Privacy Mindset for Developing Internet of Things Applications for Social Sensing:
Software Engineering Challenges

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Social Sensing

- Social sensing has emerged as a new paradigm for collecting sensory measurements by means of "crowd-sourcing" sensory data collection tasks to a human population.
- Humans can act as
  - sensor carriers (e.g., carrying GPS devices that share location data)
  - sensor operators (e.g., taking pictures with smart phones)
  - sensors themselves (e.g., sharing their observations on Twitter)

Internet of Things

- The Internet of Things (IoT) is "…the network of physical objects—devices, vehicles, buildings and other items—embedded with electronics, software, sensors, and network connectivity that enables these objects to collect and exchange data…"#

- By 2020, there will be 50 to 100 billion devices (i.e. things, sensors, smart objects) connected to the Internet*
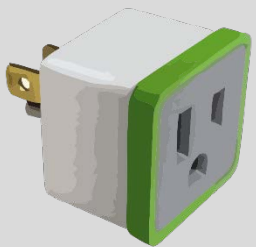
International Telecommunication Union, Internet of Things Global Standards Initiative, 2015, http://www.itu.int/en/ITU-T/gsi/iot/Pages/default.aspx
* International Data Corporation (IDC) Corporate USA, "Worldwide smart connected device shipments," March 2012, http://www.idc.com/getdoc.jsp?containerId=prUS23398412
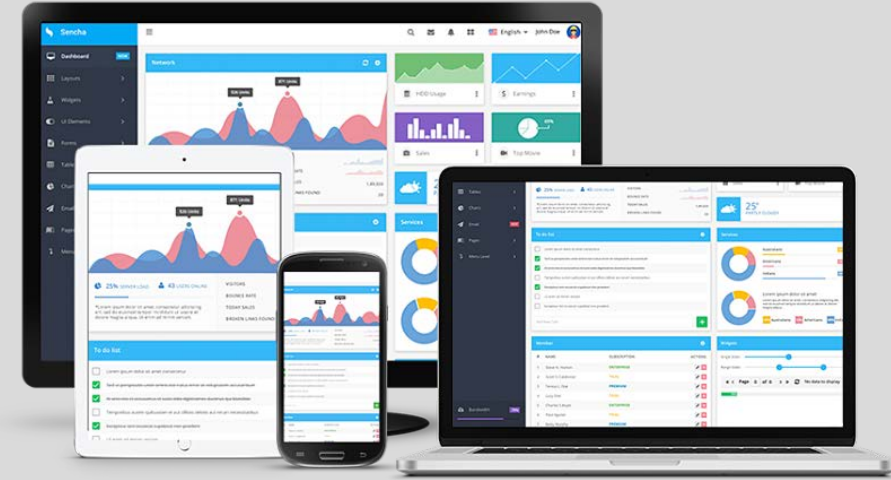
Application Development

Desktop Application

Mobile Application

Web Application Application

- Processing happens locally
- UI sits locally

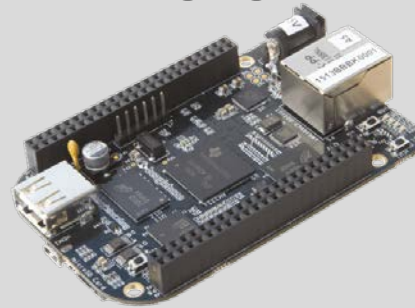- Processing happens locally complemented by cloud resources
- UI sits locally

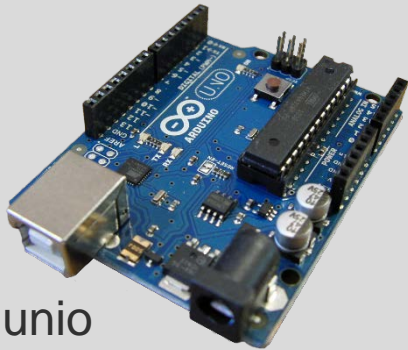- Processing happens remotely
- UI sits locally
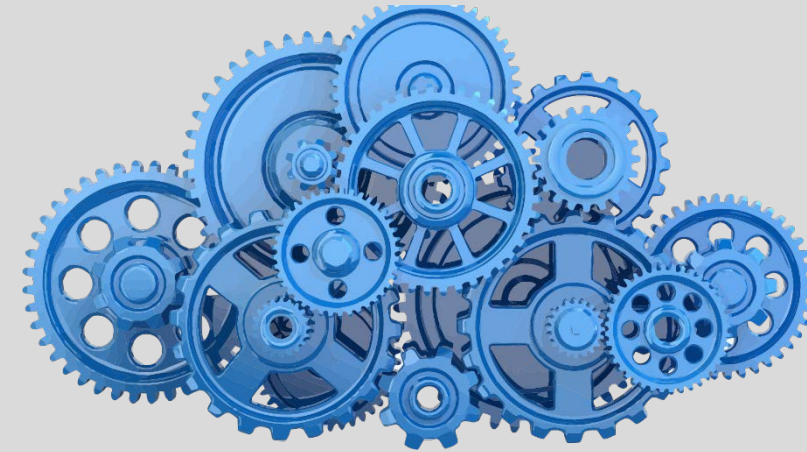
Internet of Things Application Development

Waspmote

Ardunio

Gadgeteer

BeagleBone

Raspberry Pi

Dragonboard 410C

Cloud Computing
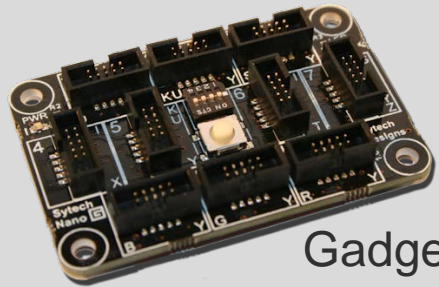
- **NO Operating System**
- **Less Powerful**

- **OS Driven**
- **More Powerful**

- **Unlimited Computational Resources***

Privacy Challenges

- **IoT applications are complex** by nature as they involve both software and hardware as well as many different types of computational devices (e.g., sensors, gateways, cloud)

- Privacy is a significant problem in IoT applications, especially when used for social sensing tasks, because they handle data that can be used to derive **very sensitive personal information**

Why not Privacy is a concern

- IoT (applications, service, platforms) is still new; **Not mature enough**

- Most IoT platforms follow the philosophy "**You feed your data our platform, we do the processing and give back you the results**"

- IoT engineering complexities have forced software engineers to put most of their efforts towards addressing other challenges such as interoperability and modifiability, resulting in privacy concerns being often overlooked. Privacy is not a major concern for them.

- In order to address this issue, it is important to develop **Privacy mindset** among software engineers.

Developing Privacy Mindset

- Privacy mindset encourages software engineers to think about privacy awareness of their IoT applications at early design phases, not as an after thought.

- Privacy need to be treated as a first class citizen in IoT application development processes. Privacy mindset can only be developed by providing strong guidance to the software engineers and by reducing the effort and time required to embed privacy protecting measures into IoT applications.

- There **isn't any process/methodology/framework** to help software engineers in designing privacy aware IoT applications

Developing Privacy Mindset
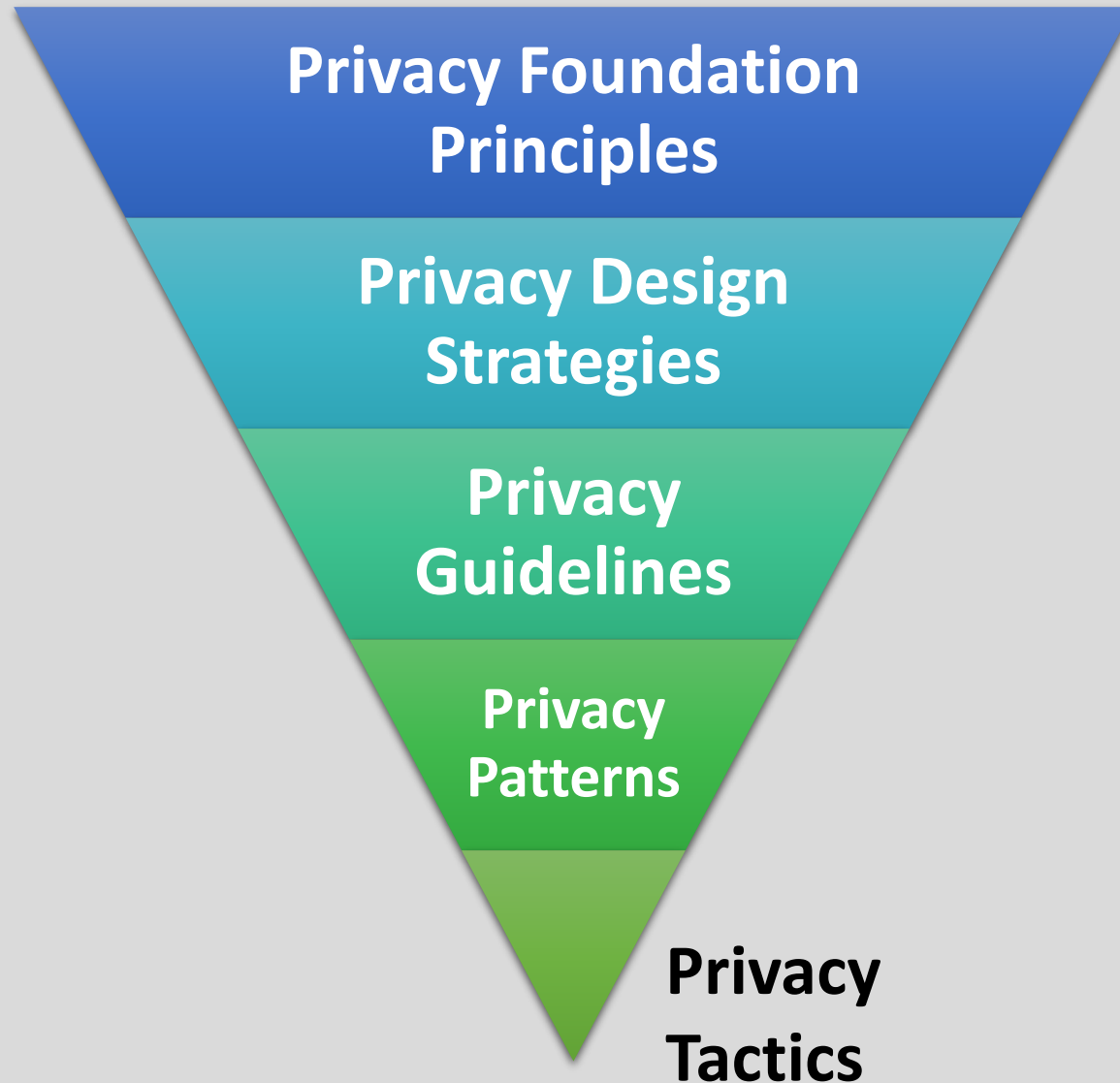
Developing Privacy Mindset

- We need to build an *unified PbD design framework* that incorporates not only high level principles, but all the way to patterns and tactics.

- We need to build automated (or at least semi-automated) *tools* that can help software engineers to apply privacy protecting measures into their IoT applications.

- Different types of tools will be required to support different phases of the IoT application life-cycle (e.g., design, runtime) and different components (e.g., edge nodes, gateway nodes, cloud nodes).

Thank You