BACdroid
A versatile platform for building automation

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Agenda

- BACnet in a nutshell
- BACdroid – BACnet stack on Android
- Integration scenarios in building automation
- CCTV example use case
- Conclusion & outlook
Building automation

Lighting, Shading

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Building automation

Heating, Ventilation, Air Conditioning
Building automation

Security & Safety

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Building automation

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BACnet in a Nutshell

- Communication protocol for „Building automation and control network“
- Vendor independent
- Defines network view and topology for process- and control data (HVAC, Lighting, Security, Safety)
- Defines services for data access
- User application „out of scope“
- Typically used in management and automation tier
1987: Start of development by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)


2003: First ISO 16484-5
Building Automation and Control Systems (BACS) – Part 5: Data Communication Protocol

Continuously developments and additions to the current standard (BACnet addendum)

BACnet networks are local networks

- Typically small messages are exchanged
- Low protocol overhead
- Sequence control, segmentation, flow control → application layer
- Various transport media possible
- BACnet/IP uses BACnet Virtual Link Layer on top of UDP/IP
Physical segments are extended using repeaters.

Physical Segments are connected using bridges forming a network with single MAC address domain.

Multiple networks are connected through routers forming a BACnet Internetwork, probably with different transport media (Ethernet, MS/TP, Lon, BACNet/IP,..:) used by the networks.
Process and control data is represented through objects

Application layer service provides access to the data and additional functionalities, for example alarm or management features.

User application not defined

No API defined
Generic standardized BACnet object types, e.g., Binary Input Object Type:

<table>
<thead>
<tr>
<th>Property Identifier</th>
<th>Property Datatype</th>
<th>Conformance Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object_Identifier</td>
<td>BACnetObjectIdentifier</td>
<td>R</td>
</tr>
<tr>
<td>Object_Name</td>
<td>CharacterString</td>
<td>R</td>
</tr>
<tr>
<td>Object_Type</td>
<td>BACnetObjectType</td>
<td>R</td>
</tr>
<tr>
<td>Present_Value</td>
<td>BACnetBinaryPV</td>
<td>R</td>
</tr>
<tr>
<td>Description</td>
<td>CharacterString</td>
<td>O</td>
</tr>
<tr>
<td>Device_Type</td>
<td>CharacterString</td>
<td>O</td>
</tr>
<tr>
<td>Status_Flags</td>
<td>BACnetStatusFlags</td>
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</tr>
<tr>
<td>Event_State</td>
<td>BACnetEventState</td>
<td>R</td>
</tr>
<tr>
<td>Reliability</td>
<td>BACnetReliability</td>
<td>O</td>
</tr>
<tr>
<td>Out_Of_Service</td>
<td>BOOLEAN</td>
<td>R</td>
</tr>
<tr>
<td>Change_Of_State_Time</td>
<td>BACnetDateTime</td>
<td>O</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Services

- Client/server based confirmed and unconfirmed services
- Service groups (alarm and event services, file access services, object access services, remote device management services, virtual terminal services)
- Example - object access service provides the generic operations `CreateObject`, `DeleteObject`, `ReadProperty`, `WriteProperty`, `AddListElement`
BACdroid

- Port of the BACnet I/P for Java[1] stack for Android
- Stack in general compatible with Android Java
- Minor compatibility issues fixed
- Android platform 2.1 – API Level 7
- Closed library: seroUtils.jar → decompiled, compile issues fixed

Listing 1. BACnet4J - android problems

W/dalvikvm(20033): VFY: unable to resolve direct method
5449: Ljava/lang/String;.<init> ([Ljava/nio/charset/CharsetName])V
D/dalvikvm(20033): VFY: replacing opcode 0x70 at 0x0007
D/dalvikvm(20033): VFY: dead code 0x000a-000a in Lcom/serotonin/util/queue/ByteQueue;.popString (Ljava/nio/charset/Charset;Ljava/lang/String;)

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Integration Scenarios

1. Management Tier
   - System operator
   - BACdroid
   - Local Area Network
   - General Building Control
   - Access Control
   - Enterprise Systems

2. Automation Tier
   - DDC – Zone 1
   - BACdroid
   - DDC – Zone 2

3. Field Tier
   - BACdroid

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Use Case: CCTV integration in BACnet

- Integration of CCTV in BACnet
- Embedded device equipped with camera detects safety and security events
- Local detection allows to avoid video stream traffic and reduces privacy concerns
Architecture

BACnet device

Camera Event Object

Device Object

File Object 1 File Object 2 File Object n

BACnet/IP Internetwork

Standard object type

Proprietary object type

CAP
## Camera Event Object

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</tr>
<tr>
<td>Description</td>
<td>CharacterString</td>
</tr>
<tr>
<td>Event_Type_List</td>
<td>List of BACnetCameraEventType</td>
</tr>
<tr>
<td>Event_Deadline_List</td>
<td>List of BACnetDateTime</td>
</tr>
<tr>
<td>Event_File_ID_List</td>
<td>List of BACnetDateTime</td>
</tr>
<tr>
<td>Latest_Camera_Event</td>
<td>BACnetDateTime</td>
</tr>
</tbody>
</table>

- Events stored in a ring-buffer data structure, accessible through lists
- Latest_Camera_Event used for Change-of-Value notification
Proof of Concept Implementation

BACnet device

Camera
Event
Object

Device Object

File Object 1  File Object 2  File Object n

Standard object type
Proprietary object type

BACnet/IP interwork

Bluetechnik SBC-i.MX51

Linux Ångström Distribution

Suspicious Motion Detected!

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Conclusion & Outlook

- Native interaction with building automation based on BACnet/IP
- Ad-hoc access for system operator with Android device
- Use case CCTV integration in BACnet

Outlook

- Integration of sensors and actuators running on Android devices
- New scenarios for interaction with building automation
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Acknowledgement

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References


