



Dynamic Integration of Zigbee Home Networks into Home Gateways Using OSGi Service Registry

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Abstract



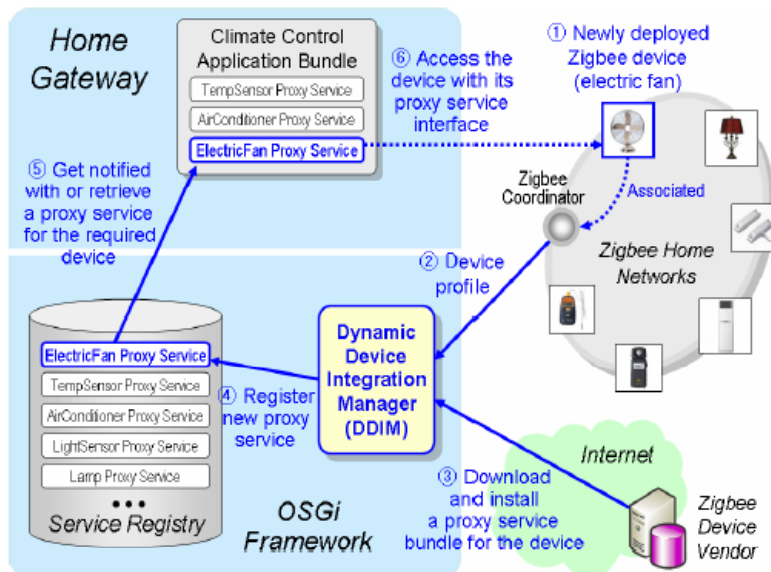
- Zigbee has become the most promising for wireless home networking.
- It is essential functionality in home gateway system that is interoperation between Zigbee and home network devices.
- This paper proposed an effective architecture for above mentioned by OSGi.
- The architecture can support flexible interoperability between applications and Zigbee consumer devices.





Introduction

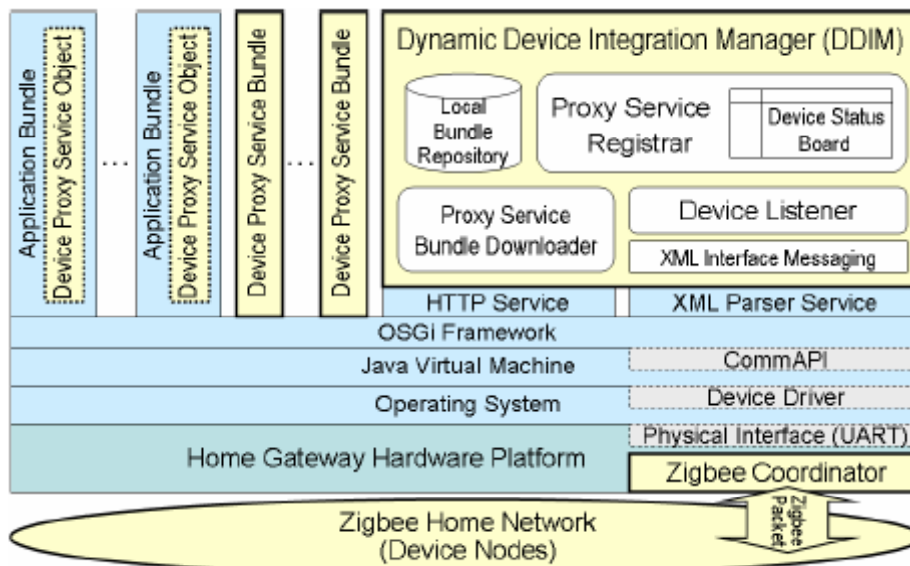
- OSGi is a framework, It can present device proxy service and modify service dynamically.
- Proxy service can be downloaded automatically, install, and registered in the OSGi service registry by dynamic device integration manager (DDIM).



The Architecture



- Architecture consists of the DDIM, proxy service bundles, application bundle, Zigbee network coordinator, device nodes.



Zigbee Home Networks(1/2)



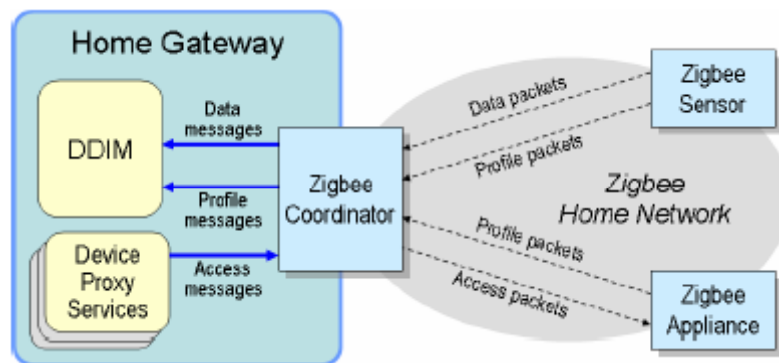
- Zigbee home network consists of a coordinator and devices nodes.
- Coordinator is a special node that manages the entire Zigbee network. It can acts a gateway or sink node that collects data from sensor nodes.
- Zigbee device send a packet to coordinator that contain profile, and coordinator encodes the data stored in the packet into the XML message.



Zigbee Home Networks(2/2)



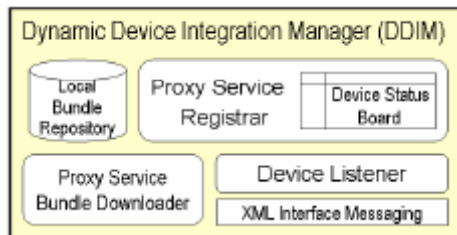
- DDIM will get a XML message from coordinator, it contain device profile, device access, and sensor data message.
- Device profile is generated from the Zigbee appliance and sensor, it announce the existence of Zigbee device.
- Sensor data message is generated from Zigbee sensor, device access message is generated by proxy service.



DDIM



- DDIM is the core component of the architecture, and it consists of service registrar, device status board, a bundle repository, device listener, and a bundle downloader.



- Its work procedure consists of service registration and device access, access sensor data, and un-registration of Zigbee network device.

Service Registration and send to Device(1/2)

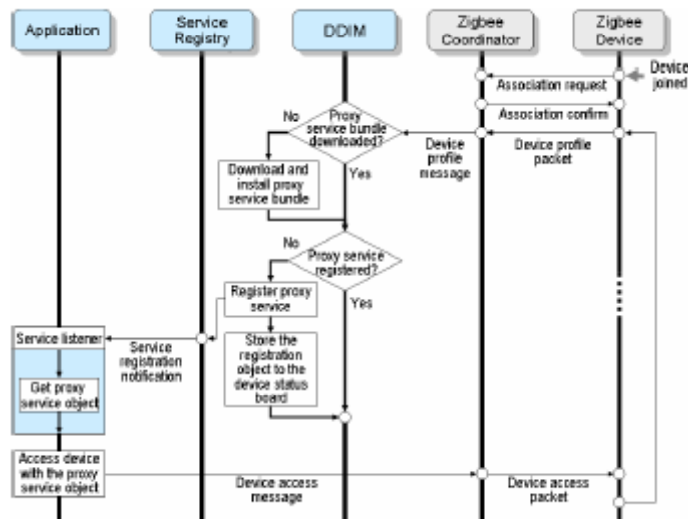


- The procedure to register a service for a newly deployed Zigbee device and access the device with the service.
- When DDIM get a new XML message, device listener interprets the message and notify service registrar
- If a device bundle is not stored in the repository, the downloader will download the newly bundle from vendor's site, and it will stored into repository.

Service Registration and send to Device(2/2)



- When service is registered, registrar stores the resulting on the device status board.
- Application can get service object and send to device by listeners.



Access Sensor Data

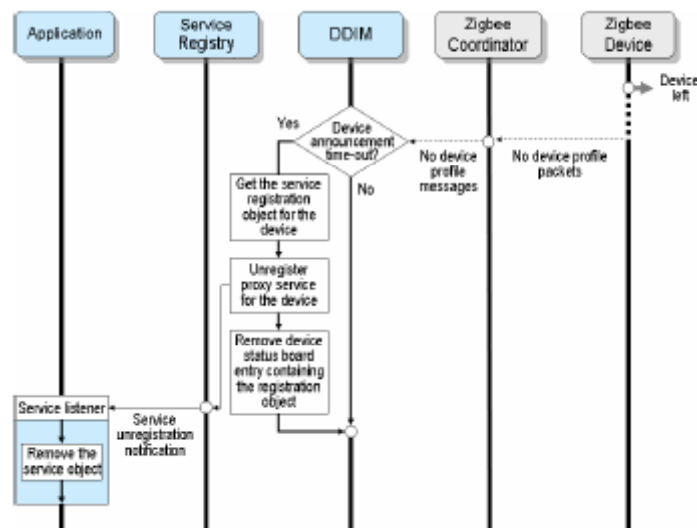


- When DDIM get XML message(contain Sensor data), the registrar retrieves service object and update value from status board.
- Application is notified that new value from sensor, and get the value by invoking appropriate data read method of service object.
- Status Board maintains registration information, and its time stamps updates on receiving a periodic profile packet.

Un-registration of Device Proxy Services



- When device disconnect from Coordinator, it can't send profile packets to Coordinator periodically.
- Registrar checks the time stamp of the status board, if there are no updates, it will un-registers the proxy service and removes entry on the status board.



Zigbee Network Device and Applications



- Registration can notify application that should to get proxy service object and access to corresponding device through Coordinator.
- There have a filter criteria by the device profile, the message can describe position or type for the Zigbee device.

```
<devProfile>
  <devID>10:aa:03:00:00:fa:00:01</devID>
  <objectClass>ddim.sensor.TempSensor</objectClass>
  <netAddr>00:03</netAddr>
  <devPosition>LivingRoom</devPosition>
  <vendorURI>http://www.vendor.com</vendorURI>
  <bundleURL>ftp://vendor.com/down/temp_sens.zip</bundleURL>
</devProfile>
```

Implementation Environment(1/3)



- There use a prototype home gateway system was built on a laptop PC equipped with Zigbee Coordinator module.
- There have a home network applications need to experimental for climate control and home security.

Prototype home gateway system
(laptop PC with OSGi framework)

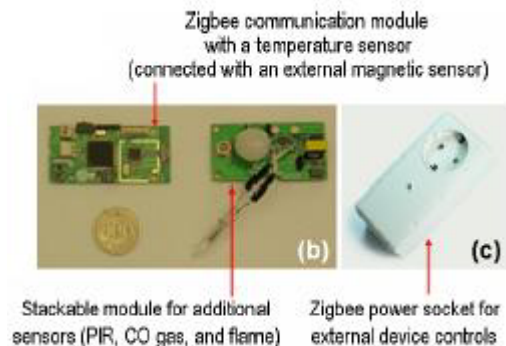


Zigbee coordinator



Implementation Environment(2/3)

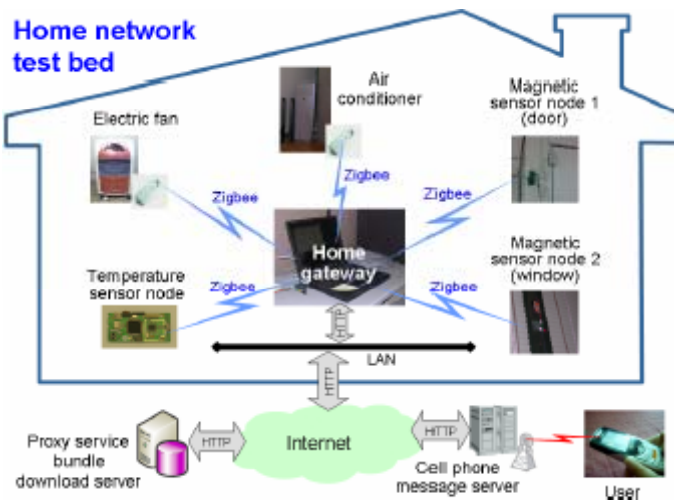
- The Zigbee sensor used in the experiments is consist of a main communication module and an additional sensor that is stackable on the main module.
- The main module can act as a temperature sensor by itself, it can act magnetic door sensor when connected to external magnetic sensor.
- To control non-Zigbee device(ex: air conditioner, electric fan) though wireless power sockets.



Implementation Environment(3/3)



- For the home security application, two Zigbee magnetic sensor were used, one sensor was attached to door and the other was attached to the window of the tested.
- The gateway system can download the service bundle and send an alarm message to user by Internet.



Experiments and Results(1/3)



- In the first experiment, the home security application monitored the security status with proxy service for the magnetic door sensor.
- When the door was opened, the sensor sent a packet to coordinator and application was notified that property of service was modified.
- Application send an intrusion alarm message to user through cell phone message server.



Experiments and Results(2/3)



- In second experiment, the climate control application monitored the current temperature of the environment, it retrieved data packet from the temperature sensor.
- If the temperature exceeded a predefined limit, the application try to retrieve air-conditioner service from registry.



Experiments and Results(3/3)



- When a new magnetic sensor is deployed to the window, application is notified by registration of another service.
- Then the application read the property value of service and automatically got ready to detect the window by new sensor
- When a electric-fan is newly deployed to the environment, proxy service was downloaded from server.
- Application was automatically notified from registration of proxy service and turn on the electric fan by invoking the method of the proxy service.

Conclusion



- The architecture has to prove its feasibility and effectiveness, it is expected to contribute to the development more and more. (ex: automotive, office)
- The current priority for architecture is to enhance its security, if some service contain malicious code, it is danger for your home gateway.