Living in a converged world - impossible without standards?

Dynamic Mobile Sensor Network Platform for ID-based Communication

Ved P. Kafle, Yusuke Fukushima, Hiroaki Harai

National Institute of Information and Communications Technology (NICT)
Tokyo, Japan
Outline

- Motivation
- Dynamic mobile sensor network platform
- Approach – proposal and extension of HIMALIS
- Implementation
- Operation scenarios
- Conclusion

*HIMALIS: Heterogeneity Inclusion and Mobility Adaptation through Locator ID Separation
Motivations – Limitations of current sensor networks

- **Application-specific**
  
  Network protocols and applications are in a package - difficult to change or add new applications

- **Static configuration**
  
  Difficult to change configuration after deployment: e.g., sensor data tx rate, reliability, security-level, access control
**Concept – Dynamic mobile sensor networks**

- **General-purpose**: Open API; easy to develop and use app, better interoperability, **remotely reconfigurable**
- **Better connectivity**: **Mobility**, multihoming support
- **Better control**: Access control, authentication, data **security**
Components – Proposed dynamic mobile sensor network platform

Big Data servers

Sensor Data

Sensor control command

Sensor admin

Sink Server

Internet

HIMALIS Gateway (HG)

Access Network

AP

Mobile Sensor Gateway (MSG)

Mobile Sensors (MS)

Sink Server

Big Data servers

Sensor Data

Sensor control command

Sensor admin

Internet

HIMALIS Gateway (HG)

Access Network

AP

Mobile Sensor Gateway (MSG)

Mobile Sensors (MS)
Approach – Extended HIMALIS architecture to sensors

HIMALIS overview –

- Introduction of **identity sublayer**
- Application and transport layers are independent of network layer
  - Mobility, multihoming, heterogeneity support
- Access and data **security**

---

HIMALIS ID-based secure and reliable communication

Each host is assigned with a hostname and ID

Store and provide hostname to ID, locator, security key mapping records

Peer authentication before starting data communication

ID-based communication

Upper layers

ID
102-304--1

ID
a01-be--100

Locators
192.168.0.200
10.32.230.5

e.g. IPv4 IP

IPv4

IPv6

Network layer

Network protocol translation

Multihoming

HIMALIS Gateway (HG)

Name Resolution Registry

HG

ch#nict.go.jp

mh#himalis.net

Multihoming

Locators
2001:db8::20
2001:5a:efd::2

Saint Petersburg, Russian Federation, 3-5 June 2014
ITU Kaleidoscope 2014 - Living in a converged world - impossible without standards?
• HIMALIS protocol stack in MS and MSG
  • For enabling ID-based communication in heterogeneous protocols (e.g., 6LoWPAN, IPv6, IPv4)
  • For remote control, configuration securely
  • For mobility support
ID-based communication in heterogeneous networks

**ID Tables**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>hostname</strong></td>
<td>~~~~~</td>
</tr>
<tr>
<td><strong>ID</strong></td>
<td>~~~~~</td>
</tr>
<tr>
<td><strong>Loc</strong></td>
<td>~~~~~</td>
</tr>
<tr>
<td><strong>key</strong></td>
<td>~~~~~</td>
</tr>
</tbody>
</table>

**Access Network (IPv6)**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ID</strong></td>
<td>~~~~~</td>
</tr>
<tr>
<td><strong>Loc</strong></td>
<td>~~~~~</td>
</tr>
<tr>
<td><strong>key</strong></td>
<td>~~~~~</td>
</tr>
</tbody>
</table>

**Internet (IPv4)**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IPv4</strong></td>
<td>IPv6</td>
</tr>
<tr>
<td><strong>IPv6</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Protocol conversion**

**Mobile Sensor Network (6LoWPAN)**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IPv6</strong></td>
<td>6LoWPAN</td>
</tr>
<tr>
<td><strong>6LoWPAN</strong></td>
<td></td>
</tr>
</tbody>
</table>

**HG**

**MSG**

**Sink**

Title: Living in a converged world - impossible without standards?
Remote control/configuration of mobile sensors

- Commands for status monitoring (e.g., sampling rate, tx rate, current reading, power-level), reconfiguration
- Sensor admin can send control commands in two ways:
  - 1. via sink server (sink acts as a security hub, common control)
  - 2. directly (by using HIMALIS secure communication)
Four mobility scenarios supported

1. **MS mobility across sensor networks**
   - MS can move between MSGs

2. **MSG mobility**
   - MSG can move alone or with MSs

3. **Session mobility in heterogeneous links**
   - MSG (multihoming) can switch links in heterogeneous networks

4. **Sink or admin mobility**
   - Sink or admin can move while getting sensor data or sending control commands

---

Saint Petersburg, Russian Federation, 3-5 June 2014
ITU Kaleidoscope 2014 - *Living in a converged world - impossible without standards?*
Implementation and operation
MS, MSG prototype development

**MSG**
- Android Tablet
- HIMALIS Stack
  - Android 4.2.2
- SensorGW App
- XBee/External WiFi

**MS**
- Raspberry Pi
- Sensor App
- HIMALIS Stack
  - Raspbian 3.2.27
- Light, Temp, Pressure, Humidity sensors
- Battery

**Dimensions**
- Front: 230mm
- Back: 121mm
- 55mm
- 85mm
- 85mm
- 160mm

Saint Petersburg, Russian Federation, 3-5 June 2014
ITU Kaleidoscope 2014 - Living in a converged world - impossible without standards?
Sensor control panel

Start Sensor Data Uploading

- **Hostname**: mobilesensor14#hnr.tr1.himalis.net
- **SamplingRate**: 3 (sec)
- **Temperature**: ON, 3 (sec)
- **Humidity**: ON, 9 (sec)
- **Pressure**: OFF
- **Illuminance**: ON, 3 (sec)

Start
Sensor data viewer

User

Sink

MSG

MS

Sensor data viewer

Sensor data

temperature

humidity

pressure

illuminance

Saint Petersburg, Russian Federation, 3-5 June 2014
ITU Kaleidoscope 2014 - Living in a converged world - impossible without standards?
Conclusion and future work

Presented the design and implementation of the ID-based communication supporting dynamic mobile sensor network

New features:

• **Remotely reconfigurable** sensor network
• **Reliable connectivity** through mobility and multihoming
• General-purpose **open API** in sensor nodes

Future work

• **Standardization**, optimization, application development
## Related standards and potential new topics

### Related standards:

- **ITU-T Y.3001** (FN objectives and design goals),
- **ITU-T Y.3031** (ID-based communication framework in FN),
- **ITU-T Y.3032** (ID and locator mapping mechanism in FN),
- **ITU-T Y.2221** (USN application and services requirements),
- **IEEE 1888** (sensor data storage format)

### Potential new topics for standardization:

1. Interfaces between sensing, computation and communication units
2. Light-weight authentication and access control methods for mobile sensors
3. Methods for ID-based communication in heterogeneous network protocols, e.g., extension to ITU-T Y.FN-heteronet (WP3/13)
Thank you!

We are open to collaborate with partners for research, development and standardization of ID-based communication in mobile sensor networks.

Contact: Ved P. Kafle  
kafle@nict.go.jp