

# A Location-based Addressing Configuration Scheme for 6lowpan

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**Abstract.** In 6lowpan networks, node's energy generally is limited because it uses battery. However, traditional ipv6 stateless address configuration causes a lot of communication overhead since it requires duplicate address detection in the entire network. So this paper proposes a location-based information address configuration scheme without address duplicate detection, where a 6lowpan network is divided into multiple virtual networks grid and nodes perform the random dichotomy algorithm to acquire the internal ID. The proposed scheme in this paper, CCAA and Strong DAD are simulated and analyzed. The results show that the propose scheme reduces the total address configuration overhead and average delay time.

## Introduction

With the development of WSN, in order to realize conveniently collect and control the state information of the surrounding environment, a large number of wireless sensor network (WSN) nodes with low power consumption need to access to the Internet. Ipv6 protocol has abundant address resources. Theoretically, it can give every grain of sand a unique identification on the earth. So it becomes urgent to connect a WSN to the IPv6 Internet. In this situation Ipv6 over low power wireless personal area network (6LOWPAN) is propose [1]. However, the standardized IPv6 address configuration cannot be directly applicable in a multi-hop 6lowpan network because the structure of 6LoWPAN network is significantly different from that traditional IP network [2]. So it is very meaningful to study the 6LoWPAN network address configuration scheme.

In general, addressing scheme in 6LOWPAN could be classified into two types, namely, stateful and stateless [3]. In stateless schemes, each node configures itself with an address, and then performs duplicate address detection (DAD) to verify it uniqueness. Usually these schemes suffer from network-wide flooding, so the address configuration cost and delay are relatively high [4]. In [5] By using the location information of the nodes, the network is divided into a plurality of geographic polar coordinate grid (GPCG), nodes perform the stateless address assignment algorithm to obtain the grid internal ID. Which controls the flooding range of DAD procedure in every GPCG. In stateful schemes assume that a central node or a set of nodes maintain the address allocation information of all nodes in the network. When a new node join the network, they send an address request message to the node(s)for allocating a unique address according to the address allocation table, so the address uniqueness can be guaranteed without DAD [6].

In 6LoWPAN network, the geographical location information is necessary for identifying the corresponding data or events. Nodes have the ability to locate which is a very important premise for many 6LOWPAN applications. Taking this characteristic into account, this paper proposes a ipv6 address configuration scheme based on location information. Firstly, the network architecture based on location is proposed in these schemes. According to the network architecture, the random dichotomy algorithm and the address borrowing algorithm are proposed. And it has the following contributions:

1. In this scheme, a 6LOWPAN network is divided into multiple network grids, each grid can be configured at the same time, the generated internal ID only needs to ensure that it is unique within the grid.
2. The address assignment task of proposed scheme is not concentrated in one node, but scattered to multiple nodes, so the time of address allocation will become shorter.
3. According to the density of the surrounding nodes that have no address to obtain the appropriate address and address space, which reduces the probability of address configuration failure within one-hop when the density of node increases.

## Proposed Scheme

**Architecture.** In this scheme, a 6LoWPAN network is divided into multiple two-dimensional grids according to network coverage and the number of nodes. As shown in Fig. 1. The area of each grid is  $S$ ,  $S = (mr)^2$  and  $r$  is wireless transmission radius of the nodes.  $m$  is a positive integer according to the number of grid nodes within the Custom [7]. Each zone is marked by coordinates  $(x, y)$ . When new node joins the network, first it obtains its location coordinates  $(Lx, Ly)$  by some appropriate positioning technology, and then get the coordinates of the area by the following Eq.1 and Eq.2.

$$x = \frac{Lx}{\sqrt{S}} \quad (1)$$

$$y = \frac{Ly}{\sqrt{S}} \quad (2)$$

**IPv6 Address Structure.** In 6LOWPAN network, it uses IEEE 802.15.4 standard in physical and MAC layer, which supports two types of addresses: 64bit long address and 16bit short address. 64-bit long address also known as EUI 64 address, has been designed in the factory, which is the MAC address of the node. Taking into account the effect of energy consumption and storage space, etc, generally we use 16bit short address as the link-layer address. so this paper proposes a location based information address scheme to generate 16bit link-layer address, and then export IPv6 address via RFC6282 [8], as shown in Fig. 2.

**Random Dichotomy Address Configuration.** In this scheme, there are mainly three types of nodes :

New Node: a node just joins the network that has no IPv6 address.

Common Node: a node that has a unique IPv6 address and the corresponding address space, which can assign the IPv6 address to the new node.

Head Node: each grid has a head node which is equivalent to a subnet. In addition, head node has the function of routing and addressing for the new node

We assume that each region has a head node and its ID is 1 which has an address space  $(1, 2^k - 2]$ . X performs the following process to obtain a unique internal ID.

(1) Y send the type-1 frames to one-hop neighbor nodes and set the clock Offer\_time for waiting. Both the value of send times and hops are set to 1.

(2) when one-hop neighbor nodes receive this typ-1 frame, they return Y type-2 frames with its ID and address space upper limit  $U$ , lower limit  $O$ .

After the specified time, Y receives the type-2 frames from its one-hop neighbor nodes, it Calculates the number of new nodes and checks address space size  $W$  that can be allocated to new nodes.  $W$  is equal to  $U - O$ . If  $W$  is less than or equal to 0. This shows that there is no free address in the one-hop range of the neighbor nodes, and then Y implements Address borrowing algorithm .

(3) If  $W$  is greater than 0, Y returns an type-3 frame to the common node with the maximum address space  $W_{\max}$  , which contains a random number  $N$ . And  $N$  satisfy the following conditions.

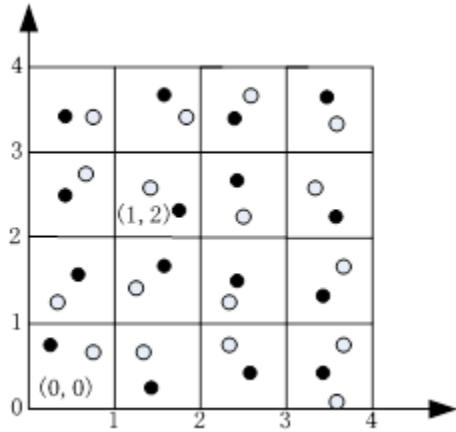


Figure 1. 6LoWPAN topology based on network grid

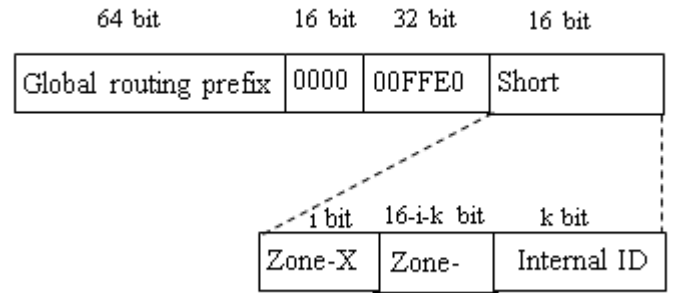


Figure 2. ipv6 address structure

If  $N_m = 0$ , then  $N$  is satisfied:  $N=1$

If  $N_m \neq 0$ , then it need to make the following judgment:

- ① If  $2N_m \leq W_{\max}$ , then  $N$  is satisfied:  $N_m \leq N \leq 2N_m$
- ② If  $N_m \leq W_{\max} \leq 2N_m$ , then  $N$  is satisfied:  $N_m \leq N \leq W_{\max}$
- ③ If  $N_m \geq W_{\max}$ , then  $N$  is satisfied:  $0 \leq N \leq W_{\max}$

(4) After node receives the type-3frame, it returns to  $Y$  a type-4 frame which payload of frame is empty. while it updates its address space to  $(O+N, U]$

(5) After  $Y$  receives the frame type-4 frame. it set its internal ID to  $(N+O)$  and the address space to  $(O, N+O-1)$ . In addition  $Y$  mark itself as a common node.

**Address Borrowing Algorithm.** If  $Y$  finds that there is no usable address within one-hop range of neighbor nodes, then it performs the address borrowing algorithm to obtain a unique internal ID. the algorithm is shown as follows.

(1)  $Y$  sends type-0x1frames to the neighbor nodes in the two-hop range.

(2) When common nodes receive this type-0x1frame, it sends a type-0x2 frame to  $Y$ , which contains its ID, address space upper limit  $U$ , lower limit  $O$  and random number  $N$ . The value of  $N$  is between  $O$  and  $U$ .

(3)  $Y$  selects the first received common node  $X$  to return a type-0x3 frame .At the same time, it set its internal ID to  $(N+1)$ and the address space to  $(N+1, U ]$ . In addition  $Y$  mark itself as a common node.

(4)After  $X$  receives this type-0x3 frame, it change its address space to  $(O, N]$ . In this way the new node obtains a unique internal ID, it combines its zone coordinates to form a 16 bit short address. which is unique in a 6LOWPAN network.

## Performance Evaluation

In this paper, we use the OPNET 15.4 simulation platform to evaluate the performance of the proposed scheme compared to three representative schemes strong DAD [9], CCAA [10]. The main simulation parameters are shown in Table 1. The posed scheme is evaluate in terms of total communication overhead and the average delay time. Simulation results are shown in Fig. 3 and Fig.

Table 1 Parameters

Name	Value
transmission rate	1024bit/s
Physical / link layer	IEEE 802.15.4
Control packet size	60bit
Simulation range	100m×100m

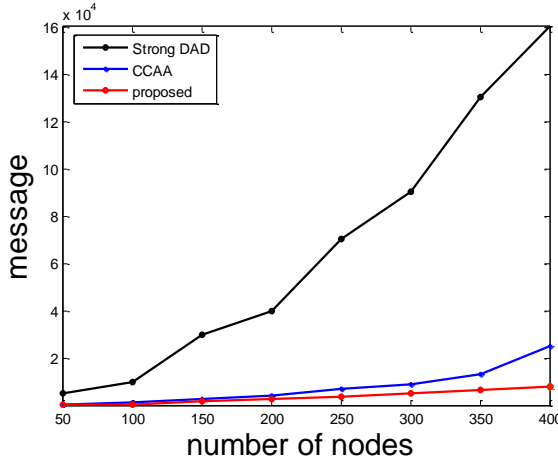


Figure 3. Communication overhead

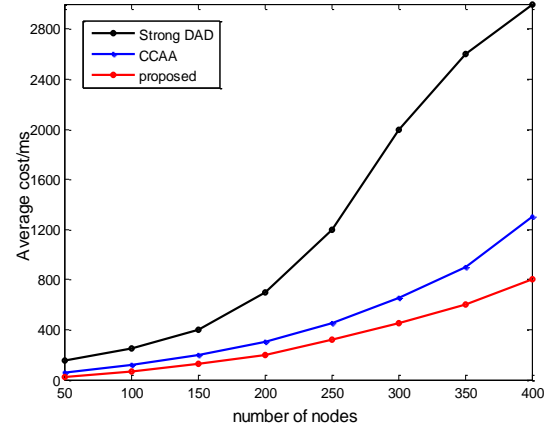


Figure 4. The average delay time

In Strong DAD scheme, when a new node joins, it randomly generates a temporary address which may be repeated, and then broadcast it to each node in the whole network to check its uniqueness. We assume that the total number of nodes in the network is  $N$ , the repetition rate is  $r$ , so the total overhead of strong DAD is  $O(2N_2 + 2)$ . With the increase of nodes, while a new node randomly generates a temporary address which the probability of collision becomes large, so the total communication overhead increases exponentially. The CCAA scheme uses the location information of nodes to map the network into RGB color space. It is compared with Strong DAD, the DAD range is controlled in a monochrome region, so which significantly reduces the address configuration overhead and delay. We assume that the average number of nodes in each color region is  $N_1$ , the repetition rate is  $N_2$ , so the total overhead of CCAA is  $O(r \times N^2)$ , in this scheme, the network is divided into multiple networks squares. random dichotomy is used to assign the internal ID, which nodes can obtain a unique address without DAD, Assumes that the number of nodes in one-hop each networks squares is  $r_1$ , so the total overhead of the propose scheme is  $O(r_1 \times N_1^2)$ . With the increase of the number of nodes. it is compared with the CCAA scheme, the total overhead of the address configuration linearly increase, so address configuration overhead is less.

## Summary

In this paper, a 6LoWPAN network address configuration scheme based on location information is proposed, which is compared with Strong DAD and CCAA in terms of total communication overhead and average delay time. The results show that the propose scheme reduces the total address configuration overhead and average address delay time.

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