ZigBee Application Profiles

Phil Jamieson, ZigBee AFG Chair

ZigBee Open House, Tokyo, Japan, February 28th, 2008
Why Do We Need Profiles?

■ Need a common language for exchanging data
■ Need a well defined set of processing actions
■ Device interoperability across different manufacturers
■ Simplicity and reliability for the end users
■ Consumer flexibility for products
■ Allows solid conformance test programmes to be created
■ Realistic application specifications developed through OEM experience
What is a Profile?

**Part 1: profile specification**
- A set of devices required in the application area
- A set of clusters to implement the functionality
  - A set of attributes to represent device state
  - A set of commands to enable the communication
- Specification of which clusters are required by which devices
- Specific functional description for each device

**Part 2: profile test specification**
- Set of PICS* for device conformance specification
- Set of test cases for conformance testing

*PICS – Protocol Implementation Conformance Statement*
Profile Classes

■ Public profiles
  ► For generically useful applications
  ► Developed publicly by members of the ZigBee Alliance
  ► Managed within the Application Framework Working Group
  ► Development follows the profile lifecycle
  ► Enables products to undergo logo certification so that the ZigBee logo can be used

■ Manufacturer specific profiles
  ► For manufacturer specific proprietary applications
  ► Developed privately by individual manufacturers
  ► Manufacturer specific profiles must use a ZigBee allocated profile identifier
  ► Commercial products built using manufacturer specific profiles must undergo network capable testing
Profile Development Lifecycle

Pre-development

Gauge interest
Profile study group formed
Call for interest

Development

Develop MRD
Profile task group formed
MRD complete

Develop TRD
TRD complete

Develop draft specification
Profile specification complete

Develop ZCL extensions
ZCL extensions complete

Define compliance test program
Compliance program complete

Qualification & certification

Demonstrate interoperable implementations
Profile complete, ratified products appear
The ZigBee Cluster Library (ZCL)

- ZigBee cluster library specifies functional domains
- Each specification specifies the cluster sets for that functional domain
- Each specification defines mandatory & optional clusters, attributes, commands and functional descriptions
- Explicit device descriptions are not defined

- ZigBee profiles specifies application domains
- Each profile collects related elements from the cluster library into application domains
- Each profile defines device descriptions for each required device
- Each profile specifies the cluster identifiers for each cluster used from the cluster library
ZCL Clusters

- **General**
  - Basic
  - Power configuration
  - Device temperature configuration
  - Identify
  - Groups
  - Scenes
  - On/off
  - On/off switch configuration
  - Level control
  - Alarms
  - Time
  - RSSI location

- **HVAC**
  - Pump configuration and control
  - Thermostat
  - Fan control
  - Dehumidification control
  - Thermostat user interface configuration

- **Lighting**
  - Color control
  - Ballast configuration

- **Security**
  - IAS Zone
  - IAS ACE
  - IAS WD

- **Measurement & sensing**
  - Illuminance measurement
  - Illuminance level sensing
  - Temperature measurement
  - Pressure measurement
  - Flow measurement
  - Relative humidity measurement
  - Occupancy sensing

- **Closures**
  - Shade configuration
ZCL: Incremental Specification

- General cluster for basic manipulation and common tasks
- Mandatory clusters for fundamental functionality
- Optional clusters for enhanced functionality
  - E.g. Turning a residential sensor into a commercial sensor
- Proprietary extensions can be added by individual manufacturers
Profiles in Progress

- Commercial Building Automation (CBA)
- Home Automation (HA)
- Personal, Home and Hospital Care (PHHC)
- Smart Energy (SE)
- Telecom Applications (TA)
- Wireless Sensor Applications (WSA)

- Future profiles proposed by member companies…
Commercial Building Automation (CBA)

■ Scope & Purpose
  ► Applications targeted at a commercial building environment. Such an environment may: have a coverage area of up to 100,000 square feet or more; be typically professionally managed; buildings may have unrestricted access, with attendant security implications; inter-working with an installed base of existing products on other networks (e.g. BACnet) need to be considered.

■ Status
  ► Market Requirements Document Complete
  ► Profile Specification Complete
  ► Test Program In Progress
CBA: Example Devices

■ Ballast Unit
  ► Allows the control of a light source within a lighting fixture. Basic control functionality is on/off, dim up/down, set light level. Control can be via sensors, from a switch or a remote control.

■ Commissioning Tool
  ► Allows the lighting system functionality to be built into a system of installed lighting devices, i.e. which switch controls which ballast.

■ Sensors
  ► Allows automatic feedback to ballast units to control the light level. Typical sensors could be occupancy or light level.

■ Thermostat
  ► The Thermostat device can have either built-in or separate sensors for temperature, humidity or occupancy. It allows the desired temperature to be set either remotely or locally. The thermostat may send heating and/or cooling requirement notifications to a heating/cooling unit (e.g. an indoor air handler) or may include a mechanism to control a heating or cooling unit directly.
CBA: Professional Lighting Systems

- Lighting Ballast
- Occupancy Sensor
- Wall Switch
- System Commissioning
- PDA Controller
- Lighting Management System
Home Automation (HA)

- Scope & Purpose
  - Applications for the residential automation market to allow OEMs to produce products that will meet the needs of customers ranging from DIY homeowners to professional installers.

- Status
  - Market Requirements Document: Complete
  - Profile Specification: Complete
  - Test Program: Complete
## HA: Devices

### Generic
- On/off switch
- Level control switch
- On/off output
- Level controllable output
- Scene selector
- Configuration tool
- Remote control
- Combined interface
- Range extender
- Mains power outlet

### HVAC
- Heating/cooling unit
- Thermostat
- Temperature sensor
- Pump
- Pump controller
- Pressure sensor
- Flow sensor

### Lighting
- On/off light
- Dimmable light
- Color dimmable light
- On/off light switch
- Dimmer switch
- Color dimmer switch
- Light sensor
- Occupancy sensor

### Intruder alarm systems
- IAS control and indicating equipment
- IAS ancillary control equipment
- IAS zone
- IAS warning device

### Closures
- Shade
- Shade controller
HA: Home Control

TV/Display

Set-top-box

Lighting

Switches

Security

Closures

Heating/cooling

Remote access
Scope & Purpose

- The PHHC profile will be used by all the devices which jointly cooperate to fulfil the requirements of a non-invasive health care application. The devices involved in a health care application could be separated in medical devices (blood pressure monitor, oxygen saturation monitor, EEG, etc.) and non-medical devices (gateway, cell phone, light system, etc.). The health care application use cases presented in this document can be logically separated into the following categories:
  - Chronic disease monitoring
  - Personal wellness monitoring (ensuring an individual's wellness and safety)
  - Physical fitness

Status

- Market Requirements Document: Complete
- Technical Requirements Document: Complete
- Profile specification: In progress
PHHC: Example Devices

- **Data Collection Unit**
  - The Data Collection Unit (DCU) gathers the data from the different on-body medical and non-medical devices and delivers it to a gateway. The DCU might perform some local aggregation and/or compression before sending the data to a gateway. Typically, a DCU is a portable device that is more capable than the on-body devices (medical or non-medical). Its functionality could be integrated into a mobile device such as a PDA or phone.

- **Electrocardiograph**
  - This is a device that records and measures the electrical activity of the heart over time. The frequency of measurement is a few times a day, or continuously for periods of a few hours in some use cases.

- **Pulse Monitor**
  - A pulse monitor measures a proxy value for the heart rate. For healthy persons, the value of this measure is an accurate measure for the heart rate. The frequency of measurement varies from a few times per second to a small number of times per day.

- **Sphygmomanometer**
  - A sphygmomanometer (blood pressure meter) is a device that measures the blood pressure. Typically, the frequency of measurement is several times a day.
PHHC: Patient Monitoring

- Heart rate monitor
- SpO₂ monitor
- Hand held diagnostic tool
- Blood pressure monitor
- Data collection unit
- Nurses station
Smart Energy (SE)

■ Scope & Purpose
  ► Applications for two-way communications of metering data and energy management to provide more efficient and reliable energy usage. Goes beyond automated meter reading to demand-response systems for real-time pricing and voluntary load shedding.

■ Status
  ► Market Requirements Document Complete
  ► Technical Requirements Document Compete
  ► Profile specification Complete
  ► Test program In progress
SE: Example Devices

- **Energy Services Portal**
  - The Energy Services Portal connects the energy supply company communication network to the metering and energy management devices within the home. It may be installed within a meter, thermostat, in-premise display, or may be a standalone device, and it will contain another non-ZigBee communication module (e.g. power-line carrier, RF, GPRS).

- **Metering End Device**
  - The Metering End Device is a meter (electricity, gas, water, heat) that is fitted with a ZigBee device. Depending on what is being metered the device may be capable of immediate (requested) reads or it will send autonomously readings periodically. A Metering End Device may also be capable of communicating certain status indicators (e.g. battery low, tamper detected).

- **In-Premise Display**
  - The In-Premise Display will relay energy consumption data to the user by way of a graphical or text display. The display may or may not be an interactive device. At a minimum it will show current energy usage, a history over selectable periods, billing information and efficiency data. The display may also show critical pricing information to advise the customer when peaks are due to occur so that they can take appropriate action.

- **Others**
  - Extension of Home and Commercial Building Automation devices for use with Ami services such as load shedding.
ZigBee helps extend the infrastructure of Advanced Metering beyond meter reading to include two way communications.

Makes possible:
- Improved grid reliability and efficient energy delivery
- Two-way communication between utility and customer
- Real-time pricing and true competition in the energy market
- Enhanced consumer control over balance between lifestyle and budget
Telecom Applications (TA)

■ Scope & Purpose
  ► The profile will be applied in telecom value-added services and supplementary services to enhance and fulfill the telecom network functions, and it also includes some applications integrated with some mobile terminals and plug-in modules.

■ Status
  ► Market Requirements Document Complete
  ► Technical Requirements Document Complete
  ► Specification In progress
TA: Example Devices

- **ZigBee Mobile Terminal**
  - ZigBee Mobile Terminal will integrate functions of a general mobile device and functions of a ZigBee device into one single device. Note a general mobile device could be a cellular phone, a PDA, a Wi-Fi phone or a WiMax phone in the future.

- **ZigBee SIM Card**
  - ZigBee SIM Card is a Subscriber Identity Module (SIM) card providing ZigBee functionalities such as wireless short-range connection, secure data transfer and profile functions (deriving from TA Profile or other ZigBee profiles).

- **ZigBee Point-of-Sales**
  - ZigBee Point of Sales (ZigBee POS) is a device that can be used for payments services (e.g. mobile payments). It can communicate to ZigBee TA profile devices like ZigBee Mobile Terminal and ZigBee SIM card in order to operate payment transactions or deliver an electronic product code to complete required payment operations.
TA: Information Delivery

Remote Server

Operator Network

SubNet 1

SubNet 2

SubNet 3

Client

ZigBee Access Network

Cellular Access Network

ZigBee Access Point

ZigBee Mobile Terminal or ZigBee SIM card
Scope & Purpose

This profile is designed to enable wireless sensor network (WSN) applications. Three distinct applications are defined that can be categorized as WSN applications:

- Environmental Monitoring of either indoor or outdoor areas
- Asset Tracking of mobile tagged-things or persons
- Structural or Machine Monitoring

Installation scenarios may include areas with little or no infrastructure such as networks that are deployed outdoors, or as temporary installations. In such situations, the assumption of a powered backbone is no longer tenable. The nodes themselves should be capable of battery powered routing or forwarding of their neighbors’ data to one or more centralized collection points. Note that with sensor data, the key assumption is that the data must be collected and pulled out of the network.

Status

- Market Requirements Document: Complete
- Profile Specification: In Progress
WSA: Example Devices

- Acoustic/Ultrasonic Output Device
  - This device shall have the ability to produce an audible signal for alarming or acoustic ranging applications. An acoustic output device could satisfy the need for a simple user interface or provide output during an actuation process. The intent is to only incorporate an acoustic output device on select nodes in the network.

- Binary Output Device
  - This generates an output state of either 1 or 0. It may be latching or pulsed. The binary output device could satisfy the need for a simple user interface or provide output during an actuation process. The intent is to only incorporate the binary output device on select nodes in the network.

- Sensors
  - Sensors measure one of several parameters, and either report the measurement to other devices either periodically, or when they are queried. There are a wide range of sensor types, some of which are already available in the ZCL.
WSA: Sample Applications

Agricultural sensing

Asset tracking

Structural monitoring
Summary

Profiles Organisation
- Can be public or manufacturer specific
- Public profile development follows a well defined procedure
- The ZigBee Cluster Library provides a repository of functionality
- Profiles are built incrementally
- Manufacturer specific extensions can be added

Profiles in Development
- Commercial Building Automation
- Home Automation
- Personal, Home & Hospital Care
- Smart Energy
- Telecom Applications
- Wireless Sensor Applications
Any Questions?