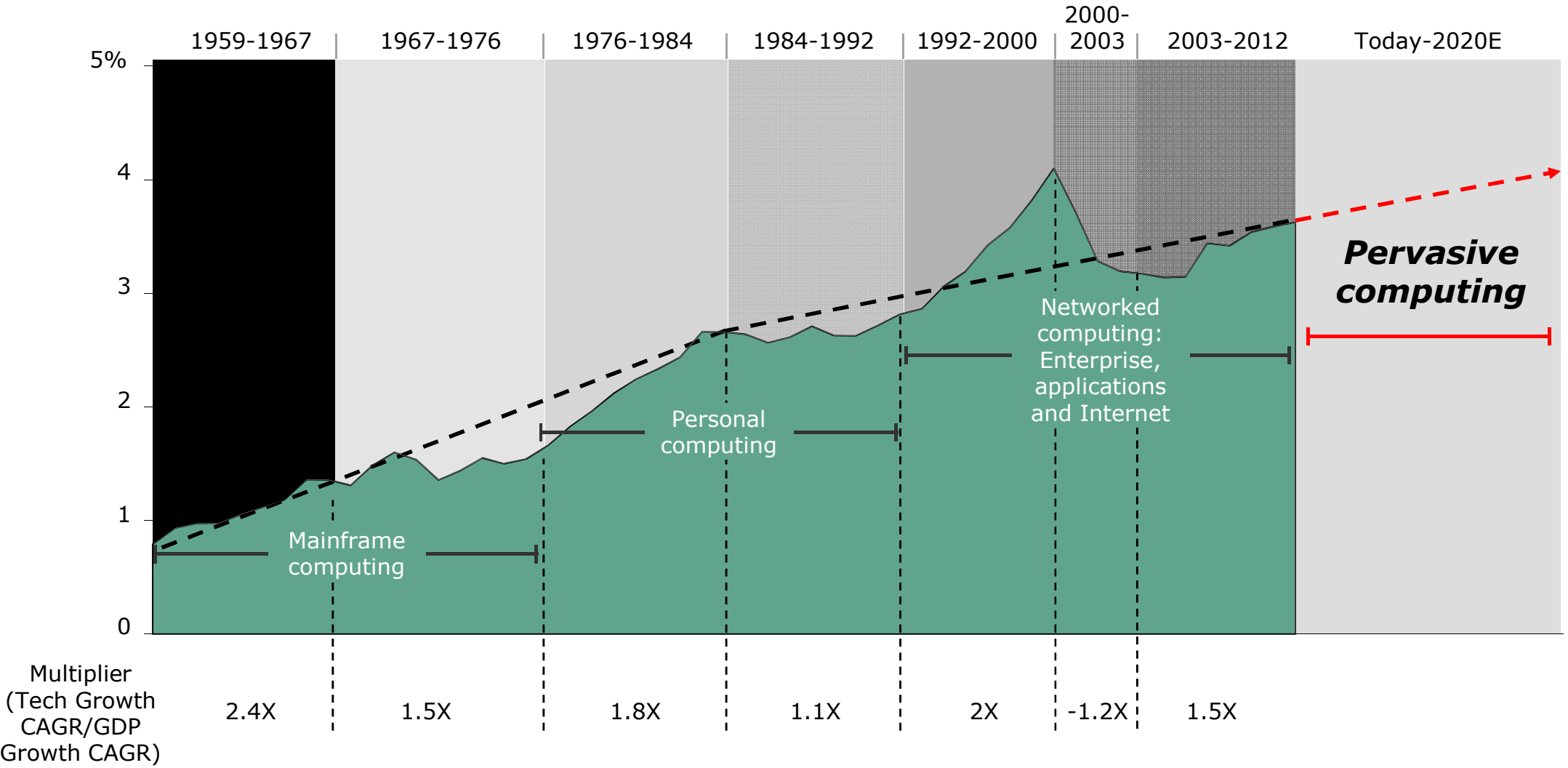
Pervasive Computing will allow to generate the **maximum value from next Digital Era**…

M2M *for business process optimization*	**M2M** *enables specific business models*	**Pervasive computing** *across any/all devices*
		Maximum value creation

Examples

- **Coke vending machine** senses stock levels and re-orders items that are low

- **Carsharing companies use M2M within its ecosystem**, but does not draw in substantial data from outside

- **Convergence of data across ecosystems** – e.g., retailer using weather, BI, in-store behavior sensor, and other data to target additional commercial opportunities

… representing the **next wave of growth in technology's** share of GDP

E.g. Nominal US tech spend to nominal US GDP ratio

	1959-1967	1967-1976	1976-1984	1984-1992	1992-2000	2000-2003	2003-2012	Today-2020E
Multiplier (Tech Growth CAGR/GDP Growth CAGR)	2.4X	1.5X	1.8X	1.1X	2X	-1.2X	1.5X	

Labels on chart: Mainframe computing; Personal computing; Networked computing: Enterprise, applications and Internet; **Pervasive computing**

Pervasive computing sits at the **intersection of mobile, big data, and cloud**

MOBILE (ANYTIME/ANYWHERE)

- More **convenient and user-friendly CE** (smaller, lighter, cheaper, longer battery life)

- **Ubiquitous wireless** connections

- **Better, cheaper screens/sensors**

- Advanced, **vertical-specific, intuitive UIs**

- **New standards/legal frameworks** (e.g., HIPAA certification in healthcare)

- **More devices per user**, and more time spent on devices than ever

BIG DATA

- **Data/storage explosion**

- **Consumer comfort** with sharing data

- **Millions of apps, users, machines**

- **Real-time data analytics** to drive more effective business decisions

- **Publicly-available datasets**

- **Fast processors** to enable data processing (multi-core)

Pervasive computing

CLOUD

- **Service delivery platform**

- Scalable solutions

- **Interoperability across devices**

- **SaaS business models**

- **Networking protocols** (ZigBee, RFID, etc.)

Source: Lit search; Bain Analysis

Implications of pervasive computing on technology industry will be deep and broad

| # OF CONNECTED DEVICES | VOLUME OF DATA GENERATED & REPLICATED | MOBILE NETWORK TRAFFIC |

Connected devices (B)

Volume of data in zettabytes
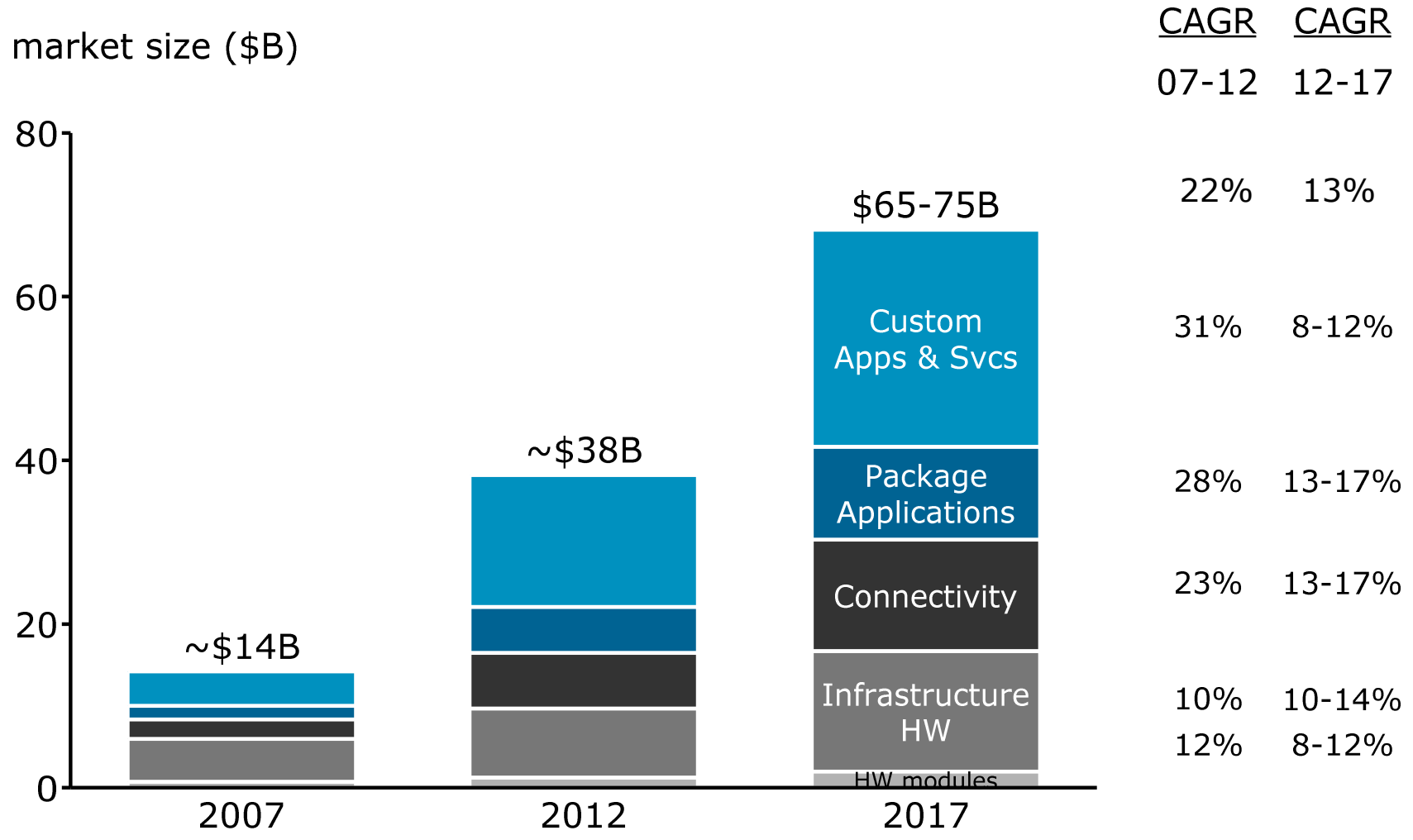
Mobile network traffic in exabytes
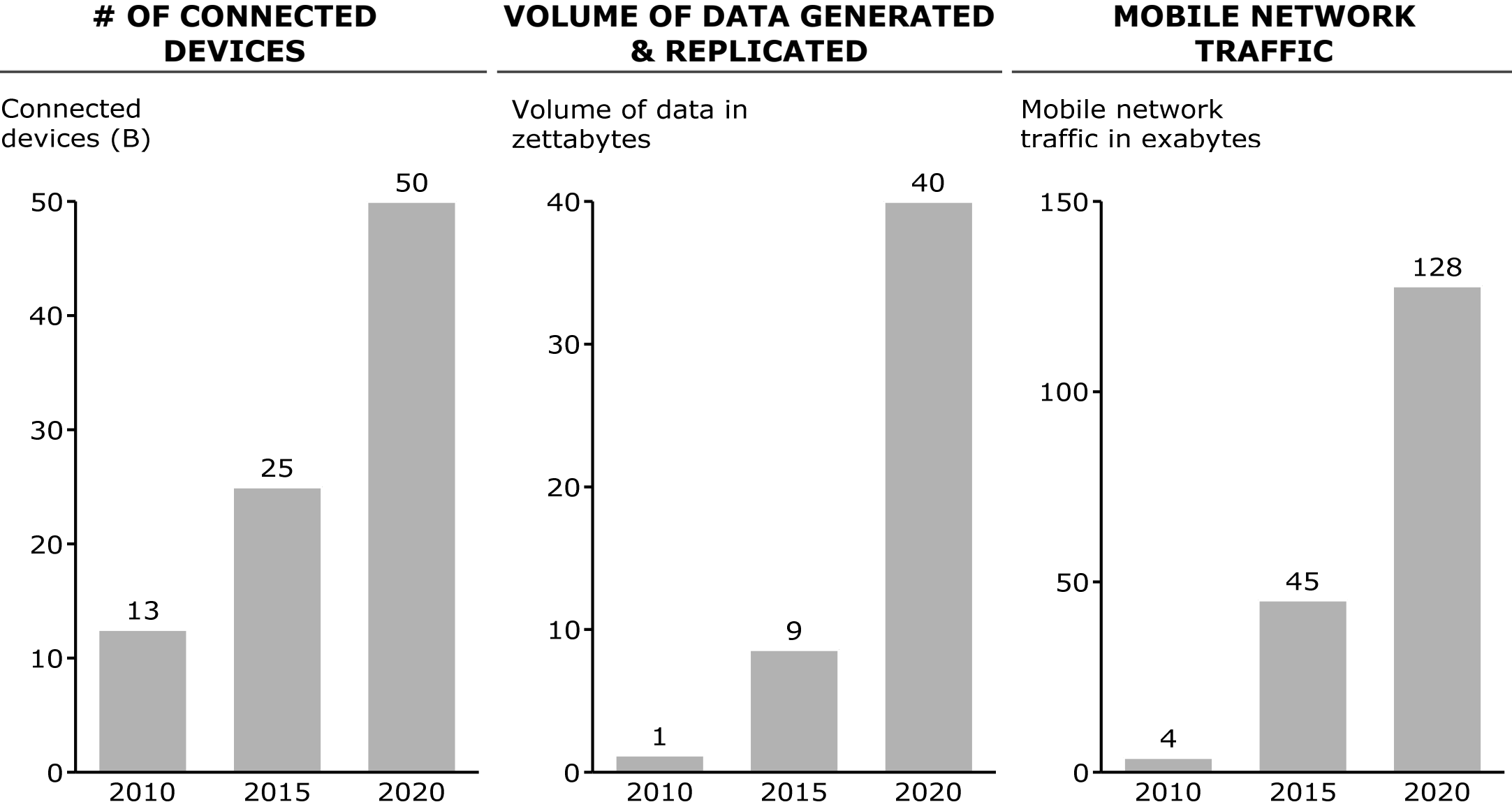
Source: Cisco; IDC Digital Universe Study; IDATE & UMTS Forum

Core pervasive computing market could reach $75B by 2017...
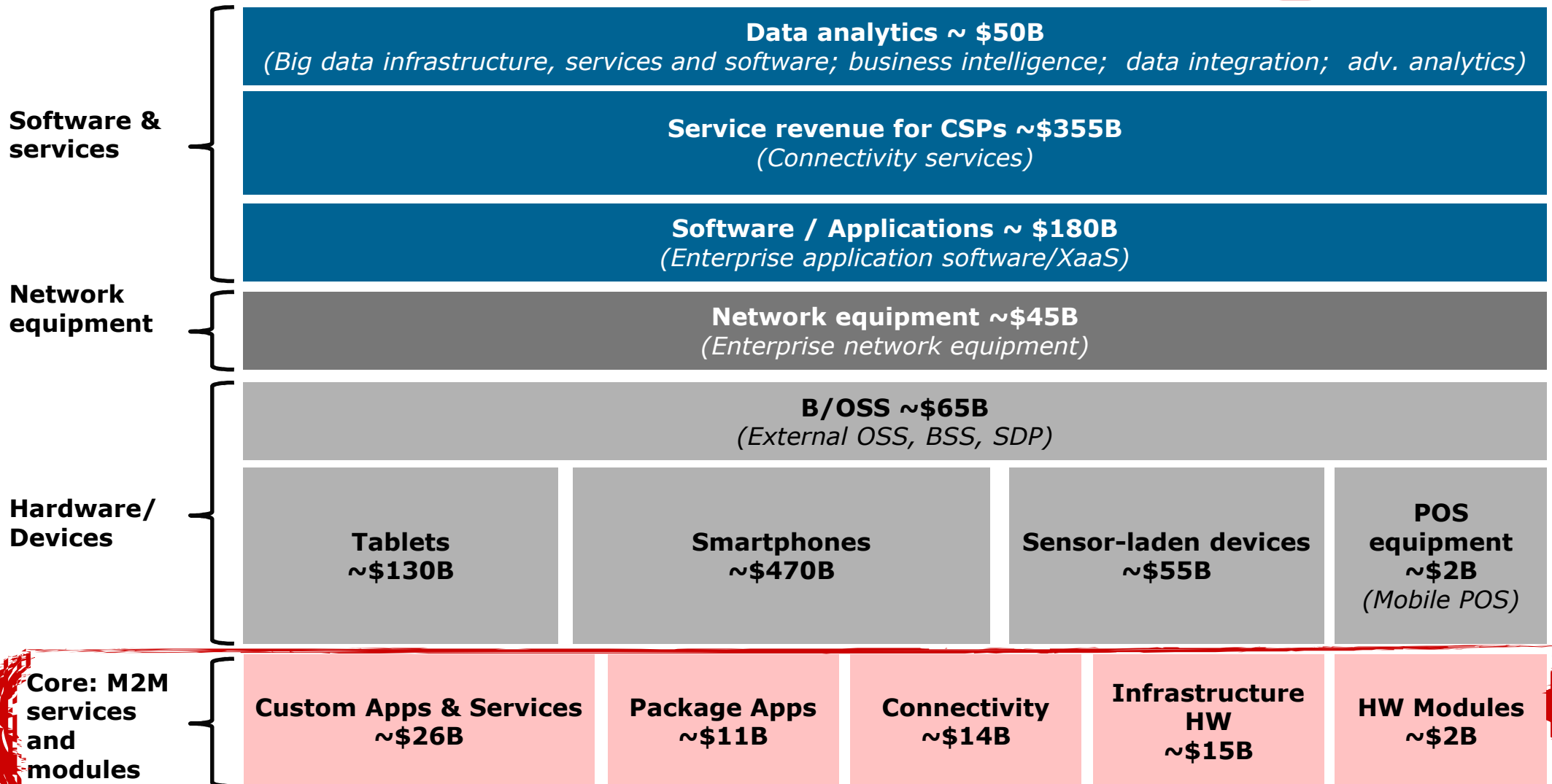
Core M2M market size ($B)

	CAGR 07-12	CAGR 12-17
	22%	13%
Custom Apps & Svcs	31%	8-12%
Package Applications	28%	13-17%
Connectivity	23%	13-17%
Infrastructure HW	10%	10-14%
HW modules	12%	8-12%

Source: Budde; IDATE; IDC; IDTechEx; IHL Group; Gartner; Wall Street research; Bain analysis

... and will drive **growth in adjacent markets** worth ~$1.4T

Estimated global M2M/IoX 2017 opportunity

~$1.4T (2017)

Software & services

Data analytics ~ $50B
(Big data infrastructure, services and software; business intelligence; data integration; adv. analytics)

Service revenue for CSPs ~$355B
(Connectivity services)

Software / Applications ~ $180B
(Enterprise application software/XaaS)

Network equipment

Network equipment ~$45B
(Enterprise network equipment)

Hardware/ Devices

B/OSS ~$65B
(External OSS, BSS, SDP)

Tablets ~$130B	**Smartphones ~$470B**	**Sensor-laden devices ~$55B**	**POS equipment ~$2B** *(Mobile POS)*

Core: M2M services and modules

Custom Apps & Services ~$26B	**Package Apps ~$11B**	**Connectivity ~$14B**	**Infrastructure HW ~$15B**	**HW Modules ~$2B**

Source: IDATE; IDC; IDTechEx ; IHL Group; Gartner; Ovum; Operator M2M Strategy Update 2012; Wall Street research; Bain analysis

Currently, pervasive computing ecosystem is **highly complex** and key layers remain **fragmented** (e.g., apps)

To realize full potential, **barriers must be overcome**

1 **Privacy and data security**

2 **Unclear ROI** for some use cases/applications

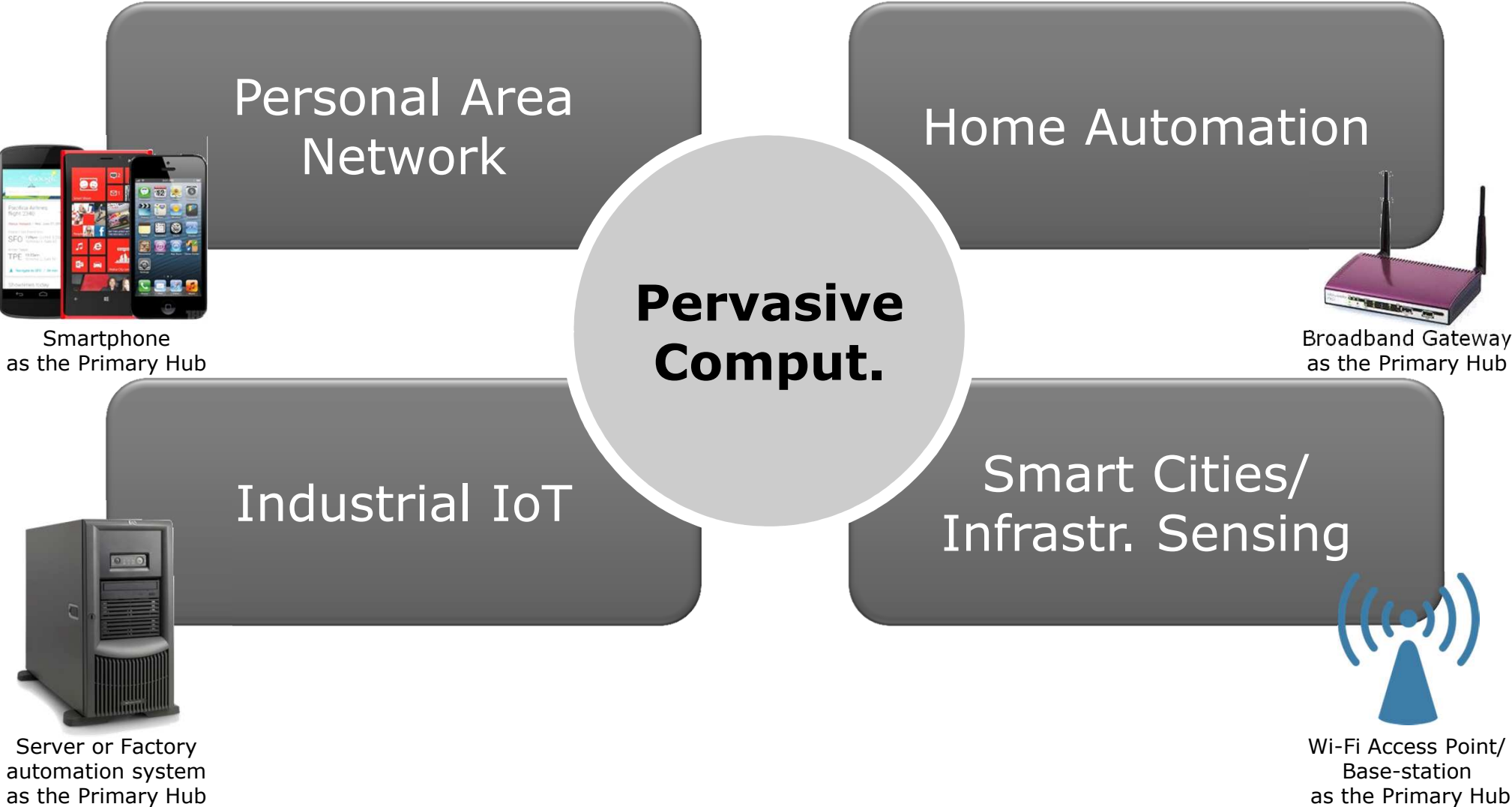**3** **Some key vertical use cases to accelerate adoption** in select industries (e.g. utilities, healthcare)
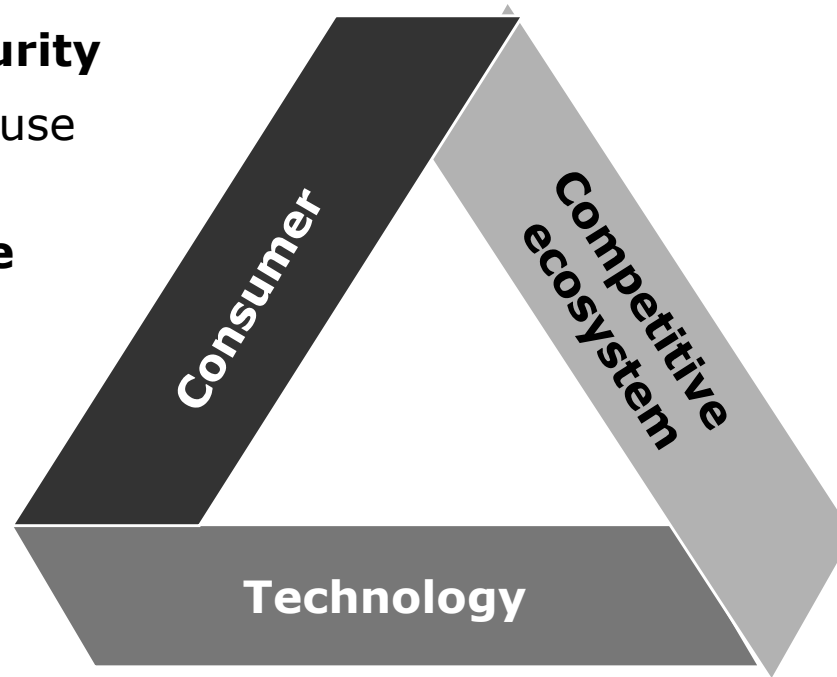
4 **Business/monetization models** for new offerings not established

5 **Network operating architecture** optimized for cell voice/data, not pervasive computing

Consumer

Competitive ecosystem

Technology

6 **Lack of standards around data formats and communications protocols**
- Within and across verticals

7 **Limited scalability in IPv4**
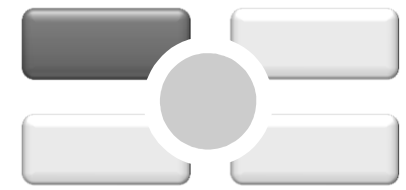- Need to transition to IPv6

8 **Global network/mobile connectivity**
- Roaming charges
- High upgrade costs as early gen networks retire

9 **Network quality issues** in advanced apps (e.g., real-time video transfer over 2G/3G challenging)

Pervasive Computing could be separed in **4 main areas** of application, based on **different hub devices**

Personal Area Network

Smartphone
as the Primary Hub

Home Automation

Broadband Gateway
as the Primary Hub

Pervasive Comput.

Industrial IoT

Server or Factory
automation system
as the Primary Hub

Smart Cities/ Infrastr. Sensing

Wi-Fi Access Point/
Base-station
as the Primary Hub
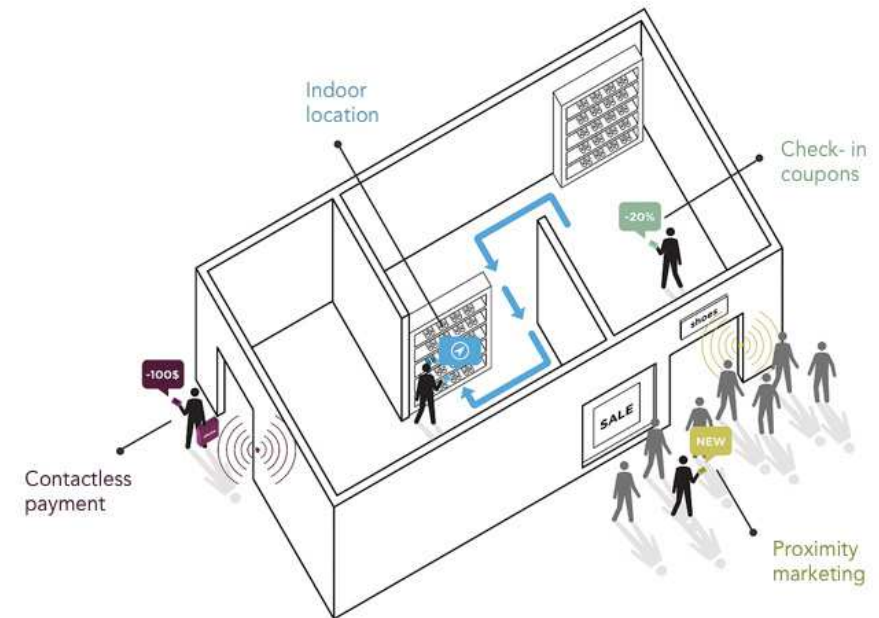
Personal Area Network

Highlights

- **The hub today is the smartphone**. In the future, the hub may be an iWatch or other piece of **wearable technology**.

  - c.a. **2B smartphones** in use with at least a 3G cellular connection and a **vast majority of them incorporate Wi-Fi**, Bluetooth and GPS
  - In **2016 there will be 4B smartphones**

- By **2016** some models will also **incorporate fingerprint sensors** for security and additional means of communication. Thus, the **phone will be used to identify** and, if need be, **authenticate a user**.

- As the phone enters into the proximity of other Pervasive Computing devices, **data or control can be transferred to the phone** in a **context aware manner**

- **5 to 10 nodes on an average personal area network** over the next several years in developed economies

Application Example

- Smartphone become your **personal shopper...**

Indoor location

Check-in coupons

-20%

-100$

Contactless payment

SALE

NEW

Proximity marketing

- ... which require retailers to **update their in-store digital infrastructure** with appropriate **sensors and client nodes**

Home Automation
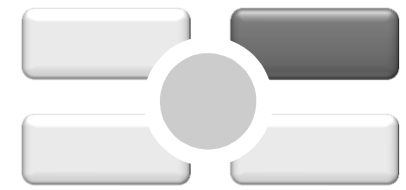
Highlights

- The **Pervasive Computing hub** **in the home will likely be** **broadband connection devices** or a home gateway.

- Currently Comcast, Time Warner, Lowes and others are **offering security services** that can monitor entry into the home, identify who is outside the door or alert the homeowner in case of a break in.

- These are **rudimentary services**, but moving forward **TV, appliances, the HVAC system, lighting and irrigation systems will be networked**.

- **Average 10s of nodes** in a home in a developed economy in next future

Application Example

example 1

- You are watching TV, the **washing machine sends a message to the TV** that the laundry needs to be moved to the dryer

- **When you go** to the basement the **lights turn on** and when you leave, they turn off
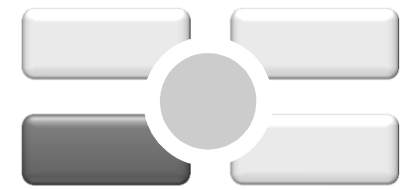

example 2

- You could **unlock your front door for a visitor** allowing access remotely if no one is home

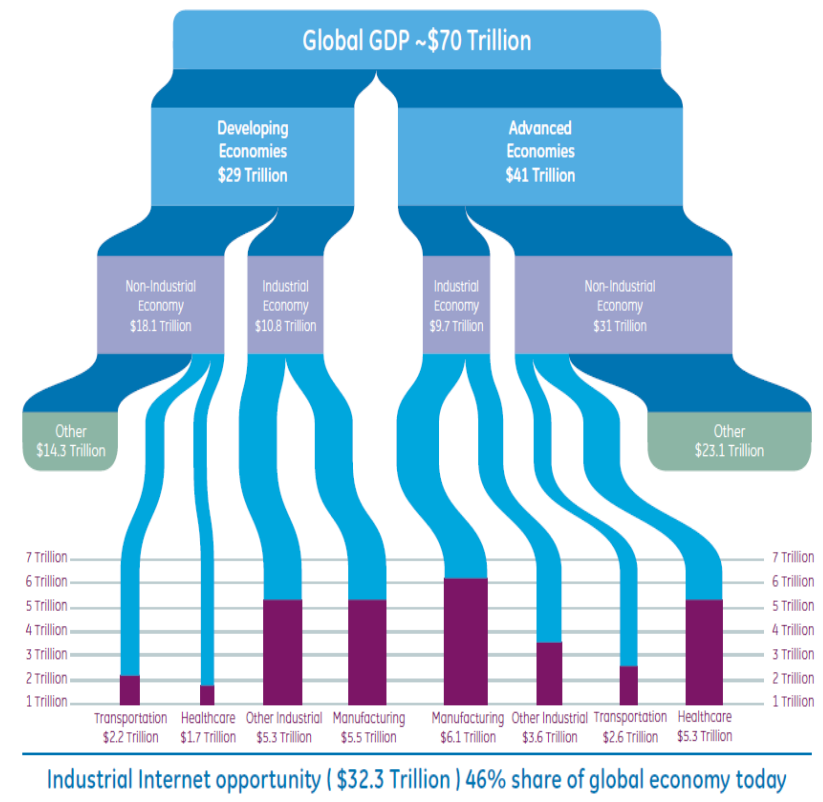- You can **monitor when the person leaves a**nd **what room the person entered**

Industrial IoT

- The industrial Internet of Things is a compelling proposition for a **wide variety of business applications**

- It can **improve productivity** by **reducing truck rolls** or **remotely monitor equipment in the field** and in the plant.

- Industrial IoT can **increase equipment uptime** by reducing unscheduled maintenance, improving equipment efficiency and reducing equipment failure.

- Moreover, the industrial IoT can **reduce the cost of regulatory compliance** and **improve worker safety**

- The industrial IoT can **eliminate the need for a person to go out and read a utility meter**

Application Example

- *GE economists estimate that **over 20 years the industrial IoT could save $10-$15T***

Global GDP ~$70 Trillion

Developing Economies $29 Trillion — Advanced Economies $41 Trillion

Non-Industrial Economy $18.1 Trillion | Industrial Economy $10.8 Trillion | Industrial Economy $9.7 Trillion | Non-Industrial Economy $31 Trillion

Other $14.3 Trillion — Other $23.1 Trillion

Transportation $2.2 Trillion | Healthcare $1.7 Trillion | Other Industrial $5.3 Trillion | Manufacturing $5.5 Trillion | Manufacturing $6.1 Trillion | Other Industrial $3.6 Trillion | Transportation $2.6 Trillion | Healthcare $5.3 Trillion

Industrial Internet opportunity ($32.3 Trillion) 46% share of global economy today

Source: World Bank, 2011 and General Electric

Smart Cities and Infrastructure Sensing

Highlights

- In this area of application **roads, bridges and other infrastructure** can be **monitored and queried remotely**.

- In addition, **assets and valuable possessions can be tracked**.

- The **combination among Sensors, Network and Device** is expected to support City and Infrastructure interaction evolution in an **adaptive, senseable and efficient environment**

- In 2012, spending for **Smart City programs worldwide account for >30Bn€**

- Smart City programs are based on **sustainability and enriching citizens' life**

  - Considering sustainability, for instance, smart application could **save up to -30% on public energy consumptions**
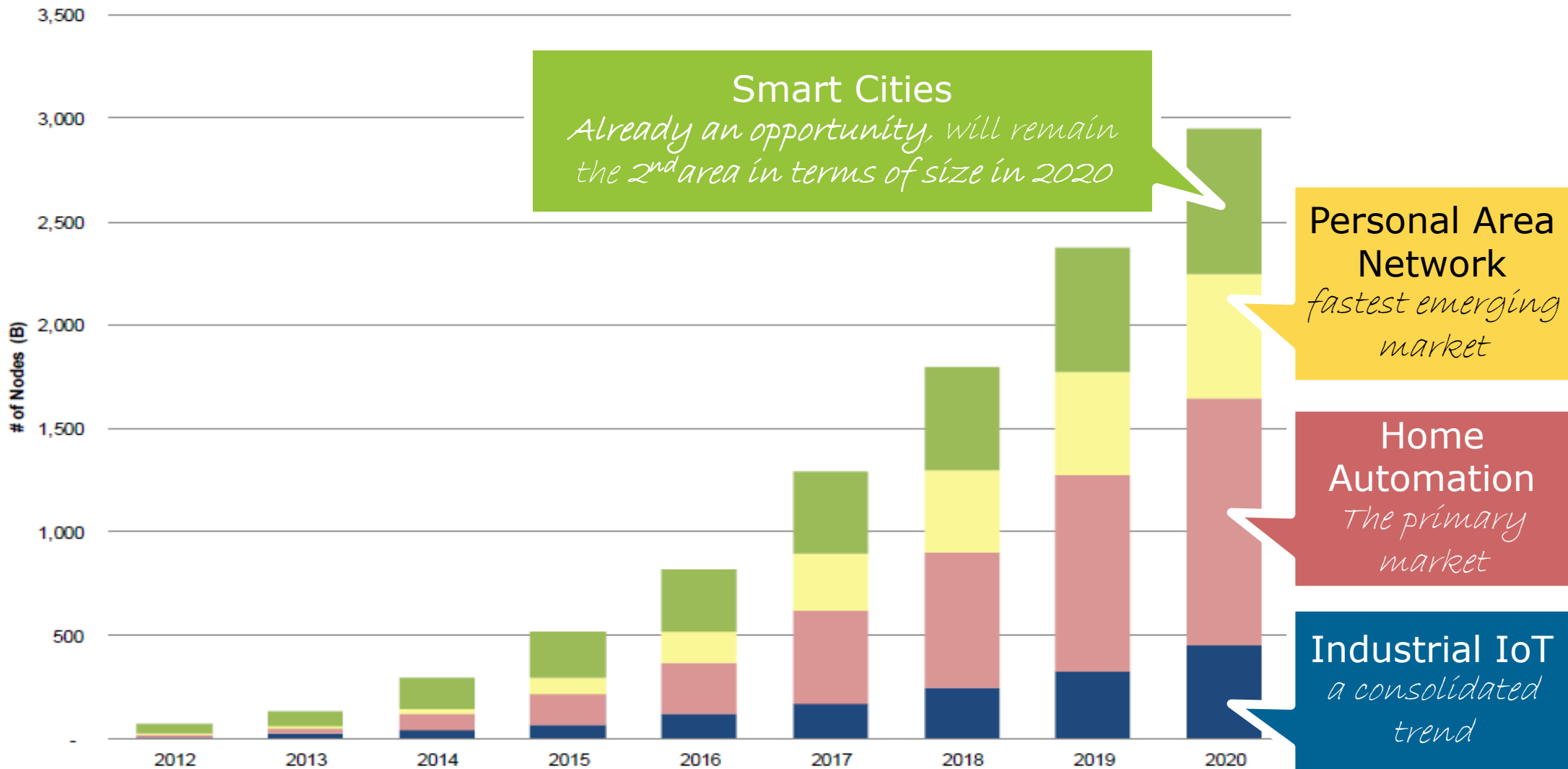
Application Example

Environment **Transportation** **Buidling**

Security **Utilities**
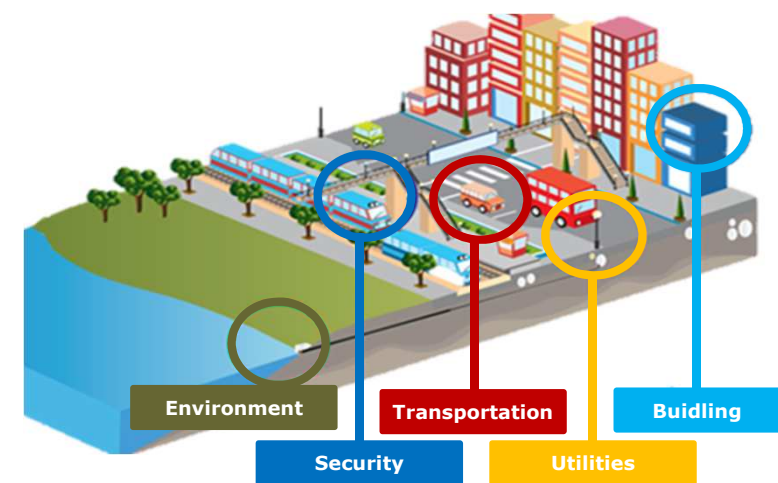
- **Smart Parking**

- **Structural health**

- **Noise Urban Maps**

- **Traffic Congestion – driving/ walking routes**

- **Smart Lightning**

- **Waste Management**

- **Forest Fire Detection**

- ...

Market evolution for the different application areas
Considering as a Proxy Client Node expected evolution (Bn of Nodes)

Smart Cities
Already an opportunity, will remain the 2nd area in terms of size in 2020

Personal Area Network
fastest emerging market

Home Automation
The primary market

Industrial IoT
a consolidated trend

Source: Piper Jaffray 2013 Analyst Report

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