

The efficient DA placement Method in SLP

Moon TaeKwon*, bilal Zafar*, Ryu JaeTek**, Kim KiHyung*, Yoo SeungWha*

*School of Computer science, Ajou University, Suwon Korea

**School of information and communication, Ajou University, Suwon Korea

{silentv, bilal, ricman, kkim86, swyoo}@ajou.ac.kr

Abstract— In this paper, we suggest the efficient allocating method in Service Location Protocol (SLP). From the wired protocol SLP to the wireless protocol, we have to solve some problems. For example, efficient power consumption is the most significant problem that we have to solve. In this paper, we suggest the effective DA placement, and for this method we solved the effective power consuming problem. For this method, we make the new concept named Basement Directory Agent(BDA). It's role is make the networks DA placement's start point. We can effective DAs by using our proposed scheme by BDA

Keywords—Wireless Sensor Network, SLP, DA placement, service discovery

I. INTRODUCTION

Recently, for the development of internet, sensor network communication technique is developed rapidly. Also this rapidly development, sensor network is used broad and frequent. For the usage of sensor network communication by internet gives us some advantages. First, we can use sensor network communication that anywhere anytime environment monitoring. It can used for danger area to real-time monitoring, and this can be realization of ubiquitous sensor network environment. Sensor network communication technique could realization by low-cost. And for the develop of wireless technique, sensor network could have the robustness characteristic. for this advantages, Wireless sensor network is used in various area, i.e. prevention of crime and disaster, medical, soldiery, education, industrial, etc. for this various usage, users have been interested to service discovery of their valid services. Thus, the Service Discovery is developed for this need.

The Service Discovery is the service searching what user want. It already developed in wired environment, and how to exchange from wired to wireless is most issue. A kind of Service Discovery are Universal Plug and Play (UPNP) [1], Service Location Protocol (SLP) [2] [6], Jini [3], JXTA [4], etc. It all are wired network based. For the exchange the protocol for the wireless, we must solve the problems. It is not important problem in wired, but in wireless some trivial problem can be fatal problem. For example, power consumption can be significant issues in wireless. For the wired environment, the energy offered by power line, but the

wireless environment, the energy is strict by battery. For instance, a kind of sensor model MicaZ is work by two AA size batteries. And it must live about 2 years per that given energy. But we have to perform well in this restricted environment. The performance will be little low quality, but the service discovery could be promised to user. Thus, in this paper, we will suggest the effective power consumption model by using SLP. We will suggest the effective DA placement method and for this we will show the how to energy saved and effective DA placement.

For the next chapter, we will explain some related works.

II. RELATED WORKS

For the understanding our proposed scheme, before we introduce the proposed scheme, we will explain some related works.

A. Wireless Sensor Network

The Wireless Sensor Network uses the IEEE 802.15.4. The IEEE 802.15.4 is named Low-Rate Wireless Personal Area Network(LR-WPAN). The LR-WPAN's communication concept is the low cost, low data rate. The Wireless sensor Network is used to various area, i.e. medical, industrial, scientific, educational, etc. however, if we use the LR-WPAN, we have to consider about some issues. The issue is described in below.

- The developing cost
- The power consumption in develop and use.
- The security problem

The Wireless sensor network uses the ISM bandwidth. The ISM band is unlicensed band, so if we develop in the wireless sensor network, it can save much money.

In the wireless sensor network protocol, IEEE 802.15.4 uses the superframe structure. The superframe structure is the frame format of IEEE802.15.4. The slot of superframe structure is divided by the time. Typically, each time slot is basically 125 μ s. It defined by coordinator. The superframe structure is composed two parts named active period and inactive period. The IEEE 802.15.4 concept is contention based access. And contention failed nodes is sleep for next superframe period. The active period is composed two parts, Contention Access Period(CAP), Contention Free Period (CFP). It uses the CSMA/CA. All nodes that want to send packet, overhear the channel and if the channel is CLEAN than the node start the

contention with their neighbor who want to send packets in the CAP. It is for the efficient power consuming. The CFP is for the frequently contention failed nodes or real-time reliability nodes. In this period, nodes don't use the CSMA/CA. It uses TDMA mechanism. In other words, the coordinator manages some specific nodes (the nodes request) time schedules in CFP. But the CFP is restrict about 7 slots. So coordinator can modify the CFP length. If the node want to communicate to the coordinator node must contention with another nodes. The node try to connect it overhear the channel to decide CLEAN about three times. If node failed to connect by overhearing than node connection is failed. It is for the reduction of unnecessary traffics. It could also reducing unnecessary power consumption.

The Figure 1 shows that superframe structure of IEEE 802.15.4.

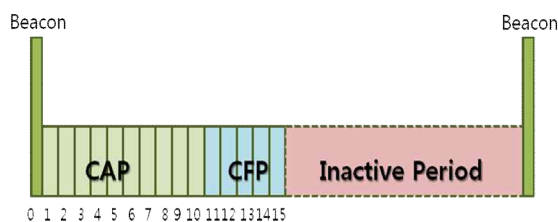


Figure 1. The Superframe Structure of IEEE 802.15.4

B. SLP (Service Location Protocol)

One of the service discover technique named Service Location Protocol (SLP) is describe at RFC2608, in IETF. Now, the SLP is usually using in version 2, and SLP is work for the wired environment.

The member of SLP is User Agent (UA), Service Agent (SA), Directory Agent (DA). Each member's role is describe in the below.

- User Agents (UA) : devices that search for services
- Service Agents (SA) : devices that announce one or more services
- Directory Agents (DA) : devices that cache services. They are used in larger networks to reduce the amount of traffic and allow SLP to scale. The existence of DAs in a network is optional, but if a DA is present, UAs and SAs are required to use it instead of communicating directly.

Figure 1. shows that the service registration and the service discovery mechanism of SLP. The DA sends periodically advertise messages to the whole network by multicast. If the SA near the DA, hear the DA's multicast message, than SA send to the DA for the registration message by unicast. And than DA record SA's registration message to DA's SA list. If DA record SA table successfully, than DA send the service Acknowledge message to the SA by unicast message. This is the service registration process. And service discovery process is describes the left side of Figure 1. In the case of UA access the SLP Network, than UA send to the DA service request message by unicast message. If DA hear the UA's unicast message, than DA sends service reply message to the UA. It is form of SA's URL.

Basically, UA performs service discovery process through the DA. But the UA meet the SA directly, than UA can also discover the SA not through the DA.

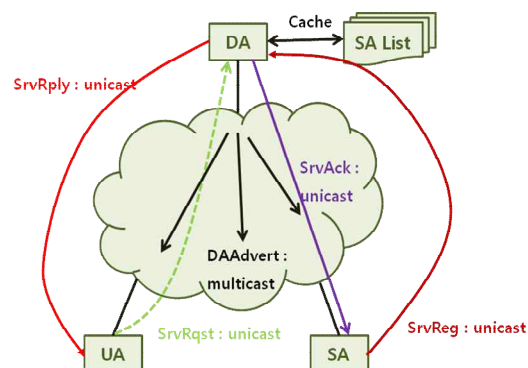


Figure 2. SLP Service register and search process

C. Complexity Analysis of the Improved Relay Node Placement Algorithm

The Table I shows that the Data structure and notation. And the Table II shows the IMPROVED RELAY NODE PLACEMENT ALGORITHM. Table II steps 1,2, and 3 are initialization steps which are executed only once at the start. In the initialization part it calculates the distance of all sensor nodes to each base station which takes $l \times N$ steps where l is the size of BSSet. Steps 4-9 are executed, in worst case, N times; where N is the number of sensor nodes. Among these steps, step 4 selects the sensor node with minimum SN.Distance which takes no computation since heap is used to keep sorted list of disconnected sensor nodes. Step 5 deploys a number of relay nodes, say Q number of relay nodes, and for each of them, it calculates the distance from every sensor node. Since the relay nodes are deployed in straight line, in a worst possible case, the number of relay nodes required for step 5 is equal to

Table 1. DATA Structure and Notation

Symbols	Definition
BS	Base Station
SN	Sensor Node
RN	Relay Node
SNSet	Collection of Sensor Nodes
RNSet	Collection of Relay Nodes
BSSet	Collection of Base Stations
N	Total number of Sensor Nodes
R	Transmission Range of RN/BS
R	Transmission Range of SN
$SN_i.ClosestRN$	Closest Relay Node to Sensor Node i
$SN_i.Distance$	Distance between SN_i and its closest Relay Node
$SN_i.Mark$	Indicates whether a sensor node is connected or disconnected
CSNSet	Collection of candidate sensor nodes to cover
$SN_i.CRN$	The point along the straight line from $SN_i.ClosestRN$ to SN_i at a distance R
$SN_i.CRN.k$	The number of sensor nodes that can be covered by placing a relay node at point $SN_i.CRN$

C	Size of CSNSet
R'	Size of RNSet
1	Size of BSSet

Table 2. THE PROPOSED RELAY NODES

PLACEMENT ALGORITHM

1	If BSSet is empty deploy the first relay node beside the sensor node at the top left corner of the region otherwise Set RNSet = BSSet
2	For each SN 2 SNSet Set SN.ClosestRN = Null Set SN.Distance = ∞ Set SN.Mark = Disconnected End for
3	For each RN 2 RNSet and for $0 < i < N$ If $d_{RN,SN_i} < SN_i.Distance$ Set $SN_i.Distance = d_{RN,SN_i}$ Set $SN_i.ClosestRN = RN$ End if If $d_{RN,SN_i} < r$ Set $SN_i.Mark = Connected$ and remove it from the set SNSet End If End for
4	Set SNc to the disconnected sensor node for which SN.Distance is minimum. If there are more than one disconnected sensor nodes with minimum SN.Distance select any one of them. If $SN_c = f$ Exit else
5	If $(SN_c.Distance > 2r)$ Deploy $Z - 1$ number of relay nodes along the straight line from $SN_c.ClosestRN$ to SN_c Set $SN_c.ClosestRN$ to the closest newly deployed RN End if
6	For each SN 2 SNSet and $SN.Mark = Disconnected$ If $d_{SN,SN_c.ClosestRN} > r + R$ Add SN to CSNSet Set SN.CRN to point along the straight line from $SN_c.ClosestRN$ to SN at a distance R from $SN_c.ClosestRN$ Set $SN.CRN.k = 0$ End if End for
7	For each SN 2 CSNSet and for $0 < i < C$ If $(d_{SN_i,SN.CRN} < r)$ $SN.CRN.k ++$ End if End for
8	Deploy new relay node at SN.CRN for which SN.CRN.k is maximum. If more than one SN.CRN has maximum SN.CRN.k select the one closer to $SN_c.ClosestRN$
9	For each newly deployed relay node RNnew do Add newly deployed relay node RNnew to RNSet For each SN 2 SNSet and $SN.Mark = Disconnected$ If $(d_{SN,RNnew} < SN.Distance)$ Set $SN.Distance = d_{SN,RNnew}$ Set $SN.ClosestRN = RNnew$ End if

	If $(d_{SN,RNnew} < r)$ Set $SN.Mark = Connected$ and remove it from the set SNSet End if End for Empty CSNSet End for
10	Go to step 4
11	Exit

the number of relay nodes required to connect two most distant locations in the deployment region.

It depends on the size and shape of the deployment region but for a specific deployment region, the maximum possible value of Q is constant which is not dependent on N. So, in step 5, it requires QN steps. In step 6, it finds candidate sensor nodes that are within distance $(r+R)$ from a selected relay node and it takes N steps in worst case. Step 7 calculates the number of sensor nodes covered by each candidate sensor node. In a worst case, it takes N2 steps. Step 8 requires a linear search with a cost of N and step 9 requires QN steps to update the SN.Distance of all sensor nodes. As a whole the number of steps required is $O(lxN + N(1 + QxN + N + N2 + N + QxN)) = O(lxN + N(N2 + 2(Q + 1)N + 1))$. As l and Q are constant for a given problem set the worst case time complexity is $O(N3)$

III. PROPOSED SCHEME

In this paper, we will proposed the scheme based the related work. Using the Improved Relay node placement algorithm, we will suggest the method of effective DA placement. For the effective DA placement, randomly distributed SA can within DA coverage in the Personal Area Network.

In this paper, we assume the SA's boundary is uniformly circular radius of r. and DA's circular radius of $R(R>r)$. So the DA can search SA for the distance of $r+R$. In this method we can deconcentration of UA. Because this is the SLP infrastructureing method. Besides, in this paper, we describe of BDA(Basement of Directory Agent). The BDA is the start point and base point of DA placement. For the real-world BDA's role can performed by the PAN's coordinator.

Our proposed scheme is described in the Figure 3. First each SA(it is nodes) and BDA(it is coordinator) is distributed randomly(Figure 3. (a)). And BDA is searching in their boundary $r=R$. in this area SA can covered by BDA, and BDA searching $r+R$ boundary. For the SA, between the inner and outer circle area must covered by DA. Than from the BDA to the SA between the inner and outer circle area can draw the strict line and BDA's boundary can meet with the strict lines. It is candidate of placement DA (Figure 3. (b)). In the Figure 3.(b), there are 4 candidates(green point). Between the candidates, they can calculate of DA boundary, and most SA covered point is the DA placement position. We will placement the DA1 at the third position in the figure. Than from the DA1 they process again to the DA2. It process there are no SA discover in the distance of $r+R$. (Figure 3. (d))

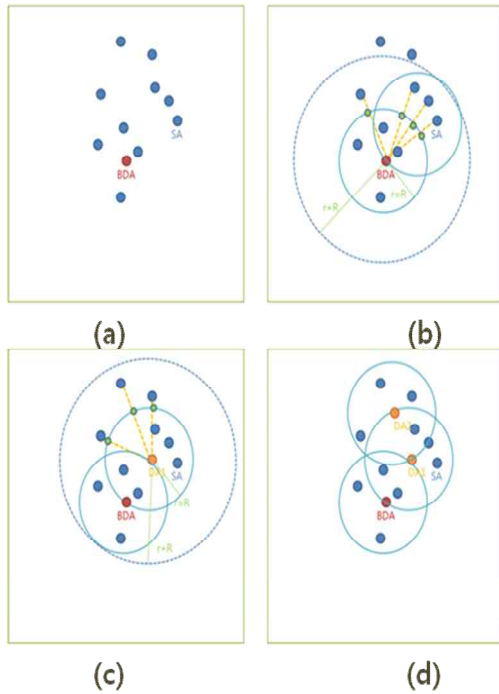


Figure 3. DA placement method

IV. EVALUATION

For evaluate our proposed scheme, we use the sensor network simulation named Qualnet. We deployed 25 SAs and evaluate area scale is 100 X 100 meters. Each evaluation performed 5minutes. We use the IEEE 802.15.4 PHY/MAC. And we compare proposed scheme with Grid DA deployment method. In this evaluation, we use the algorithm of deployment method [7]. And we deployed 25 SAs randomly. We set the SAs in our evaluation area by randomly, and we evaluate this 5 times in different SA deployment. And we calculate optimized amount of DA deployment. For the normal scheme grid deployment got the 25 DAs. And our proposed scheme needs the 15.6 DAs. So we approximate this amount to 16 DAs.

Then, we consider UA also in this evaluation. For the same condition mobile UA moves random speed and direction in this area. The evaluation figure is shown below, Figure 6. Inner red-lined circle device is mobile UA and this UA is move randomly in evaluation area. Figure 4 is our evaluation of proposed scheme. The device of red-circled is UA. And during the evaluation it moves anywhere of green square, randomly.

The result of this evaluation is shown in Figure 5 and 6. The Figure 5 is shown that the amount of packet sent. In the proposed scheme, the DAs sent the packet less than the normal scheme. But the number of DA is reduced, so number of packet sent per DA is increases. Normal scheme is 3.96 and proposed scheme is 5.31. It may be the IEEE 802.15.4's character. IEEE 802.15.4 is contention access. So the heavy

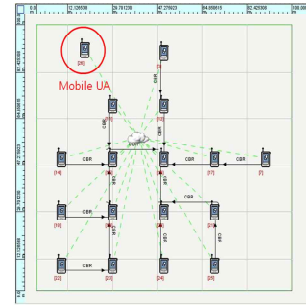


Figure 4. UA-DA mobile evaluation in proposed scheme

traffic can cause the more packet drop. So we can say that the proposed schemes are more reliable model.

The Figure 6 shows the amount of packet received. The proposed scheme received packets less than the normal scheme. So, it can reduce energy consumption and save more energy.

Thus, we can say that our proposed scheme is more effective method than the grid method. The “effective” means more reliable and less power consumption.

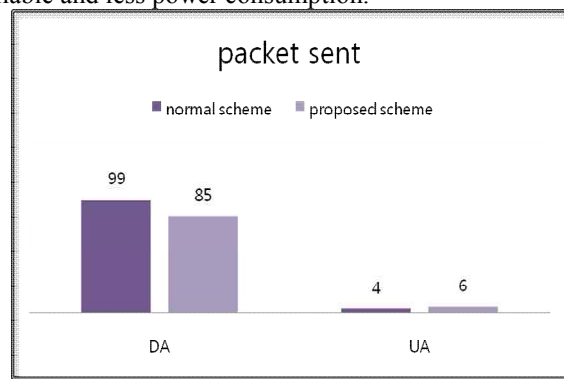


Figure 5. packets Sent of UA and DAs

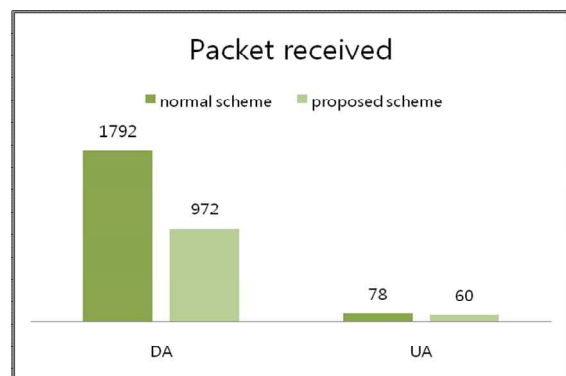


Figure 6. packets received of UA and DAs

V. CONCLUSION

In this paper, we proposed the efficient method of DA placement Method in SLP. Fundamentally, minimal DA deployment concept is essential cause of saving resource. But, the algorithm of minimal DA deployment method needs complex calculating. Minimal deployment and complexity are trade-off relation. In this paper, we suggest the optimized DA

deployment method. In our paper, this can solve the effective DA deployment. In the evaluation, we shows that our proposed scheme can be save more packets and energies. Its amount is less than the normal grid method about 3~5times.

For the less traffic can be also result of less drop rate. The reason is that the IEEE 802.15.4 is contention-based access model. So the nodes are overhear and inference of channel condition. Thus, heavy traffic can be more chance of mistaken. So, we can say that our proposed scheme is reliable than grid method.

However, DA is not balanced in this evaluation, so the DA's life is much different. So, next time, we will research the advanced schemes like a clustering, etc.

REFERENCES

- [1] Universal Plug and Play Forum, <http://www.upnp.org>
- [2] E. Guttman, Perkins, C., Veizades, J., Day, M., "Service Location Protocol, Version 2". RFC 2608, June 1999.
- [3] K. Arnold. The Jini architecture: dynamic services in a flexible network. In Proceedings of the 36th ACM/IEEE conference on Design automation, pages 157-162,1999.
- [4] Project JXTA Home Page, <http://www.jxta.org>
- [5] Sanem Kabasayi, Christine Julien, "Enabling Local Communication for Immersive Mobile Computing", Pervasive Computing and Communications(Percom) 2007
- [6] Weibin Zhao, Henning Schulzrinne "Enhancing Service Location Protocol for efficiency, scalability and advanced discovery". The Journal of Systems and Software 75(2005) 193-204
- [7] Bilal Zafar, Zeeshan Hameed Mir, S.M. Saif Shams, Muhammad Ikram, Ki-Hyung Kim, Seung Wha Yoo; "On Improved Relay Nodes Placement in Two-Tiered Wireless Sensor Networks"; MILCOM, 09, 18-21st Oct, 2009(accepted paper)
- [8] Shams, S.M.S.; Chowdhury, A.H.; Ki-Hyung Kim; Noh Bok Lee. A fast approximation algorithm for relay node placement in double-tiered wireless sensor network; MILCOM 2008, pp.1-6.