Introduction to the Internet of Things. Big Data in IoT.

Dr. Dr. Mikhail Komarov

Department of Innovations and Business in IT
School of Business Informatics

Introduction

Dr. Dr. Mikhail Komarov – 31 y.o, professor, Academic supervisor of Master program in E-Business, Academic supervisor of vocational studies programme Executive master of management in Industry 4.0, deputy head for international relations, School of Business Informatics, Faculty of Business and Management, National Research University Higher School of Economics, Moscow, Russia.

- PhD in IT – 2016 – Tampere University of Technology, Tampere, Finland (Big Data/Network challenges/New sources of data).
- PhD in IT – 2012 – Moscow State Institute of Electronics and Mathematics, Moscow, Russia (Autonomous wireless sensor networks for intralogistics).
- **Senior IEEE Member**
- Visiting professor – universities in Austria, Germany, France, UK.
- University of Birmingham, UK. Human-Interaction-Team. Research Internship. (October 2010 - August 2011)
- Member of the Technical Committee on Business Informatics and Systems IEEE
- Member of the Association of Information Systems / Founding member of Special Interest Group on Big Data Applications; member of the Global Advisory Board of The Institute of Certified E-Commerce Consultants; member of the American Academy of Project Management
- Has more than 50 publications, 8 patents.

Introduction

Economical development – technical progress.

What history tells us:

• GSM and mobile networks – 1946

• Internet – (idea by DARPA – 1957) – 1969

• Social Networks – let's say the Facebook – 2004

• Mobile applications networks etc. – 2010

• Big Data era

M. Zuckerberg: "We're going to execute this mission to make the world connected and build value over the long-term. The bigger question that will define how we've done is how we do with mobile"

http://www.youtube.com/watch?v=xzmQm-hRgTg&feature=player_embedded
http://www.youtube.com/watch?feature=endscreen&NR=1&v=lUljrP6ILN0

Introduction

What is m-business?

Mobile business (m-business) refers to new business models enabled by the extensive deployment of key mobile and wireless technologies and devices (for example, Bluetooth, e-purses, smartphones, UMTS and WAP), and by the inherent mobility of most people's work styles and lifestyles. The value proposition of m-business is that the user can benefit from information or services any time and in any place.

Gartner IT glossary

Mobile marketing? https://www.youtube.com/watch?v=OJmSnwD1WXg
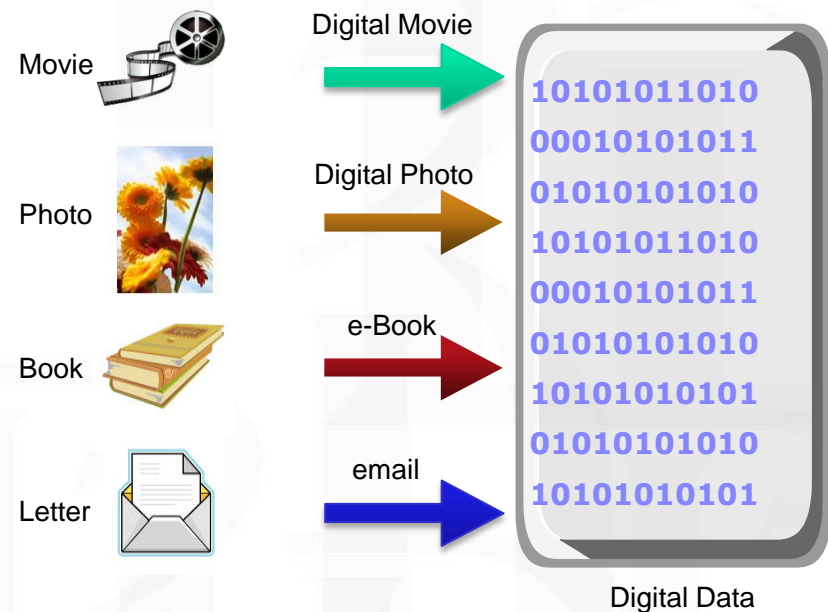
Key characteristics?
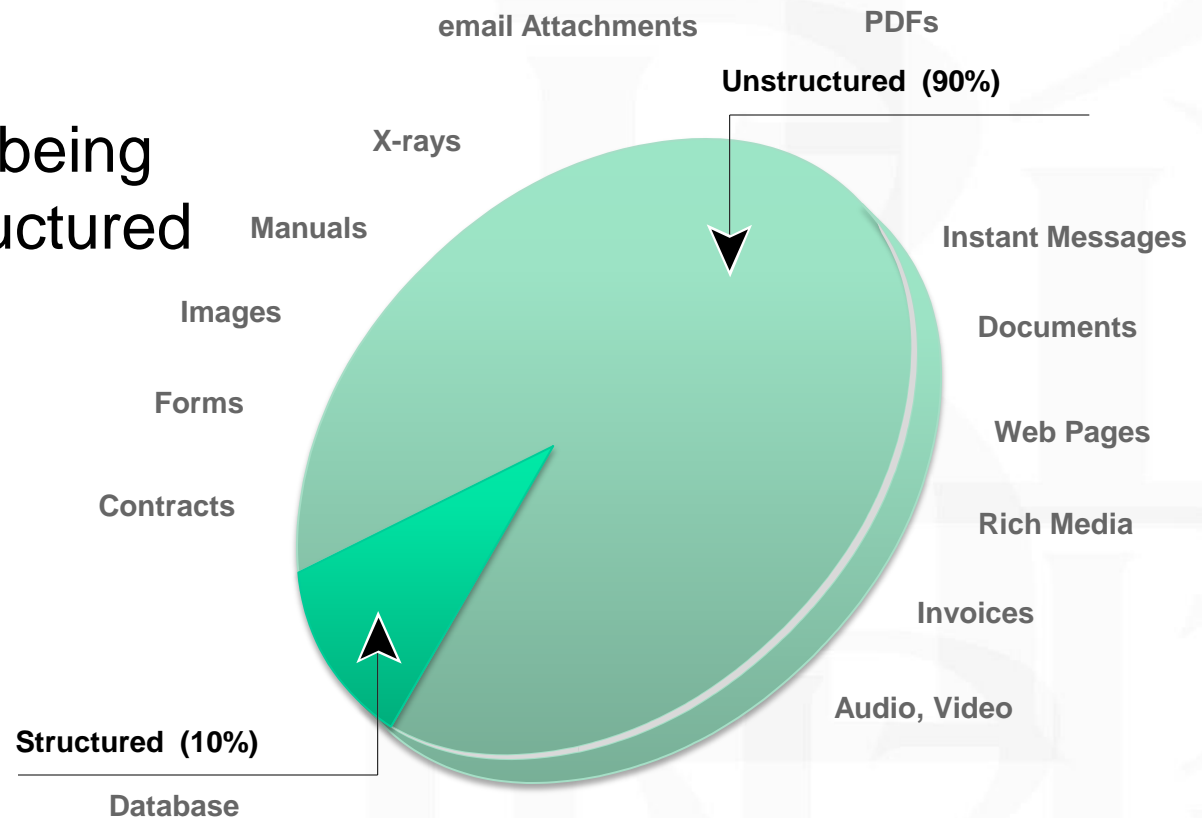
Geo-information, any time (!).

Information

- Information is the knowledge derived from data
- Growth of digital information has resulted in information explosion
- We live in an on-command, on-demand world
  - We need information when and where required
- Increasing dependency on fast and reliable access to information
- Businesses seek to store, protect, optimize, and leverage the information
  - To gain competitive advantage
  - To derive new business opportunity

Data

Data - is a collection of raw facts from which conclusions may be drawn.

- Data is converted into more convenient form − digital data

- Factors for digital data growth are:

  - Increase in data-processing capabilities

  - Lower cost of digital storage

  - Affordable and faster communication technology

  - Proliferation of applications and smart devices

Movie → Digital Movie →

Photo → Digital Photo →

Book → e-Book →

Letter → email →

Digital Data

10101011010
00010101011
01010101010
10101011010
00010101011
01010101010
10101010101
01010101010
10101010101

- Data can be classified as:
  - Structured
  - Unstructured

- Majority of data being created is unstructured

email Attachments   PDFs

Unstructured (90%)

X-rays

Manuals   Instant Messages

Images   Documents

Forms   Web Pages

Contracts   Rich Media

Invoices

Audio, Video

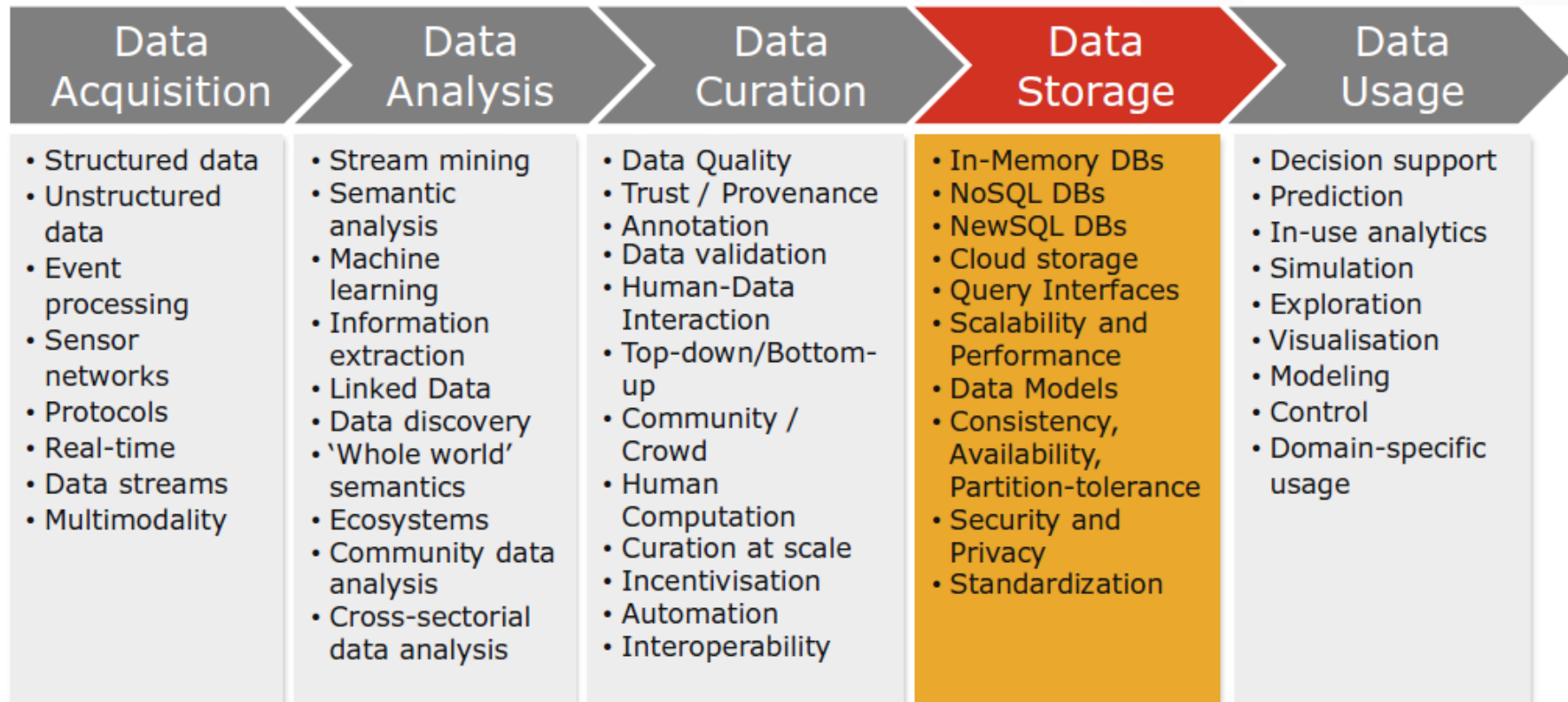**Structured (10%)**

Database

Big Data

- *Big Data refers to data sets whose sizes are beyond the ability of commonly used software tools to capture, store, manage, and process within acceptable time limits*

- Includes both structured and unstructured data generated by variety of sources

- Big data analysis in real time requires new techniques and tools that provide:

  - High performance

  - Massively parallel processing (MPP) data platforms

  - Advanced analytics

- Big data analytics provide an opportunity to translate large volumes of data into right decisions
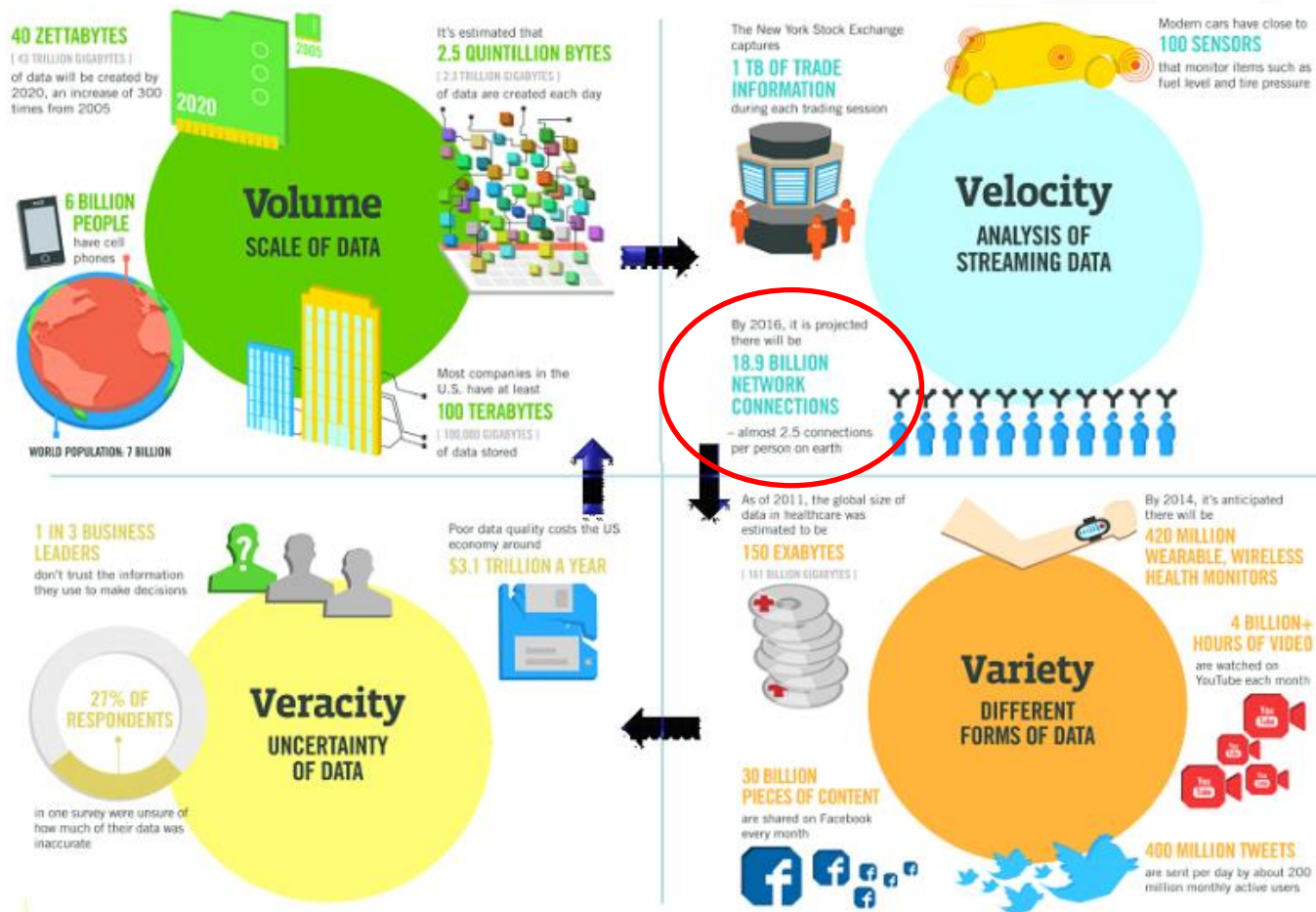
Storage

- Stores data created by individuals and organizations

- Provides access to data for further processing

- Examples of storage devices are:
  - Media card in a cell phone or digital camera
  - DVDs, CD-ROMs
  - Disk drives
  - Disk arrays
  - Tapes

- Storage model, an evolution:
  - Centralized: mainframe computers.
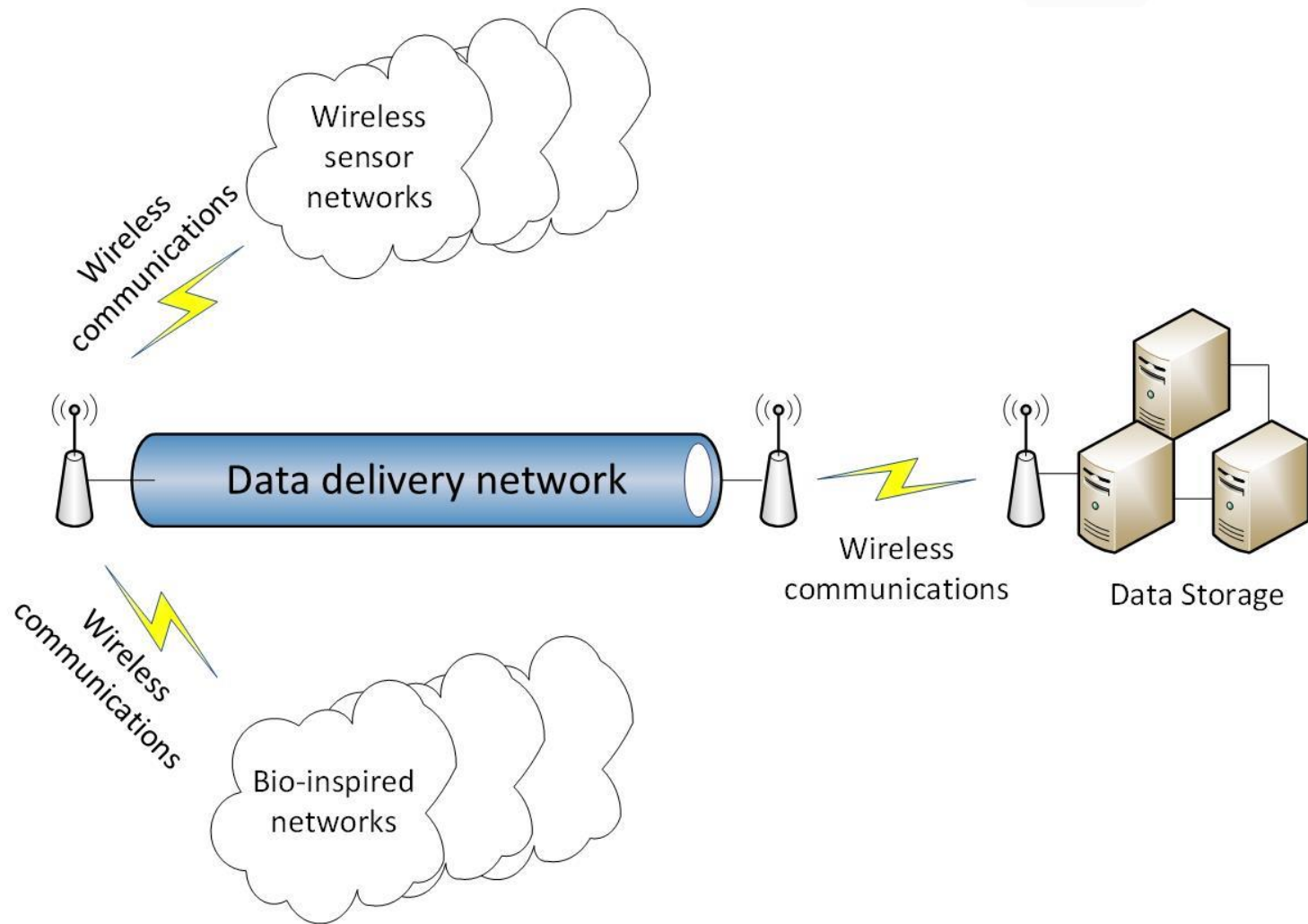 - Decentralized: Client –server model.
  - Centralized: Storage Networking.

Big Data value chain

Data Acquisition	Data Analysis	Data Curation	Data Storage	Data Usage
• Structured data • Unstructured data • Event processing • Sensor networks • Protocols • Real-time • Data streams • Multimodality	• Stream mining • Semantic analysis • Machine learning • Information extraction • Linked Data • Data discovery • 'Whole world' semantics • Ecosystems • Community data analysis • Cross-sectorial data analysis	• Data Quality • Trust / Provenance • Annotation • Data validation • Human-Data Interaction • Top-down/Bottom-up • Community / Crowd • Human Computation • Curation at scale • Incentivisation • Automation • Interoperability	• In-Memory DBs • NoSQL DBs • NewSQL DBs • Cloud storage • Query Interfaces • Scalability and Performance • Data Models • Consistency, Availability, Partition-tolerance • Security and Privacy • Standardization	• Decision support • Prediction • In-use analytics • Simulation • Exploration • Visualisation • Modeling • Control • Domain-specific usage

Big Data Challenges?

Big Data Challenges?

Internet of Things

Internet of Things - is a scenario in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. IoT has evolved from the convergence of wireless technologies, micro-electromechanical systems (MEMS) and the Internet.[1]
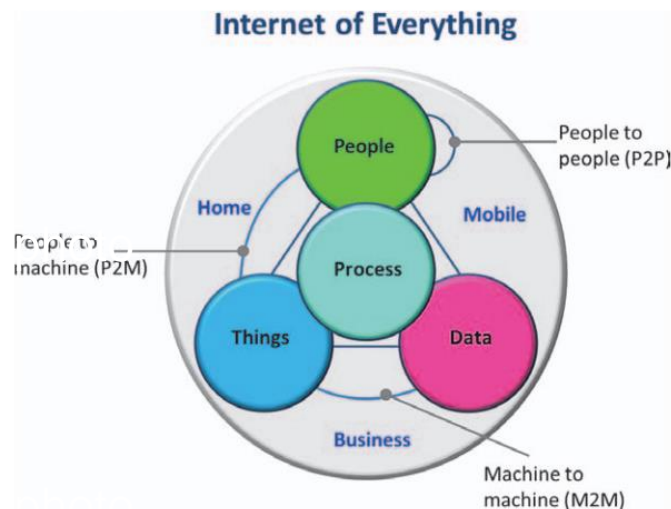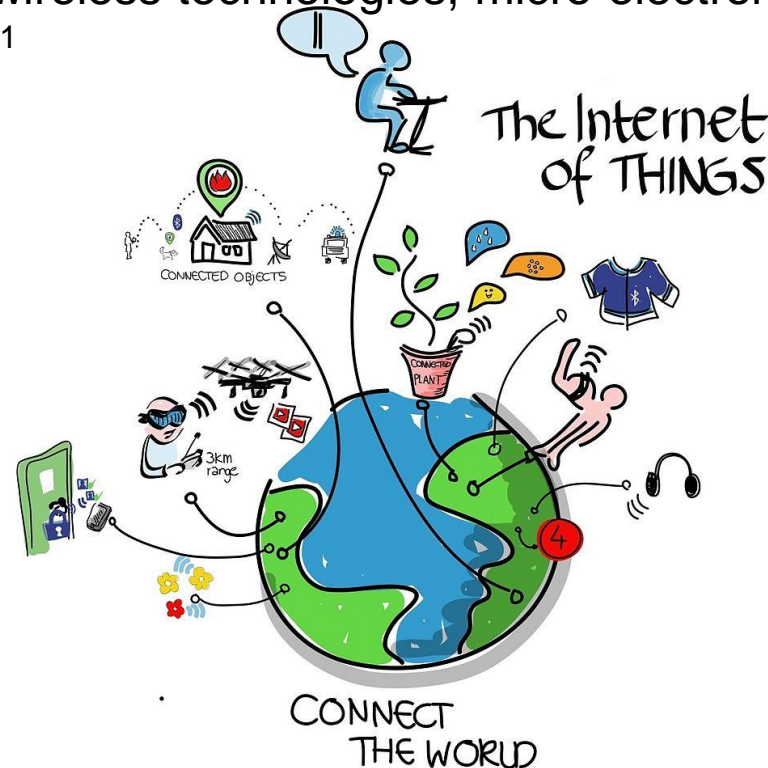

Fig. 2.6 Internet of everything.
(*Source*: Cisco).

1. http://whatis.techtarget.com/definition/Internet-of-Things

Internet of Things

- M2M communication. Sensors. Identity.
  - http://www.youtube.com/watch?v=QaTlt1C5R-M
  - http://www.cisco.com/web/solutions/trends/iot/overview.html
  - http://www.infoworld.com/article/2611319/computer-hardware/the--internet-of-things--will-mean-really--really-big-data.html
  - http://www.forbes.com/sites/gilpress/2014/08/18/its-official-the-internet-of-things-takes-over-big-data-as-the-most-hyped-technology/

Real-time monitoring

Real-time monitoring service - Monitoring and measuring environmental developments with technology and communications systems that provide time-relevant information to the public in an easily understood format people can use in day-to-day decision-making about their health and the environment.[1]
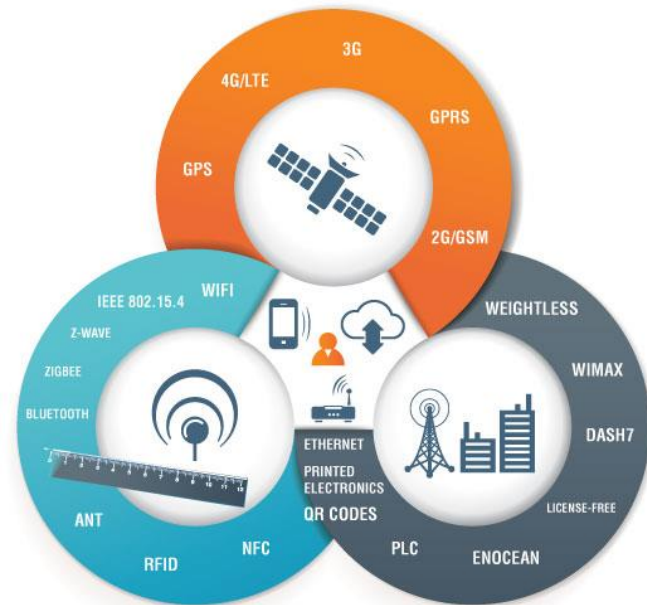
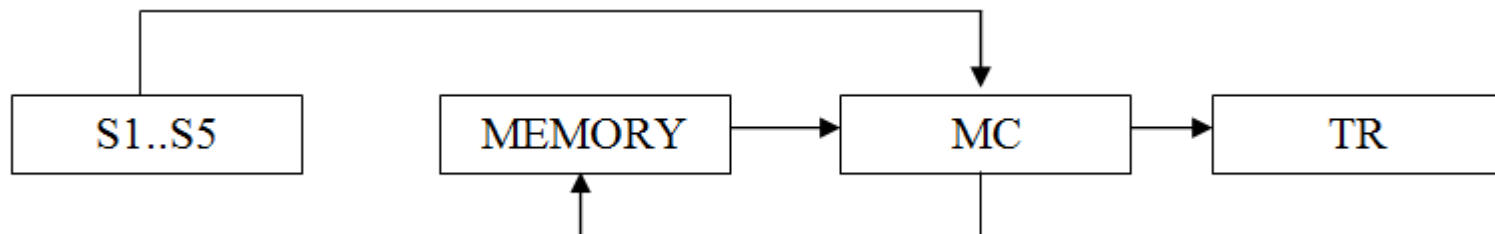1. http://www.caslab.com/Real-Time_Monitoring_Meaning/
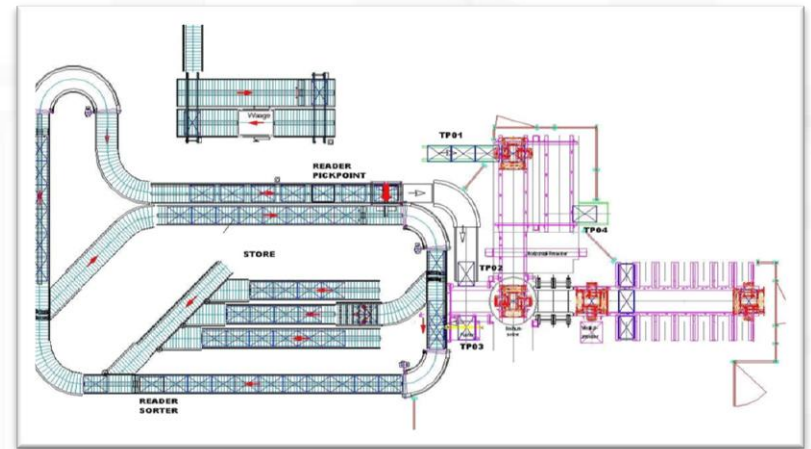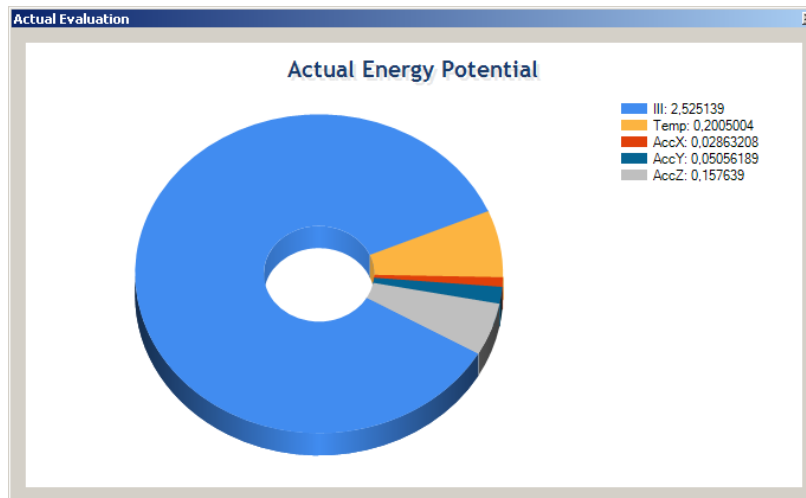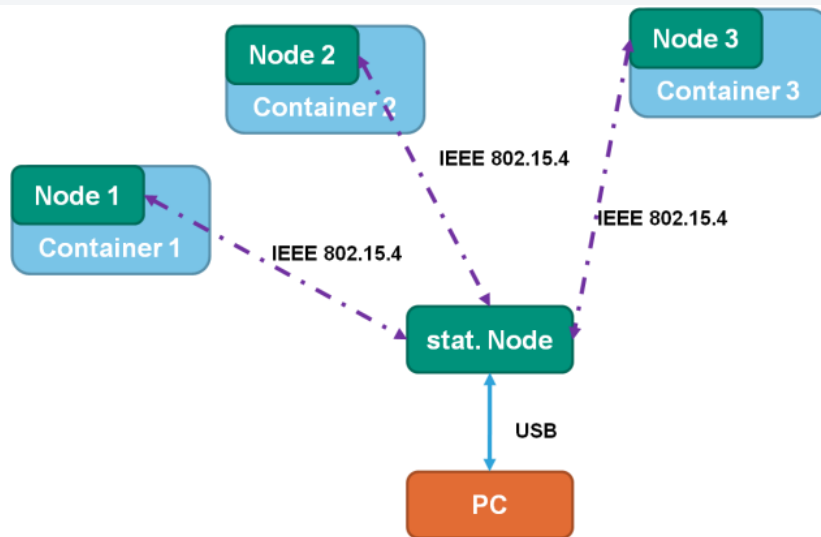
How it works?

The software collects the data with the following sampling rates:

- **Acceleration sensor – up to 1000 Samples/s**
- **2x Temperature sensor 10 Samples/s**
- **Humidity sensor 10 Samples/s**
- **Luminance 10 Samples/s**

The acquired data will be buffered for **3 seconds** in case the data can not be sent within 1 second to the stationary node.

```
   ┌──────────────────────────────────────────┐
   │                                          ▼
┌─────────┐        ┌──────────┐        ┌─────────┐        ┌─────────┐
│  S1..S5 │        │  MEMORY  │ ─────▶ │    MC   │ ─────▶ │   TR    │
└─────────┘        └──────────┘        └─────────┘        └─────────┘
                        ▲
                        └───────────┘
```

At least 24h cycles.

Amount of data from one container: (1000*A+20*T+10*H+10*L)*3600*24?

Service evolution

a Service - is a set of one time consumable and perishable benefits delivered from the accountable **service provider**, mostly in close coaction with his internal and external service suppliers,

effectuated by **distinct functions** of technical systems and by distinct activities of individuals, respectively,

commissioned according to **the needs of his service consumers** by the **service customer** from the accountable service provider,

rendered **individually** to an **authorized service consumer** at his/her dedicated trigger,

and, finally, consumed and **utilized** by the **triggering service consumer** for **executing** his/her upcoming **business activity** or **private activity**.
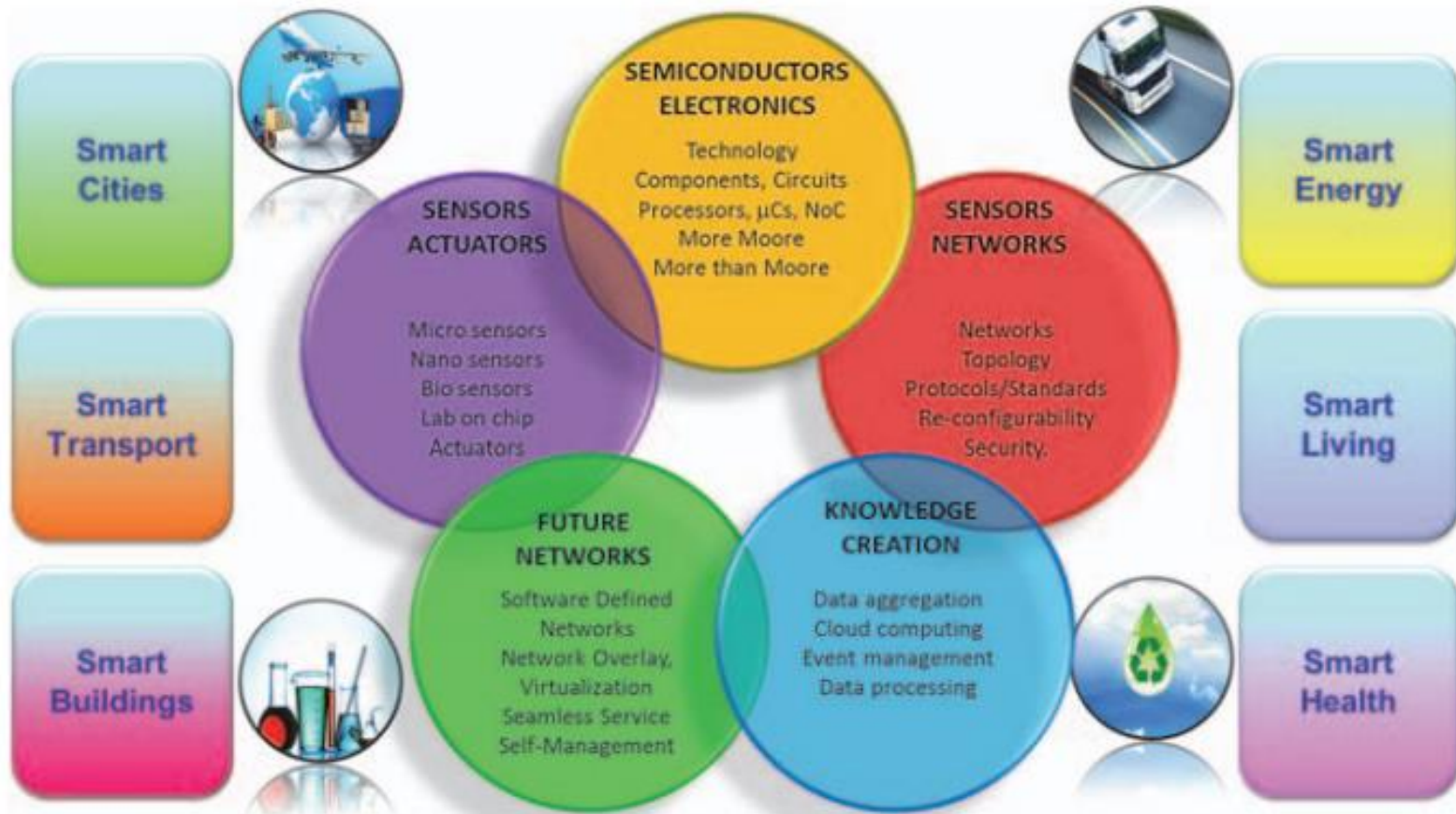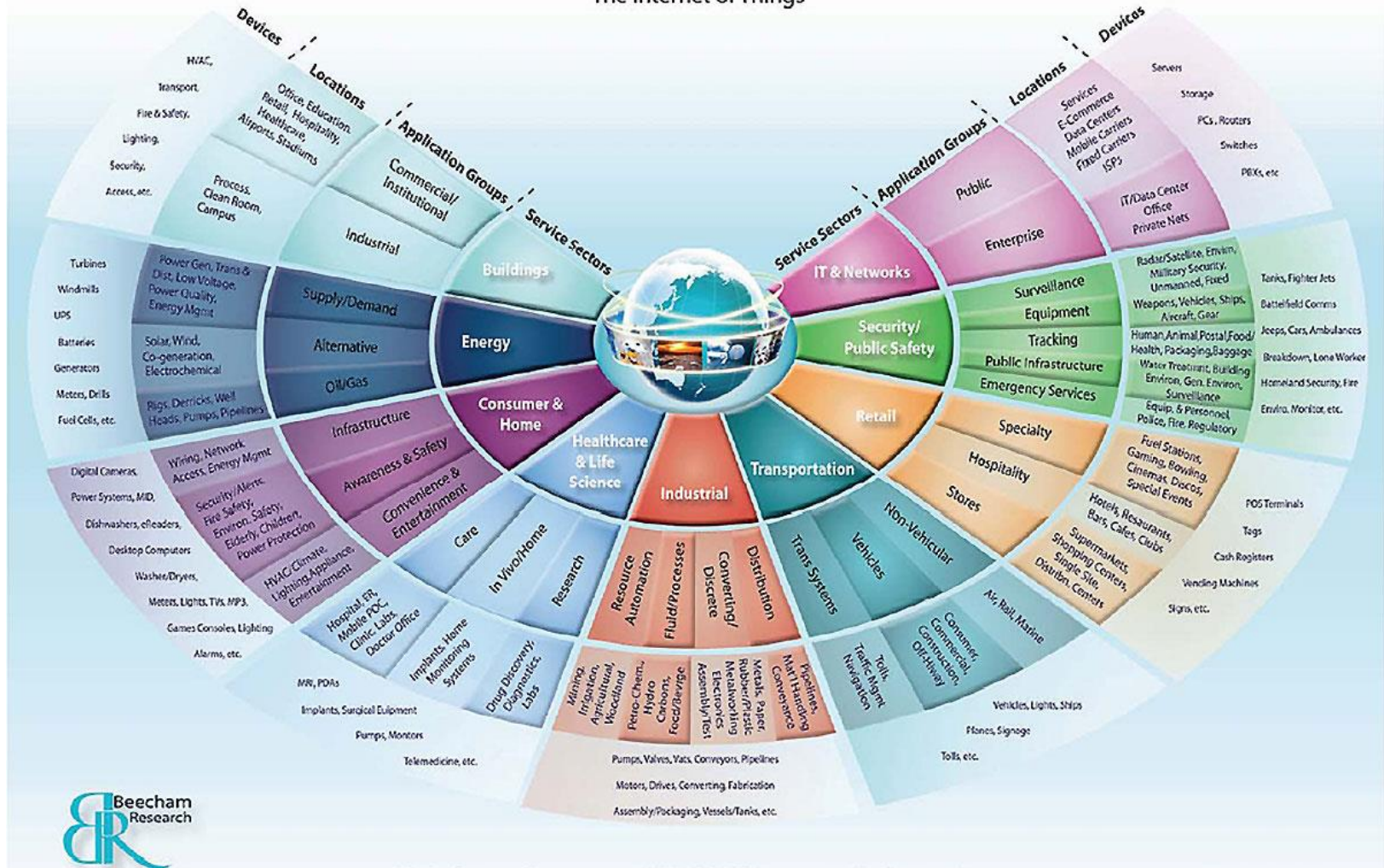

GENERATE STORE ANALYZE INSIGHTS
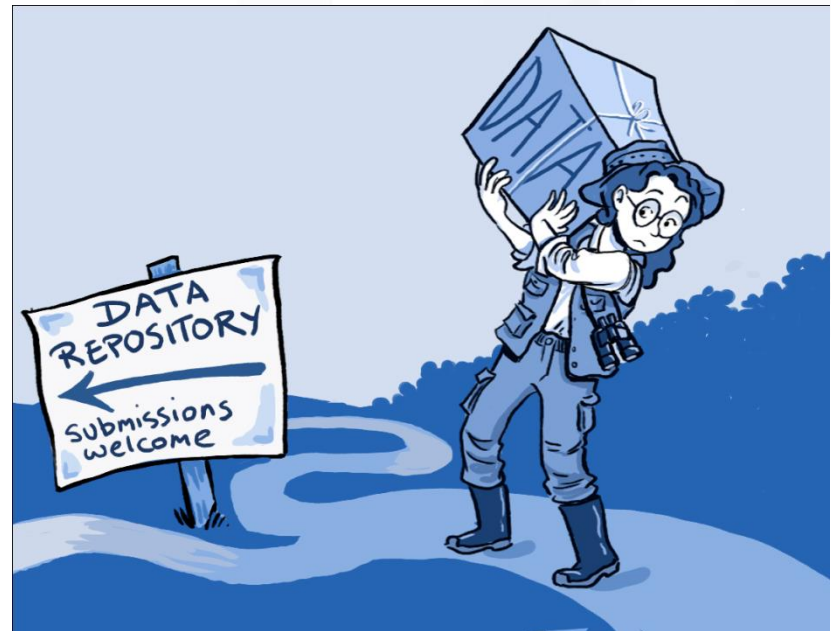
The Internet of Things

Beecham Research

Collaborative data sharing

Crowd service funding – next stage of crowd funding – by official participation as a service provider/service supplier for any participant (social web of things as an example).

- Data sharing may violate some providers' terms of services.

- Data verification.

- The data should be anonymized.

"Mobile" statistics in 2018

• According to the latest figures from Statista, the number of mobile phone users in the world will reach 4.9 billion in 2018. This will be driven by the increasing popularity of smartphone usage which is set to reach 2.5 billion next year. That means next year over half of all mobile users will be smartphone users for the first time.

• Asia Pacific will be core to mobile subscriber growth (China and India alone have over 1 billion mobile subscribers and both of these countries will account for nearly 50% of mobile subscriber growth from 2017-2020.)

• Huawei surpasses Apple for the first time (Huawei has now overtaken Apple in global smartphone sales for this first time making it the second largest smartphone maker in the world. The increasing popularity of Huawei phones is believed to be due to their large displays and advanced camera functions.)

• Android surpasses Windows for the first time to become leading OS(This growth has been driven by developing markets where smartphone usage has outstripped PC usage, particularly in Asia).

• 4.7-inch and 5-inch screen sizes most popular.

"Mobile" statistics in 2018

- Qualcomm top chipset vendor for Android devices.

- 80% of top-websites use Adaptive Web Design.

- Mobile page speed not increasing (In 2016, Google's DoubleClick found that the average load time for mobile sites is a whopping 19 seconds. Worryingly, research body Think with Google conducted a similar study this year of 900,000 mobile ads' landing pages and found that the average load time was 22 seconds.

The majority of the mobile sites were slow and bloated with too many elements which have a major impact on the next point.).

- Bounce rates rocket and conversions drop for each second your page takes to load (To put it another way: if your business is making $100,000 on your site every day, an improvement of just 1 second in page speed could mean an increase in revenue of $4.3 million every year.).

- Time spent on mobile still increasing (Digital usage reached 5.7 hours per day in 2017, an increase of 0.3 hours (or 18 mins) from 2016. Decreases in usage of desktop and laptop are being partly offset by increased usage of mobile.).

- Most conversions still occurring on desktop (desktop (3.83%) smartphone (3.38%) and tablet (1.34%)).

"Mobile" statistics in 2018

- 78% of shoppers will ignore a retailer's offer if it is not personalized

- 197 billion mobile apps downloaded this year.

- Apps dominate mobile usage (percentage of mobile minutes spent on mobile apps is between 80%-90% in the USA, UK, Canada, Spain, China, Italy, Indonesia, Brazil and Mexico).

- Dynamic in-app ads improve conversion rates (on order to produce a significant level of uplift, many ad variations need to be created based on user context. Ad formats directly impact conversion rates).

- The most searched for industries by mobile users: Food & Beverage - 72%; Health - 68%; Sport 68%.

- Digital media helped drive $1 trillion in offline sales (consumers depend on mobile phones to research products more than they do to make purchases, making it even more vital for businesses to invest in mobile more).
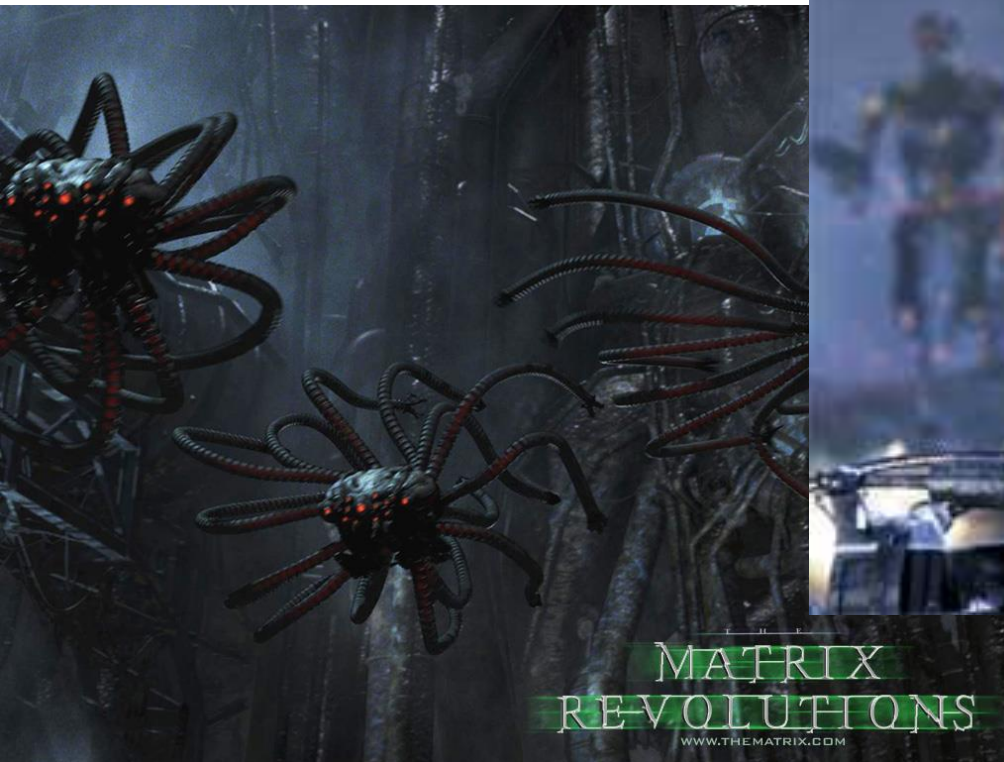
DeviceAtlas 2017 *https://deviceatlas.com/blog/18-mobile-market-statistics-you-should-know-2018*

- Real-time monitoring services - statistics – data-based services – DaaS – architecture. Personalized.

- Subscription-based predictive services.

- Mobile-based services.

- Collaborative data sharing – services suppliers.

- Social-oriented.

- Transnational nature.

- Nano-networks – processing on device.

What is going to be next?

Only lack of energy will be a problem soon. Otherwise we would have all of these.

NATIONAL RESEARCH
UNIVERSITY

Thank you
for your attention!

https://www.youtube.com/watch?v=-N9i-YXoQBE

https://www.youtube.com/watch?v=a3713oGB6Zk TO WATCH (!)

Ovidiu Vermesan, Peter Friess "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers, 2013

mkomarov@hse.ru