Internet of Things
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Life Cycles

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John Carpenter, 1982
Questions

• What is the life cycle of IoT systems and components?
Life cycle

- The life cycle of a product or system is the series of stages it goes through from inception to decline.

- A typical life cycle for a software system is given to the right.

- More detail is obtained by adding information regarding the activities in the stages.

- Notes:
  - also system parts have life cycles, affecting the overall system.
  - the life cycle should also address evolution, redesign.

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Typical IoT Device life cycle

- Device life cycle
  - specification
  - design
  - implementation
  - testing
  - (re-)commissioning
    - software install
    - physical deployment, placement
    - configuration
      - security keys
      - bootstrapping information and connections
        » proxy, life cycle server
  - operation
  - update
    - reconfiguration
    - adjusted application
    - new firmware
  - end of life

- Life cycles have a generic structure but are different for each device type
- Examples:
  - phone: deployment is through purchasing; other commissioning is through manufacturer. Life cycle server is with connectivity provider or manufacturer.
  - office IoT: commissioning is by an installation company. Life cycle server is with owner or with manufacturer.
- Important aspects concern responsibilities and control by involved stakeholders
  - in particular: responsibility for software updates
IoT: involved software types

- Embedded Operating System / runtime executive
- Libraries
  - e.g. a CoAP library, linked into an executable
- (Runnable) components exposing services
  - e.g. a CoAP based service for inspecting the temperature or adjusting the heater
- Applications
  - e.g. a management application using temperature services and controlling the heater
  - e.g. a data analytics application
IoT: software update packaging

- Firmware
  - full update of a node’s software
- Module
  - a library or application component, possibly even an OS or system part
- Setting
  - parameter settings on the existing system
Possible IoT component life cycle

- Component life cycle
  - specification
  - design
  - implementation
    - linking libraries
  - testing
  - (re)commissioning
    - deploy/install on device(s)
    - configure
    - register, for discovery
  - operation (deliver the service)
  - end of life

- Life cycles have a generic structure but are different for each system

- Examples:
  - temperature sensor: a temperature service is installed on the sensor over the air using a particular software framework

- Recommissioning is triggered by renewal of libraries, of version

- Important again are responsibilities and control by involved stakeholders
  - in particular: responsibility for software updates after first install
Possible IoT Application life cycle

- Application life cycle
  - specification
  - design
  - implementation
    - linking libraries
  - testing
  - deployment
    - deploy/install, possibly multiple components
  - operation
    - service discovery, binding
    - execute application logic
  - end of life

- Life cycles of applications may depend on life cycles of components, libraries

- Examples:
  - thermostat application: searches and finds services that yield temperature and control services that control the heater (needs further details and access control of course)

- Important aspects concern access control by involved stakeholders
Questions

- What is the life cycle of IoT systems and components?