

Border security and surveillance using the Internet of Things Technology

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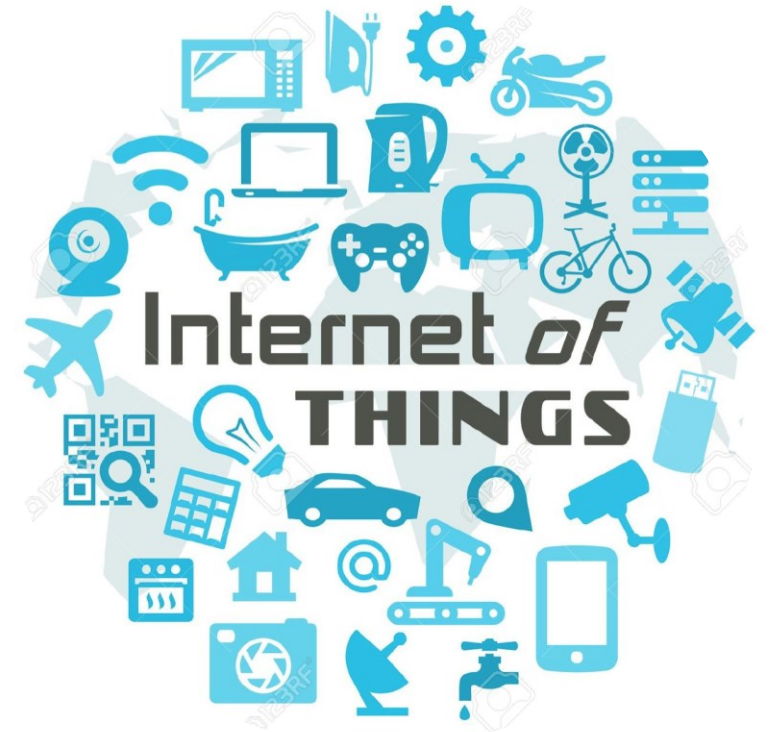


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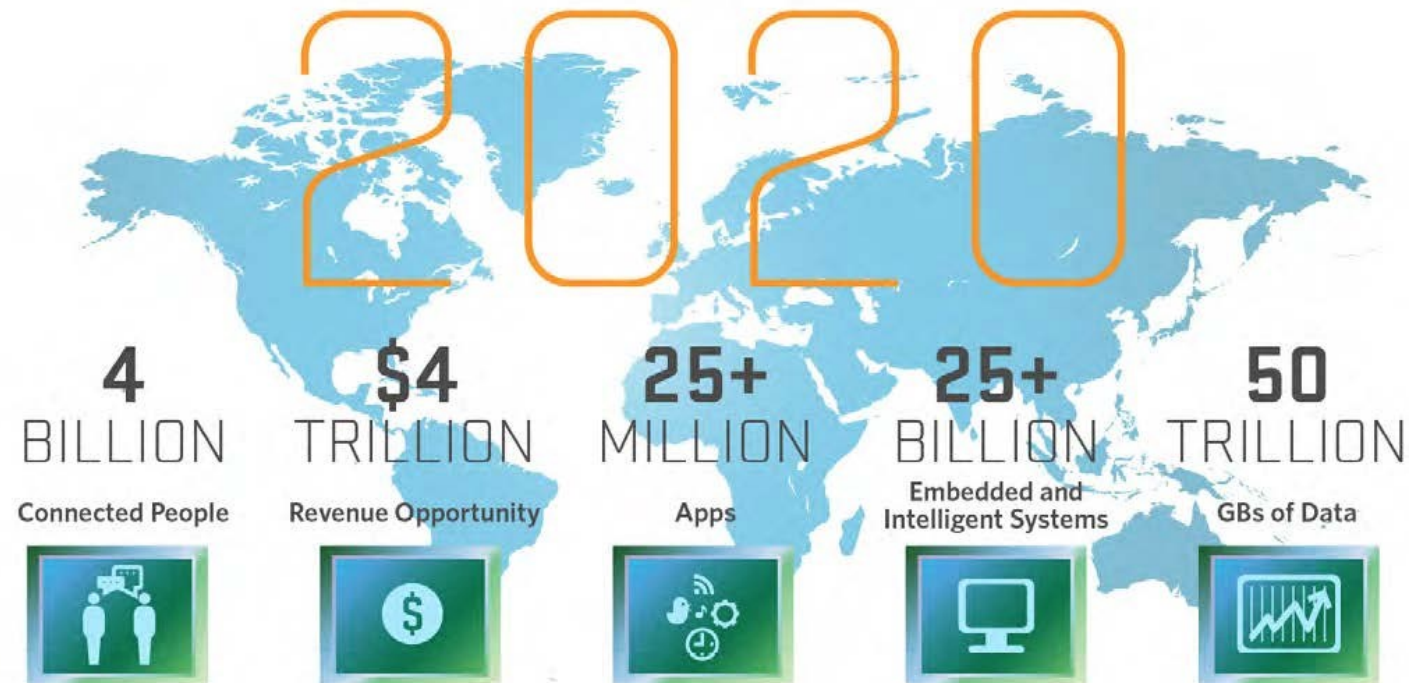
What The Phrase Means

- Kevin Ashton coined "***Internet of Things***" phrase to describe a system where the Internet is connected to the physical world via ubiquitous sensors
- The technologies and solutions that enable connection and inter-communication between real world devices and physical objects is often referred to as the Internet of Things (IoT)



How Ubiquitous?

Gartner: "IoT Installed Base Will Grow to **26 Billion Units** By 2020."
That number might be too low

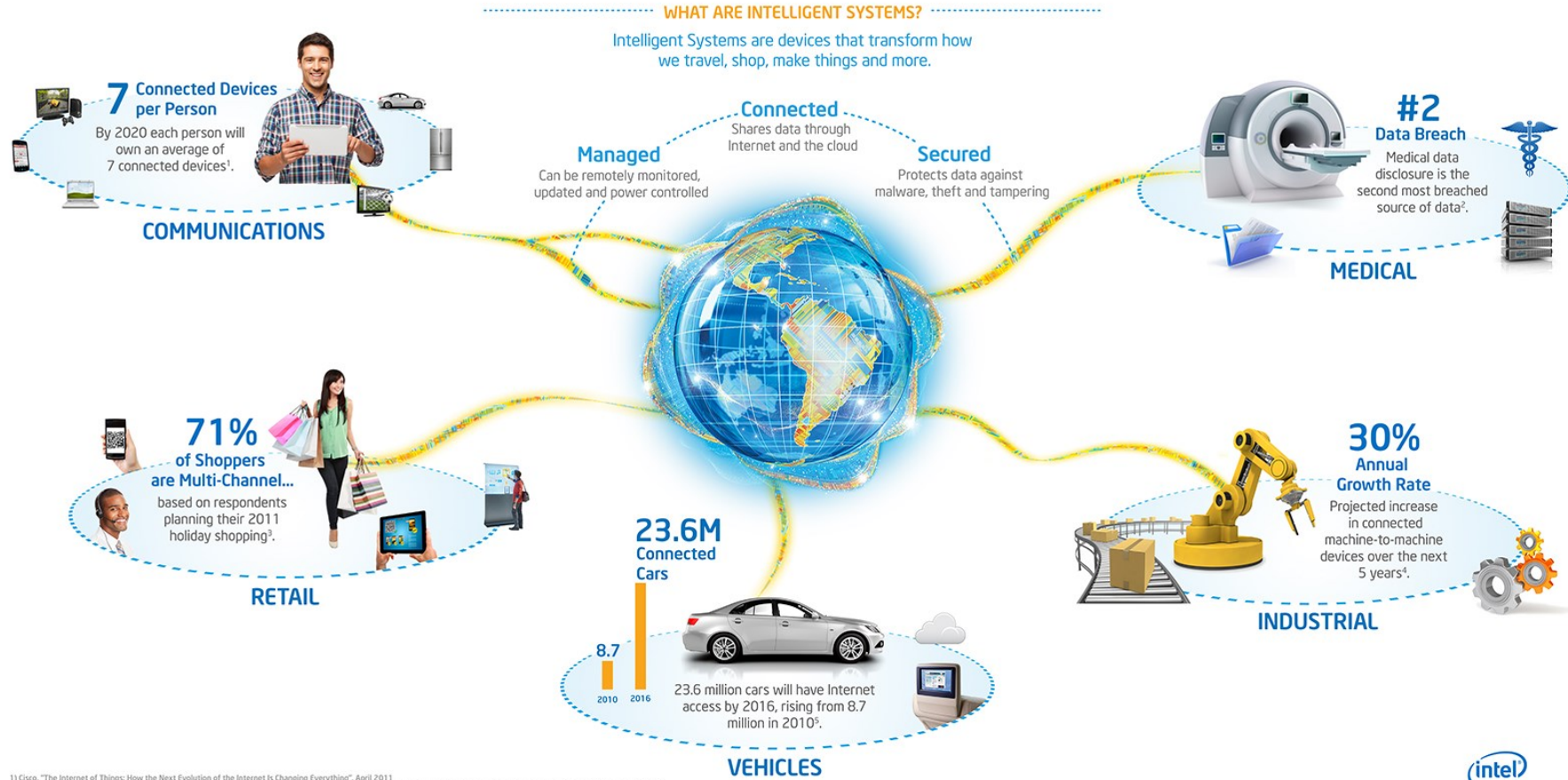


Why should you learn about IoT?

- Emerging technology
- Growing IoT Services and Applications in various areas including smart cities, healthcare, transport, logistics, retail, safety and security, etc.
- Business trends and new opportunities

Opportunities

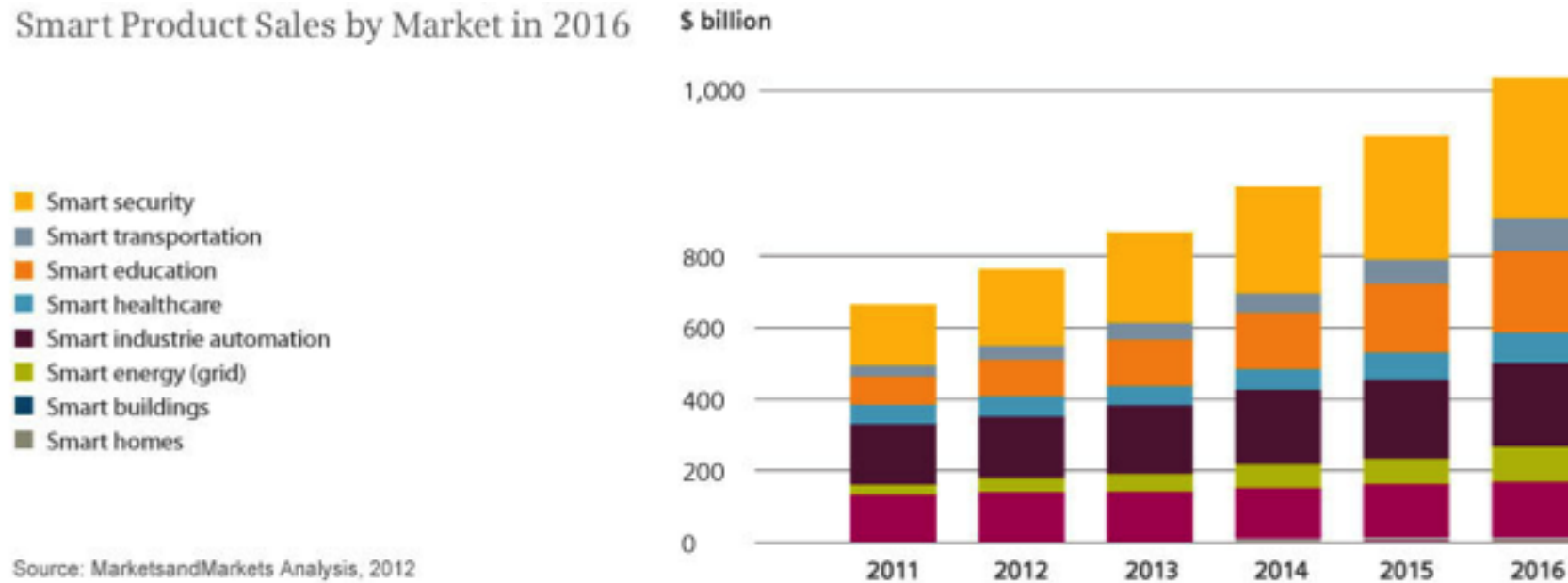
Intelligent Systems for a More Connected World



1) Cisco, "The Internet of Things: How the Next Evolution of the Internet is Changing Everything", April 2011
 2) Bloom Research, "Security challenges in the US healthcare sector" White Paper, December 2010, <http://www.mcafee.com/us/resources/white-papers/wp-bloom-healthcare-security.pdf>
 3) Deloitte U.S., 2011 Annual Holiday Survey, http://www.deloitte.com/assets/Dcom-UnitedStates/Local%20Assets/Documents/Consumer%20Business/us_retail_AnnualHolidaySurvey_2011_pr_102611.pdf
 4) McKinsey Global Institute analysis, "Big data: The next frontier for innovation, competition, and productivity", June 2011
 5) Wall Street Journal, <http://online.wsj.com/article/SB10001424052702304066504576349763614933844.html>, estimate from research firm, Frost & Sullivan



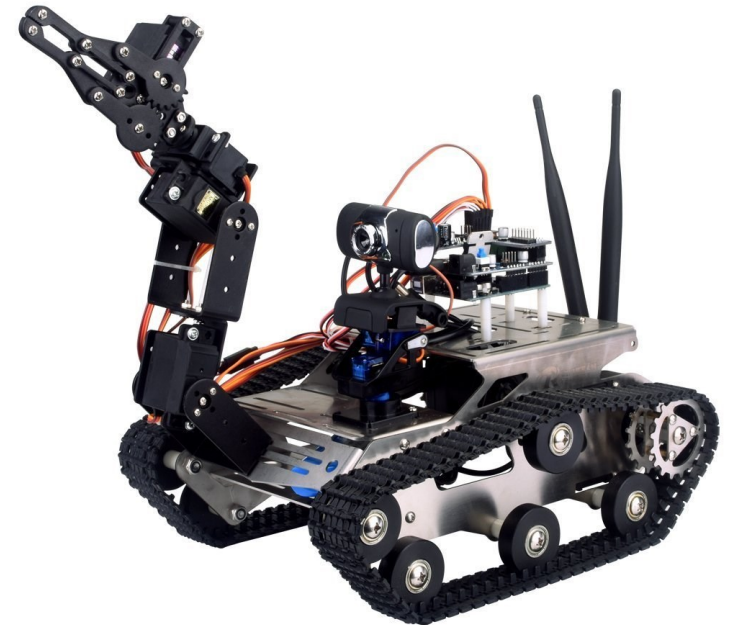
Smart product sales



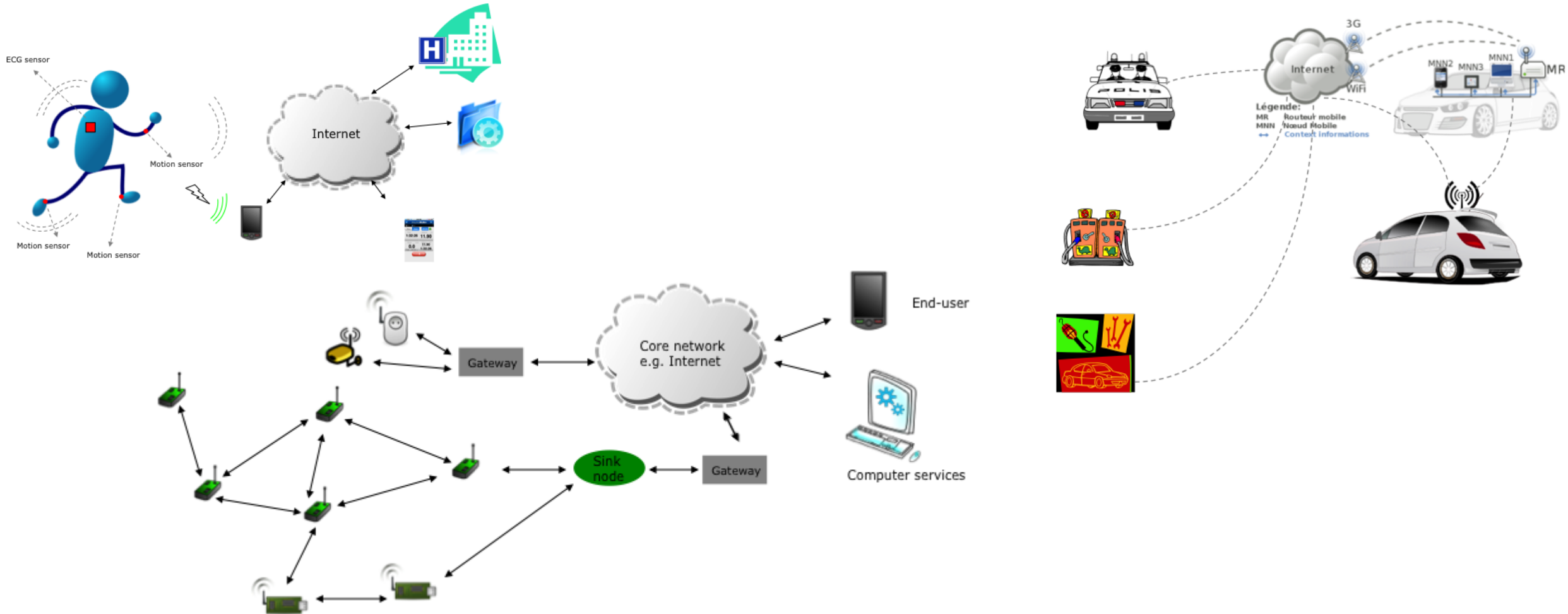
Source: Siemens, http://www.siemens.com/innovation/apps/pof_microsite/_pof-fall-2012/_html_en/facts-and-forecasts-growth-market-of-the-future.html

Things

- We can turn almost every object into a “thing”
- A “thing” still looks much like an embedded system currently
- A “thing” generally consists of four main parts:
 1. Sensors & actuators
 2. Microcontroller
 3. Communication unit
 4. Power supply
- A “thing” has the following properties:
 1. It’s usually powered by battery
 2. It’s generally small in size and low in cost
 3. It doesn’t usually perform complicated tasks



More things are being connected



The Challenges

- Systems are needed to help those devices ***talk to each other, manage all that data, and enforce proper access control***
- All of the ***messaging, management, and access control*** technologies used in these large-scale device networks must be massively scalable
- Lightweight protocols for devices to work together, communicate
- Unique and extensible identifiers for all those billions of devices
- Lack of interoperability – structural and semantic heterogeneity
- Cybersecurity
- Privacy and policy

IoT Data- Challenges

- Multi-modal and heterogeneous
- Noisy and incomplete
- Time and location dependent
- Dynamic and varies in quality
- Crowded sourced data can be unreliable
- Requires (near-) real-time analysis
- Privacy and security are important issues
- Data can be biased!

IoT for Border security and surveillance

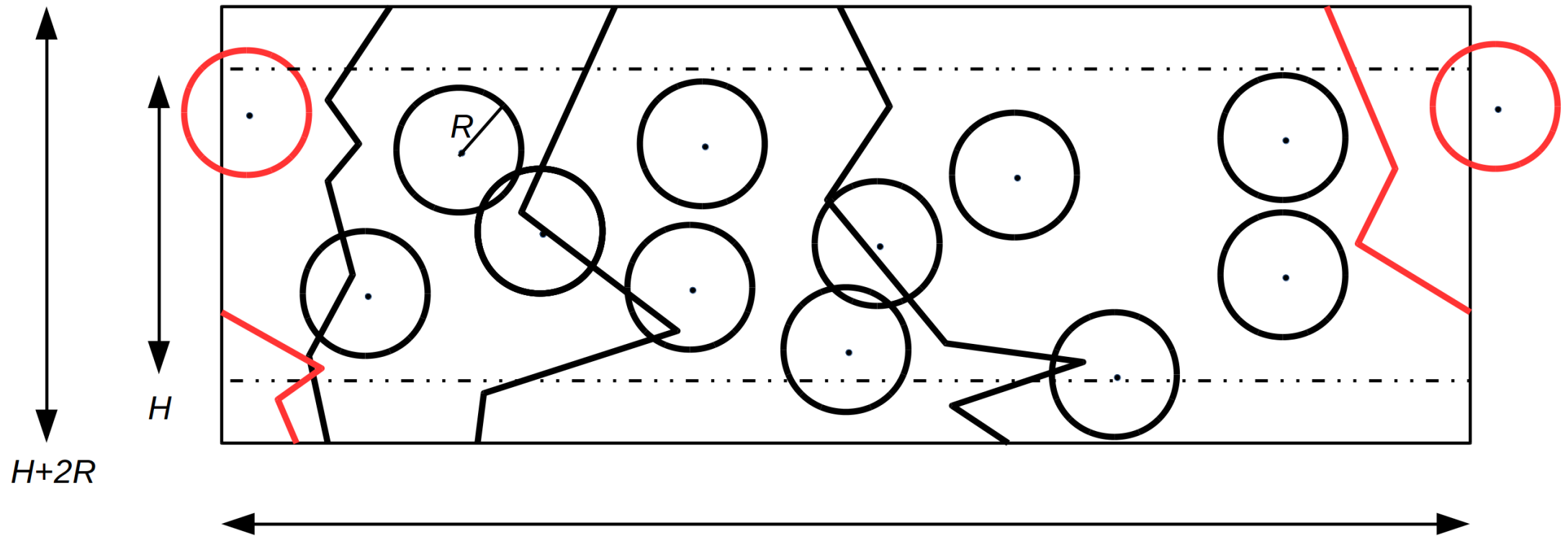
IoT for Border security and surveillance

Why not use:

1. Fences
2. Satellites
3. Border guards
4. Drones
5. ...



System topology



LIoTs Characteristics

1. Linear topological structure
2. Sparse deployment
3. Shared communication routes
4. Known node location
5. Structure-based duty cycles
6. Node density

We address the following questions:

1. What is the minimum network density to achieve *k-barrier* coverage in a given belt region?
2. Given an appropriate network density, how to determine if a region is indeed *k-barrier* covered?
3. How to find a path connecting the two ends of the border such that every point on the path is not covered by a sensor node?
4. How to balance workload across sensor nodes?
5. How to elongate network life time and meet quality of service requirements?

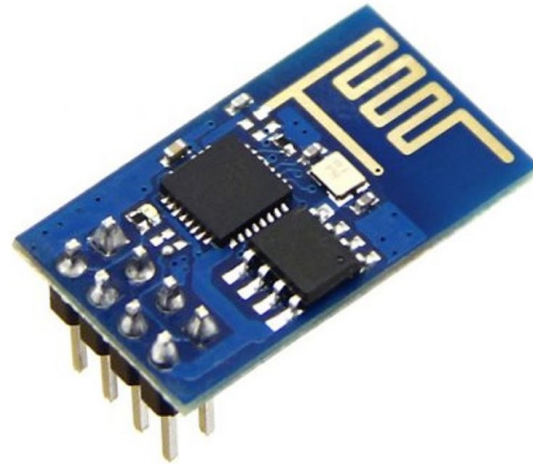
We address the following questions:

1. What is the minimum network density to achieve *k-barrier* coverage in a given belt region? *Mathematical modelling*
2. Given an appropriate network density, how to determine if a region is indeed *k-barrier* covered? *Monte Carlo Simulation*
3. How to find a path connecting the two ends of the border such that every point on the path is not covered by a sensor node? *Monte Carlo Simulation*
4. How to balance workload across sensor nodes? *Simulation*
5. How to elongate network life time and meet quality of service requirements? *Simulation*

Evaluation



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Questions