# Development of an Optimal Node Selection and Communication Route Construction Algorithm for Mobile Sensing Using Wi-SUN FAN

## ~ Successful Field Demonstration Using an Autonomous Walking Robot ~


**Summary**

A research group led by Professor Hiroshi Harada of the Graduate School of Informatics at Kyoto University, together with Researcher Hiroko Masaki and Master's student Kanon Sekiya (hereinafter collectively referred to as "Kyoto University"), has developed an optimal node selection and communication route construction algorithm for mobile sensing using the international IoT (Internet of Things) wireless communication standard "Wi-SUN FAN." The proposed technology enables the collection and management of various sensing data and location information over wide areas from mobile devices traveling at speeds of up to 68 km/h. Furthermore, the research group developed a mobile sensing system implementing the proposed algorithm and successfully demonstrated its operation using an autonomous walking robot.


**Key Points**

- Successfully developed a communication route construction algorithm that enables optimal destination node selection for mobile communication using Wi-SUN FAN
- The proposed algorithm maintains a high transmission success rate even for mobile devices traveling at speeds of up to 68 km/h
- Successfully demonstrated and verified the operation of the proposed algorithm through field experiments using an autonomous walking robot

### 1. Background

The international wireless communication standard "Wi-SUN FAN" has been established for IoT systems that require large-scale communication involving hundreds of devices over wide geographic areas spanning several kilometers or more, such as smart cities and smart metering systems.

Wi-SUN FAN enables each node to autonomously search for communication partners and expand the network. Because it can autonomously construct alternative communication paths even in environments obstructed by buildings and other structures, the standard is capable of building highly robust wireless networks with excellent fault tolerance. Wi-SUN FAN was originally designed as a system for autonomously connecting fixed nodes.

However, in recent years, with the advancement of IoT systems, there has been increasing demand for the application of Wi-SUN FAN to mobile devices. On the other hand, RPL (IPv6 Routing Protocol for Low-Power and Lossy Networks), which is adopted as the routing algorithm for Wi-SUN FAN, has faced the challenge of being unable to optimally select parent nodes in response to dynamic changes in the communication environment of mobile nodes. As a result, packet transmission success rates significantly decrease as the mobility speed increases.

## 2. Research Results

We successfully developed a communication route construction algorithm that is independent of mobile node speed, enabling seamless selection of the optimal destination node for mobile communications using Wi-SUN FAN. Furthermore, we conducted field experiments using an autonomous walking robot equipped with the proposed algorithm and confirmed its effectiveness.

The developed route construction algorithm is based on the RPL routing method adopted in Wi-SUN FAN while incorporating a mechanism that eliminates time constraints in route selection. This enables rapid selection of the optimal destination node. In addition, we introduced new methods for transmitting control frames (packets used to exchange information necessary for route construction) and for maintaining connections with destination nodes. As a result, we realized an algorithm that preferentially selects nearby terminals with high communication reliability as destination nodes.

We applied the developed algorithm to a mobile node and evaluated the packet transmission success rate through computer simulations using an evaluation model consisting of 10 fixed nodes (routers) labeled R1 through R10 and a Border Router (BR) for information collection, as shown in Figure 1.

As shown in Figure 2, we confirmed that the proposed method maintained a packet transmission success rate of nearly 100% even at a movement speed of 19 m/s (68.4 km/h). In addition, the transmission success rate was approximately 2.9 times higher than that achieved by the conventional RPL method defined in the Wi-SUN FAN standard. Furthermore, as shown in Figure 3, although the conventional RPL method may fail to switch to a more appropriate destination node even when one is available, we confirmed that the proposed algorithm appropriately switches communication nodes throughout the entire movement path. (In Figure 3, the destination node is referred to as the “parent node.”)

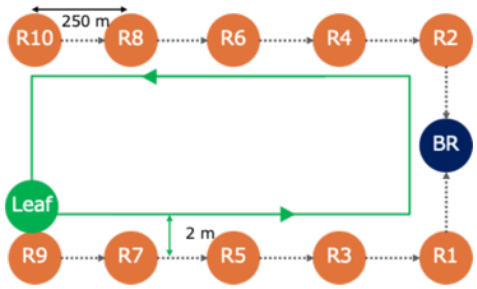


**Figure 1**: Evaluation Model

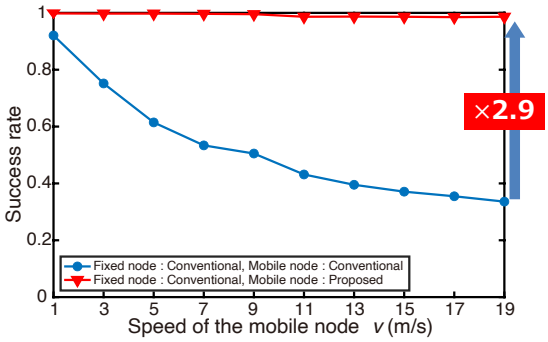


**Figure 2**: Packet Transmission Success Rate

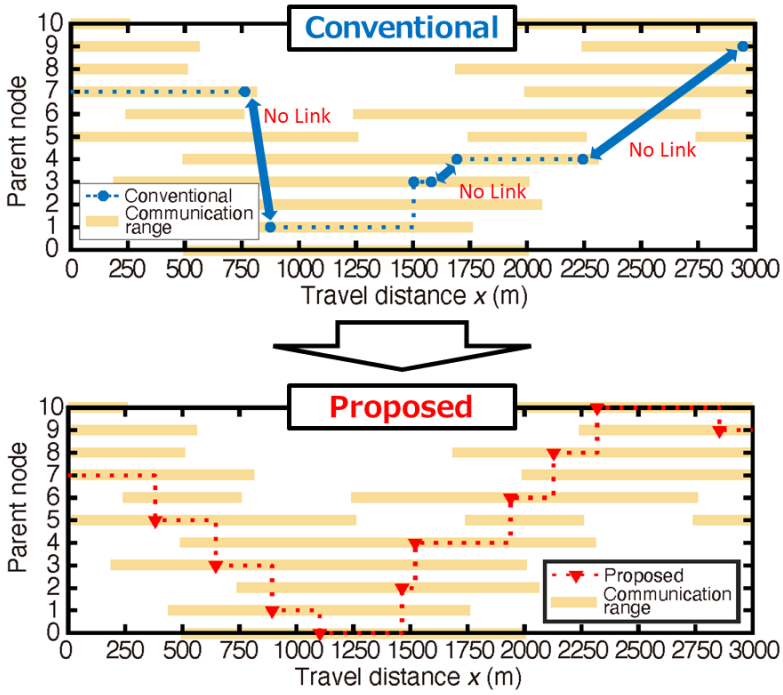


**Figure 3**: Parent Transition (Movement Speed 19 m/s)

Furthermore, we implemented the developed Wi-SUN FAN radio system on an autonomous mobile robot and conducted field experiments in an environment consisting of one border router and two routers, as shown in Figure 4, in order to verify the operation of the proposed algorithm using the robot shown in Figure 5. As shown in Figures 6 and 7, we confirmed that, even in the demonstration environment, the robot successfully selected nearby nodes with high communication reliability as communication destinations and achieved seamless handover. In addition, by visualizing the communication destination nodes, we confirmed that it is possible to determine the router area in which the autonomous walking robot is currently located. These results demonstrate that Wi-SUN FAN, which was originally designed for communication among fixed nodes, can also be used to construct systems capable of collecting and managing various sensing data and location information from mobile devices over wide areas.

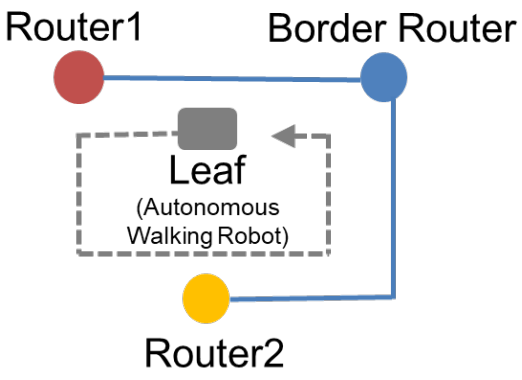


**Figure 4**: Demonstration Experiment Movement Path


**Figure 5**: Autonomous Walking Robot

**Figure 6**: Field Test of the Developed Algorithm Using an Autonomous Walking Robot (Robot moving from the border router to Router 1)

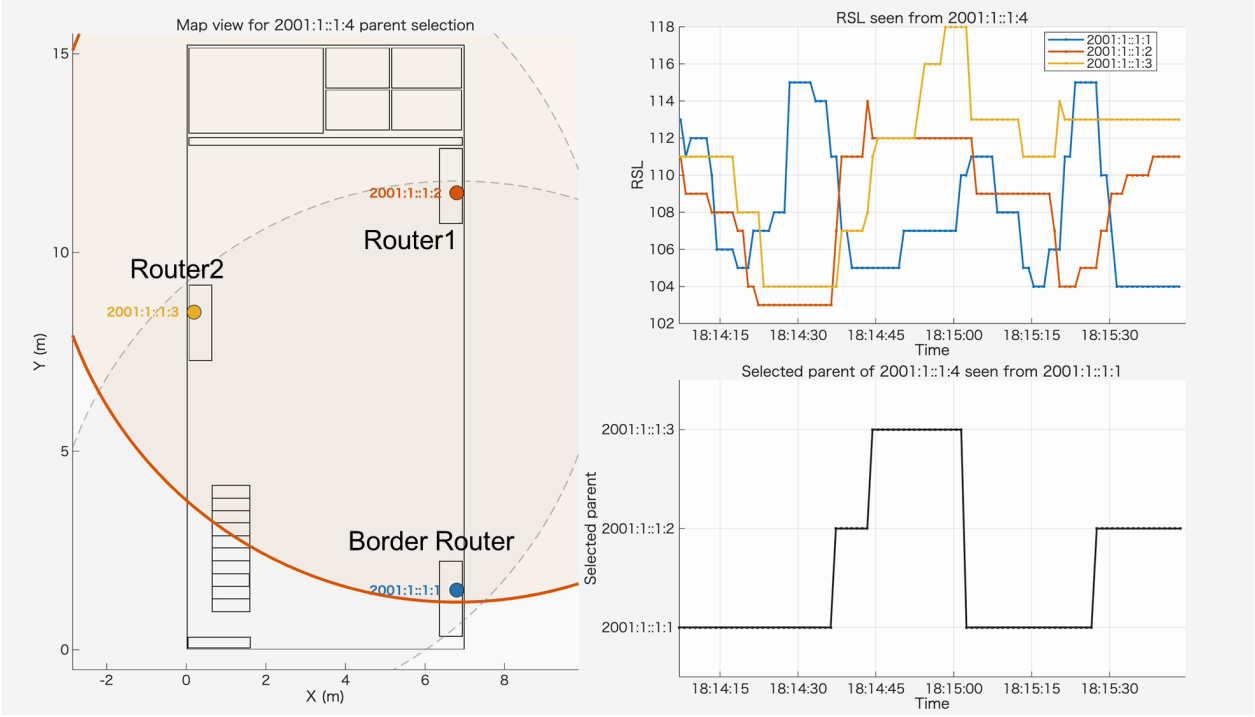


**Figure 7**: Field Test of the Developed Algorithm Using an Autonomous Walking Robot (Visualization tool: Displays the robot's location and destination node information)

### 3. Future Developments

Moving forward, we will continue our verification studies under conditions involving random node movement and varying speeds, and we will further promote efforts toward the societal implementation of

mobile communication technology using Wi-SUN FAN. In addition, the results of this research are scheduled to be presented at a technical meeting of the Institute of Electronics, Information and Communication Engineers (IEICE) in August 2026.

**4. Acknowledgments**

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<**Glossary**>

1. Wi-SUN FAN (Field Area Network)

   Wi-SUN FAN is a communication standard established by the Wi-SUN Alliance for the wireless implementation of smart grids—supporting smart metering and distribution automation—as well as smart city applications such as infrastructure management, intelligent transportation systems, and smart lighting. It is an IPv6-compatible multi-hop communication specification designed for sensors and meters and is characterized by its ability to construct wide-area, highly reliable IoT networks. Version 1.0 was established in 2016, and Version 1.1, which supports higher-speed communication and lower power consumption, is currently in use.

2. RPL (IPv6 Routing Protocol for Low-Power and Lossy Networks)

   RPL is an IPv6-compatible routing protocol for low-power and lossy wireless IoT networks standardized by the IETF. It is characterized by its ability to autonomously establish communication connections between nodes while exchanging information such as received signal strength and communication quality.