Indoor Seamless Roaming for VoIP Using IPv6 Location Assisted Network

NUR HALIZA A. WAHAB[1], SHARIFAH H. S. ARIFFIN[2], SAZZAD HUSSEIN[2], NORHIDAYU S. ABU HASSAN[2], N. FISAL[2], S. K. SYED-YUSOF[2], ROZEHA RASHID[2], LIZA A. LATIFF[2], K. N. CHOONG[3], RAJINA M.A RAJ MOHAMED[3]
[1]Management and Science University, Shah Alam, Selangor Darul Ehsan, Malaysia.
[2]UTM MIMOS Center of Excellence, Universiti Teknologi Malaysia, Skudai, Johor, Malaysia.
[3]MIMOS Berhad, Technology Park Malaysia, Kuala Lumpur. Malaysia.
sharifah@fke.utm.my

Abstract—**In this paper, we present an approach to estimate the location of mobile unit in an indoor WiFi network environment. The estimated location information is then used to perform seamless session mobility across devices (i.e. device switching) in an IPv6 network. Prototype implementation of such location-assisted device switching has been developed and experimented. The proposed location estimation approach is based on the received Signal Strength Indicator (RSSI), to calculate an accurate Path Loss Exponent for a triangulation-based location estimation function. Results showed that our approach achieved an average error of 1.07m in an area of 10x10m. We have also monitored the detailed SIP and RTP messages exchanges for the device switching process to verify our prototype execution.**

Index Terms— **device switching, Internet Protocol version 6 (IPv6), Location tracking, received signal strength indicator (RSSI), Session Initiated protocol (SIP),**

I. Introduction

Locating moving objects has become a necessity but trivial in most people's daily life and Global Positioning System (GPS) is the choice to estimate the moving object location. However, the GPS [1] concepts and theory had been established exclusively for outdoor usage. Due to indoor channel characteristics, estimating location indoors accuracy remains a difficult problem. There are various ways to determine and tracking position indoors [2,3,4,5], but to do so accurately remain very costly. Sometimes it is quite difficult to measure the accurate positions of the moving nodes. Modern researches on the location tracking are not only focusing on the distance but also on the development of communications between the nodes [6]. Apparently, Session Initiation Protocol (SIP) [7] is a signaling protocol, which is widely used for controlling multimedia communication sessions such as voice and video calls over Internet Protocol (IP). This protocol able to establish, maintain, and tear down multimedia sessions. Most operational experience with SIP to date has been over the IPv4 network. However, SIP implementations that support IPv6 are starting to emerge. In SIP, IPv6 support needs to be provided not only by the host on which a SIP element is executing itself [8].

Wireless local area network (WLAN), provides users the mobility freedom to move and roam around within the local coverage area. WLAN technology simplifies the network by linking two or more computers or devices to enable communication between devices. In addition, WLAN simultaneously share resources within a broad coverage area. Using radio frequency (RF) technology, WLAN transmit and receive data over the air, without additional or intrusive wiring. The mobility and roaming capabilities gives user a freedom to be connected everywhere and anywhere. This also allowed users to move around rapidly. This situation introduces a system called 'Location Tracking' to keep track of the user movement in the network boundary. The importance of location tracking application has led to the design and implementation of systems that provides location information, particularly in indoor and urban environment where the Global Positioning System (GPS) does not work well. By using WLAN structures, it is possible to reduce the cost to implement the indoor positioning

In this project, a system has been developed that consist a location tracking mechanisms using RSSI to track the position of the mobile unit (such as WiFi enabled devices or PDA) and calculated the nearest device so that a device switching can be done to switch the SIP session via VoIP to the nearest device or node without having to terminate the session. In this work a framework has been formulated and

Manuscript received October 9, 2001. (Write the date on which you submitted your paper for review.) This work was supported in part by the U.S. Department of Commerce under Grant BS123456 (sponsor and financial support acknowledgment goes here). Paper titles should be written in uppercase and lowercase letters, not all uppercase. Avoid writing long formulas with subscripts in the title; short formulas that identify the elements are fine (e.g., "Nd–Fe–B"). Do not write "(Invited)" in the title. Full names of authors are preferred in the author field, but are not required. Put a space between authors' initials.

F. A. Author is with the National Institute of Standards and Technology, Boulder, CO 80305 USA (corresponding author to provide phone: 303-555-5555; fax: 303-555-5555; e-mail: author@ boulder.nist.gov).
S. B. Author, Jr., was with Rice University, Houston, TX 77005 USA. He is now with the Department of Physics, Colorado State University, Fort Collins, CO 80523 USA (e-mail: author@lamar.colostate.edu).
T. C. Author is with the Electrical Engineering Department, University of Colorado, Boulder, CO 80309 USA, on leave from the National Research Institute for Metals, Tsukuba, Japan (e-mail: author@nrim.go.jp).

test bed is set up to verify the system. A location tracking mechanism that been developed is integrated into the network with real time application. The soft switch module will ensure continuous multimedia communication in the Internet while roaming

This paper is presented as follows. In section II, related work on location tracking mechanism is review. This section also looks at the SIP communication for real time application such as Voice over Internet Protocol (VoIP). Section III detail on the testbed configuration developed in this work. This follows by section IV which presents the algorithm and measurements. The results and analysis is presented in section V. Finally the paper is conclude in section VI.

II. RELATED WORK

A. Location Tracking Mechanism

There are several location tracking methods to estimate the location of object. Proximity method [9] is a method to detect object entering a certain area at low cost. The method is also considered as a robust method to track object against electromagnetic noise, especially indoors. A tracked object will be located once a base station can sense signal from the object, which will indicate that the object is in an area covered by certain base station. However, proximity method cannot estimate the exact coordination of any objects but the area the objects locate in. Vision & Media Computing Lab. of Nara institute is a sample of tracking systems using proximity method by using IR sensors, RF tags, and etc.

Scene analysis method in [10,11] is another location tracking method. In this method it analyze the real area in order to measure signal strength of an object at all coordination of such area and store the data into a database. Once the system tracks any objects, the signal strength received from these objects will be compared with signal strengths in the database in order to find the nearest coordination and use them to estimate location of the tracking object. The number of coordination depends upon a size of area and a size of grid (the smaller size of grid, the accuracy will be higher). However, this is tedious when it comes to larger area or if it uses smaller size of grid. An example of project using this method is Microsoft Lab's RADAR Location System.

Triangulation method [12,13,14] is mostly used location tracking methods. This is due to the simplicity of the processing. The method needs at least three base stations. The three base stations function as the reference node. The base station will transmit signal periodically to the mobile object. The values of signal strength will be converted to three distance values from the object to all three base stations. The distances will be used to estimate the location of the object by drawing three circles, which have all three base stations as a center point of each circle. The radius of each circle equals the distance we have calculated from the signal strength. The distance from each base station may also be calculated from transmission time once the station receive signal from the object, since transmission time can be converted to distance, if we know the velocity of such signal. Examples of technology using this technique are MIT's Cricket [15], Active Bat System [16], GPS (Global Positioning System) [17], and etc.

B. SIP Communication Based

There are several research on location based for SIP communication environment. Although they show potential for indoor tracking, each method has its own limitations.

SIP-RLTS [18]: An RFID Location Tracking System Based on SIP introduces a location tracking system, named SIP-RLTS by using RFID technology. This project integrated the RFID (Radio-frequency identification) into location-based communication services where SIP has been used as the main control protocol. SIP model has been created to support the PUSH and PULL operations require by most Location based Services (LBS). RFID tags and readers have limited capability in data computing and SIP communications. To overcome this problem they have introduced a location-oriented RFID middleware to solve the resource constraint problem and to cut the cost of deploying RFID tracking system. They have provided cache and stabilization mechanism in the location engine to keep the location information update timely and reliably. The RFID is integrated into the SIP communication network and transfer the location information with the same SIP format. When the location server or a watcher receives a SIP message, it only cares about who the user URI represents and where the user is, rather than how the user is sensed and by what type of positioning systems. RFID middleware can subscribe and obtain the location of a Wi-Fi enabled handheld reader, which is then used to update the Reader-Zone relationship. In PUSH and PULL model, the user does not need to send query for location information every time but only required subscribing it. The SIP-RLTS can only be used with either active or passive RFID tags as the positioning technology.

A SIP-based Seamless-handoff (S-SIP) Scheme for Heterogeneous Mobile Networks proposed the SIP-based end-to-end mobility management without the need to modify the network architecture or end-user terminals [19]. It has used SIP extensibility and scalability to operate the SIP at the highest layer and use of text-based control messages. SIP has also being customized as the signaling protocol used for session control in the IP Multimedia Subsystem (IMS) for mobile networks. It has minimized the delay for real-time multimedia services. It has maintained security associations (SA) between the Mobile Node and neighboring domains in advance, and the execution of the authentication procedure locally that handoff delay has been shortened. The temporary session between the Mobile Node and the base station (BS) has been set up to forward in-flight data packets during the handoff process. However, this scheme requires all BSs in the networks to be equipped with the Back-to-Back User Agents (B2BUA), which may not be preferred by some operators. This scheme implements SIP-based end-to-end seamless handoff scheme (S-SIP) to support seamless interdomain roaming and a "make-before-break" handoff procedure to provide seamless handoff management. S-SIP does not require any modifications to network entities.

C. SIP for VoIP

In this project, the SIP is based on VoIP. The VoIP software that is used in this project is KPhone (4.2 and above). KPhone is a SIP User Agent for Linux. It implements the functionality of a VoIP Softphone but is not restricted to this. KPhone is written in C++ and it uses the Qt toolkit. KPhone establishes Sessions via the Internet to enables communication between the endpoints. Audio is the "session type" which is used most frequently, but others such as video and text are also possible. The main feature why KPhone is been used in this project is, because KPhone's software can support IPv6.

Using Session Initiation Protocol (SIP) with IPv6 network is now reality and offers advantages. In [20] the authors have successful developed session establish and media exchange using SIP. The SIP is a signaling protocol, widely used for setting up and tearing down multimedia communication sessions such as voice and video calls over the Internet. Practical experience from the deployment of SIP based services across network and platform boundaries has been gained in [20].

III. TESTED CONFIGURATION

The test bed for this project consist of a Switch or Hub, a Location Server, a PC Router, three (3) Access Points (APs) and four (4) Laptops (Mobile Node). The distance from one AP to another AP is 10 meter (refer to Figure 1), will be refer to the IPv6 Island.

For this project, hub will be use to connect all the devices via WLAN expect the Location Server and PC Router that connected via cable. Each Mobile Node (MN) will be installed with SIP-based Kphone software as a VoIP application. In addition, mobile nodes (MNs) has a wireless communications package or wireless card adapter for providing received signal strength indicator (RSSI) and a processing unit for transmitting data about the device such as the signal strength, location, IP address and so on.

This architecture is specifically designed for indoor devices possessing intermittent RSSI availability, a characteristic commonly found in real indoor wireless networks which the Location Server receive all data of each devices. The Location Server will process the received data and identifying the location estimated for each MNs.

The timing sequence for the proposed location tracking system is illustrated in Figure 2. Firstly, the user should run the PC Router that provides IPv6 addresses to all the devices that are connected to the PC Router. Then, user need to run the SIP server which is located at Location Server so that all MNs are able to use VoIP communication. After that, user should operate the location tracking system at the Location Server to receive data via scanning all the MNs for processing, calculating and storing.

Figure 3 shows the workflow of the Location Server. All MNs need to register with the SIP server to enable the Kphone software to support VoIP application. After the MNs are successfully registered, user can make a 'CALL' to other user that connected to the PC Router as well. The domain or host name used for this system is *'utm-test.edu.my'* which created for represent the IPv6 address.

IV. ALGORITHM AND MEASUREMENTS

A. Reference Parameters

For initial setup, reference parameter will be measure prior to the experiment. In this project, the reference parameter is P_r (d_o) which, is the received power at the reference distance d_o as shows as equation (1). P_r (d_o) should be measure manually before run the system. The system needed to be set up to be implemented into the test bed. This P_r (d_o) value is needed in the equation of Distance Power Law to measure distance by RSSI reading taken. Theoretically, the indoor signal path loss obeys the Distance Power Law that is given in equation (1).

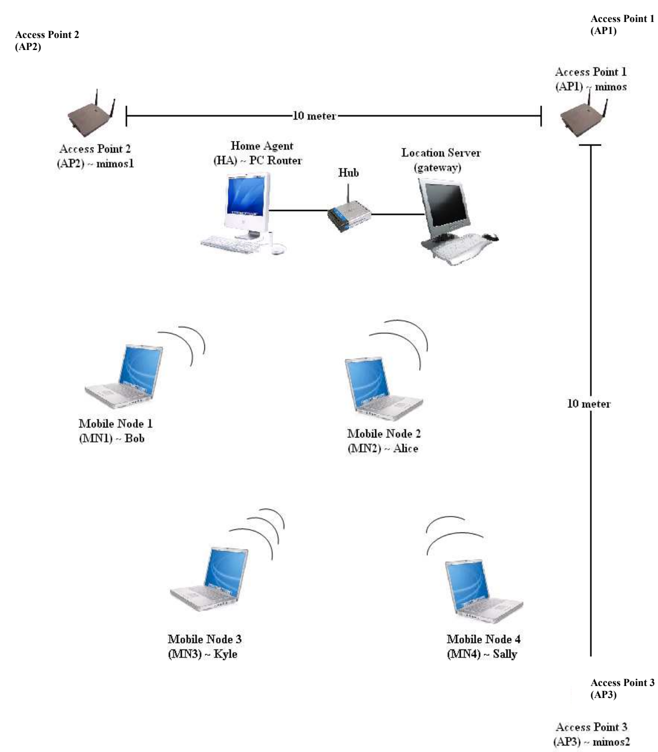

Fig. 1. Test-Bed architecture for the location tracking system

$$P_r(d) = P_r(d_o) - 10n\log\left(\frac{d}{d_o}\right) + X_\sigma \,(dBm) \quad (1)$$

In this equation, P_r is the received power and n is the path loss exponent that indicates the rate at which the path loss increases with distance. It depends on the surrounding and building type. d_o is the close-in reference distance (1m) and d is the separation between the RF signal transmitter and receiver. The term X_σ is a zero mean Gaussian random variable with standard deviation σ

Equation (1) is modified to include Wall Attenuation Factor (WAF) [12]. The modified distance power law is given as equation (2), where T is number of walls between transmitter and receiver. The P_r (d_o) measurement is shown in the Figure 2. The MN would be any of MNs (i.e: *Alice*, *Bob*, *Kyle* or *Sally*). Three (3) of the Access Point (APs) are AP1, AP2, and AP3. The MN will run the scanning process to receive signal strength from the APs.

$$P_r(d) = P_r(d_o) - 10 \cdot n \cdot \log(\frac{d}{d_o}) - T * WAF \qquad (2)$$

B. Location Estimation

Figure 4, shows the location of the desire MN (in this case is P_1) that needs to be track. To track the location of the MN, the angle α should be measure first. The angle α can be calculated using equation (3).

Equation (3) was modified from Cosinus Law's equation as given as equation (4). Law of cosines also known as the cosine formula or cosine rule is a statement about a general triangle that relates the lengths of its sides to the cosine of one of its angles.

$$\alpha = \cos^{-1}\left(\frac{a^2 + d_1^2 - b^2}{2 \cdot d_1 \cdot a}\right) \qquad (3)$$

$$b^2 = a^2 + d_1^2 - 2.\, a.\, d_1 \cos \alpha \qquad (4)$$

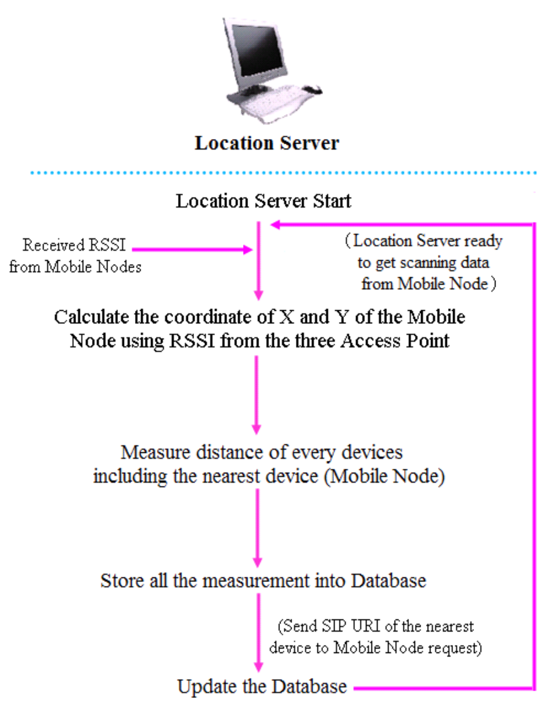

Fig. 3. Signaling sequence in the location tracking system.

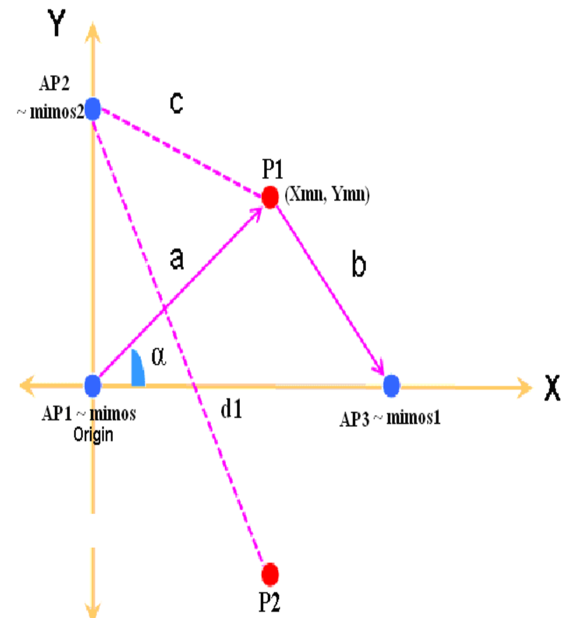

Fig. 4. Triangular estimation.

After the angle α measured, Xmn of the P_1 will be calculated using equation (5) and the Ymn of P_1 can be calculated using equation (6).

$$X_{mn} = a \cdot \cos(\alpha) \qquad (5)$$

Referring to Figure 4 P_1 and P_2 are the possible locations for Y-axis. This possible location can be either at a positive Y-axis or negative Y-axis (refer to equation (6)).

$$Y_{mn} = \begin{cases} a \cdot \sin(\alpha), & |d_{p1} - c| < |d_{p2} - c| \\ -a \cdot \sin(\alpha) & otherwise \end{cases} \qquad (6)$$

The scope for calculating the location of the MN is only inside the first quarter (0° -90°) so that, if the MN is at P_2 (negative y axis), equation (7) is used.

$$if\ Y_{mn} < 0,\ so\ Y_{mn} = -Y_{mn} \qquad (7)$$

When the location of an MN had been measure, the distance of every MNs will be calculated by using equation (8). The Location Server will calculate the distance for every MNs in the network and compare all the distance to find out which is the nearest MN (from the current MN).

$$Dist = \sqrt{\left((X_{mn\,1} - X_{mn\,2})^2 (Y_{mn\,1} - Y_{mn\,2})^2\right)}$$

(8)

All measurement and calculation will be store into the database at Location Server. Location Server will send the data (SIP URI) needed if there is MN required to do the transfer or switching VoIP session.

V. Result and Analysis

A. RSSI Experiment

An experiment is conducted to compare the normalized RSSI determined by the location server with the original RSSI receive by the location server. This step is done to decrease the probability of fluctuation of the RSSI due to interference. Since the project is based mainly on the RSSI and triangulation algorithm, we need to ensure the esimated RSSI caluated by the location server is comparable with the RSSI receive at the location server in order to upgrade the accuracy of the location tracking system.

Figure 5 shows the layout for lab's testbed where the experiment held. It shows that the distance between Access Point 1 (AP1) and Access Point 3 (**AP3**) is in y meter and the distance between Access Point 1 (**AP1**) and Access Point 2 (**AP1**) is in x meter. Figure 6 shows the location of the Mobile Node (MN) for distance between every Access Point is 10 meter each.

Figure 6 shows the location of the Mobile Node (MN) for distance between every Access Point is 10 meter each. The real location of the MN is (5, 5). The 'blue dot' is the experiment location that been calculated by Location Server. The average experiment location for the calculated data is (5.607373, 5.531393).

The comparison graph between experiment result that been calculated by the Location Server and the result from Equation 1, shows in Figure 7. In figure 6 shows that the RSSI value is decreased if the distance increases.

B. Office Indoor Space Experiment

Two experiments are conducted to analyze the accuracy of the location tracking system. The experiments are located in an indoor open space environment. The following are the distance between APs referring to Figure 1.

Experiment 1, {x = 10 meter and y = 10 meter}

Experiment 2, {x = 5 meter and y = 5 meter}

In experiment1, the distance between Access Point (AP) AP1 and AP3 (*x*) is set to 10 meter and distance between AP1 and AP2 (*y*) is also set as 10 meter (refer to Figure 1). For this experiment, the accuracy of error that we calculated is about 1.06915 meter. This experiment was done during office hour, where there are people moving around.

Figure 8 shows a plotted graph for real location of the Mobile Node and experimental location calculated by the Location Server. Figure 8 shows that, there is some error between the experimental location and the real location. Table 1 shows the real location and the experimental calculated location of the MN. The error is calculated to find the percentage of the accuracy. The average error calculated is 1.06915 meter

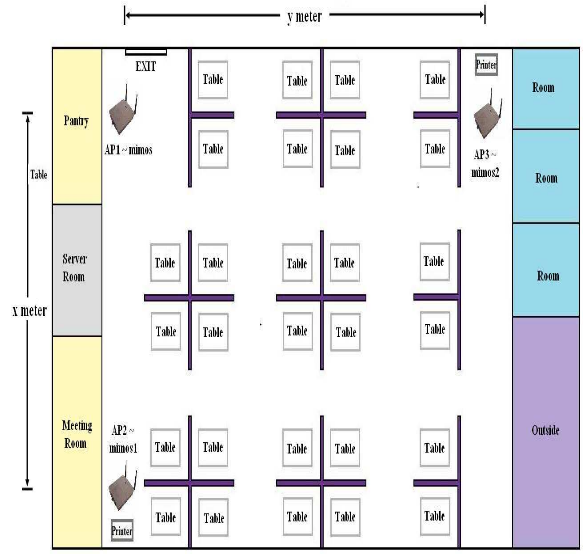

Fig. 5. The office space experiment layout

For experiment 2, the distance between Access Point (AP1) and AP2 (*x*) is set to be 5 meters and distance between AP1 and AP3 (*y*) is also set as 5 meters (refer to Figure 1). In this experiment, the accuracy calculated is about 0.210433 meter.

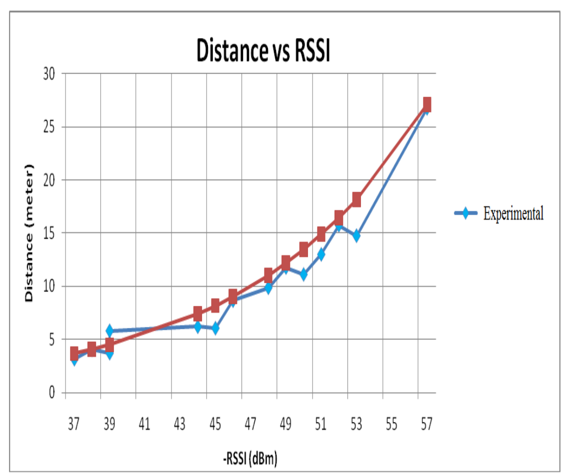

Fig. 6. Distance vs RSSI

In this small area, the interference caused by other signal AP is low, because of the strength and it can also get the signals from AP's (AP1, AP2, AP3) with small power energy lost. Due to this factor, the signal level is nearly accurate.

Moreover, in this small area, there is less people moving around. The accuracy calculated is much better compared with experiment1.

The Figure 9 shows the graph plotted for real location of the Mobile Node and experimental location that been calculated by the Location Server for 5 meter distance of every Access Points. Figure 9 shows that, there is some error of the experimental location with the real location.

Table 2 shows the real location and the experimental calculated location of the MN. The error is calculated to find the percentage of the accuracy. The average error calculated for this experiment is 0.210433 meter.

C. SIP VOIP Session

In this experiment, the seamless connectivity of the SIP VoIP session is analyzed during the device switching. All the mobile nodes are equipped with Kphone user agent and registered to the Location Server. These mobile nodes are denoted as mobile node 1 (*Bob)*, mobile node 2 (*Alice)* mobile node 3 (Kyle) and mobile node 4 (*Sally)*. Laptops have been used as Mobile Nodes for this project. This experiment is to analyze the SIP VoIP sessions transfer. The experiment will be conducted as follows;

Bob will make a call to *Alice* and after a certain time *Bob* will transfer *Bob*'s session to the nearest Mobile Node *Sally* which is measured by the Location server. *Alice* will receive the call from *Bob* and Alice will maintain the session after *Bob* transfer *Bob*'s session to *Sally*. *Sally* will then accept the SIP invitation from Alice when *Bob* transfer its SIP VoIP session to *Sally*.

Figure 10 shows RTP (Real-time Transport Protocol) and SIP packets transfer during the time interval of *Bob* Audio session in an interval of between time 20s to time 150s. RTP is use by the KPhone user agent to make voice calls. While SIP transmit its highest amount of packets, the RTP packets transmission drops when *Bob* transfers it session at time between 90s and 100s (shown in the circle of figure 10). Wireshark software has been used to acquire these results. Wireshark is open source network analyzing software, which is used with Ubuntu linux based operating system.

Figure 11 shows the SIP and RTP packets transmission in Alice Audio Session in an interval of between time 20s to time 150s. While *Bob* transfers the session to *Sally*, the SIP packet transfer was quite high and at the same time, RTP packet, which is used for audio call, decreases. Later at time 100s it is observed that the RTP packets rise again. This happens when *Alice* is successfully connected to *Sally*.

The immediate drop (shown in the circle of figure 11) happened because the SIP session was being transferred. There was few seconds' interruption on audio call because of SIP session transfer between the Mobile Nodes but SIP graph line shows that SIP session is still running.

TABLE 1
ERROR BETWEEN REAL LOCATION AND EXPERIMENTAL LOCATION FOR EXPERIMENT 1

Real Location (x, y)	Experimental Location (x, y)	Error (meter)
(0.5, 0.5)	(0.28, 0.18)	1.796788
(1.0, 1.0)	(0.57, 1.24)	0.96988
(1.5, 1.5)	(1.48, 2.17)	1.219341
(2.0, 2.0)	(2.02, 1.05)	0.95434
(2.5, 2.5)	(2.63, 2.31)	0.23334
(3.0, 3.0)	(2.79, 3.30)	1.021836
(3.5, 3.5)	(3.64, 3.95)	1.161133
(4.0, 4.0)	(4.78, 3.90)	1.348737
(4.5, 4.5)	(4.75, 4.56)	0.747723
(5.0, 5.0)	(5.40, 5.08)	1.600336
(5.5, 5.5)	(5.65, 5.43)	1.29174
(6.0, 6.0)	(6.00, 6.21)	0.212865
(6.5, 6.5)	(6.67, 6.86)	1.402395
(7.0, 7.0)	(7.48, 7.11)	1.007647

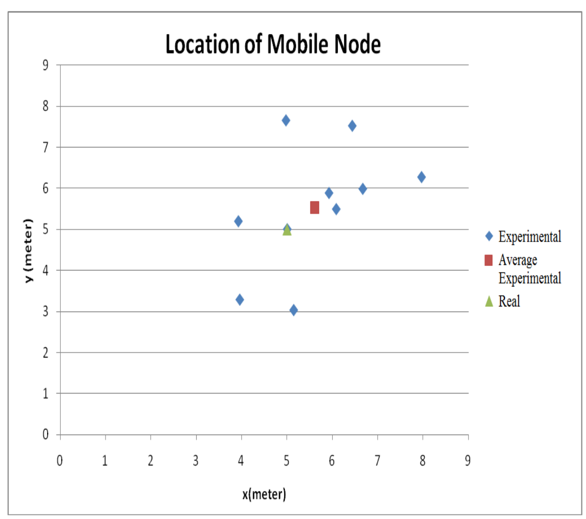

Fig. 7. Location of MN detected by Location Tracking System and real location of MN

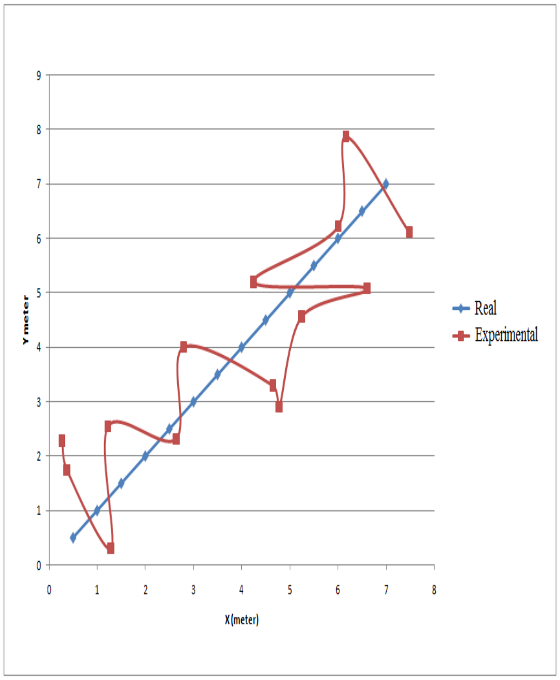

Fig. 8. Real location compare with estimated location by the location Server for office space experiment1.

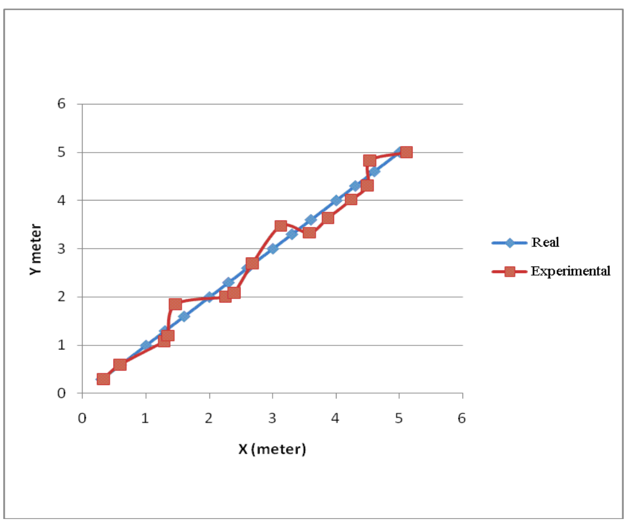

Fig. 9. Real location compare with estimated location by the location Server for office space experiment 2.

TABLE 2
ERROR BETWEEN REAL LOCATION AND EXPERIMENTAL LOCATION FOR EXPERIMENT 2

Real Location (x, y)	**Experimental Location (x, y)**	**Error (meter)**
(0.3, 0.3)	(0.33, 0.30)	0.028552
(0.6, 0.6)	(0.59, 0.60)	0.010673
(1.0, 1.0)	(1.29, 1.08)	0.298345
(1.3, 1.3)	(1.34, 1.20)	0.110870
(1.6, 1.6)	(1.46, 1.85)	0.284453
(2.0, 2.0)	(2.25, 2.00)	0.253798
(2.3, 2.3)	(2.39, 2.08)	0.232361
(2.6, 2.6)	(2.67, 2.69)	0.119174
(3.0, 3.0)	(3.13, 3.47)	0.489279
(3.3, 3.3)	(3.57, 3.33)	0.275987
(3.6, 3.6)	(3.87, 3.64)	0.271211
(4.0, 4.0)	(4.24, 4.02)	0.239303
(4.3, 4.3)	(4.50, 4.31)	0.193024
(4.6, 4.6)	(4.53, 4.83)	0.237010
(5.0, 5.0)	(5.11, 5.00)	0.112454

VI. CONCLUSION

The aim of this project is to develop an IPv6 network that provides location-tracking mechanism to track the position of the mobile units (such as WiFi enabled devices or PDA). This is to allow device switching for VoIP application to switch session from one device to another in order to provide seamless roaming in an IPv6 network. In this project a framework has been formulated and set up as a test bed, which had run successfully.

In this paper, we have shown the accuracy of the location tracking using RSSI approach for two office scenarios at 10m x 10m, where the results of the real location are comparable with the location using the proposed location tracking algorithm. We have also presented the seamless connectivity of the SIP VoIP session between mobile node 1 with mobile node 2 and after that able to transfer the session to the third party seamlessly.

On progress, we are extending the current location tracking for better accuracy using clustering fingerprinting. We also will able to enhance the usage of the location tracking to two levels platform (3D) instead of only one level (2D) for more robust applications.

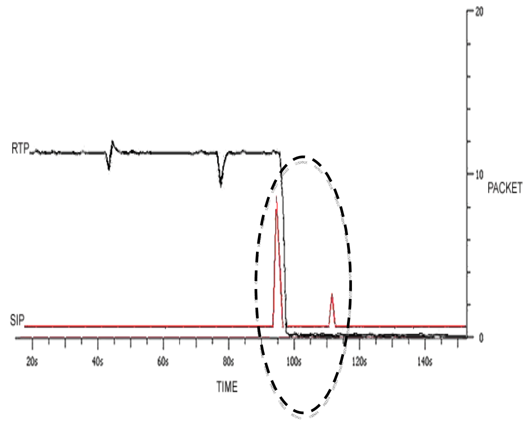

Fig. 10. Mobile node 2 (Alice) audio session.

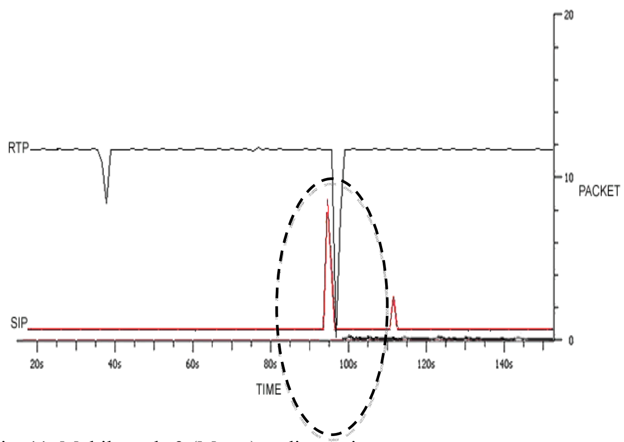

Fig. 11. Mobile node 2 (Marry) audio session.

ACKNOWLEDGMENT

This work was supported by the Minister of Science and Innovation Malaysia (MOSTI) and MIMOS (M) BhD.

REFERENCES

[1] Matthew B. Higgins, "HEIGHTING WITH GPS: POSSIBILITIES AND LIMITATIONS", http://www.fig.net/commission5/reports/gavle/hig ns.p df, 14th October 2010

[2] R. Want, A. Hopper, V. Falcao, and J. Gibbons, "The Active Badge Location System, " ACM Trans.Inf. Syst., vol.10, no. 1, pp. 91-102, 1992

[3] A. Smith, H. Balakrishnan, M. G oraczko, and N. Priyantha, "Tracking Moving Devices with theCricket Location System," in MobiSYS 04: Proceedings of the 2nd international conference on Mobile systems, applications, and services, 2004, pp. 190-202

[4] P. Bahl and V. N. Padmanabhan, "RADAR: An In- building RF-based User Location and Tracking System," in INFOCOM (2), 2000, pp. 775-784.

[5] Faruk Bagci, Florian Kluge, Theo Ungerer, and Nader Bagherzadeh, "LocSens – An Indoor Loction Tracking System using Wireless Sensors," Computer Communications and Networks, ICCCN '08: Proceedings of 17th International Conference, 2008, pp. 1-5

[6] Nur Haliza Abdul Wahab, and Sharifah H.S.Ariffin, "Development of IPv6 Network with Location Assisted Transfer for Real Time Applications", APAN Research Paper

[7] Wikipedia Foundation,'Session Initiation protocol", http://en.wikipedia.org/wiki/SIP, 10 September 2010.

[8] Bosco Eduardo Fernandes, "IPv6 the Catalyst for Convergence", Workshop on IPv6, Geneva, 22-23 June, 2005.

[9] Jie Zhang, Henry C. B. Chan and Victor C. M. Leung," A SIP-based Seamless-handoff (S-SIP) Scheme forHeterogeneous Mobile Networks", IEEE Communications Society subject matter experts for publication in the WCNC 2007 proceedings, pp.3949-3953.

[10] M. Sakata; Y. Yasumuro; M. Imura; Y. Manabe; K. Chihara. ALTAIR:Automatic Location Tracking system using Active IR-Tag. *Proceeding in IEEE Conference on Multisensor Fusion and Integration for Intelligent Systems, (MFI)* **2003**, Tokyo, Japan.

[11] P. Bahl; V. N. Padmanabhan. Enhancements to the RADAR user location and tracking system. Technical report, Microsoft Research 2000, Feb..

[12] P. Bahl; V. N. Padmanabhan. RADAR: An in-building RF-based user location and tracking system. *INFOCOM* **2000**

[13] A. Smith; H. Balakrishnan; M. Goraczko; N. Priyantha. Tracking Moving Devices with the Cricket Location System. *Proceeding in 2nd USENIX/ACM MOBISYS Conference* **2004**, Boston, MA.

[14] A. Harter; A. Hopper; P. Steggles; A. Ward; P. Webste. The Anatomy of a Context Aware Application. *Proceeding in 5 th Annual ACM/IEEE International Conference on Mobile Computing and Networking (MOBICOM)* **1999**, Seattle, Washington, USA

[15] A. Smith; H. Balakrishnan; M. Goraczko; N. Priyantha. Tracking Moving Devices with the Cricket Location System. *Proceeding in 2nd USENIX/ACM MOBISYS Conference* **2004**, Boston, MA.

[16] A. Harter; A. Hopper; P. Steggles; A. Ward; P. Webste. The Anatomy of a Context Aware Application. *Proceeding in 5 th Annual ACM/IEEE International Conference on Mobile Computing and Networking (MOBICOM)* **1999**, Seattle, Washington, USA.

[17] P. Enge; P. Misra. Special Issue on GPS: The Global positioning System. *Proceeding of the IEEE* **1999**.

[18] M. Navarro and M. Nájar, "TOA and DOA estimation for positioning and tracking in IR-UWB," in *Proceedings of the IEEE International Conference on Ultra-Wideband (ICUWB '07)*, pp. 574–579, Singapore, September 2007.

[19] Zang Li, Chao-Hsien Chu, and Wen Yao, "SIP-RLTS: An RFID Location Tracking System Based on SIP", 2008 IEEE International Conference on RFID The Venetian, Las Vegas, Nevada, USA April 16-17, 2008, pp.172-182

[20] Bosco Eduardo Fernandes, "IPv6 & IP Multimedia Subsystem (IMS)", *IPv6 GLOBAL CHINA SUBMIT*, 13-14th April, 2006

Nur Haliza Abdul Wahab is a lecturer in MSU in department of. She hold an engineering degree from Universiti teknologi Malaysia (UTM) in 2008 and Master degree from the same University.

Sharifah Hafizah Syed Ariffin is a Senior Lecturer in the Telematic and Optic Engineering departmet at Universiti Teknologi Malaysia. She hold and Engineering degree from North London University in 1997 and Master degree from Universiti Teknologi Malaysia in 2001. Dr Ariffin received her Ph.D from Queen Mary, University of London in 2006.

Sazzad Hussein is master student in Telematic Research Group in Universiti Teknologi Malaysia.

Choong Khong Neng received his Master of Science and PhD from the Department of Computer and Communication Systems Engineering, Faculty of Engineering, University of Putra Malaysia (UPM), Malaysia in 1999 and 2003 respectively, majoring on IT and Multimedia Systems. His research interests include IMS technology and evolution, Mobile cloud communications, internet content delivery methods, QoS provisioning issues in the field of fixed/mobile convergence and distributed systems design.