M2M and IoT

Embedded Interface Design

with **Bruce Montgomery**

Learning Objectives

- Students will be able to…
  - Recognize the definitions of and differences between M2M and IoT
  - Understand the importance of these topics to modern industry

IEEE: M2M Defined

- M2M: Machine-to-Machine [1]
- "**Machine-to-Machine (M2M) communications** is the communication between two or more entities that do not necessarily need any direct human intervention. M2M services intend to automate decision and communication processes."
- "**M2M Device**: A device that runs M2M application(s) using M2M service capabilities. M2M devices connect to network domain in the following two ways: "

M2M Connections

- "**Direct Connectivity:** M2M devices connect to the network domain via the access network. The M2M device performs the procedures such as registration, authentication, authorization, management and provisioning with the network domain. The M2M device may provide service to other devices connected to it that are hidden from the network domain."
- "**Gateway as a Network Proxy:** The M2M device connects to the network domain via an M2M gateway. M2M devices connect to the M2M gateway using M2M area network. The M2M gateway acts as a proxy for the network domain towards the M2M devices that are connected to it. M2M devices may be connected to the network domain via multiple M2M gateways."
- Definitions from [1]

Typical M2M Architecture

- Architecture by Domain [2]:
- Device domain
- Device – to Network Gateway
- Network domain
- Network – to – Application Services
- Application domain
- M2M tends to be more focused on embedded device design
- M2M Protocols tend to focus on the within/below network layer communications

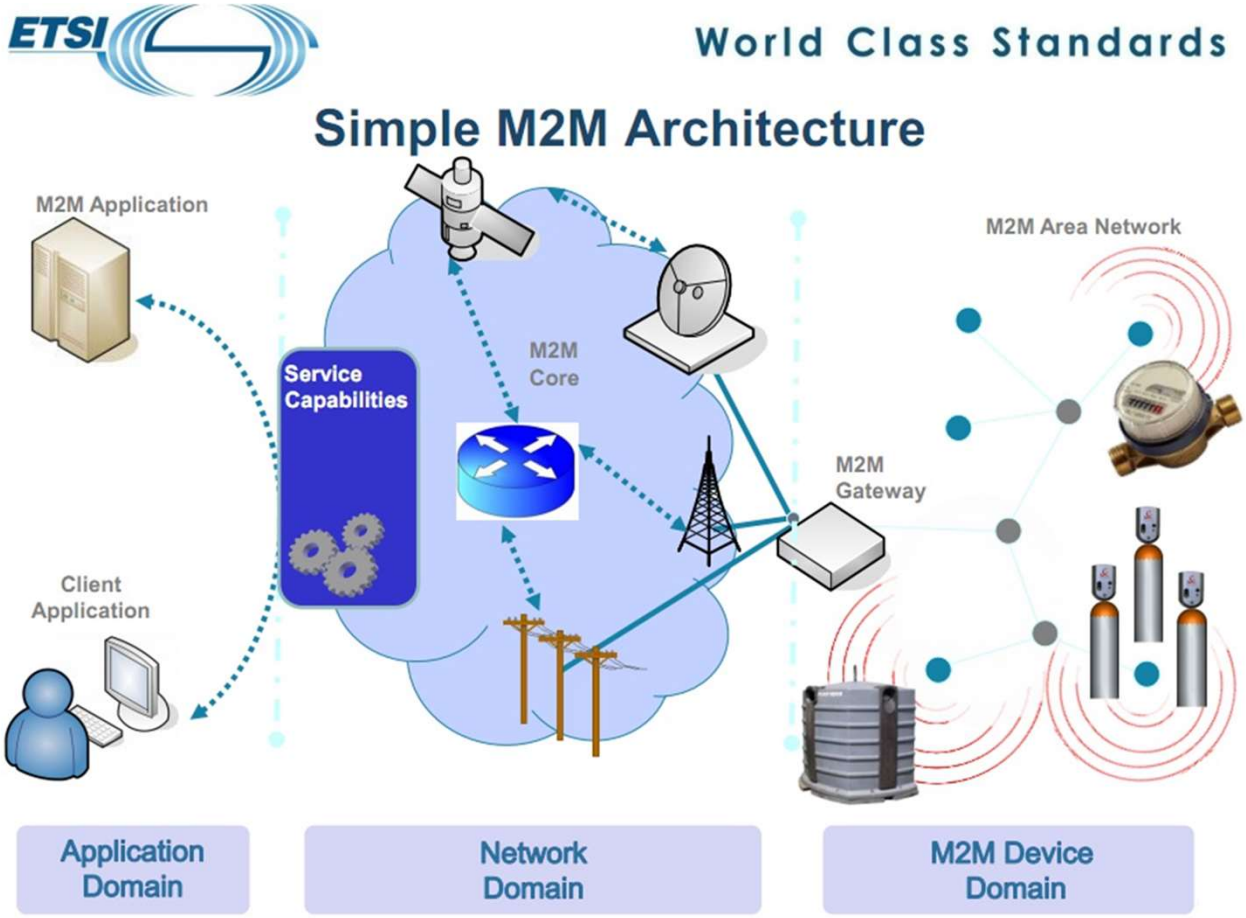


Image from [2]

IEEE: IoT Defined

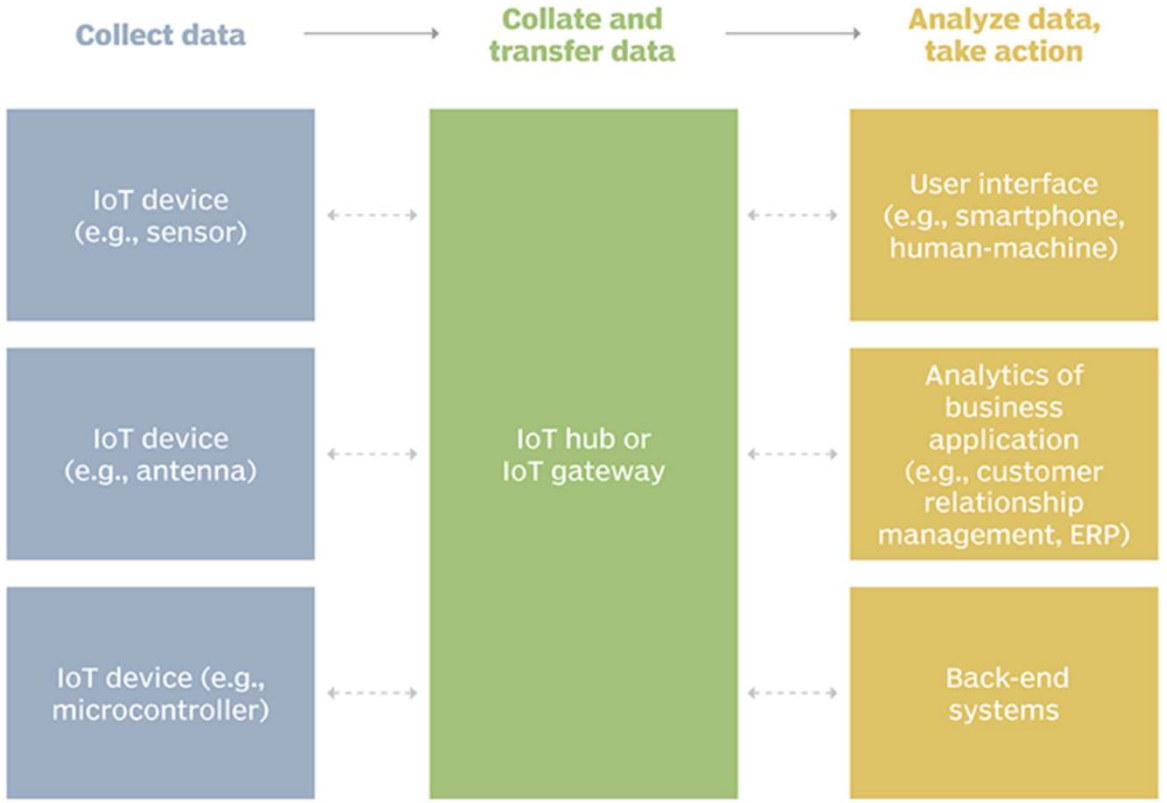
- IoT: Internet of Things [1]
- "A global infrastructure for the information society, enabling advanced services by **interconnecting (physical and virtual) things** based on existing and evolving interoperable information and communication technologies."
- "The basic idea is that IoT will **connect objects** around us (electronic, electrical, non-electrical) to provide seamless communication and contextual services provided by them. Development of RFID tags, sensors, actuators, mobile phones make it possible to materialize IoT which **interact and co-operate** with each other to make the service better and accessible anytime, from anywhere."
- "The original 'Internet' is based on the TCP/IP protocol suite but any network based on the TCP/IP protocol suite cannot belong to the Internet because private networks and telecommunication networks are not part of the Internet even though they are based on the TCP/IP protocol suite. In the viewpoint of IoT, **the 'Internet' considers the TCP/IP suite and non-TCP/IP suite** at the same time."

M2M/IoT Interface Points (Communication Protocols)

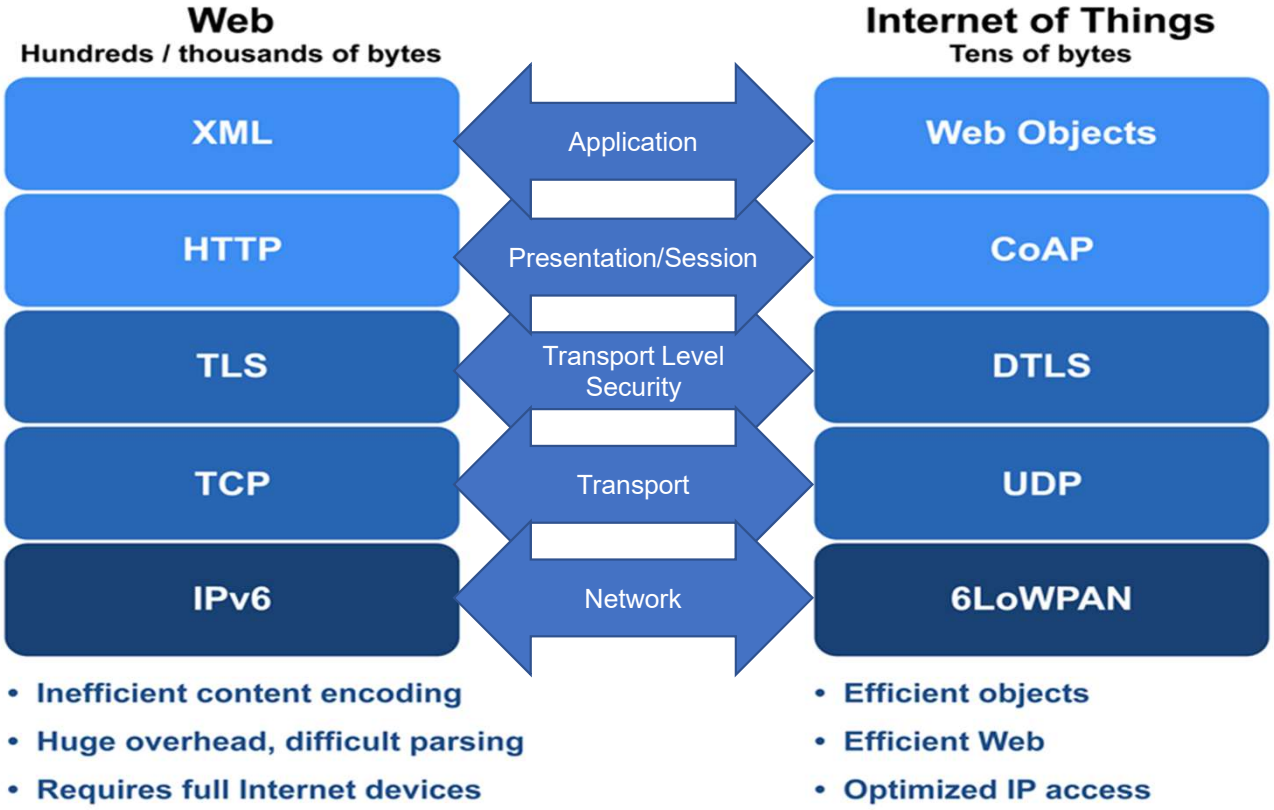
- Low-level Protocols: I2C, UART, GPIO, SPI, 1-Wire, ADC, DAC, etc.
- M2M Wired Protocols: USB, RS-232, RS-485, POTS Modems, etc.
- M2M LAN Wireless Protocols: RFID, BLE, NFC, ANT, 6LowPAN, Zigbee, Z-Wave, DECT ULE, WiFi, etc.
- Internet Protocols: IPv4/IPv6, TCP/IP, UDP/IP, HTTP, FTP, etc.
- Web Service Protocols: SOAP, XOP, WSDL, WS-CDL, REST, HTML, etc.
- Data Encoding: JSON, XML, RDF, etc.
- IoT Application Protocols: WebSockets, MQTT, CoAP, etc.
- LPWAN/Cellular: 2G/3G/4G, LTE, LTE-M, NB-IoT, LoRaWAN, Sigfox, etc.
- Cloud Frameworks: AWS IoT, IBM BlueMix, MS Azure, GE Predix, etc.

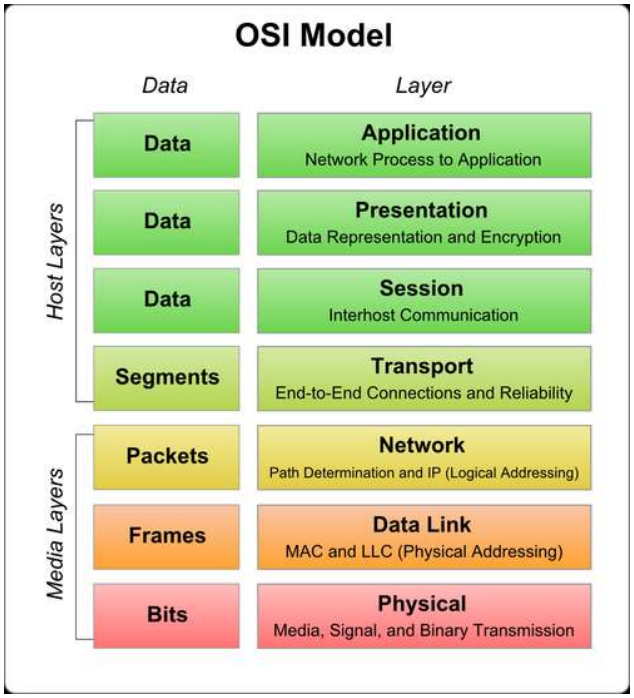
Typical IoT Architecture

- Typical IoT Architectures include “edge” devices, “connection” nodes, “gateways” to an IP network, and cloud, mobile, or web elements for application or UI access [4]
- IoT Application Protocols tend to focus above the network layer
- IoT is less concerned about the specific embedded device designs than the system: the software, services, and applications of the solution.



ISO Layer/OSI Model: Comparison of Web vs IoT





ISO = International Organization fro Standardization
OSI = Open Systems Interconnect
Images from Reference [5]

Importance of IoT/M2M: Scale [8]

Table 1: IoT Units Installed Base by Category (Millions of Units)

Category	2016	2017	2018	2020
Consumer	3,963.0	5,244.3	7,036.3	12,863.0
Business: Cross-Industry	1,102.1	1,501.0	2,132.6	4,381.4
Business: Vertical-Specific	1,316.6	1,635.4	2,027.7	3,171.0
Grand Total	**6,381.8**	**8,380.6**	**11,196.6**	**20,415.4**

Source: Gartner (January 2017)

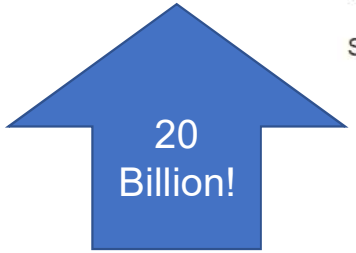


Table 2: IoT Endpoint Spending by Category (Millions of Dollars)

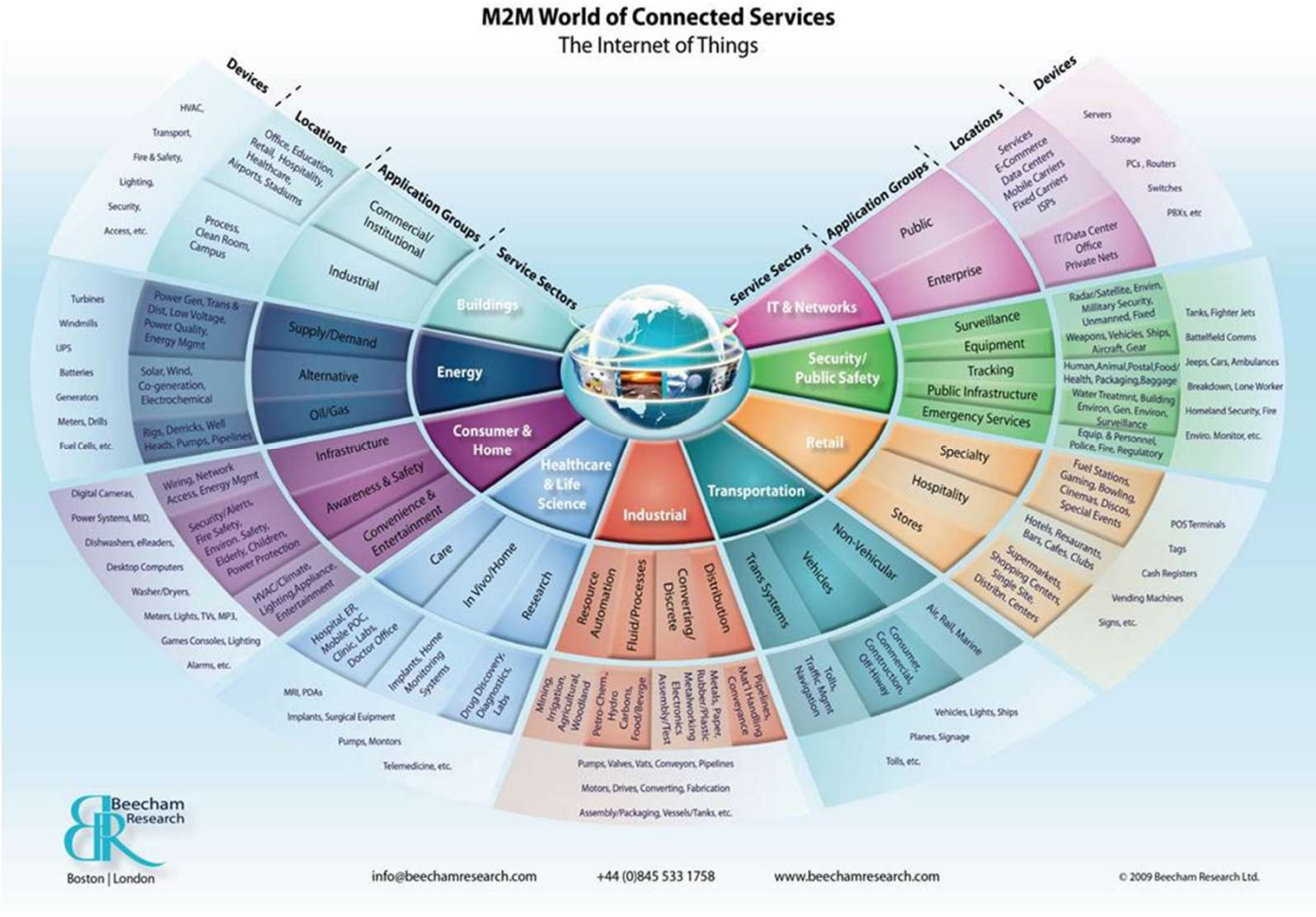
Category	2016	2017	2018	2020
Consumer	532,515	725,696	985,348	1,494,466
Business: Cross-Industry	212,069	280,059	372,989	567,659
Business: Vertical-Specific	634,921	683,817	736,543	863,662
Grand Total	**1,379,505**	**1,689,572**	**2,094,881**	**2,925,787**

Source: Gartner (January 2017)

Importance of M2M/IOT: Pervasive

- Buildings
- Energy
- Consumer
- Healthcare
- Industrial
- Transportation
- Retail
- Security
- IT

Image from [9]



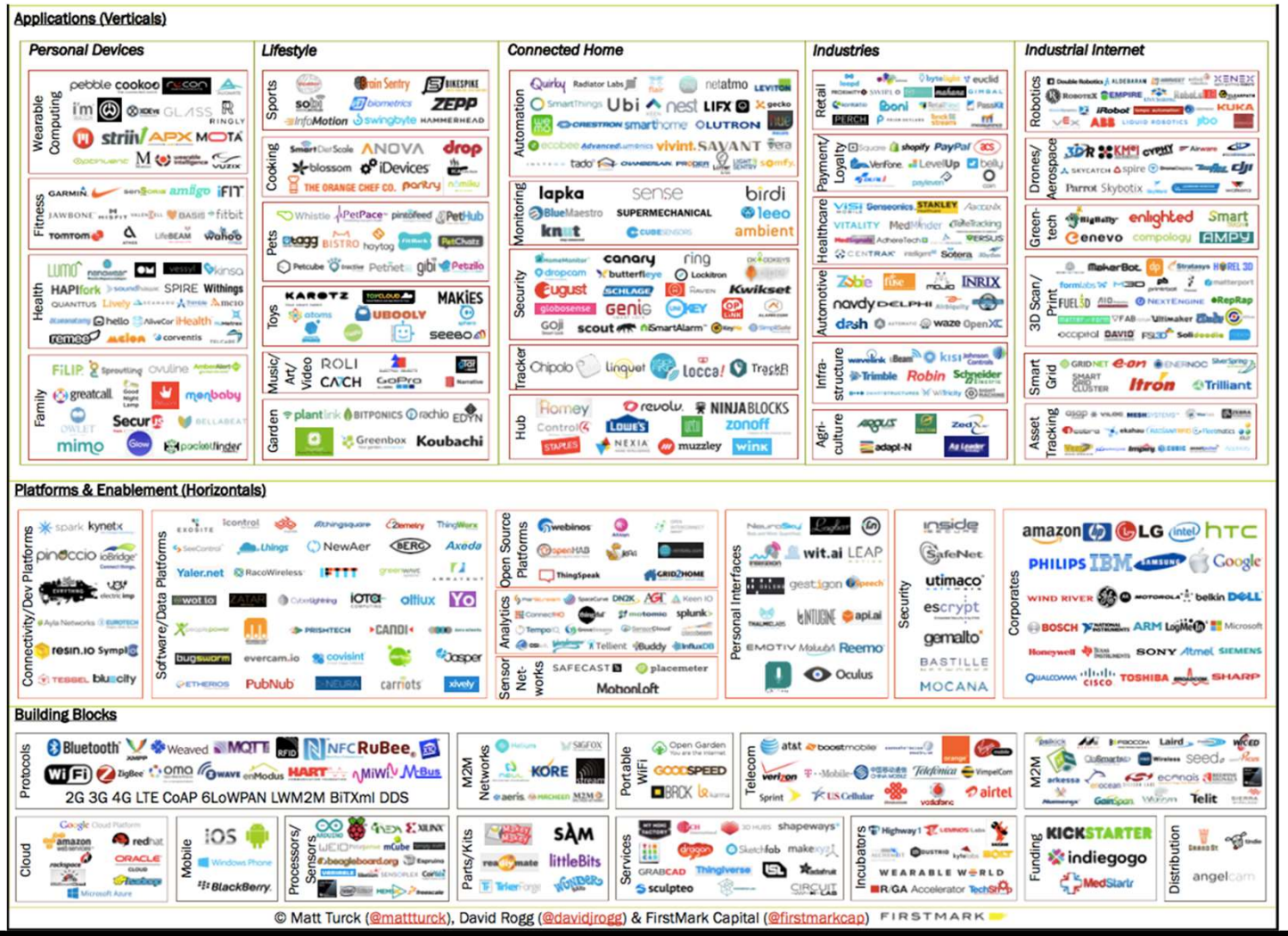
Constant Focus on IoT Trends

IoT Trends from Recent CES [11]

- Voice UIs
- IoT in Supply Chain
- Integrating IoT into older products
- Improving robotics
- Automotive interfaces/functions
- IoT-enabled sporting events
- Cameras with Machine Learning
- Self-driving vehicles
- Consolidation of IoT product lines

Relevance?

Looking for a job?
Companies involved in the development of IoT embedded devices or components [10]

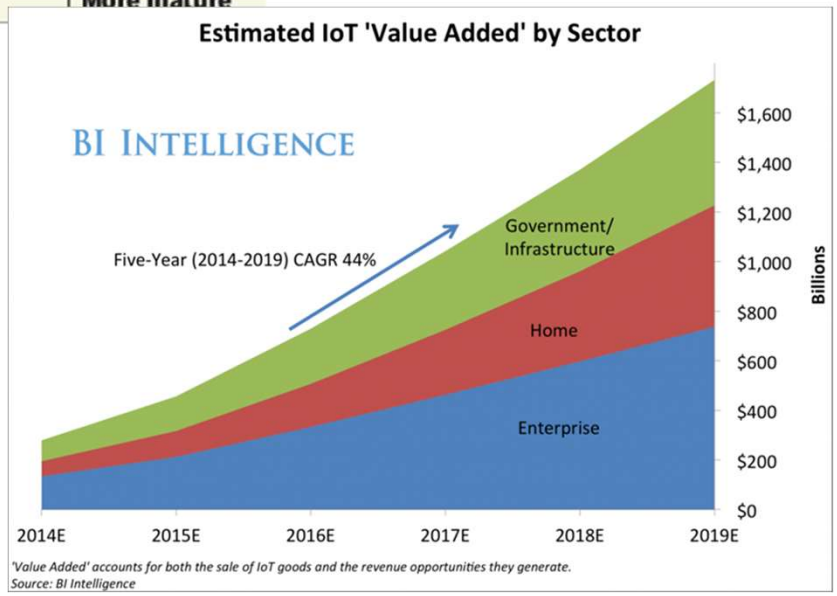


Relevance?

- Follow the money…
- Investments in startups… [6]
- Sale of IoT devices and related revenue opportunities [7]

Where enterprise IoT investments are going

Sub-Category	Total Funding	Startup	Funded Startups	Status
IoT Agriculture	$960M	61	33	More mature
IoT Automotive	$728M	49	28	More mature
IoT City and Buildings	$1.3B	64	40	More mature
IoT Corporate	$2.3B	26	18	More mature
IoT Industrial	$536M	24	16	Newer
IoT Retail	$320M	30	18	More mature
IoT Security	$338M	17	10	



References

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