ZigBee vs. 6LoWPAN

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Introduction

ZigBee vs. 6LoWPAN

- Both are often compared
- Sometimes it is reported that one replaces the other
- We briefly introduce their characteristics and differences
802.15 is the IEEE’s working group for Wireless Personal Area Networks (WPAN)

802.15.4 firstly considered low power consumption and low data rates

- only defines physical and data link layer
- data transfer rates between 20 and 250kbps
- Carrier Sense Multiple Access (CSMA) for channel sharing
- maximum payload of 127 bytes in physical layer
ZigBee

- Created in 2004 by the ZigBee Alliance
- Based on IEEE 802.15.4
- Very popular in the home automation domain
- Different frequency bands
  - 2.4 GHz (global ISM)
  - 915 MHz (North America)
  - 868 MHz (Europe)
- **End Manufacturer**
  Used by developers for own application

- **ZigBee**
  NWK layer alongside ZigBee services

- **IEEE 802.15.4**
  MAC and PHY layers

**Figure:** Stack structure of ZigBee[1]
ZigBee Device Types

- **End Devices**
  Simple sensor nodes with reduced functionality

- **Network Coordinator**
  Central brain of the network

- **Router** *optional*
  Used to create multihop networks

- **Gateway** *optional*
  Serves as a bridge to another technology

- **Trust Center**
  Responsible for the security features
ZigBee Topologies

Figure: Possible ZigBee Topologies[2]
ZigBee Characteristics (1)

- **Reliable**
  - End-to-End ACK with retransmission
  - Controlled redundancies possible

- **Interference Avoidance**
  - Interference likely
  - Spread spectrum
  - Switch channel

- **Global Implementation**
  - Almost globally accepted
  - Different bandwidths in different countries
ZigBee Characteristics (2)

- Long Battery Life
  - End-devices sleep most of the time
  - Up to multiple years
- Low Cost
  - Simple and flexible platform
  - Low energy consumption
- Security
  - Strong encryption and authentication on multiple layers
  - Different key types used
- Scalable
  - Single network: 255 nodes
  - Interconnected networks: 65,525 nodes
ZigBee Application Areas

- Personal Health Care
  - Increasing population age
  - Health and fitness monitoring

- Home Automation
  - Widespread use already
  - Cost-efficient and easy to use

- ZigBee Smart Energy
  - Better visualisation for users
  - Use energy more efficiently
IPv6 over low-power wireless personal area networks
based on IEEE 802.15.4
offers IP-based networking on wireless embedded devices
described by the Internet Engineering Task Force (IETF) in 2007
enabling technology for the Internet of Things (IOT)
6LoWPAN Architecture

- **Transport Layer**
  - User Datagram Protocol (UDP)
  - Internet Control Message Protocol (ICMP)

- **Network Layer**
  - IPv6

- **Adaption Layer**
  - ensure interoperability between IPv6 and LoWPAN networks
  - packet fragmentation
  - header compression
  - edge routers / gateways

- **IEEE 802.15.4**
  - MAC and PHY layers

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**Figure: 6LoWPAN Protocol Stack**

<table>
<thead>
<tr>
<th>Application protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPv6</td>
</tr>
<tr>
<td>LoWPAN</td>
</tr>
<tr>
<td>IEEE 802.15.4 MAC</td>
</tr>
<tr>
<td>IEEE 802.15.4 PHY</td>
</tr>
</tbody>
</table>
6LoWPAN Architecture

Figure: 6LoWPAN Architecture[3]
6LoWPAN Characteristics

- **Scalability**
  - very good due to adaption layer

- **Mobility**
  - advantageous usage of IP-mobility

- **Manageability**
  - Simple Network Management Protocol (SNMP) in application layer

- **Interference**
  - vulnerable to link failures because of shared communication band

- **Security**
  - AES-128
  - ongoing research
6LoWPAN Application Areas

- Industrial Monitoring
  - Process Monitoring
  - Machine Surveillance
  - Supply Chain Management
- Health Care
  - Wearable Remote Control
  - Tele-Assistance
- Disaster Management
## Comparison

<table>
<thead>
<tr>
<th>Feature</th>
<th>Zigbee</th>
<th>6LoWPAN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Security</strong></td>
<td>AES-128 plus application layer security</td>
<td>AES-128</td>
</tr>
<tr>
<td><strong>Scalability</strong></td>
<td>255 single network 65535 interconnected</td>
<td>high</td>
</tr>
<tr>
<td><strong>Reliability</strong></td>
<td>ACK, retransmissions, link quality estimators</td>
<td>simple 16bit checksum mechanism</td>
</tr>
<tr>
<td><strong>Power Consumption</strong></td>
<td>low</td>
<td>medium</td>
</tr>
<tr>
<td><strong>Network Management</strong></td>
<td>medium</td>
<td>high with <em>SNMP</em></td>
</tr>
<tr>
<td><strong>Data Rate</strong></td>
<td>250kbps</td>
<td>20 - 250kbps</td>
</tr>
<tr>
<td><strong>Application Types</strong></td>
<td>home automation, building automation</td>
<td>health care, industrial monitoring</td>
</tr>
<tr>
<td><strong>Network Topology</strong></td>
<td>star, tree, mesh</td>
<td>mesh</td>
</tr>
<tr>
<td><strong>Network Routing</strong></td>
<td><em>AODV</em> and tree routing</td>
<td>ad-hoc on-demand distance vector routing and dynamic <em>MANET</em> on-demand routing</td>
</tr>
</tbody>
</table>

*Table: Comparison of Zigbee and 6LoWPAN[3]*
Which is the better protocol?

- It wouldn’t make sense to pick a "winner"
Summary

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- Heavily depends on use-case
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Which is the better protocol?

- It wouldn’t make sense to pick a "winner"
- Heavily depends on use-case
- Both will be around for quite some time
Summary Examples

**Building Automation**
ZigBee
because of its widespread use in existing building equipment

**Disaster Management**
6LoWPAN
because of the direct internet connectivity via IPv6

**Industrial Applications**
Neither ZigBee or 6LoWPAN
because of the lack QoS support and interference evasion features
*WirelessHART may be a better option*
