Introduction to Internet of Things

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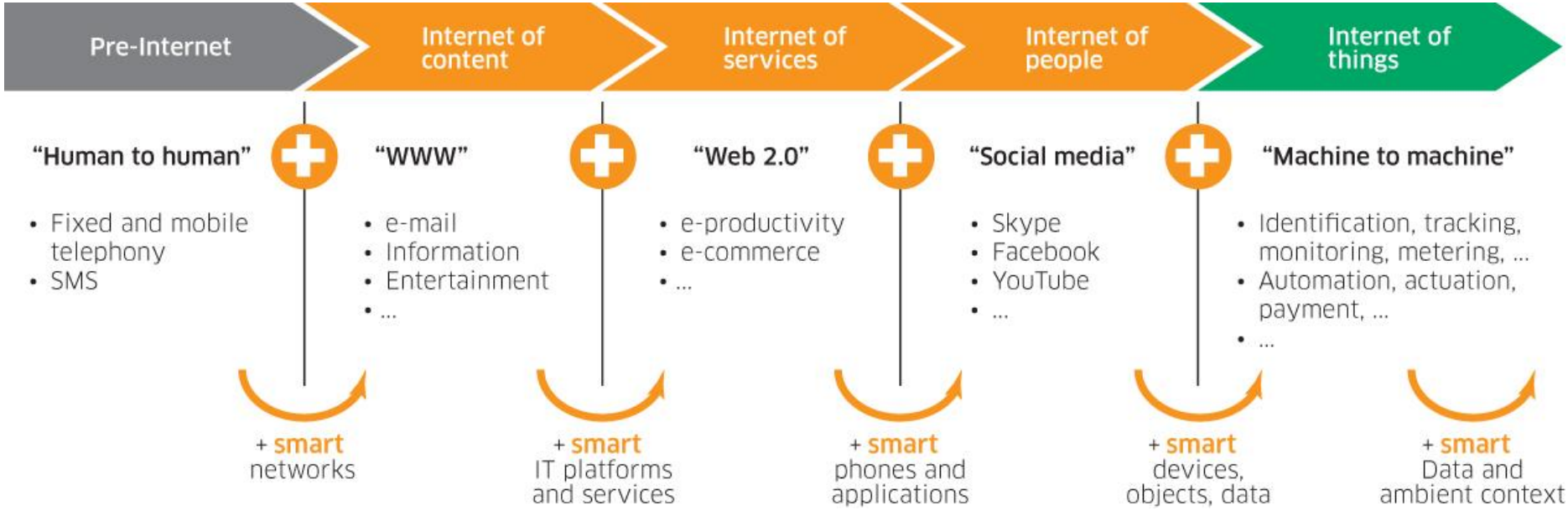
Internet of Things - Evolution



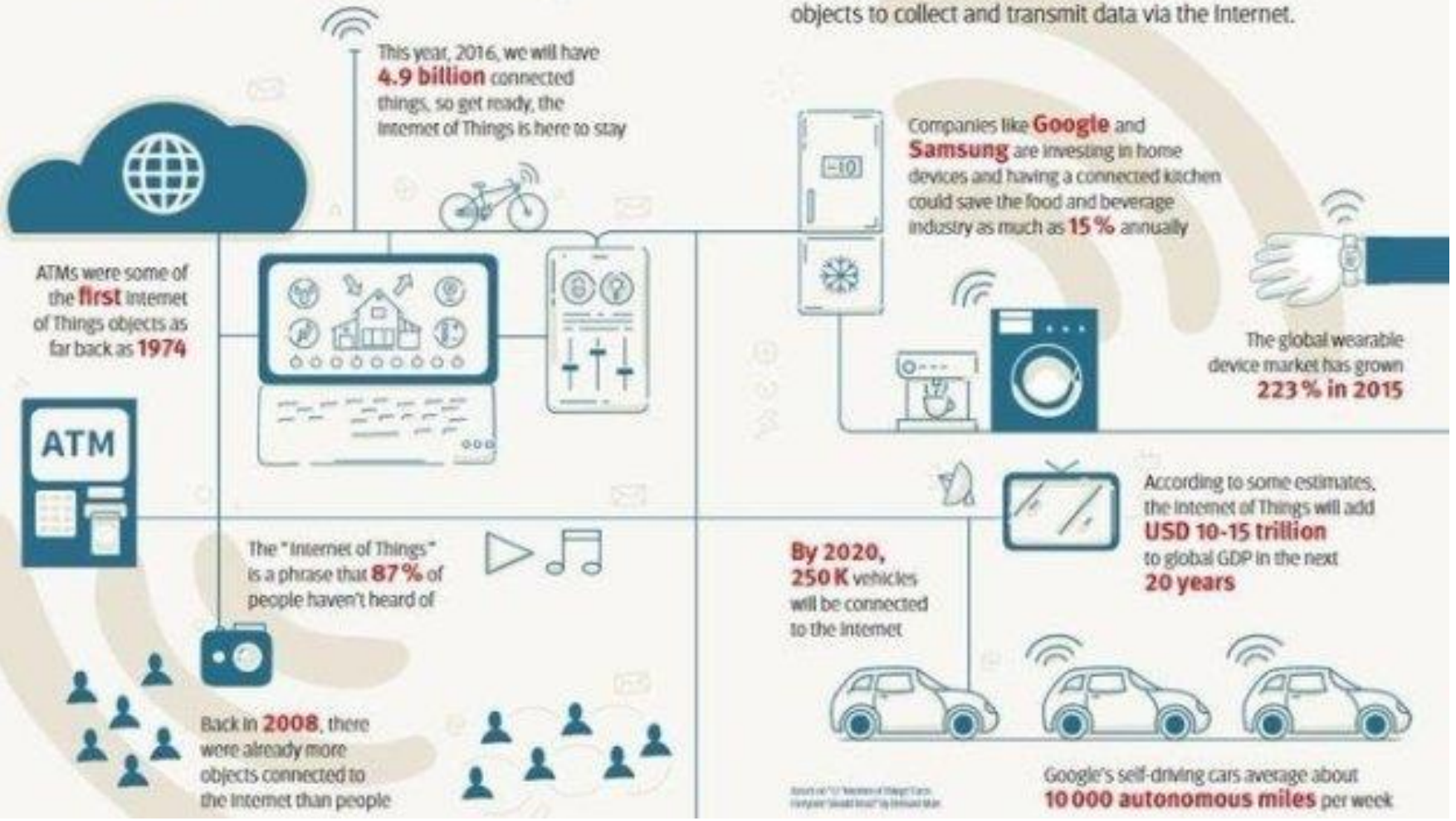
What are Things?

- Thing = Not a computer
- Phone, Watches, Thermostats, Cars, Electric Meters, Sensors, Clothing, Band-aids, TV, Etc.
- Anything, Anywhere, Anytime
- IoT will enable machines to handle many tasks currently handled by humans → Comfort + Unemployment

VS

The Internet of Things
a very short story

The Internet of Things is the network of physical devices, vehicles, buildings and so on embedded with electronics, software, sensors and network connectivity that enable these objects to collect and transmit data via the Internet.



Internet of Things (IoT)

- Only 1% of things around us is connected. Refrigerator, car, washing machine, heater, a/c, garage door, should all be connected but are not.
- An IoT device could range from a child's toy to a driverless truck / a complicated jet engine
- From 10 Billion (2015) to 50 Billion in 2020
- $14 Trillion over 10 years → Third in the list of top 10 strategic technologies by Gartner (After Mobile devices, Mobile Apps, but before Clouds, ...)
- a.k.a. **Internet of Everything** by Cisco
  Smarter Planet by IBM
  Industrial Internet by GE
  Cyber-Physical Systems (CPS)

Machine-to-machine (M2M)

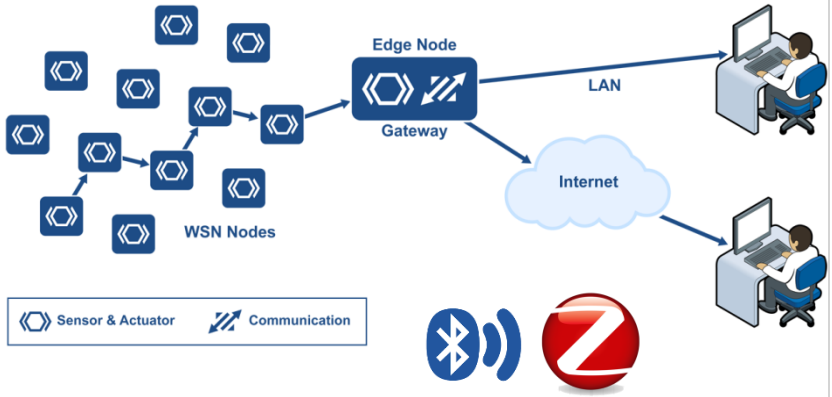
- 1.1 Billion smartphones
- 244 Million smart meters
- 487 Million e-readers and tablets
- 2.37 Billion networked office devices
- 86 Million medical devices
- 45 Million connected automobiles
- 547 Million connected appliances
- 105 Million connected military devices
- 431 Million information technology devices
- 45 Million supervisory control and data acquisition (SCADA)
- 5+ Billion other (non-phone/tablet/e-reader) electronic

ABCD's of IoT

Applications

Big Data Analytics

Connectivity and Communication



Devices – that are smart!

Photos – Libelium, Google Image Search

Smart Egg Tray

Egg Minder syncs with your smartphone to tell you how many eggs you've got at home (up to 14 eggs) and when they're going bad.

http://www.quirky.com/shop/619

Smart Garbage Cans

BigBelly alerts when it needs to be emptied so smarter collection decisions can be made.

http://www.bigbelly.com/solutions/stations/smartbelly/

Smart Slow Cooker

Enjoy remote access to all your slow cooker's functions, no matter where you are.

http://www.belkin.com/us/Products/home-automation/c/wemo-home-automation/

Smart Weather Statio

The Netatmo Weather Station allows you to use indoor temperature, relative humidity and CO_2 readings to live in a healthier home.

http://www.netatmo.com/en-US/product/weather-station/

Smart A/C

Aros learns from your budget, location, schedule, and usage to automatically maintain the perfect temperature and maximize savings for your home.

https://www.quirky.com/shop/752-aros-smart-window-air-conditioner

Smart Gardening

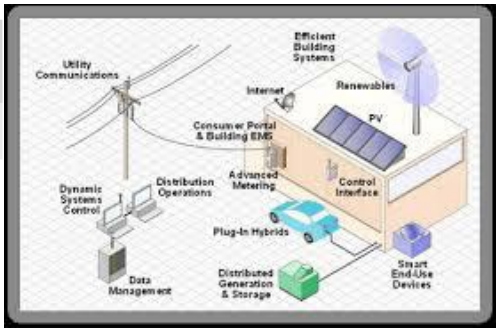
Bitponics gives data on plants and conditions surrounding them for better gardening.

http://www.bitponics.com/

Smart Transportation

Source: Raymond James research.

More IoT Applications



Smart Grid

Smart Health

Smart Home

Smart City

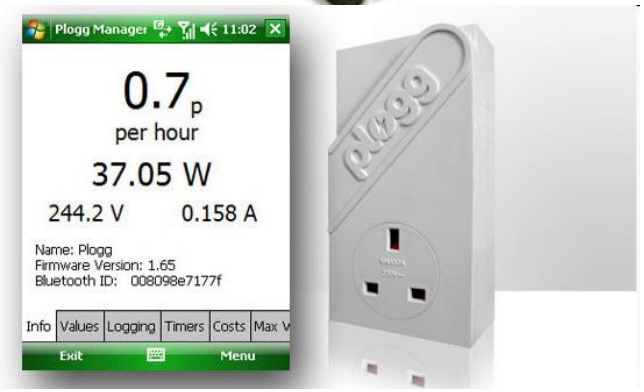
Smart Industries

Smart Car

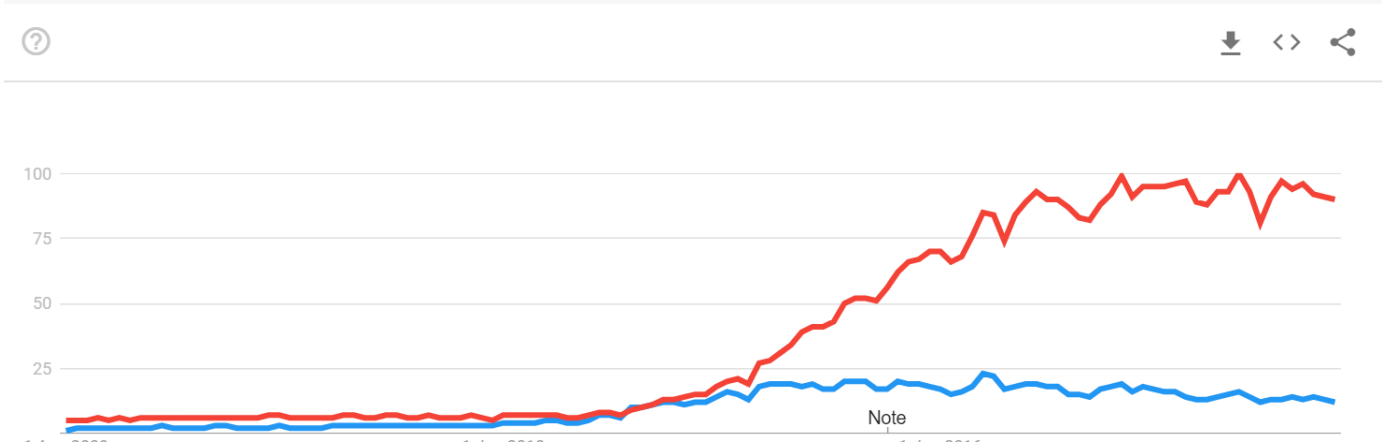
Driving Forces of IoT

- IoT = Sensing + Communication + Computation
- Micro-Sensors: Temperature, Moisture, Pressure, Air-quality
- Ubiquitous Connectivity & Energy Efficient Communication: Small or no batteries
- Widespread Adoption of IP
- Computing Economics - Micro-Computing: Micro multi-core chips, Raspberry Pi, Intel Galileo, Arduino, etc.
- Miniaturization – Sensors, Computing, Communication Modules
- Advances in Data Analytics
- Rise of Cloud Computing - Little or no local computing
- Open/Small operating systems: Linux

Driving Forces of IoT



Why IoT Now?

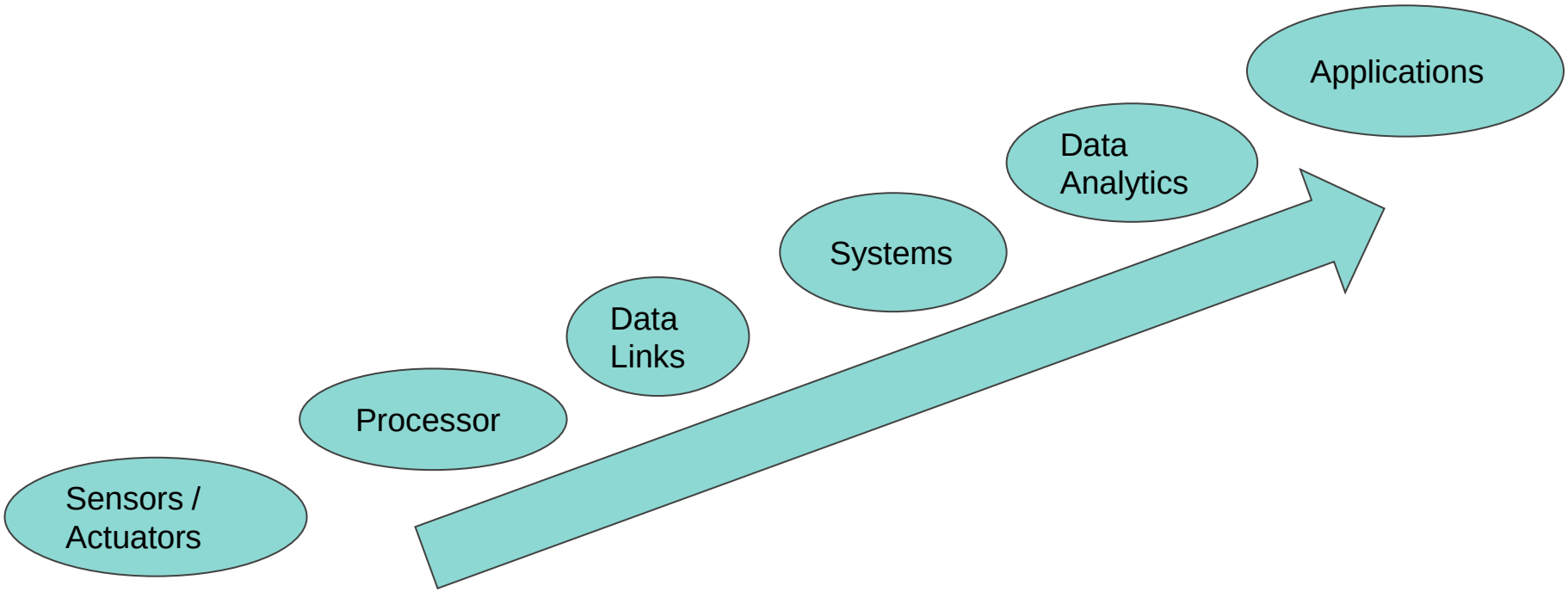


Google Trends on IoT and Internet of Things

- 70 M € in European Research program FP7 - Internet of European Things
- Networking and Information Technology Research and Development (NITRD)
  - Group of 15 Federal agencies: NSF, NIH, NASA, DOE, DARPA, ONR, … Recommends supplement to the president's annual budget
  - CPS is one of the areas recommended by NITRD starting 2012
    - Smart infrastructure Smart Grid, Smart Bridges, Smart Cars, tele-operational surgical robots, Smart Buildings
- March 2014: £45M for IoT research in UK

IoT leads innovations in various domains

- Components: Sensors, wireless radios, protocols
- Smart Objects: Smart TV, Camera, Watch, etc.
- Systems: Buildings, Cars, Health, etc,
- Network and Cloud service providers: ISP, AWS, Google Cloud, etc.
- Application Service Providers: Monitoring, Analytics, Apps, etc.



Venture Activities in IoT

- $1.1B invested in IoT startups by VCs in 153 deals in 2013
  - Healthcare sensors: Wearable clock, sleep monitors
  - Energy management
  - Home Automation: Kitchenware, locks
  - Environmental monitoring: Air Quality sensors, personal weather stations
- January 2014: Google buys NEST for 3.3B
- May 2014: $150M in VC investments in IoT by Cisco
- 2017: Intel buys mobileye (Connected Car Technology) for $15.3B, Samsung buys Harman (automated car technology) for $8B
- Center of Excellence for IoT and Ai in India funded by Meity, ERNET, and NASSCOM

Internet of Things (IoT)

- Extending the current Internet and providing connection, communication, and inter-networking between devices and physical objects, or "Things," is a growing trend that is often referred to as the *Internet of Things*.

- "The technologies and solutions that enable integration of real-world data and services into the current information networking technologies are often described under the umbrella term of the *Internet of Things* (IoT)"

- "The *Internet of Things* is the intelligent connectivity of physical devices driving massive gains in efficiency, business growth, and quality of life"