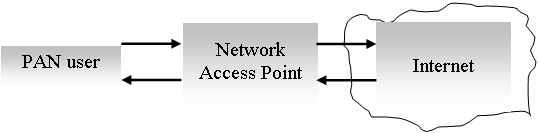
**Bluetooth PAN profile**

Nokia’s Bluetooth® enabled devices can organize networks according to PAN profile.   
The payloads from other networking protocols can be encapsulated into BNEP protocol packets.  
Devices can participate in network in different roles as PAN users, NAPs (network access points) and Group Ad-hocs participants.

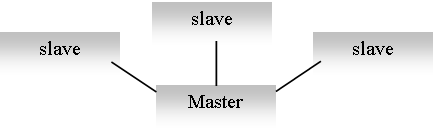
**Network Access Point**

The Network Access Point acts as a bridge, router or proxy between Bluetooth® network and other network technologies. For example NAP can provide Internet connection over Bluetooth®.

[](http://developer.nokia.com/community/wiki/File:Contrib_011_i01_nap.gif)

**Group Ad-hoc Networks**

Group Ad-hoc Networks allows devices:  
 - to form networks among themselves and  
- to exchange information by IP and other networking protocols.  
 This scenario is based on Bluetooth® piconet. So there are a master and slaves.

[](http://developer.nokia.com/community/wiki/File:Contrib_011_i02_adhoc.gif)

**PAN Users**

PAN users can work in 3 ways:

* PAN users can communicate directly just the two together.
* PAN users can connect to NAP
* PAN users can join the Group Ad-hoc Network

[Contrib 011 i03 panupanu.gif](http://developer.nokia.com/community/wiki/File:Contrib_011_i03_panupanu.gif)

Diagram 3 - PANU-PANU scenario

**Service Discovery**

As Bluetooth® technology has service discovery protocol, PAN profile also has. By this way application running on mobile phone can choose PANU, NAP or GN service from other phone device.

# Important points from PAN spec sheet

The document describes how to use the Bluetooth Network Encapsulation Protocol (BNEP) Specification to provide networking capabilities for Bluetooth devices.

The document describes the first version of the Bluetooth PAN profile. Phase I addresses the following:

• Ethernet Encapsulation

• Single-Piconet IP PAN

• Master Forwarding

• Network Access Point

## Bluetooth Networking Functional Requirements (points of interest)

## The functional requirements for the PAN profile include the following:

• Provide support for common networking protocols such as IPv4 and IPv6. For other existing networking protocols support may or may not be provided.

• Provide support for network access points where the network could be a corporate LAN, GSM, and other data networks.

The PAN profile defines a means of enabling Bluetooth devices to participate in a personal area network.   
Completely un-modified Ethernet payloads can be transmitted using the Bluetooth Network Encapsulation Protocol (BNEP) to exchange packets between Bluetooth devices.

The profile defines how PAN is supported in the following situations.

(a) Ad-hoc IP networking by two or more Bluetooth devices in a single piconet.

(b) Network access for one or more Bluetooth devices.

The Bluetooth Network Encapsulation Protocol specifies the transmission of Ethernet payloads over Bluetooth.

The PAN profile is dependent on the Generic Access profile.

## Scenarios

For this profile, three general scenarios are discussed:   
(1) Network access points,   
(2) Group Ad-hoc Networks,   
(3) PANU-PANU.   
Each of the scenarios has unique network architecture and unique network requirements, but all are various combinations of a PAN.

### **2.1.1 Network Access Points**

A network access point is a unit that contains one or more Bluetooth radio devices and acts as a bridge, proxy, or router between a Bluetooth network and some other network technology.

Network access points SHALL provide access to other networks via technologies such as Ethenet, ISDN, Home PNA, Cable Modem and cellular.

According to my understanding we can use NAP as follows:

Bluetooth device 🡨 NAP 🡨 Internet (i.e. NAP is used as a bridge to reach the internet technology)

**2.1.2 Group Ad-hoc Networks**

Group ad-hoc networking allows mobile hosts to cooperatively create ad-hoc wireless networks without the use of additional networking hardware or infrastructure.

A piconet consists of one Bluetooth device operating as a piconet master communicating with between 1 and 7 active Bluetooth devices operating as slaves. Communications in a piconet are between the master and the slaves and under the control of the master. There MAY be further non-active piconet members that are in park mode.

The limitation of 7 active slaves in a piconet is enforced by the Bluetooth active member-addressing scheme.

A group ad-hoc network is a set of computing devices which interact with each other to form a self-contained network. A typical group ad-hoc network consists of eight active computing devices connected in one piconet.

### **2.1.3 PANU-PANU**

In this scenario, a point to point connection between two PANUs allows direct communication between these two nodes only.

Profile

## Summary of profile scenarios/roles

The NAP role provides network services to each of the Bluetooth devices connected.

GN role allows two or more Bluetooth devices to become part of an ad-hoc network.

Connections between two PANUs are used to simulate a cross-over cable between two nodes only.

Connecting to a Network Access Point or the formation of a Group Ad-hoc Network provide the facility for applications to use IP and other networking protocols.

## Configuration and Roles

**Network Access Point (NAP) and NAP service:**

The device with the NAP service forwards Ethernet packets between each of the connected Bluetooth devices, referred to as PAN users. A device with the NAP service is simply referred to as a NAP.

The NAP and the PAN User exchange data using the BNEP. The device with the NAP service has an additional network connection to a different network media in which the Ethernet packets are either exchanged via Layer 2 bridging or Layer 3 routing mechanism.

These devices may require additional functionality when bridging to additional networks, for example GPRS.

**Group Ad-hoc Network (GN) and GN service:**

A Bluetooth device that supports the GN service is able to forward Ethernet packets to each of the connected Bluetooth devices, the PAN users, as needed.

The Group Ad-hoc Network and the PAN User exchange data using BNEP.

Group Ad-hoc Networks do not provide access to any additional networks. Instead, Group Ad-hoc Networks are intended to allow a group of devices to form temporary network and exchange information.

**PAN User (PANU) and PANU service:**

This is the Bluetooth device that uses either the NAP or the GN service. PANU supports the client role for both the NAP and GN roles, and direct PANU to PANU communication.

## Valid interactions b/w PAN profile roles

## 

## 2.5 Profile fundamentals

The following examples illustrate how the NAP, GN and PANU roles interact in all the combinations permitted by version 1.0 of the PAN profile.

### **2.5.1 NAP example**

### A PANU connects to a NAP in order to gain access to an advertised network service. This example provides a brief summary of the typical interactions between a NAP and a PANU.

1. The first step is for the PANU to discover a suitable NAP that is within radio range. To do this the PANU could perform an inquiry for nearby devices and then use SDP to retrieve the NAP record from those devices that support the NAP role.

2. The choice of which NAP to establish a connection with MAY be based on, among other things, the service names extracted from the NAP's SDP records. Where more than one NAP provides the desired service the user or an application will have to choose one. When no Bluetooth connectionexists to the selected device the PANU SHALL create one.

3. Once an ACL connection has been created the PANU SHALL initiate the establishment of an L2CAP channel for BNEP.

4. Ethernet traffic can now flow across the link. The PANU uses the services provided by the remote network, such as obtaining an IP address by using DHCP. Other network services of interest can also be used by the PANU. The NAP SHALL forward Ethernet packets appropriately to the connected PANUs and/or over the NAP network connection. This is similar behavior as a network bridge.

5. Either the PANU or the NAP MAY terminate the connection at any time.

### **2.5.2 PANU initiates a connection to a GN**

A PANU connects to a GN to create an ad-hoc network with other Bluetooth devices.

1. The first step is to find another Bluetooth device that is within radio range and is providing the GN service by using baseband inquiries and SDP searches.

2. If there is no existing Bluetooth connection, then the PANU requests a Bluetooth connection with the selected device providing the GN service.

3. Once the connection is made, the PANU can create an L2CAP channel for BNEP and use the BNEP control commands to initialize the BNEP connection and setup filtering of different network packet types.

4. Ethernet traffic can now flow across the link. GNs might not provide networking services and therefore each of the PANUs SHALL perform various tasks to operate without these services. The GN SHALL forward Ethernet packets appropriately to the connected PANUs.

5. At any time the PANU or the GN MAY terminate the connection(s).

### **2.5.3 NAP/GN initiates a connection to a PANU**

A NAP/GN connects to a PANU to create an ad-hoc network with other Bluetooth devices. This might only be possible if the PANU advertises a PANU service record as specified in section 8.1.3 on page 47.

1. The first step is to find another Bluetooth device that is within radio range and is providing the PANU service by using baseband inquiries and SDP searches.

2. If there is no existing Bluetooth connection, then the NAP/GN requests a Bluetooth connection with the selected device with the PANU service. No master-slave switch SHALL be required.

3. Once the connection is made, the NAP/GN can create an L2CAP channel for BNEP. The NAP/GN uses the BNEP control commands to initialize the BNEP connection and the PANU MAY set up filtering of different network packet types.

4. Ethernet traffic can now flow across the link. The PANUs SHALL perform various tasks to obtain an IP address and other network services. The NAP/GN SHALL forward all Ethernet packets to each of the connected PANUs.

5. At any time the PANU or the NAP/GN MAY terminate the connection(s).

### **2.5.4 PANU initiates a connection to PANU**

A PANU connects to a PANU to simulate a cross-over cable network connection.

1. The first step is to find another Bluetooth device that is within radio range and is providing the PANU service by using baseband inquiries and SDP searches.

2. If there is no existing Bluetooth connection, then the PANU requests a Bluetooth connection with the selected device with the PANU service. No master-slave switch SHALL be required.

3. Once the connection is made, the PANU can create an L2CAP channel for BNEP. The PANU uses the BNEP control commands to initialize the BNEP connection.

4. Ethernet traffic can now flow across the link. Both PANUs SHALL perform various tasks to obtain an IP address and other network services.

## 5.3 NAP, GN, and PANU Service Packet Transfer

Each Ethernet packet is transmitted as a single L2CAP packet.

Ethernet packets are transmitted as the L2CAP payload between Bluetooth devices using BNEP Protocol.

If NAP/GN operates in PAN Profile Secrecy Mode 2, see section 7.2.2 on 41, then the packets are encrypted.

### LOW Power mode

A PANU connected to a NAP/GN could be operating in low-power mode. It is left to manufacturers to develop suitable means for providing efficient support for these low-power modes, such as buffering packets until the next park beacon for nodes in park mode.

PANUs SHALL NOT forward packets.

## 5.7 Broadcasts and Multicasts

The 802.1D standard states that Ethernet broadcast and multicast frames SHALL be transmitted to all operational bridge ports. This means that a NAP/GN SHALL transmit the frame separately to each connected PANU. It is recognized that this is wasteful of the piconet’s bandwidth when there is more than one PANU. It is left to the product manufacturers to develop suitable means for reducing the amount of un-necessary traffic sent to each PANU. A PANU connected to a NAP/GN could be operating in low-power mode. It is left to manufacturers to develop suitable means for providing efficient support for broadcast and multicast packets destined to these PANUs.

**6 Internet Protocol (IP) Support**

Support for the Internet Protocol (IP) is the major focus on the PAN profile. This protocol is defined and maintained by the Internet Engineering Task Force (IETF). IP is described by a set of RFC documents defining its usage. This section specifies the required RFCs, address assignment, and name resolution techniques required to enable IP over Bluetooth wireless communications. All of the RFCs are available from <http://www.ietf.org/rfc.html>.

## 6.3 Address Assignment

The IP address length, as well as the technique used by a node to obtain an IP address is dependent on the version of IP the node is executing. The following sections specify this process for IPv4 and IPv6.

### **6.3.1 IPv4**

### For IPv4 Address assignment, Bluetooth PAN Profile devices SHALL comply with the Dynamic Configuration of IPv4 link-local addresses [7]. This draft SHALL be used until Dynamic Configuration of IPv4 link-local addresses becomes a standard draft RFC, at which time all devices supporting the Bluetooth PAN profile SHALL comply with that RFC.

### **6.3.2 IPv6**

IPv6 supports the ability to perform address assignment as defined in RFC 2462 IPv6 Auto-Configuration.