# Intra-PAN portability of ZigBee network

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## Abstract

*A node may change its location after the network is established. When the node is moved out of the RF range of any neighbor node, routing fail may occur. If the node is capable to be a router, a new routing path may be constructed using table routing. However, if the node is an end-device which is not capable to route packet, it can only re-establish connection to the PAN by issuing a network re-joining primitive. After a roaming device is accepted by another router / coordinator of PAN, it may be assigned a new network address. This may cause several problems. This paper will provide a method to solve the roaming problem within ZigBee network.*

## 1. Introduction

Nowadays, the wireless devices are widely used by people. Taking cell phone for example, it is public used in people's life and you can see people use cell phone everywhere. While people use cell phone whether they are walking or driving, the GSM system should keep connection wherever they go.

How to keep connection with people who roam from a place to another became an important issue.

ZigBee is very popular and focus on forming a wireless network environment. The roaming problem is also a challenge for ZigBee and the solutions haven't been mentioned yet in any ZigBee related documentations.

In the ZigBee network, all nodes default set up in the fix position. In the truly application, taking portable remote controller for example, some nodes will roam in the ZigBee network. If the node roams out of the service of the original node, the roaming node should re-establish the connection to the ZigBee network. According the network layer join policy, the roaming node will be assigned a new address. This new connection will cause the old data path fail. It is a very critical problem and should be solved in the ZigBee network.

## 2. Method

While roaming device re-establish connection to the network of PAN and is accepted by another router / coordinator of the PAN, it may be assigned a new network address. This may cause several problems:

- If the device supports binding, the binging table of PAN-Coordinator must be updated.
- If the upper layer on the sender node calls *Device-Discovery* to acquire the network address of the target device, the upper layer of the sender node must be notified.
- If the original router is still alive, it should remove the device from its neighbor table.

A new roaming procedure must be taken to solve these

problems.

## 2.1. Child Roaming Procedure

A device may determine whether it lost connection to the parent when a certain amount of package is failed to transmit to the parent, or a timeout is occurred when waiting for a keep-alive packet. When the device found that it might be disconnected, the device with may invoke the roaming procedure by issuing the application layer roaming service primitive.

Upon receipt of the application layer roaming service primitive, application shall first performing the node-discover procedure by issuing network discover primitive, which will perform the scan procedure to acquire all necessary environment information.

After the network layer responses the scan result to the application layer, the application layer shall check whether the original parent is listed in the result. If the original parent is not presented, it shall create a new connection by issuing network roaming primitive. If the original parent is listed in the result, the application layer shall try to re-establish connection to the network by issuing network rejoining primitive.

When network layer receives rejoining primitive, it shall issue an MAC layer orphan scan primitive. Upon receipt of the MAC layer scan confirm primitive, the network layer shall issue the rejoining confirm primitive to the upper layer with result equals *SUCCESS*. If the device is receipted by the original parent, and the application layer shall issue the roaming confirm primitive with original short address, and status set to *SUCCESS*.

If the orphan scan is failed, the APS layer shall create a new connection by issuing network roaming request primitive. Upon receiving the roaming request primitive, the network layer shall choose one node as the new parent among the scan results, following the same procedure as standard associate. And then the network layer shall store the original network address and transceiver status. After that, the network shall turn on the transceiver, and set the network address to "not-associated" value. And then the network layer shall send out the roaming-request command packet to the chosen router using unicast.

After the transmission of roaming-request packet is finished, network layer will wait for at most 10 seconds. During this time, all indications passed by MAC layer shall be ignored, and all received packets shall be dropped except for the roaming-response network command packet. The scan shall be terminated when the waiting is timeout, or the roaming-response is received. The network layer shall reset the status of transceiver before it responses to the upper layer.

If a roaming-response packet is received during this time, and the status field of received roaming-response is set to *SUCCESS*, the network layer shall first set the network address to the value extracted from roaming-response packet, and response to the application layer by issuing network roaming confirm primitive with result set to *SUCCESS*. Otherwise the network layer shall set the network address to the original value, and issue the network roaming confirm primitive with the result set to *FAIL*.

Upon receipt of the network roaming confirm primitive, the application layer shall issue the application roaming confirm primitive with result set to corresponding value. The flowchart of child procedure is showing in the Figure 1.

## 2.2. Router Procedure

Any device that is capable to accept association must handle the roaming-request packet. When the

network layer receives roaming-request packet, it shall first check whether the device is already listed in the neighbor table, and whether it is capable to accept another child. If the device is already listed in the neighbor table, or it is not capable to accept another child, it may ignore the roaming-request, or it may optionally send a roaming-request packet with Status field set to *DENIAL* to the roaming device. Otherwise it must proceed to identify the roaming device.

First the network layer shall extract the original short address of the roaming device from the roaming-request packet. Thus it may calculate the original parent of the roaming device. Then it shall send the roaming-identify packet with command-options set to query mode to both the original parent and PAN-coordinator using unicast.

When a router node receives the roaming-identify packet with command-options set to query mode, it shall check its neighbor table. If the target device is listed in the neighbor table, it shall reply a roaming-identify packet with command-options set to authorize mode to the original source (the new parent of the roaming device.) Otherwise it shall simply ignore the roaming-identify packet. When a coordinator node receives the roaming-identify packet with command-options set to query mode, the procedure should be identical, except that it shall check both the neighbor table and the binding table.

When a router receives roaming-identify packet with command-options set to authorize mode, it should put the roaming device into the child-device list, allocate a short address (if available) and send a roaming-response packet to the roaming device using direct transmission. After the packet is successfully transmitted, the network layer shall issue a new-device indication to the application layer, and then the network layer may send a roaming-announce packet using broadcast to indicate that the roaming device is accepted and given a new network address.

When a router receives roaming-announce, it may update its neighbor table and routing-table, and then it shall issue the service-change indication primitive to the application layer.

When the application layer receives service-change indication primitive, it may optionally pass the information to the user application by issuing application service-change indication to the user application so that the user application may change the application destination address, or perform discover-service again. The message sequence chart of roaming procedure (child side) is showing in Figure 2.

### 2.3. PAN-coordinator procedure

The PAN coordinator procedure is similar to the router procedure, excepts that when a PAN coordinator node receive the roaming request packet from an orphan device, it shall first check the binding table within itself, then it shall send a roaming-identify packet to the original parent.

When a PAN coordinator receives a roaming request packet, it shall extract the MAC address of target device from the packet, and it shall check its binding table for a match. If a matched entry is found, it shall send a roaming-identify set to authorize mode to the original sender (the new parent of roaming device).

When a PAN coordinator receives a service-change packet, it shall update the binding table, and then it shall follow the same procedure as a router. The message sequence chart of roaming procedure (parent side) is showing in Figure 3.

## 3. Result and conclusion

The method described in the previous section solves the several problems occurred in the roaming device. If the device supports binding, the binging table of PAN-Coordinator will be updated. If the upper layer on the sender node calls *Device-Discovery* to acquire the network address of the target device, the upper layer of the sender node will be notified. If the original router is still alive, it will remove the device from its neighbor table.

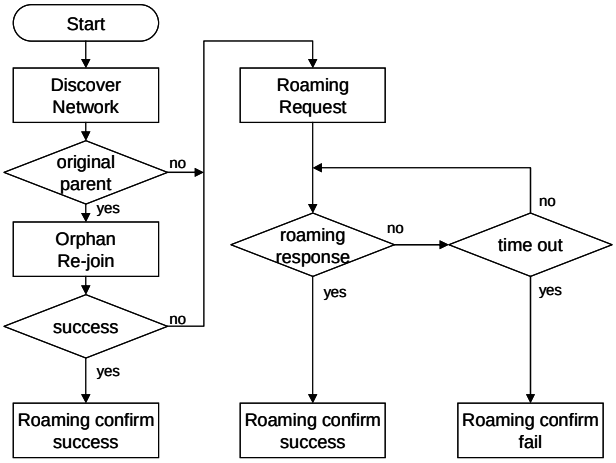


**Figure 1. Flowchart of child procedure**

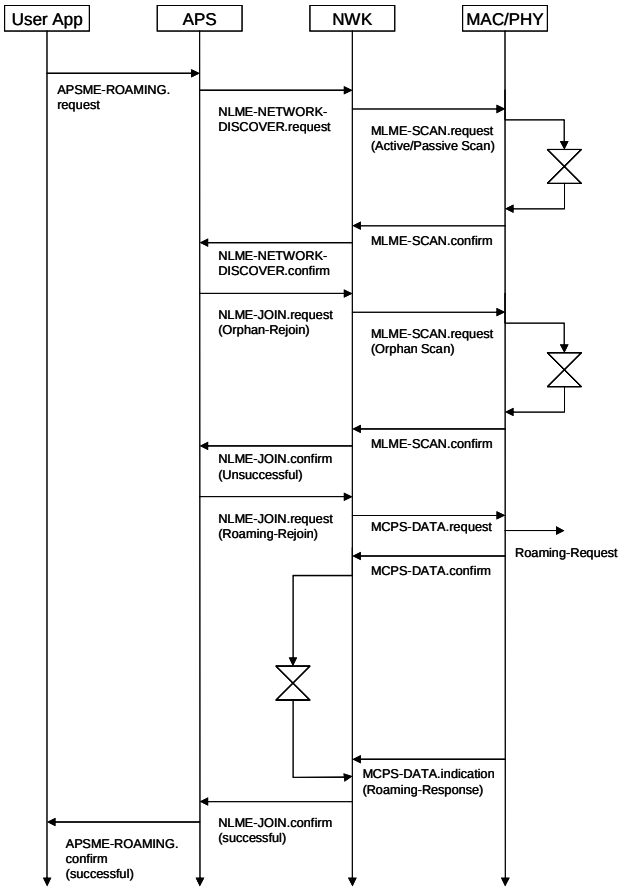


**Figure 2. The message sequence chart of roaming procedure (child side)**

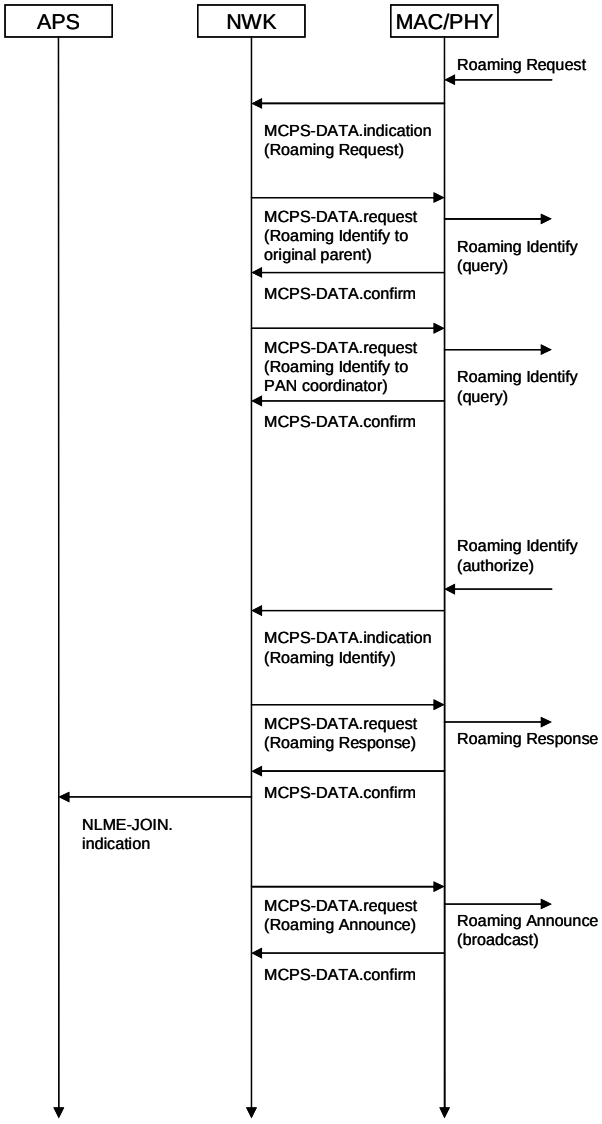


**Figure 3. The message sequence chart of roaming procedure (parent side)**

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