Technology Innovation & Hype

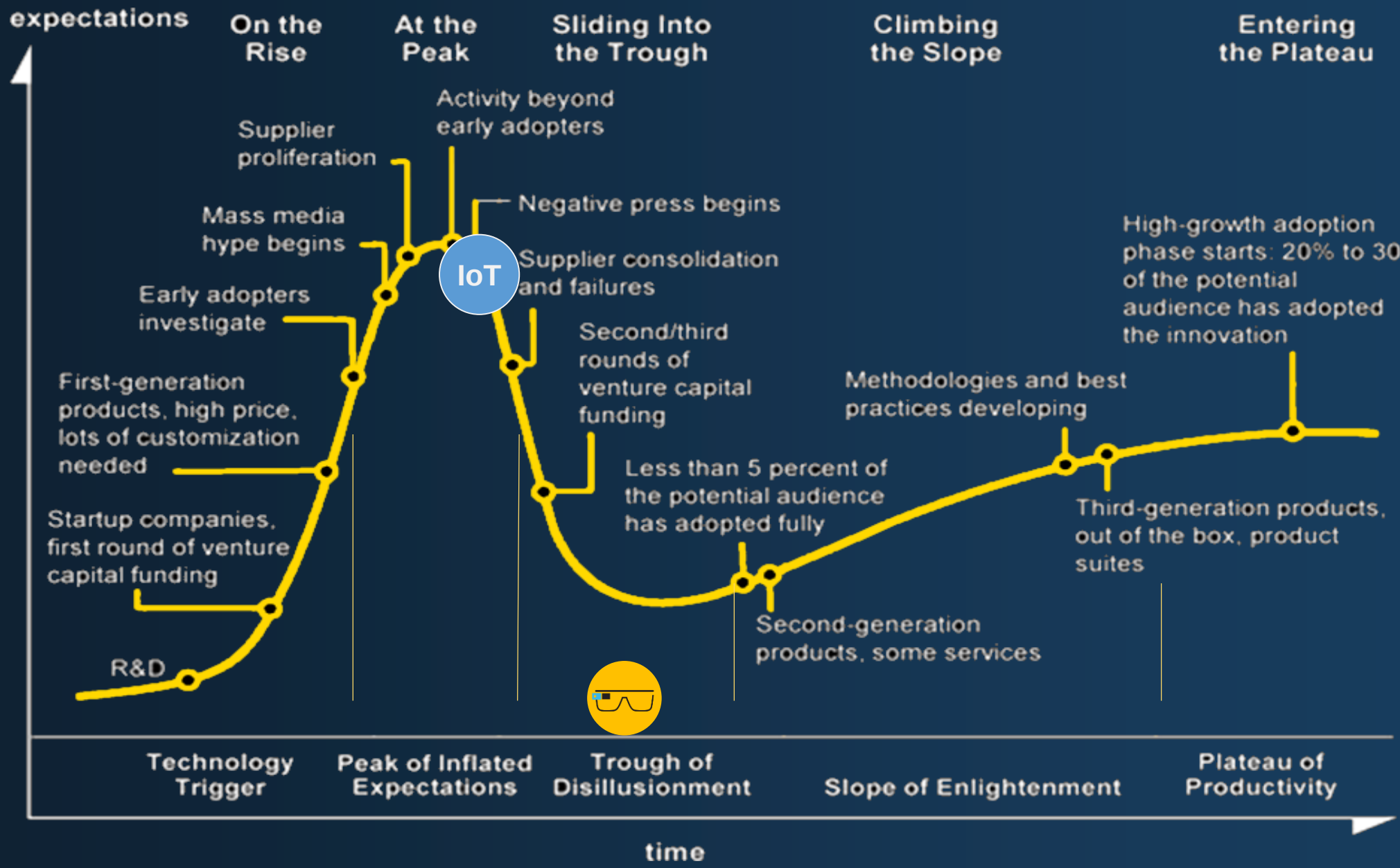
A case study:

Internet of Things

IoT Agenda

- What is IoT? Is it a Hype?
- Digital Universe & Data Expansion
- IoT General Architecture
- IoT Market Segments
- IoT Technology Impacts
- IoT Investments
- IoT in Business – A Survey
- IoT as a Startup
- Conclusion

IoT and Big Data Hype Curve



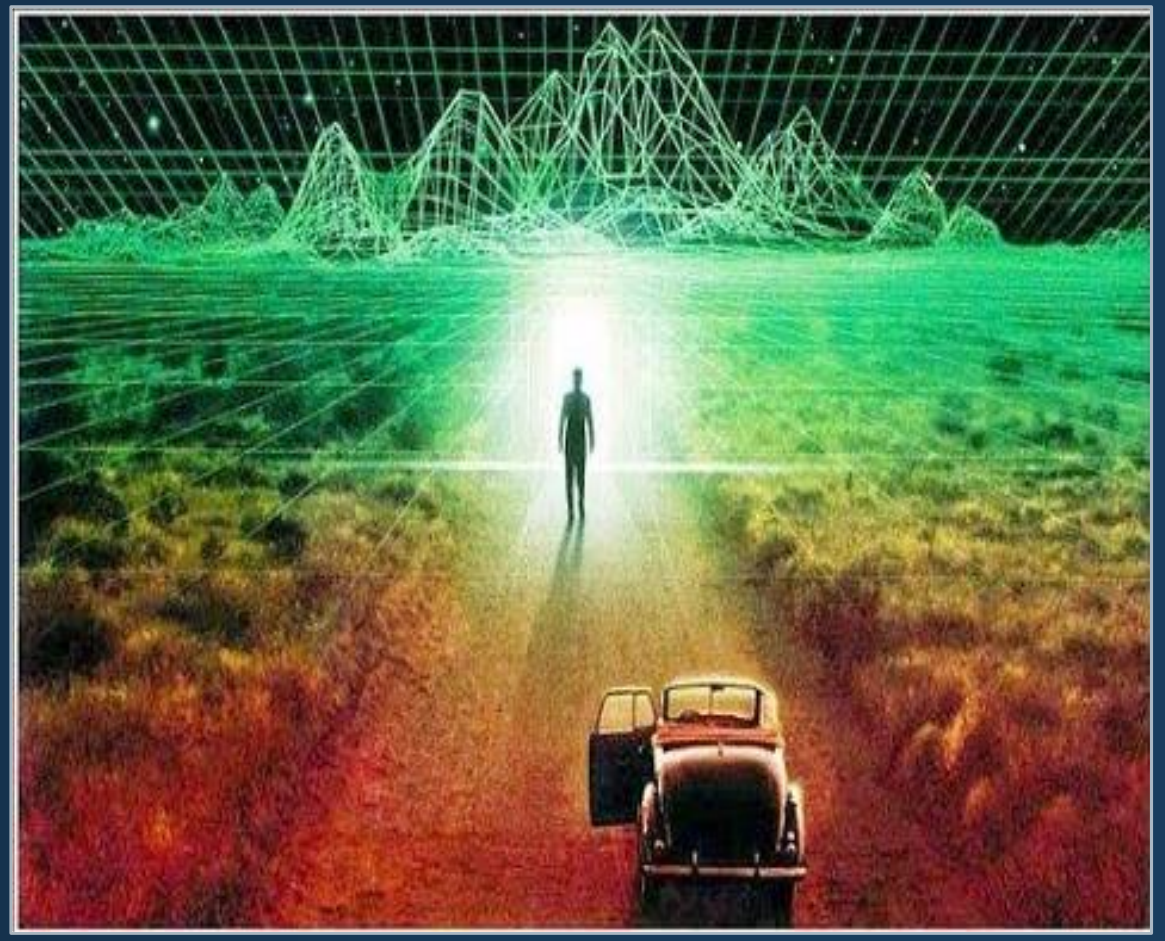
Google Glass at a Glance

Why did it fail?

Component	Score	Reason
Technology	☑	NLU, Miniaturization, Video, Audio
Financials	☒	High Price
People and Process	☒	Legal Issues Safety Issues Privacy Issue

IoT Definition

Internet of Things is not the result of a single novel technology; instead, several complementary technical developments provide capabilities that taken together help to bridge the gap between the digital and physical world.



Data Growth Outlook

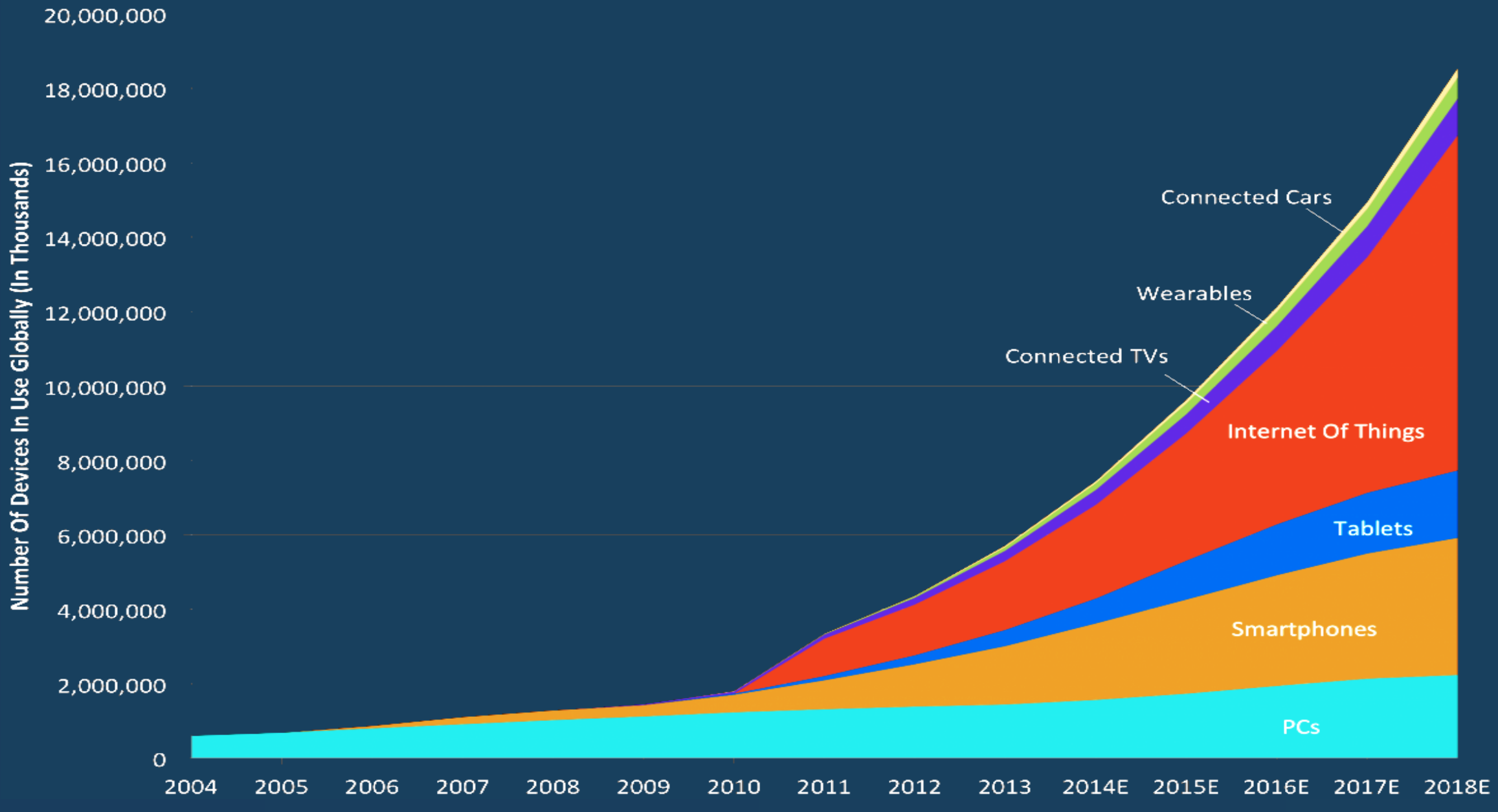
- Data will double in size every two years on the average
  "i.e., more data has been created in the past two years than in the entire previous history of the human race."
- Data will multiply 10-fold between 2016 - 2020
- Data will grow from 4.4 zettabytes to 44 zettabytes*

* 1 Zettabyte = 10^{12} Gigabyte

Impact of Social Networks

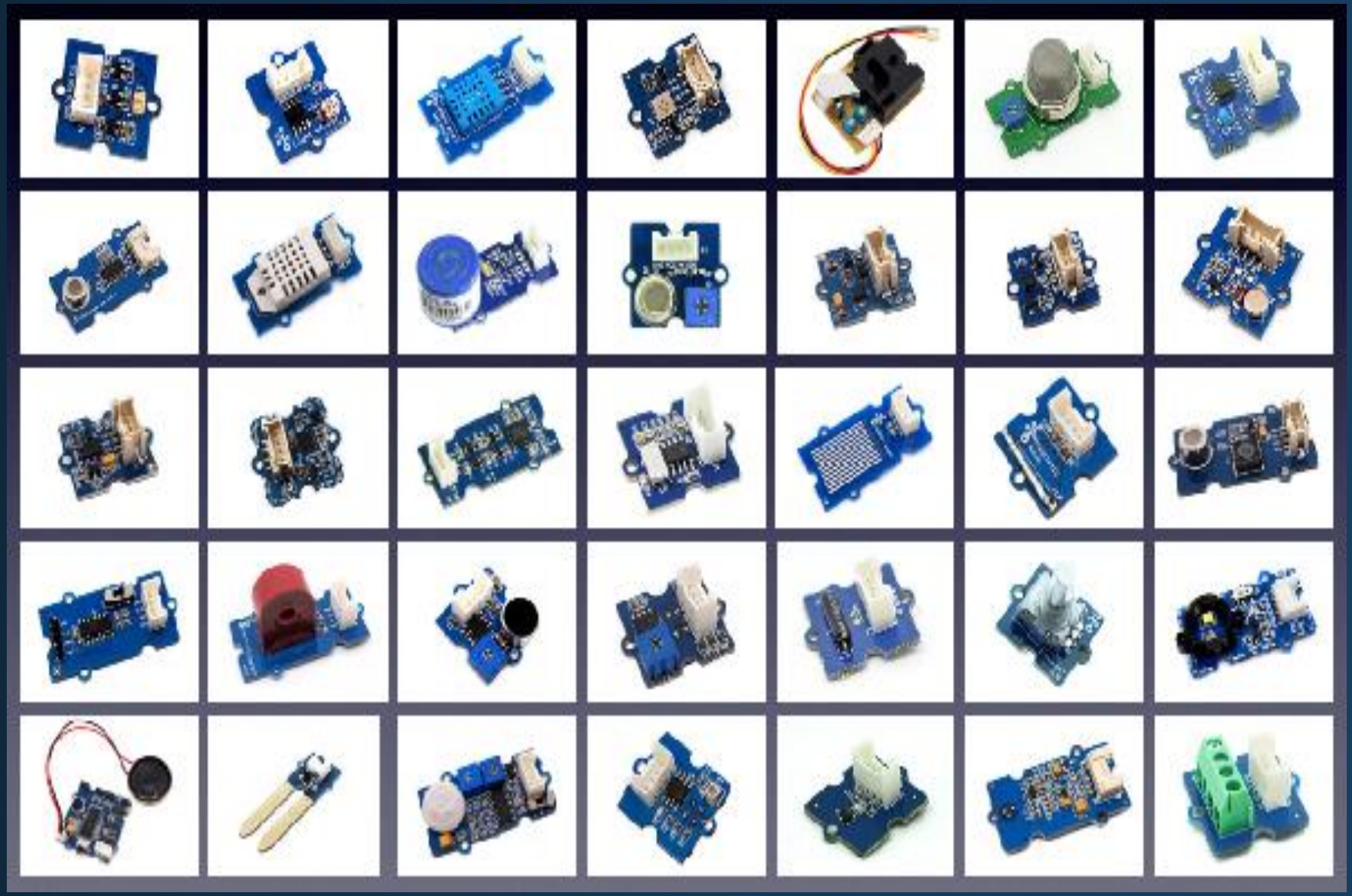
- By 2020, ~ 1.7MB /sec data is generated by every human being
- By 2020, over 6.1 billion smartphone
- On Aug 2015, over 1 billion people used Facebook/day
  - Facebook users send 31M messages/min
  - Facebook users view 2.77M videos/min
- In 2015, 1 trillion photos were taken
  - 1 billions photos shared online
- By 2017, nearly 80% of photos will be taken on smart phones.

IoT Impact on Digital Growth

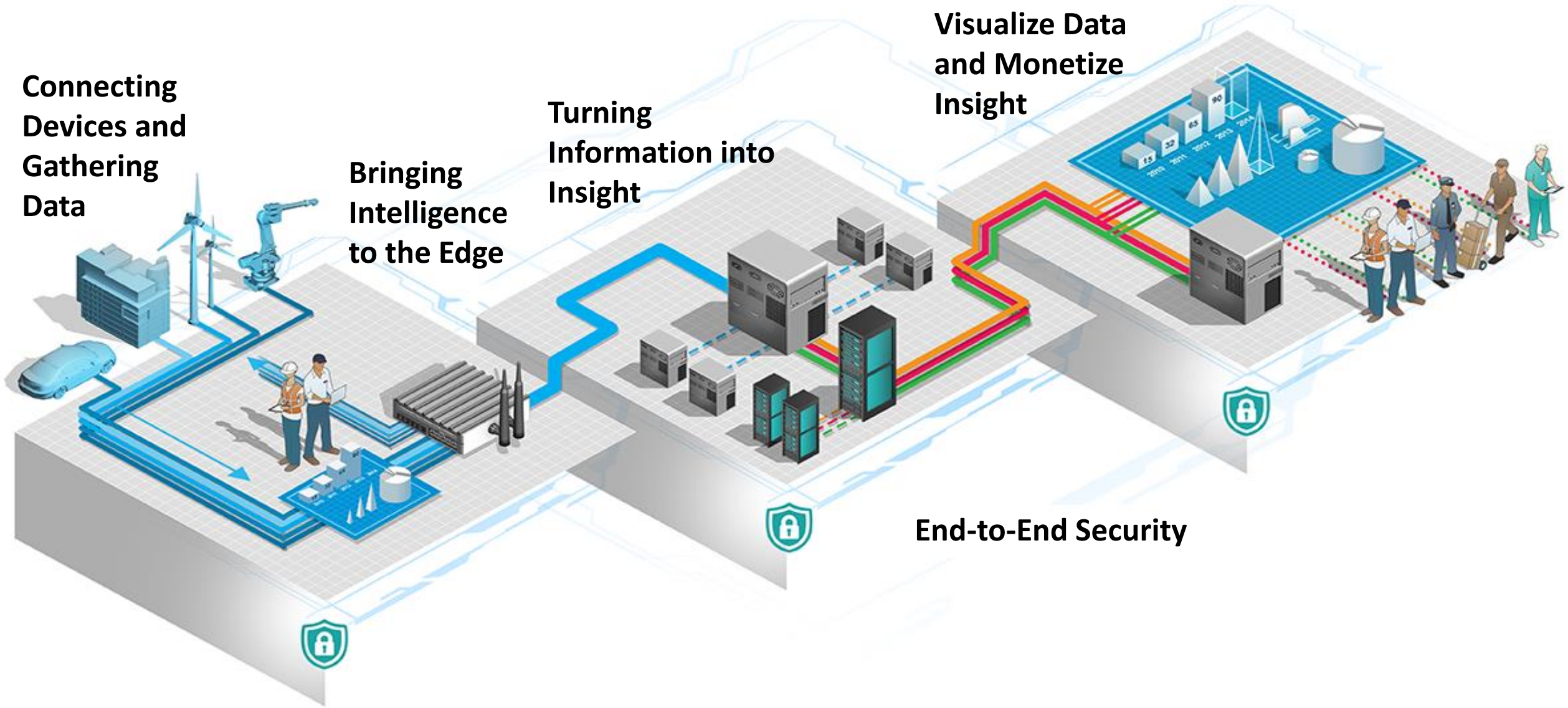


IoT Commercial Sensors

- Chemical/Gas
- Gas Identification
- Force/ Load
- Torque/ Strain
- Heat
- Humidity/ Moisture
- Motion/ Velocity
- Displacement/Position
- Presence/Proximity
- Pressure
- Transducers
- Temperature
- Tilt Switches
- Vibration & Shock
- Water Quality

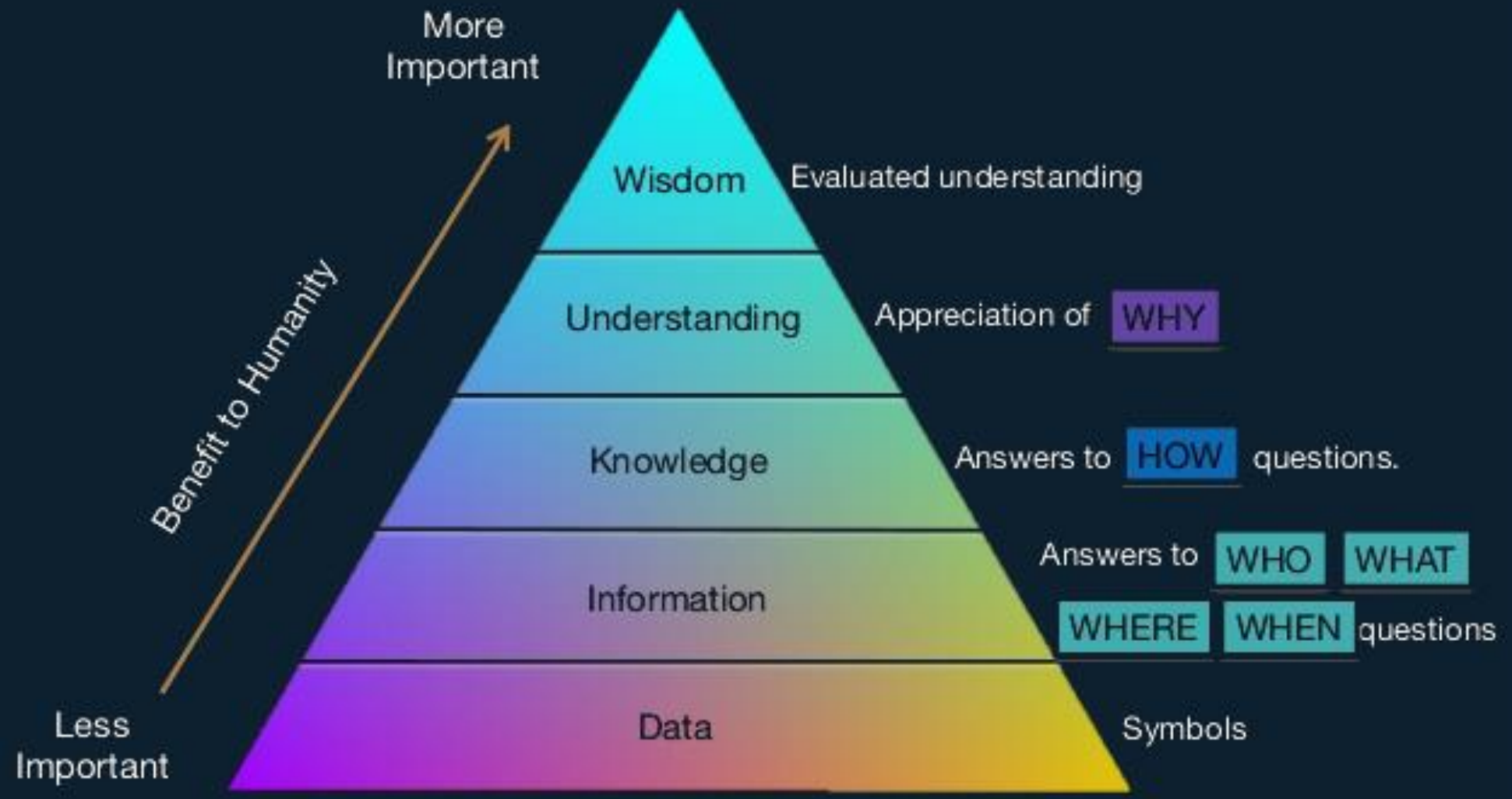


IoT's High Level Architecture



IoT Architecture Reference Model

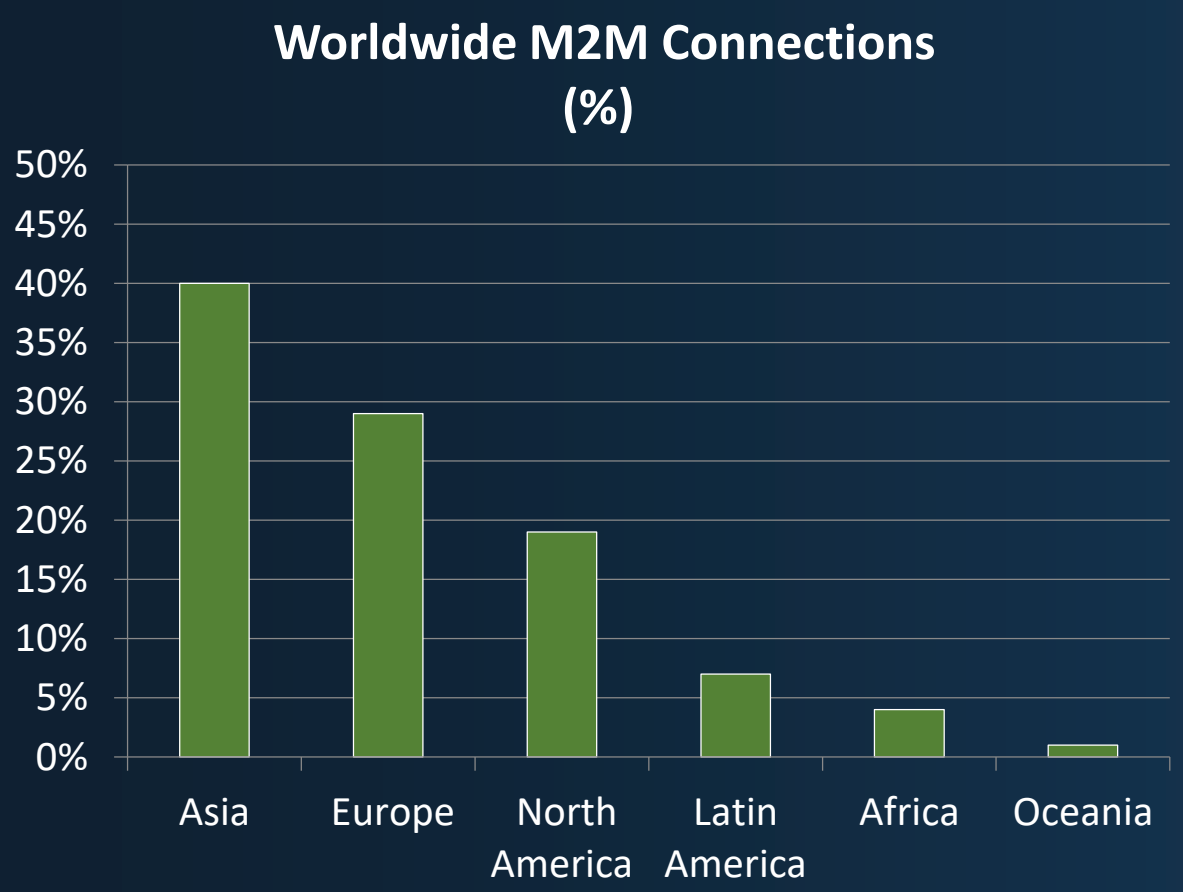
Big Data: From Data to Wisdom

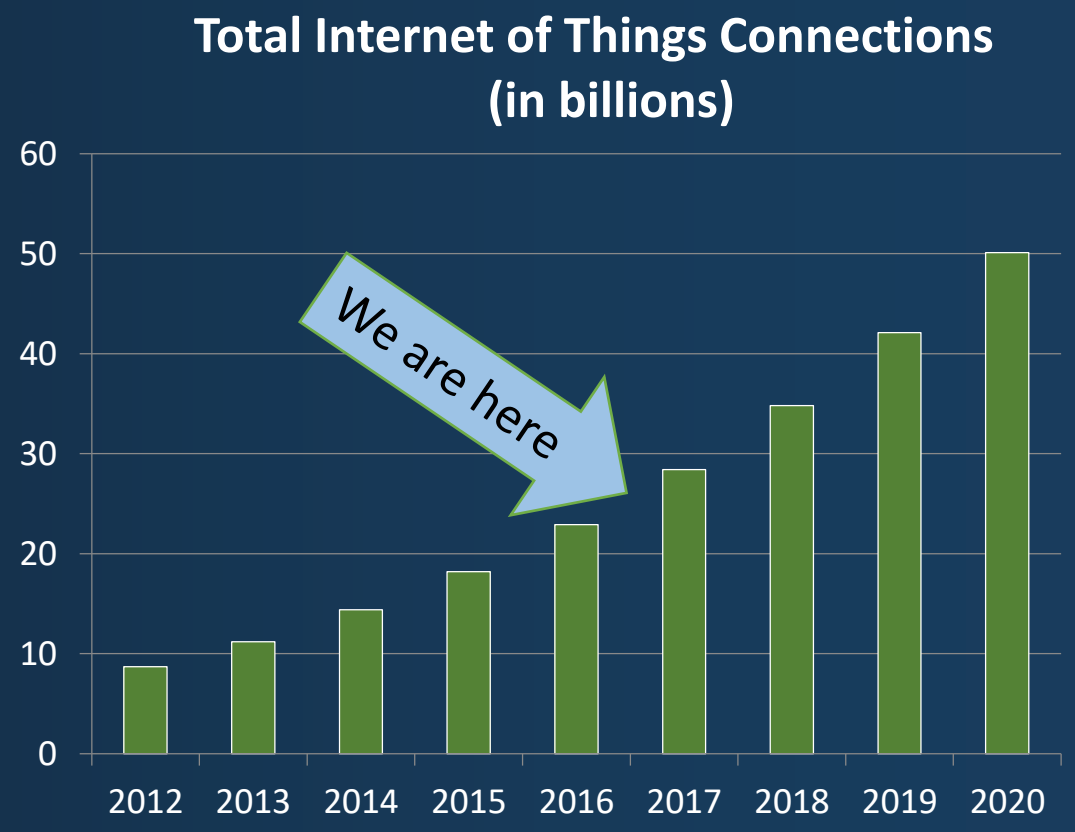


IoT needs Big Data Analysis

- In 2013, only 22% of the information in the digital universe was considered useful data, but less than 5% of the useful data was actually analyzed , i.e., ~1% of all data analyzed.
- By 2020, more than 35% of all data could be considered useful data, thanks to the growth of data from the Internet of Things, but it will be up to businesses to put this data to use.

IoT Connections





IoT Market Segments

Light bulbs
Security
Pet Feeding
Irrigation Controller
Smoke Alarm
Refrigerator
Infotainment
Washer / Dryer
Stove
Energy Monitoring

Traffic routing
Telematics
Package Monitoring
Smart Parking
Insurance Adjustments
Supply Chain
Shipping
Public Transport
Airlines
Trains

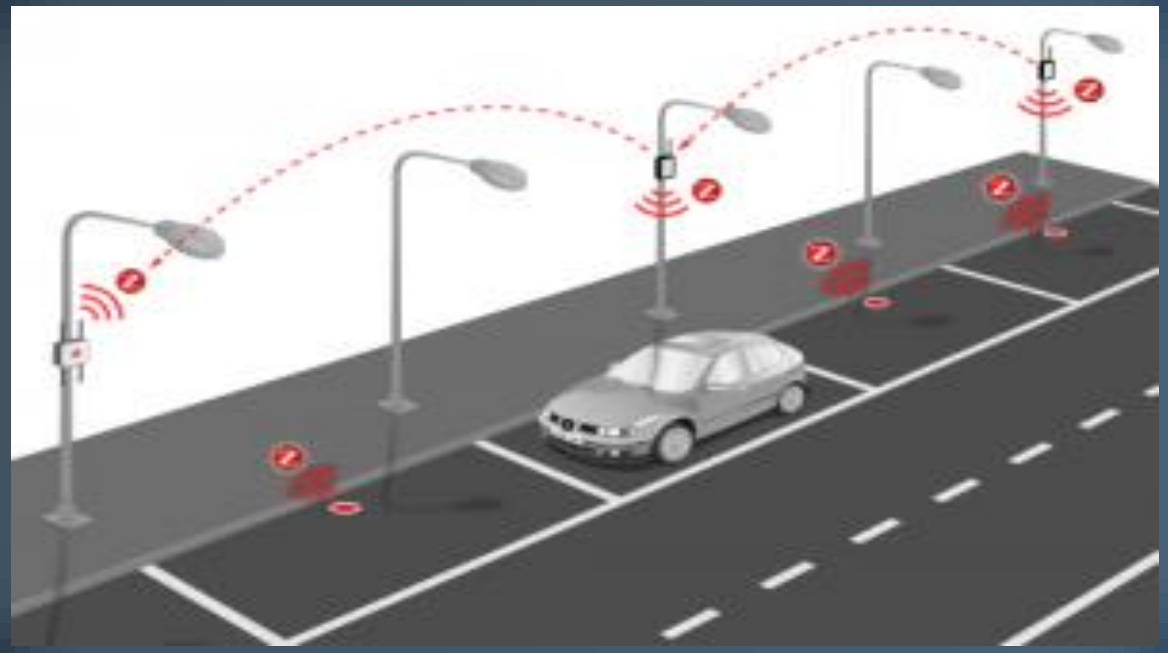
Patient Care
Elderly Monitoring
Remote Diagnostic
Equipment Monitoring
Hospital Hygiene
Bio Wearables
Food sensors

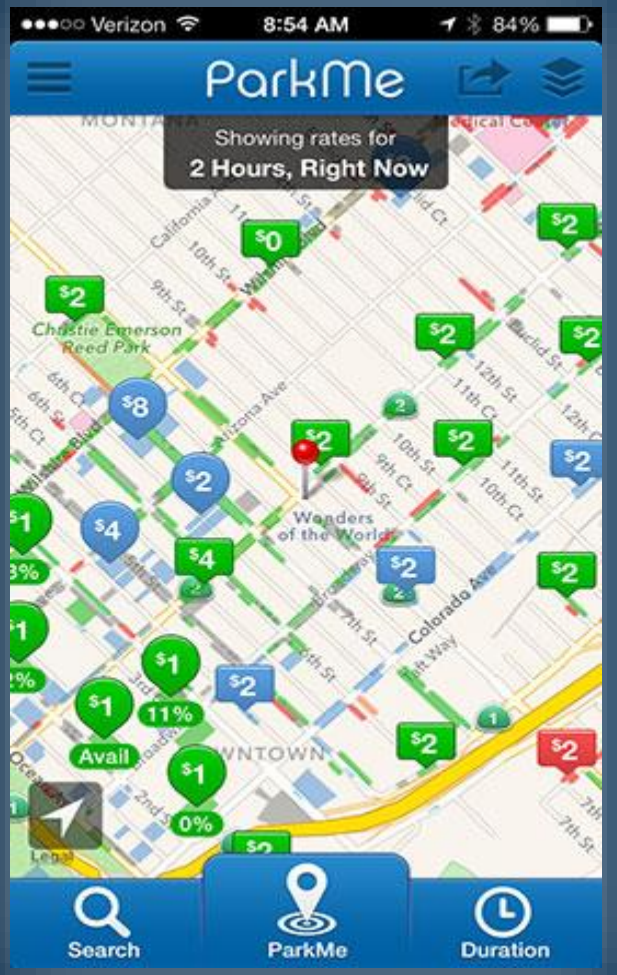
HVAC
Security
Lighting
Electrical
Transit
Emergency Alerts
Structural Integrity
Occupancy
Energy Credits

Electrical Distribution
Maintenance
Surveillance
Signage
Utilities / Smart Grid
Emergency Services
Waste Management

IoT Applications: City

30% of traffic is San Francisco is caused by cars wondering around to find a parking.





IoT Applications: Healthcare

Clinical Efficiency

AUGMEDIX
TeleTracking
fruit street
AdhereTech
Obaa
simplifeye
PRISTINE
VOLUNTIS
Connected Therapeutics
awarepoint
Location as a Service
evermind

Infant Monitoring

Sproutling
BABYBE
mimo
Owlet
Rest Assured.

Sleep Monitoring

beddit
NovaSom
hello

Clinical-Grade Biometric Sensors

QUANTTUS
vitalconnect
mc10
Senseonics
BL Healthcare
connectedhealth
Sotera
WIRELESS
iRhythm
proteus
DIGITAL HEALTH
EarlySense
EYENETRA
SilentAlert
Resident Monitor System
Monica
Healthcare

Fitness Wearables

sensoria
LUMO
signal
lark
motiv
ATHOS
ATLAS
moov
Withings
Inspire health
MISFIT
JAWBONE

Consumer / Home Monitoring

sano
GlucoVista
aira
QARDIO
WHOOP
CHRONO THERAPEUTICS
BIOSERENITY
SUNSPRITE
kinsa
TURINGSENSE
INFOBIONIC
SCANADU
cue
AliveCor
THALMICLABS
ANGEL SENSOR
3rings

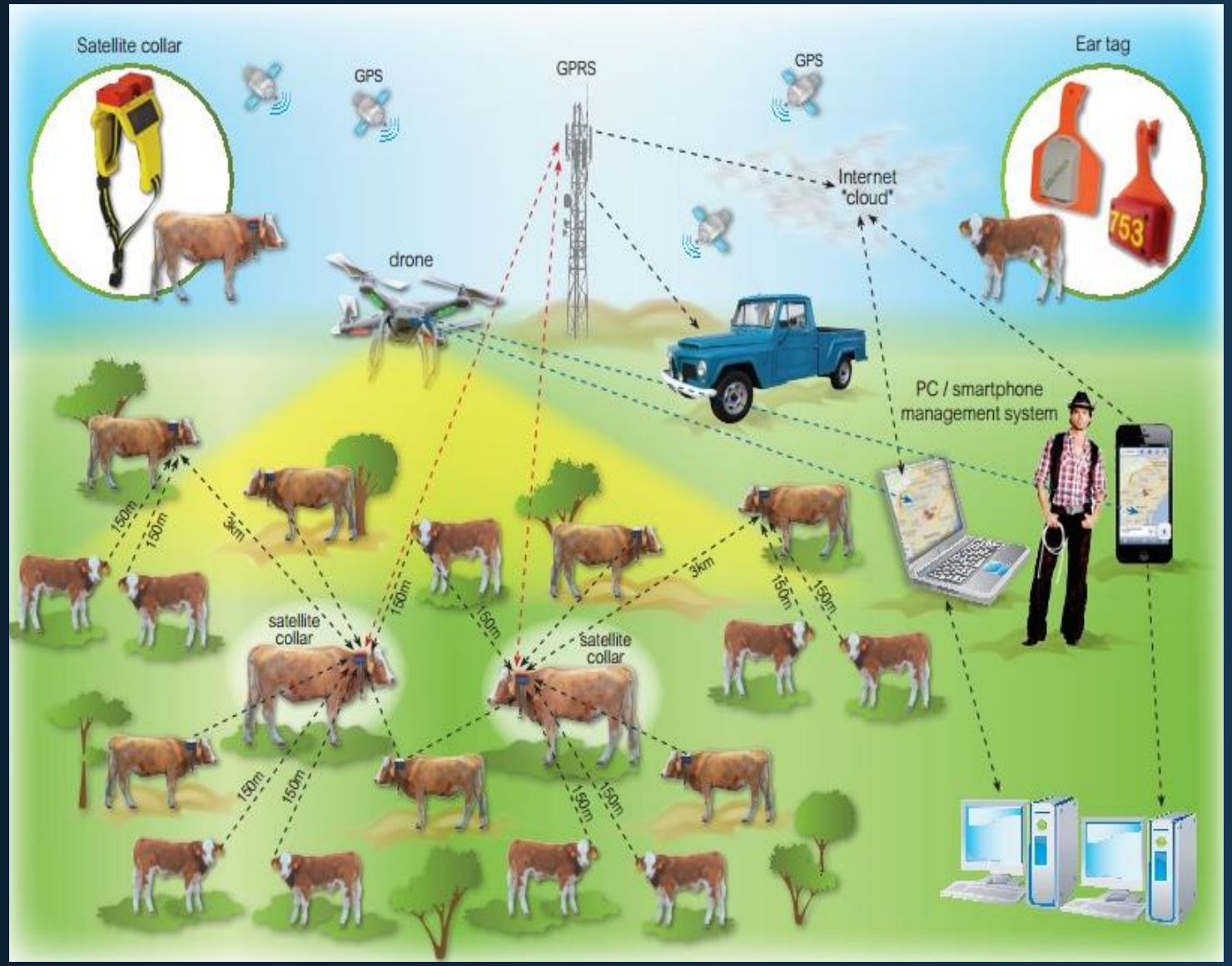
Brain Sensors / Neurotechnology

NEUROVIGIL
JAN Medical
Thync
How good feels
muse
ybrain
NeuroSky
halo
neuroscience

IoT Applications: Manufacturing

- Automation
- Automatic Adjustments
- Connected Supply Chain
- Remote Monitoring
- Remote Management
- Energy Management
- Proactive Maintenance

IoT Applications: Farming



Plant Monitoring

- Water
- Nutrition

Cattle

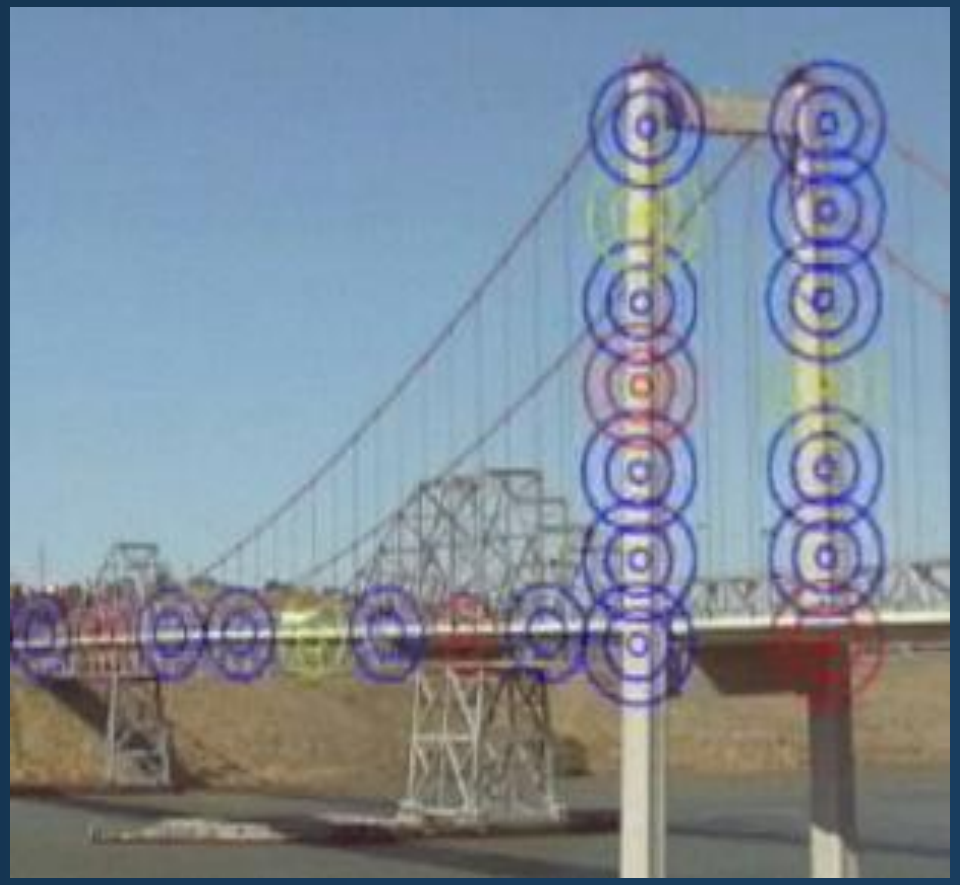
- Reproductive events,
- Disease,
- Pasture quality,
- Location

An IoT Vision Example

HP's Central Nervous System for the Earth (CeNSE):

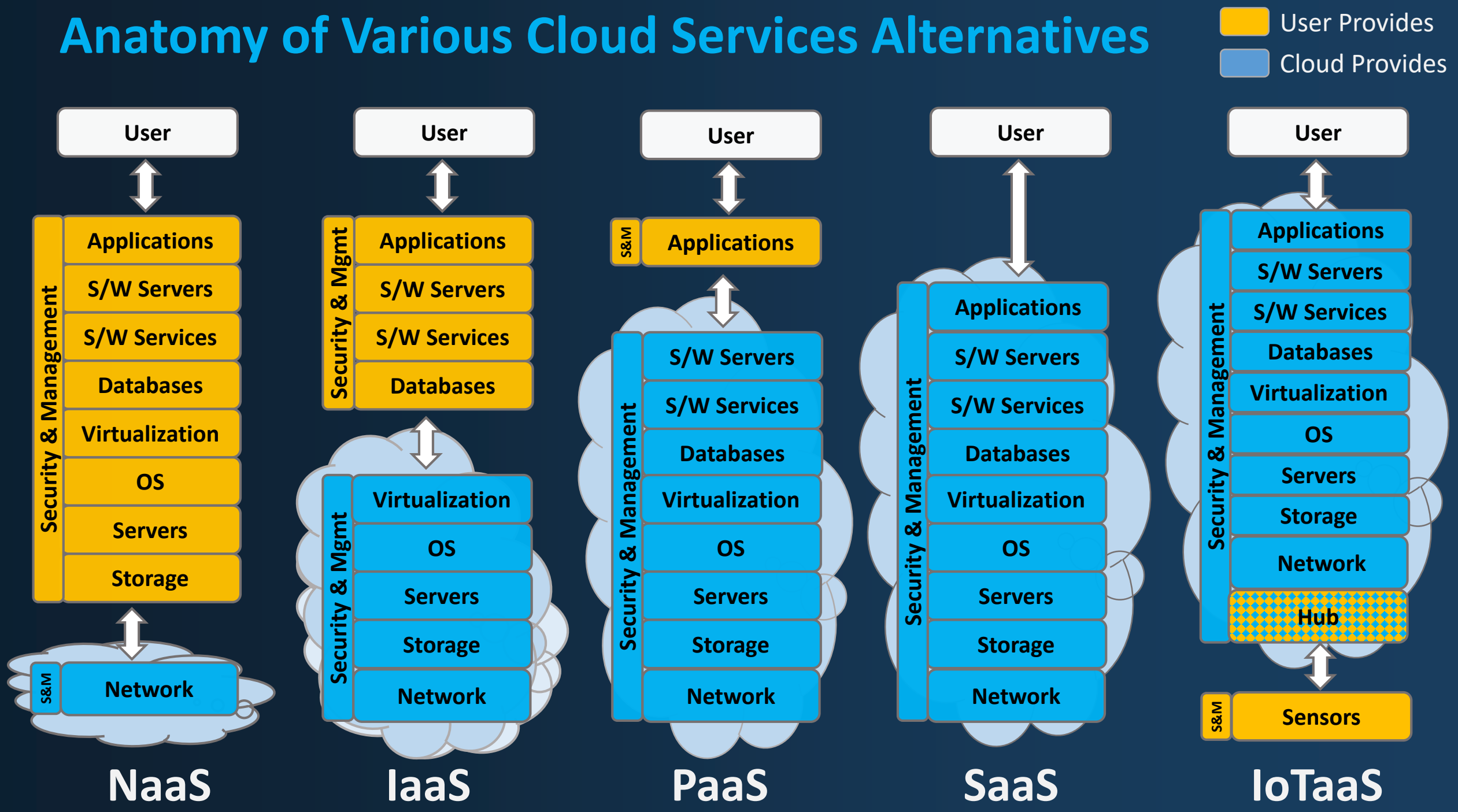
- 10,000 nanoscale sensor for a large bridge
- They feel, taste, smell, see, and hear
- The sensors can
  - Report on Pollution and Air Quality,
  - Monitor the speed and volume of traffic,
  - Noise
  - Sense wear and tear on a bridge, etc.

Similarly: Cisco's Planetary Skin, GE's Industrial Internet

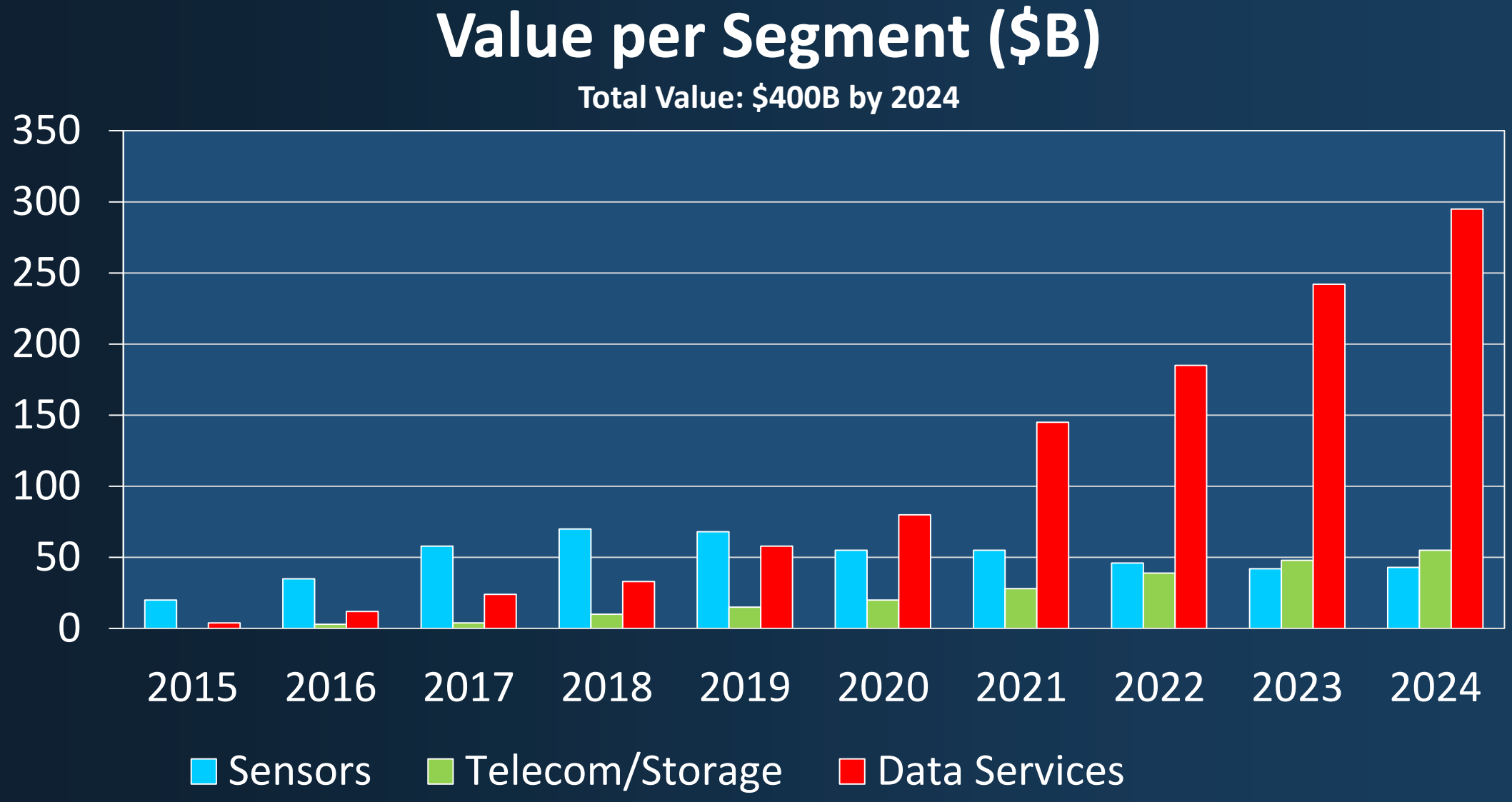


10,000 sensors for a bridge
A million sensor for a cargo ship
A trillion sensors to cover the earth

Anatomy of Various Cloud Services Alternatives



Partitioning of IoT Value in the Market



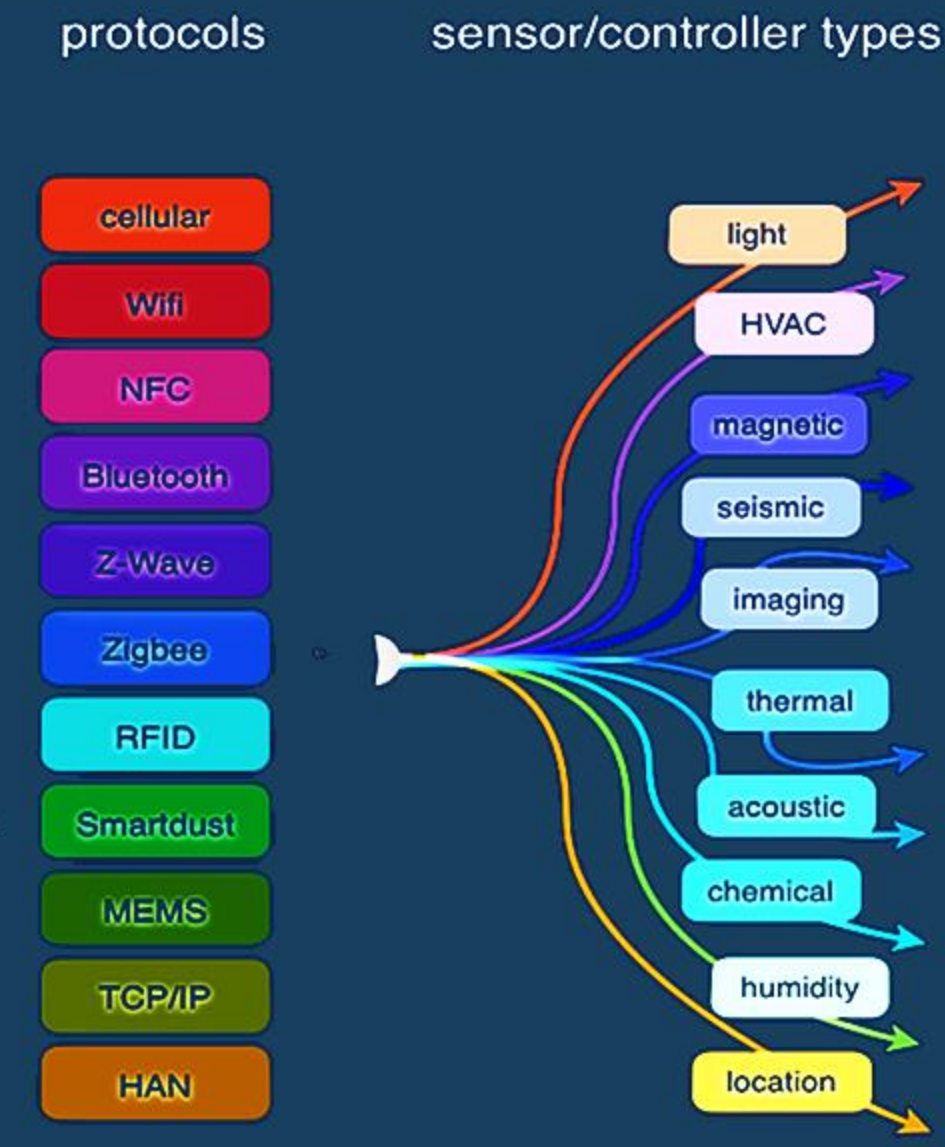
IoT Impact – End Points

End points (sensors) may not be standard network equipment

- Low energy (battery, solar)
- Low processing power
- Low storage/memory
- Low transmission ranges
- Many Protocols

Harder to Secure end-points

- Security is not primary objective by sensor vendors
- Hard to implement channel security (sleepy clients, mesh networks)
- Hard to implement encryption (low processing power, small storage)



IoT Prevailing Protocols

	NFC	RFID	Blue-tooth®	Blue-tooth® LE	ANT	Proprietery (Sub-GHz & 2.4 GHz)	Wi-Fi®	ZigBee®	Z-wave	KNX	Wireless HART	6LoWPAN	WiMAX	2.5–3.5 G
Network	PAN	PAN	PAN	PAN	PAN	LAN	LAN	LAN	LAN	LAN	LAN	LAN	MAN	WAN
Topology	P2P	P2P	Star	Star	P2P, Star, Tree Mesh	Star, Mesh	Star	Mesh, Star, Tree	Mesh	Mesh, Star, Tree	Mesh, Star	Mesh, Star	Mesh	Mesh
Power	Very Low	Very Low	Low	Very Low	Very Low	Very Low to Low	Low-High	Very Low	Very Low	Very Low	Very Low	Very Low	High	High
Speed	400 Kbs	400 Kbs	700 kbs	1 Mbs	1 Mbs	250 kbs	11-100 Mbs	250 kbs	40 Kbs	1.2 Kbps	250 kbs	250 Kbs	11-100 Mbs	1.8-7.2 Mbs
Range	<10 cm	<3 m	<30 m	5-10 m	1-30 m	10-70 m	4-20 m	10-300 m	30 m	800 m	200 m	800 m (Sub-GHz)	50 km	Cellular network
Application	Pay, get access, share, initiate service, easy setup	Item tracking	Network for data exchange, headset	Health and fitness	Sports and fitness	Point to point connectivity	Internet, multimedia	Sensor networks, building and industrial automation	Residential lighting and automation	Building automation	Industrial sensing networks	Senor networks, building and industrial automation	Metro area broadband Internet connectivity	Cellular phones and telemetry
Cost Adder	Low	Low	Low	Low	Low	Medium	Medium	Medium	Low	Medium	Medium	Medium	High	High

IoT Challenges – Telecom

New demands on communication networks

- Much larger number of end-points (x1000 or more)
- Higher Bandwidth (2x in two years)
- Management
- Sleepy client

More elaborate local “Fog-level” design

- Need for Local Management Autonomy (Automated Testing, Automated Recovery)
- Need for Local Data Management Intelligence (Filtering, Compression, Encrypt/decrypt)
- Protocol Conversion

IoT Challenges – Protocols

Small MTU

Frame size of 127 byte only for IEEE 802.15.4 (used in ZigBee, ISA100.11a, WirelessHART, MiWi, and Thread.)

- Issue: IPv6 has 40+ byte header – too much overhead
- Issue: IPv6 requires minimum MTU of 1280 bytes

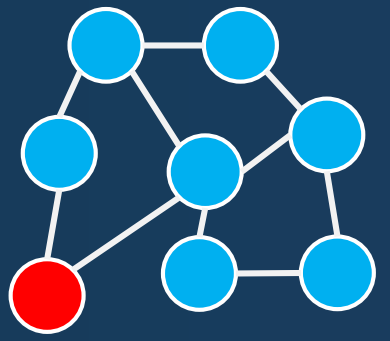
Solution: add an Adaptation Layer between Link Layer and Network Layer;

- Compress header to reduce overhead
- Fragmentation/Aggregation to fix the size issue

6LoWPAN layer does this.

IoT Impact – Communication Protocols

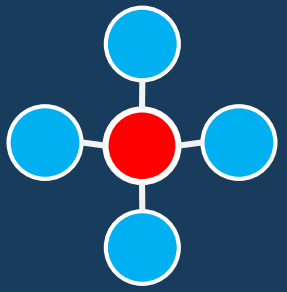
- **Multilink Subnet** – Mesh networks: Collection of Layer 2 sensors connected without a Layer 3 device
  - Multi-link subnet not anticipated by IP addressing scheme; TTL hop limit (1) breaks for IP network;
  - Require large storage to keep routing tables



Mesh

- **Multicast protocols** -- (e.g., DHCP) can break in Mesh networks
  - Multicast is normally turned off at link layer
  - Sleepy nodes don't multicast

  Solution: replace multicast with on-demand unicast pulling (6LowPAN)

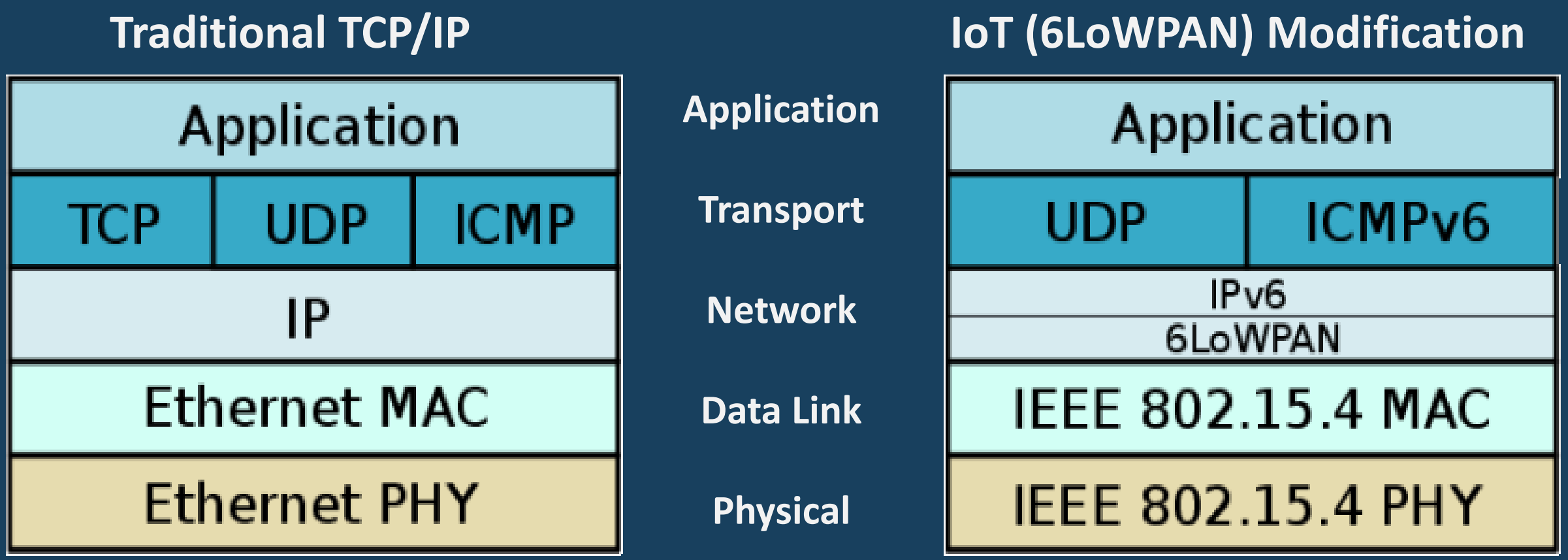


Star

- **Transport Layer** – Responsible for Reliable Delivery, Traffic Control
  - Communication channels cannot stay open (sleepy nodes)
  - Continuous establishment of connection has too much overhead
  - Some applications (e.g., actuations) may require low latency

  Possible Solution: Build transport functionalities into the application layer and choose UDP as the transport layer protocol (e.g., BACnet/IP and CoAP)

IoT Impact – Protocol Stack



IoT Impact – Network Discovery and Security

Resource Discovery

- Moving from DNS Service Discovery to URI-based Resource discovery (to support discovering devices, data etc. (e.g. in CoAP)
- Caching: TCP/IP requires both sides to be online at the same time. Sensors can't. Use of Proxy Caching to solve the issue (e.g., in CoAP)

Security

Secure communication Channel (e.g. TLS) may not work for IoT

- Sleepy sensors cannot maintain state
- Does not guarantee security when outside of the channel (e.g. in Proxy or Caches)

Solution: Object-based security with digital signature

IoT Impact – Decision Making

Effect of Big Data on Management

- **Style:** Data-driven Decision Making
- **Volume:** Much higher data volume to consider
- **Velocity:** Near Real-Time Analysis and Decision Making
- **Variety:** Decision based on different form of data

Companies in the top third of their industry in the use of data-driven decision making were, on average, 5% more productive and 6% more profitable than their competitors.

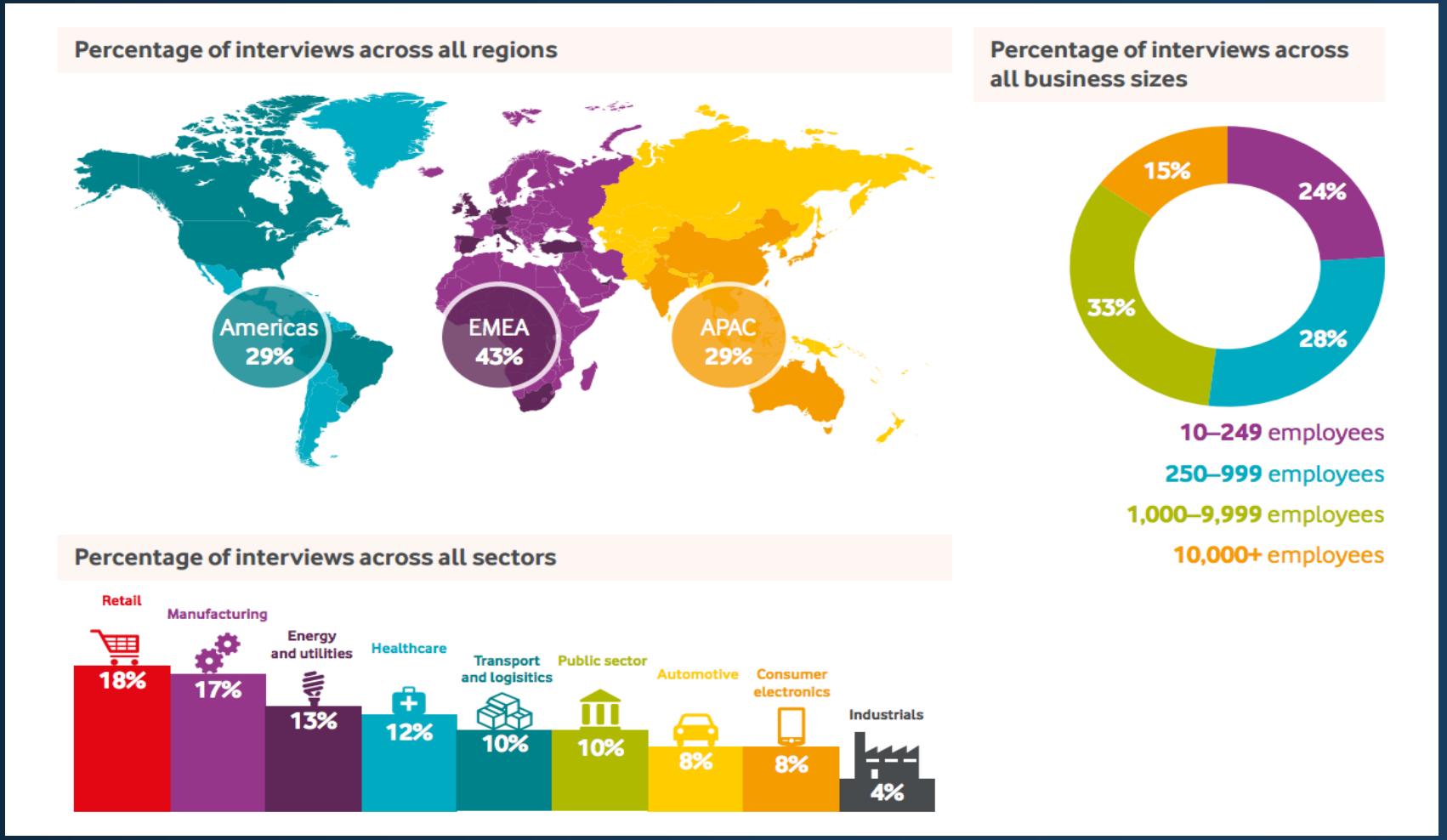
Annual Survey of IoT in Business

Survey Covered:

- 1100 Participants
- 5 Continents
- All Major business Areas
- Varying Corporate Sizes

Interest in IoT is higher than ever:

- 28% of businesses already have live IoT Projects
- 35% less than a year away from IoT launch.



Survey Results: Big commitment to IoT

IT Strategy

- 24% IoT Percent of IT Budget
- 76% IoT is Critical to Future Success
- 63% Live IoT Projects Next Year
- 63% Significant ROI from IoT

Forcing transformation

- 48% Use IoT in Large Scale Business Transformation
- 29% Use IoT to Connect Multiple Organization
- 46% Plan for IoT Connected Solutions in 2 Yrs
- 44% IoT has Improved User Experience

Get measurable results

- 20% IoT Improvement in Key Business Areas
- 68% Set Clear Targets for IoT
- 61% IoT is Integral Part of Business

Integrating with business

- 90% Store IoT Data in the Cloud
- 81% IoT Value is in Big Data Analysis
- 67% Safe to Share IoT with other Organizations

IoT – Startup Challenges

Barrier to Entry

- Patents, Complex Products, Rare skills

Time to Market

- Get Early Adopters, Hard to Replace an Incumbent

Attract Investors

- Attractive Business Case (⅓, ⅓, ⅓ Rule, 10x in 3-5 years Rule)

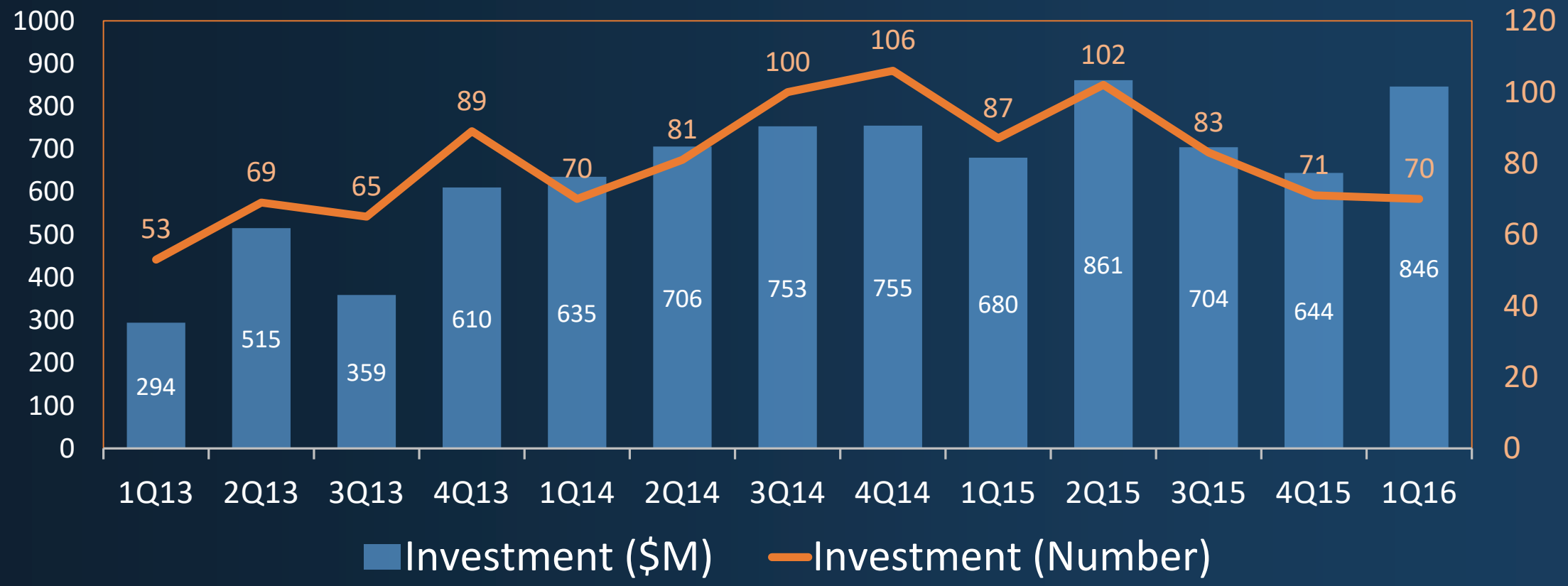
Show Value

- It’s all about Value to Customer – Customer-centric Business case

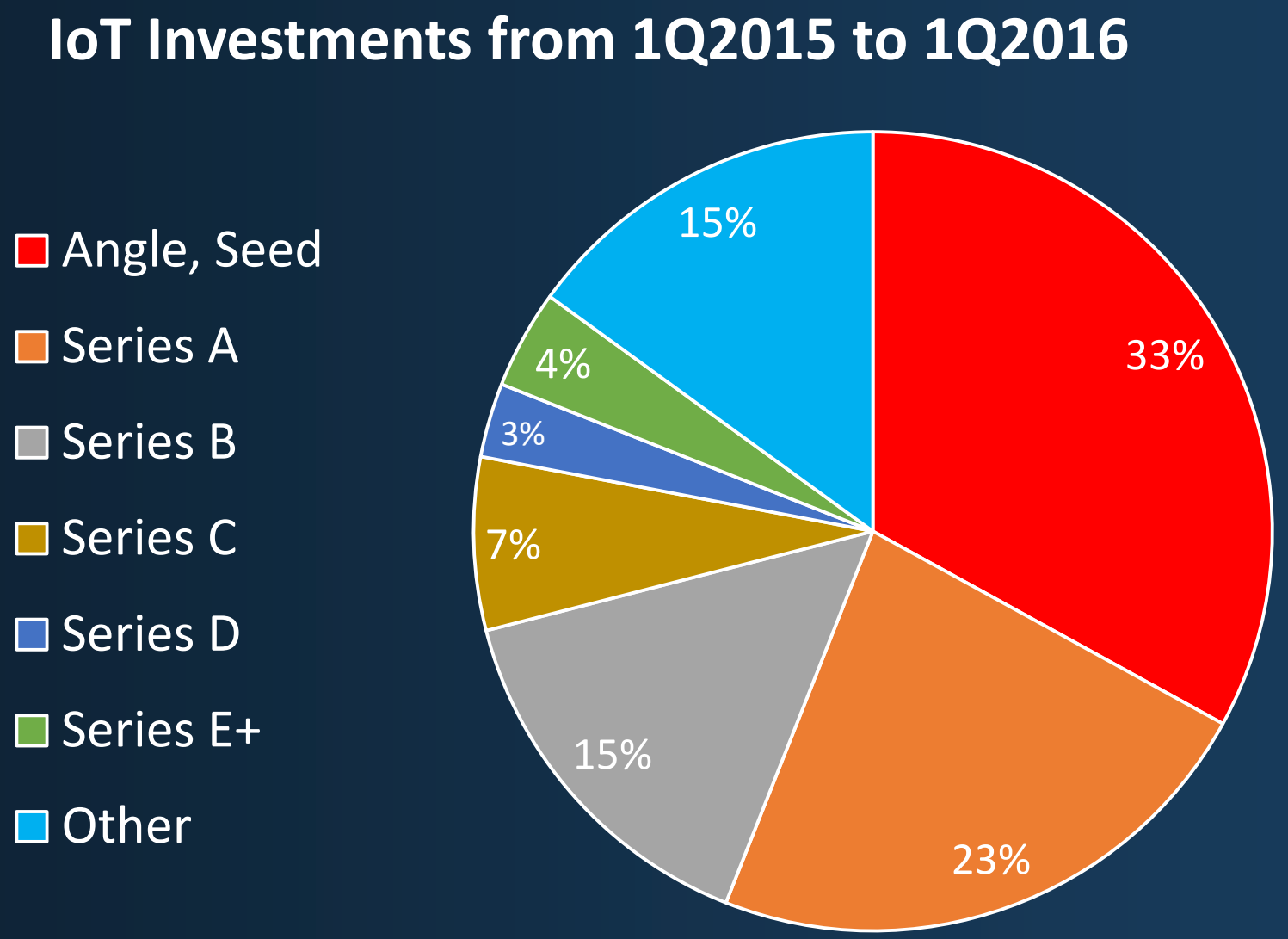
3 Dimensional View

- **Technology, Financials, Team**

IoT Global Financing



IoT Investment Stages



IoT Patents

LG, 641

Qualcomm, 590

Ericsson, 549

IBM, 438

Nokia, 367

Somfy, 279

Microsoft, 255

Cisco, 217

Samsung, 216

Intel, 209

Huawei, 189

Headwater Partners, 184

Interdigital, 165

Seven Networks, 159

Verizon, 140

IoT – Conclusion

IoT Impact

- IoT is a true Paradigm Shift
- IoT, as a whole, is here to Stay (Investments, Commitments, Benefits)
- IoT has profound effect on Digital Universe and Data Expansion
- IoT Impacts all aspect of our Business and Life
- IoT Impacts how we Manage things (Home, Health, Business, …)
- IoT Investment is strong and the forecast is promising

IoT Challenges

- Security is still an afterthought
- Too Many Competing Standards
- Crowded Landscape

Questions?