Software Technology for Internet of Things
Annotating Identity, Time and Space

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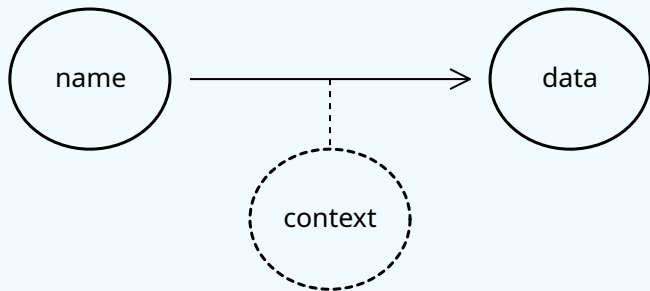
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Part 1: Naming

Naming

Naming is one of the most important concepts in computer science.

It has nothing to do with assigning a name to a concept, but everything to do with being able to reference something.

Example 1: ['/home/asjo', '.bashrc'] $\rightarrow$ /home/asjo/.bashrc
Example 2: ['myObject', 'print()'] $\rightarrow$ myObject.print()

Part 2: Identity

Identity Management

What is an identity?

It's a name!

We need to be able to name a device in order to give the datastreams associated with that device meaning. In particular to

- associate a device to something (e.g., device 12 produces data in stream 17).
- associate something to a device (e.g., room U182 contains device 12).

A device may have multiple identities ... for different purpose and exposure.

Sources of Identity

To name a few popular ones:

1. Unique device number
   e.g., a *serial* from a special *"id"* chip, the MCU or a radio.

2. User-provided
   e.g., entered using a mobile device during installation.

3. (Physical) location-derived
   e.g., a coordinate set.

4. Network-derived (logical location)
   e.g., through DNS or enumerated based on topology.

5. Context-derived
   e.g., the combination of the knowledge of *what* it is, *where* it is, and *what happens* around it.

Point of Identification

Where is identify of the node rooted?

1. Node (self-description)
   - ▶ *"Self-aware"*.
2. Cloud
   - ▶ *"Central"* knowledge.
3. Private
   - ▶ Stored with the user.
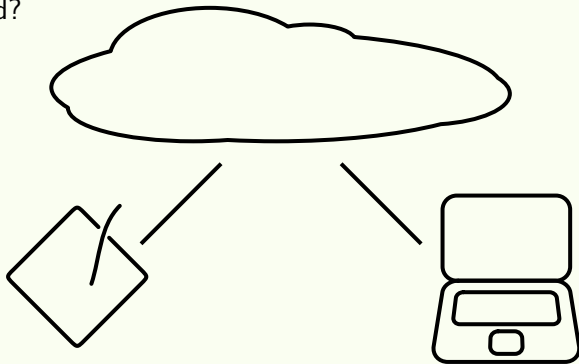
How could it possibly be useful to store the identity on the node?

The choice has consequences:

- ▶ Who knows the identity?
- ▶ Who can get the identity at which cost?

Part 3: Time

Keeping Track of Time

While running, a device will essentially be counting clock ticks. How?

This counter can be converted to an uptime.

Whenever a timestamp from a node is received over a radio, it is derived from the value of such a counter on the device of origin.

By propagating timestamps one can ensure that the network has some degree of shared sense of time.

Further reading:
- ▶ Vector clocks (e.g., student-driven slides).
- ▶ Network Time Protocol (NTP).

Point of Timestamping

1. When sampling (on device).
2. When transmitting (on device).
3. When receiving (on gateway).
4. When pushing to cloud (on gateway).
5. When receiving in the cloud (in cloud).
6. When receiving from the (from cloud).
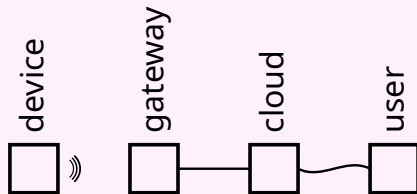
Sources of Time

On the device:

1. Offset (aka relative time).
2. Global Navigation Satellite System (GNSS): GPS/GLONASS/Galileo/BeiDou ...
3. USB cable on startup.
4. Downstream push.
5. In-channel broadcast.
6. Backchannel broadcast.
7. Network Time Protocol (NTP).

Q: Why so many GNSS systems?

A: *"Selective Availability"* is a thing (e.g., Kargil War 1999).

Part 4: Space

Triangulation of Position

Given enough distances to known positions, and small enough error margins on these distances one can narrow down the actual position to a reasonable degree of certainty.

The process is trivial when the distances are exact.

When the distances are measured (i.e., not exact) it becomes a problem of minimizing errors.

This process can happen on the device or in the cloud.

Details on wikipedia.
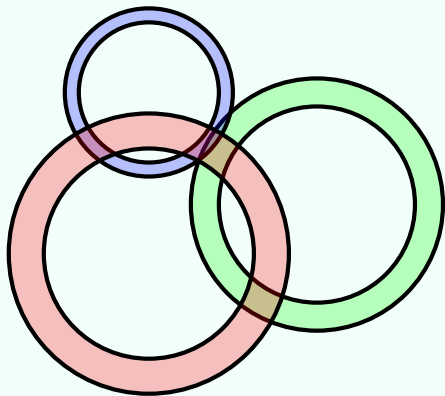
Sources of Position

Direct sources:

1. Hardcoded in firmware or flash.
2. GPS/GLONASS/Galileo/BeiDou.
3. Downstream push (i.e., manual).
4. USB cable on startup (i.e., manual).

Indirect sources (requires triangulation):

- ▶ Signal strengths of radio signals from known positions (e.g., from neighbors in a mesh).

Questions?