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Tutorial & Workshop
The SensibleThings Platform

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Stefan Forsström
Department of Information Technology and Media
Mid Sweden University, Sundsvall, Sweden

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THE IDEA

- In the future we will have a lot of connected things
  - Commonly referred to as the Internet-of-Things
- Current available solutions store data in databases
  - This will not scale to a global Internet-of-Things
  - Where all things will want to share sensor/actuator information
- We foresee the use of peer-to-peer technology
  - To enable more scalable system without any central points of failure

DEMANDED FEATURES

- From our research goals
  - *Scalable* – logarithmic or better
  - *No central point of* failure – fully distributed
  - *Bidirectional* – capable of communicating with both sensors and actuators
  - *Fast* – capable of signaling in real-time between end points
  - *Current* – all data retrieved should be the most current values
  - *Lightweight* – able to run on mobile devices with limited resources
  - *Seamless* – capable of handling NAT and different and devices
  - *Stable* – handle transient nodes with high churn rates
  - *Extensible* – capable of adding new features without redistribution

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APPROACH

- To solve this, our approach was to use:

- A fully distributed system
  - To avoid any central point of failure
- Distributed Hash Tables (DHT's)
  - To lookup identities in the system
  - Basically like a distributed DNS system
- Peer-to-Peer data exchange
  - Between connected entities
  - Similar to how file sharing work today
- Reliable UDP (RUDP)
  - To keep the response time minimal
  - Always data in the first packet, no initial handshaking

SENSIBLETHINGS PLATFORM

- Website
  - www.sensiblethings.se
- Current status of the open source project
  - DHT with a fingertable for a logarithmic lookup time
  - Fully distributed, but with a bootstrap node
  - RUDP, with the payload data in the first packet
  - Open Source LGPLv3, a non propagating license
  - Able to run on Android mobile phones and tablets
  - Capable of penetrating multiple NAT, using a proxy solution
  - Add-in and modularized architecture, capable of adding new features
    - Currently: Encryption, authentication, publish/subscribe, etc.

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How does it work? (Simplified)

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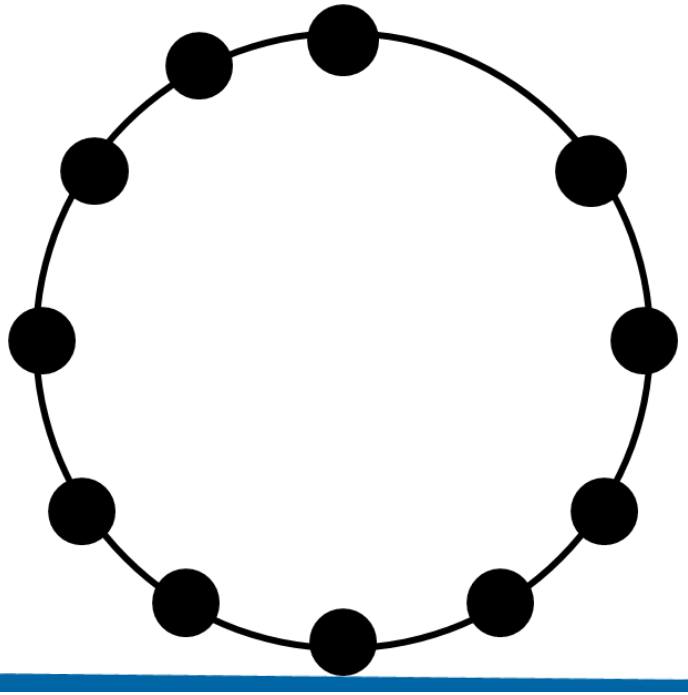
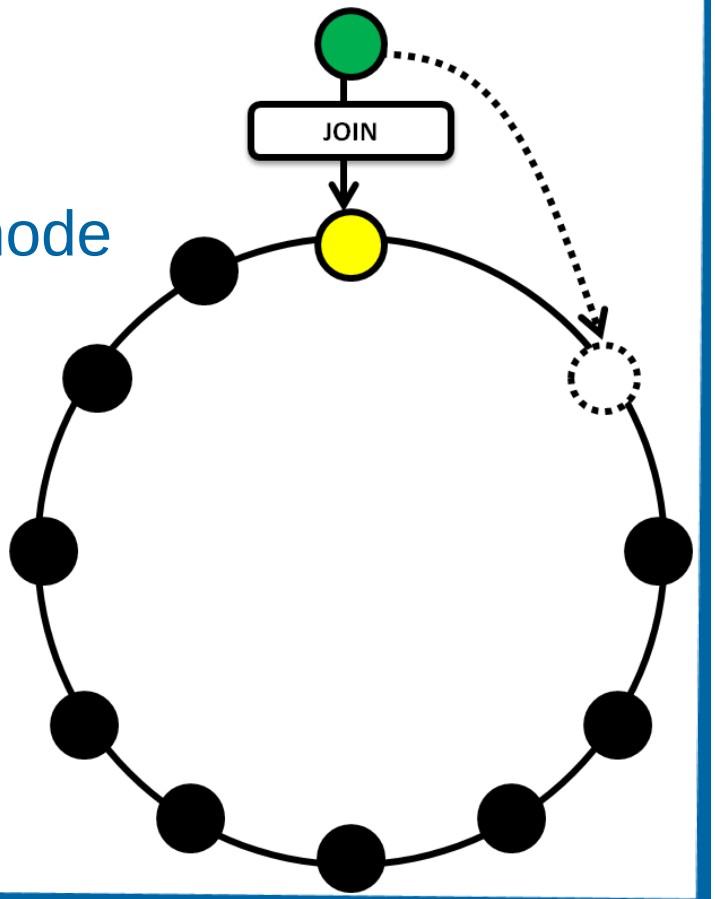
HOW DOES IT WORK?

- Entities organized in a ring like structure
  - In similarity to the Chord DHT
- A node is very ambiguous
  - It can basically be anything
    - A computer
    - A mobile phone
    - Set-top-box
    - Etc.
  - As long as it can run the code



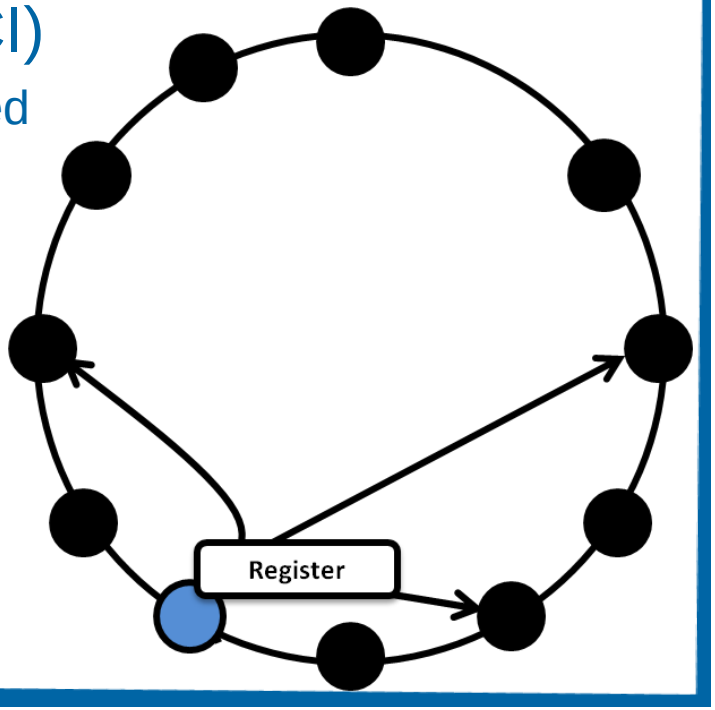
HOW DOES IT WORK?

- A new node can join the ring
  - By talking to any other node in the ring
- But we have a stable bootstrap node
  - To make it easy to join



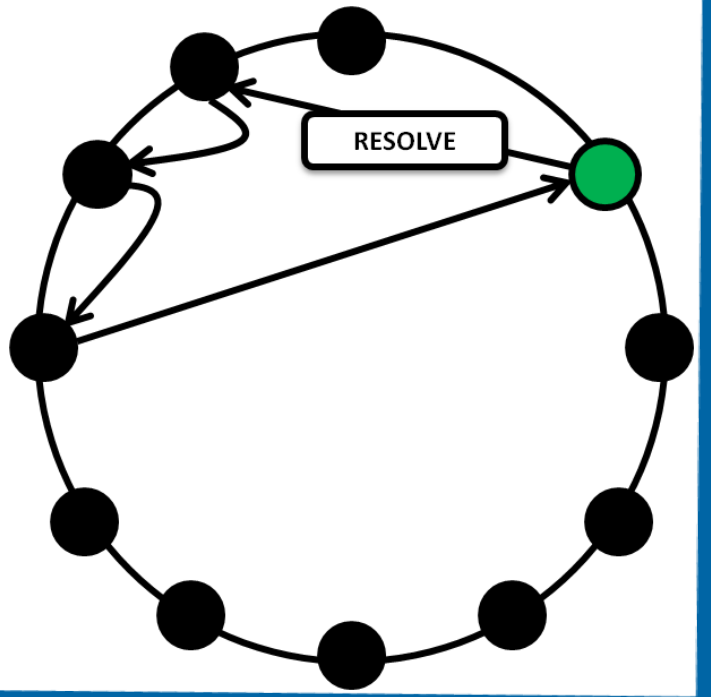
HOW DOES IT WORK?

- We can register things to ourselves
  - For example a sensor or actuator
- Universal Context Identifiers (UCI)
  - Similar to URL and email address combined
  - Ex. stefan@miun.se/temperature
- After registering a UCI
  - The whole DHT knows which UCI belongs to which node



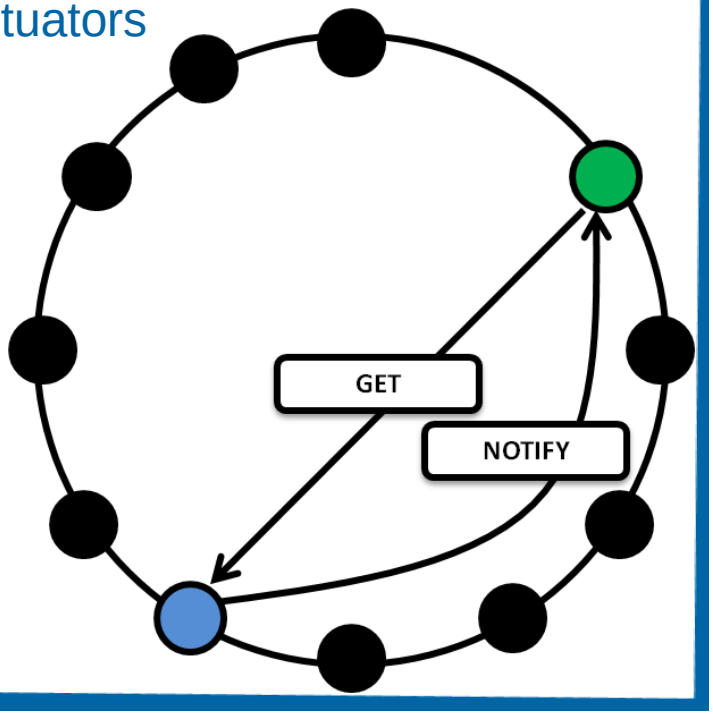
HOW DOES IT WORK?

- After registering, any other node can resolve the UCI
  - In order to find the node who owns a particular sensor or actuator
- The DHT will then translate
  - From UCI to Node address
- Quite similar to normal DNS
  - But without any centralized servers



HOW DOES IT WORK?

- When the node knows which other node owns a UCI
  - He can then set up a peer-to-peer session
  - For example to get sensor values or set actuators
- The primitives are
  - GET and SET
- But the platform also has
  - Subscriptions, Streaming, etc.



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The Code

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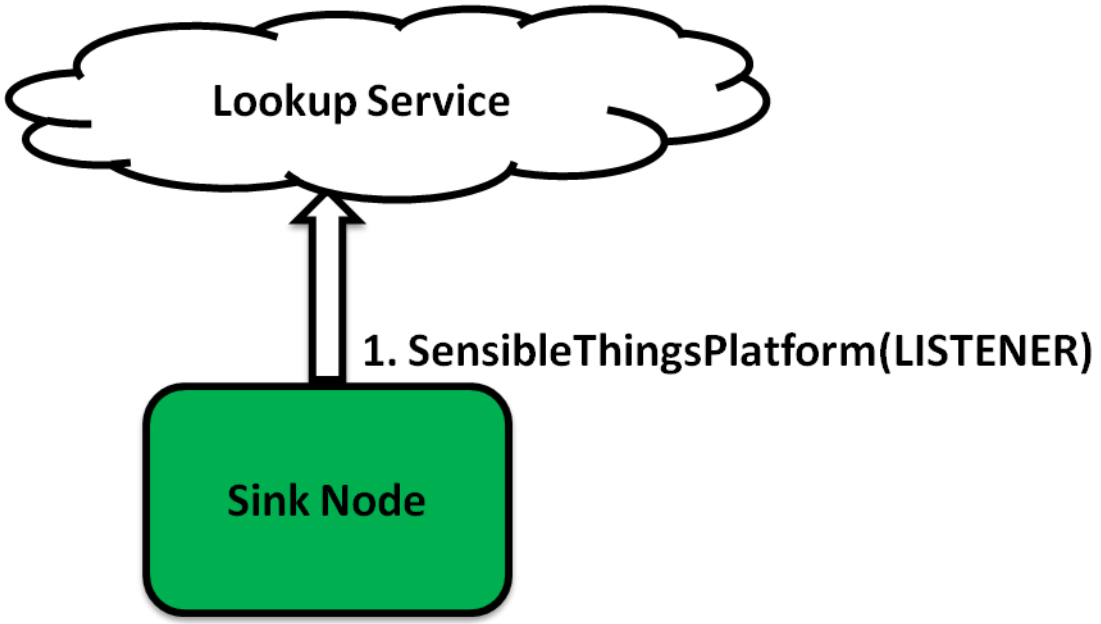
THE CODE

- The code is organized in layers (see paper for details)
  - Interface Layer
  - AddIn Layer
  - Dissemination Layer
  - Communication Layer
  - Sensor Layer

- But to create simple applications using the code
  - The only thing need to use is the interface layer
  - Called “SensibleThingsPlatform” in the code
  - For extended applications, you might want to use some add ins as well

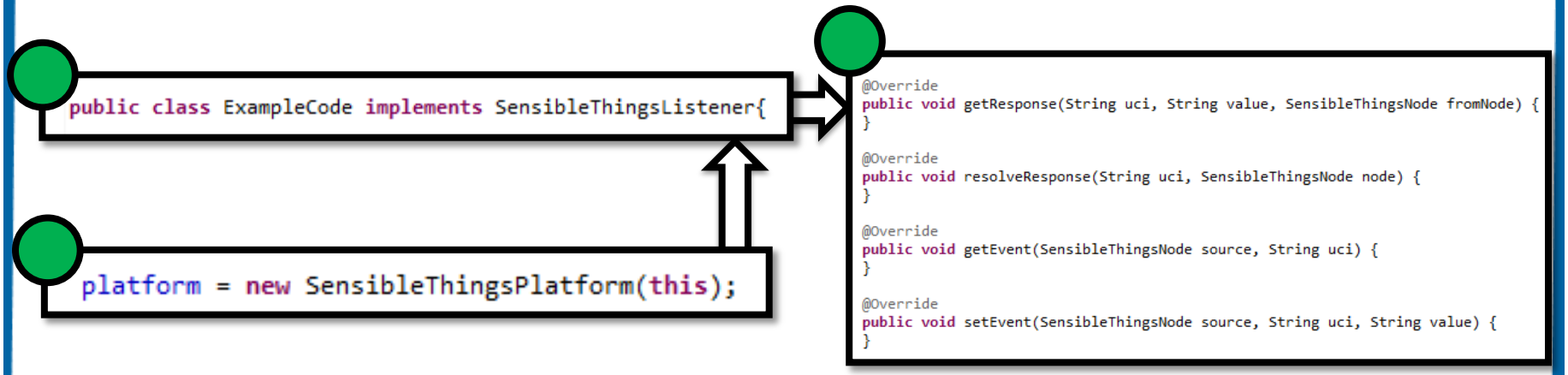
CODE TUTORIAL

- Illustrative figure for JOIN
  - 1. SensibleThingsPlatform(LISTENER)



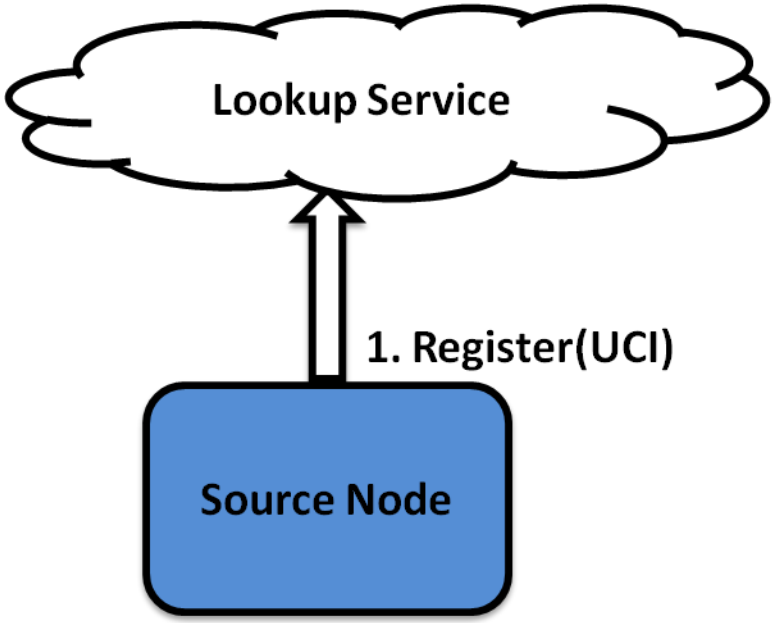
CODE TUTORIAL

- Implement SensibleThingsListener
  - To get callback functions
- Then start the platform using the constructor
  - With your SensibleThingsListener callback as the argument
  - This will use RUDP/DHT (or PROXY/DHT if behind NAT)



CODE TUTORIAL

- Illustrative figure for REGISTER
  - 1. Register(UCI)



CODE TUTORIAL

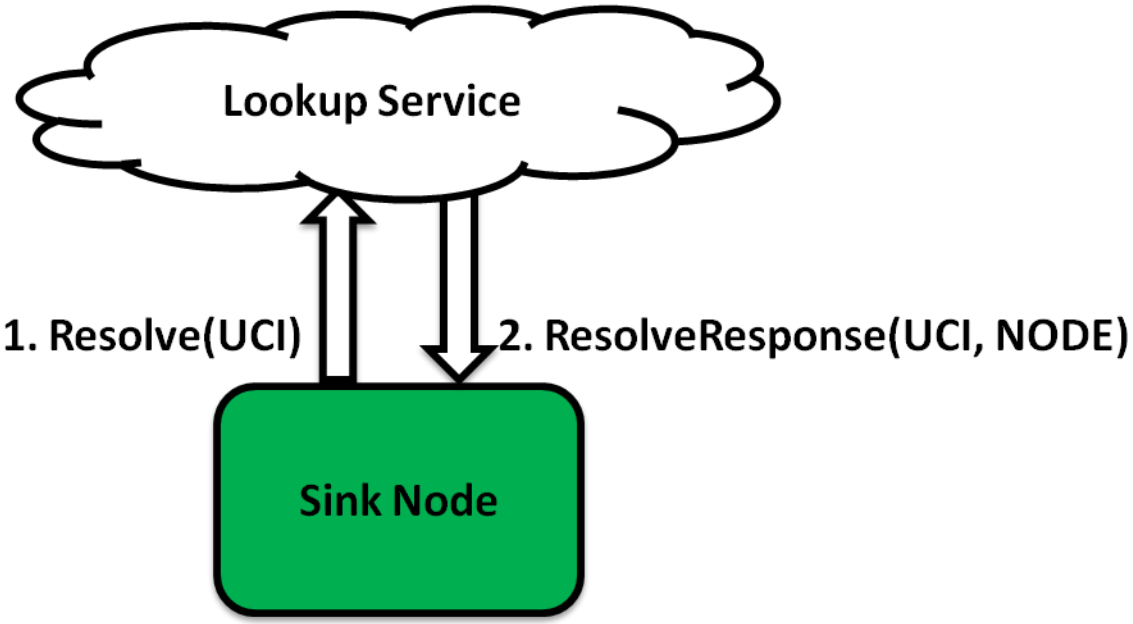
- Register a sensor using register

```
platform.register("example@miun.se/sensor");
```

- And it will now be available for resolving
  - By all nodes in the system

CODE TUTORIAL

- Illustrative figure for RESOLVE
  - 1. Resolve → 2. ResolveResponse



CODE TUTORIAL

- Resolve a sensor using resolve
  - Which will perform the lookup in the DHT

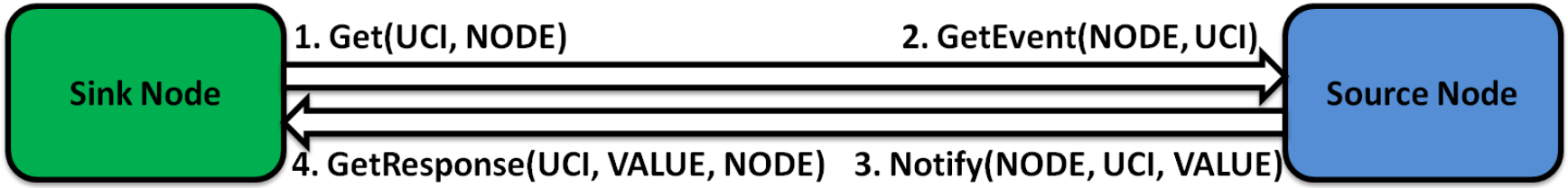
```
platform.resolve("example@miun.se/sensor");
```

- After the UCI have been resolved
  - It triggers the resolve response listener, with the results

```
@Override
public void resolveResponse(String uci, SensibleThingsNode node) {
}
```

CODE TUTORIAL

- Illustrative figure for GET
  - 1. Get → 2. GetEvent → 3. Notify → 4. GetResponse



CODE TUTORIAL

- After the resolve, we get the sensor value using get

```
platform.get(uci, node);
```

- This will trigger the GetEvent on the other side

```
@Override
public void getEvent(SensibleThingsNode source, String uci) {
```

- Send the sensor value back using Notify

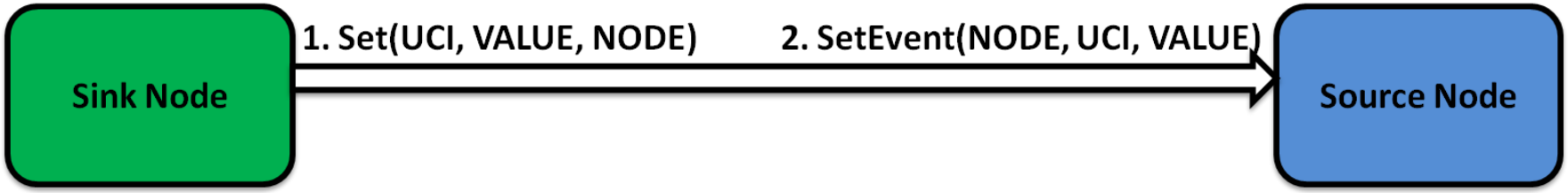
```
platform.notify(source, uci, value);
```

- Which triggers the GetResponse on the originating node

```
@Override
public void getResponse(String uci, String value, SensibleThingsNode fromNode) {
```

CODE TUTORIAL

- Illustrative figure for SET
  - 1. Set → 2. SetEvent



CODE TUTORIAL

- SET works in a similar manner

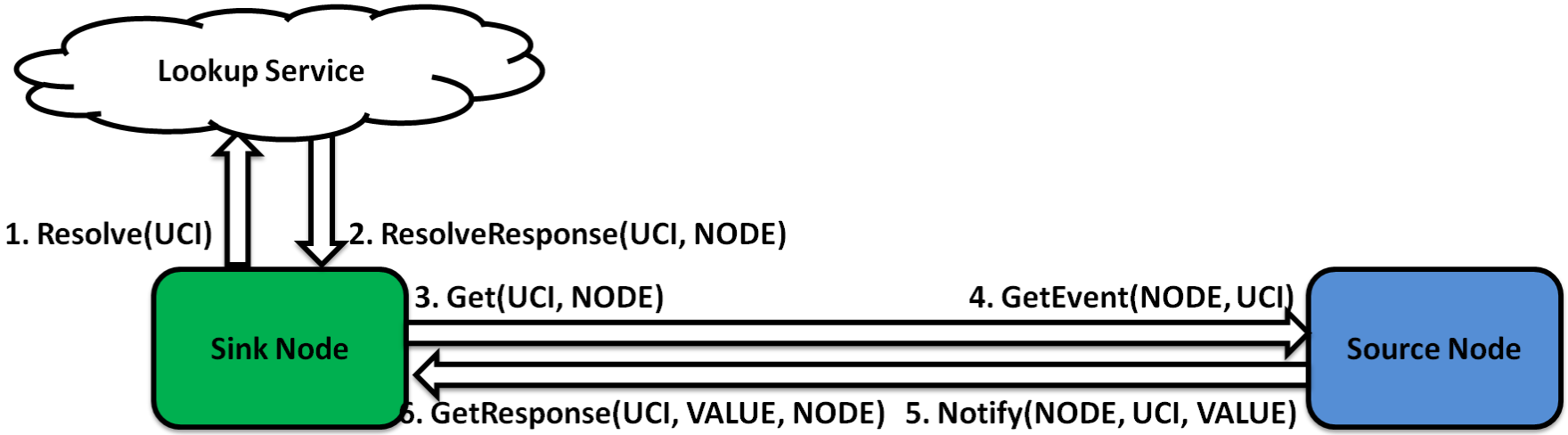
```
platform.set(uci, value, node);
```

- But triggers SetEvent on the other side instead

```
@Override
public void setEvent(SensibleThingsNode source, String uci, String value) {
}
```

CODE TUTORIAL

- Illustrative figure for a whole sequence
  - 1. Resolve → 2. ResolveResponse
  - 3. Get → 4. GetEvent → 5. Notify → 6. GetResponse



CODE TUTORIAL

- First we resolve

```
platform.resolve("example@miun.se/sensor");
```

- Which answers with a resolveResponse

```
public void resolveResponse(String uci, MediaSenseNode node) {
```

- Then we can call get

```
platform.get(uci, node);
```

- Which triggers a GetEvent on the other side

```
public void getEvent(SensibleThingsNode source, String uci) {
```

- The other side sends back a value with notify

```
platform.notify(source, uci, value);
```

- Which triggers a getResponse

```
public void getResponse(String uci, String value, SensibleThingsNode fromNode) {
```

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FAQ and Questions

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FAQ

- Problems with NAT, firewalls, etc.
  - All P2P systems generally have problems with NAT and firewalls
  - But in the latest versions of the platform
    - It will detect that you are behind NAT
    - And will tunnel you trough the NAT via a proxy
- This will effect performance
  - So for the pure experience, use public IP addresses
  - But this might be difficult, as most devices are behind NAT…
- The tunnel actually works quite good now
  - But it has problems with new messages types which it does know of
  - And ungraceful shutdowns takes ~30s to recover from

FAQ

- Add-ins are components that extend the platform
  - To add additional new functionality above the primitives
  - For example to enable caching, buffering, publish/subscribe, etc.
- All the add-ins use the add in manager
  - Simply create the add-in and new message types you want to use
  - And load it into the platform using the add-in manager
- If you want to create your own add-in
  - Simply create a class that implement either Extension or Optimization
  - And then create and load it as any other add-in
  - (Look at the source for the publish/subscribe add-in for a good example)

FAQ

- Encryption
  - The base version is unencrypted
    - All messages is sent is clear text
  - But it is possible to change to pure encrypted traffic
    - Simply use SSL or PROXY_SSL communication in the constructor to change
    - But the platform will be heavier to run and have a little worse response times

- Authentication
  - In the base version there is no real control over access control
    - Any other node can send you get/set-events
    - All you can do is observe the IP & port of the other node
  - But it is possible to enable simple authenticated access
    - Which uses a pre-shared-key scheme
    - See AuthenicationExtension for more details

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FAQ

- Java version
  - Current version is coded for Java 1.5
  - Which works on Android and other newer devices
- But it is possible to compile it to run on 1.4
  - Which is interesting for OSGI, and similar low end devices
  - To do this, you need to change some settings in Eclipse

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Thank You!

Contact Information
Lic. Eng. Stefan Forsström
E-Mail: stefan.forsstrom@miun.se

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