Research of Timestamp MAC between PHY Based Positioning Technique in Wi-Fi Environment

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Abstract. Tracking technologies which provide real-time and customized information through various information collecting and processing for pedestrians who use traffic connective and transferring center have been being examined. However some problems are caused due to the wide-range positioning error for some services as device installation and service place. It is also difficult to be applied to traffic linkage and transfer services because many situations can be happen. So we used 'TOA location surveying mode' based on Time Stamp, which is affected lesser wireless environment interference than 'RSSI mode'. And then we researched more accurate Time Stamping mode to improve surveying accuracy. Though existing Time Stamping only executed at the WLAN MAC layer, this paper researched improve data transmit time accuracy to minimize messages transmit delay for location surveying between MAC and PHY.

Keywords: TOA, Wi-Fi, Wifi, wirelesslan, timestamp

1. Prologue

A real-time positioning technology tracking user's location is necessary to provide real-time and user-specific information to service user through collection/processing various information. However some problems are caused due to the wide-range positioning error to apply a service which requires several meter error for some services as device installation and service areas.

Results are different between the technology requires and test results. As a result, we conclude that it is insufficient to apply for traffic connection and transferring service. If a test is investigated in the perfect infrastructure such as optimized place (Anti-reflection area), network device and operation method, test result could be better. But test place has to be considered due to the result with a lot of structures and other communication devices. Accuracy increasing method which has an error within a fixed range is necessary to provide well-timed services.

In this paper, we investigated position tracking of users who walk to the transferring center in the traffic connection and transferring system. And we also researched a MCBF algorithm to increase accuracy.

So in this paper, in order to provide the real time information to the pedestrian who is using the WLAN wireless environment based transport connection and transfer system in the transfer center, we proposed this precise Time Stamp based location tracking technology which can track the location and provide a higher accuracy. In the WLAN wireless communication environment, the TDOA location tracking technology needs GPS satellite level's time synchronization among each AP, but in the real word, it's impossible to reduce the location error more accuracy, so the TOA location positioning technology which doesn't need the time synchronization is used.

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2. Maintenet

2.1. Precise time stamping

TOA location positioning technology has to use the parameter of the message transmit ion Round Trip Time. For these kinds of positioning technology, 1 microsecond error indicates 300m distance error.

The same as the computer clock, AP and ND in the WLAN wireless network use the crystal oscillator as the interior oscillator. Commonly, the crystal oscillator has 1 ~ 100 microsecond error each second because it has the skew and drift character. In this situation, as the time goes by, the crystal oscillator will have a bigger error, and also, because of the exits of the Time Stamp process delay in MAC layer, the error of TOA which use the RTT will has much bigger error. In order to reduce the crystal oscillator's error, there are some methods such as use the high clock accuracy oscillator, but in this paper, we proposed one method which aims to reduce the message's Time Stamp's process delay between the MAC and PHY layer.

2.2. Precise time sptaming in Wireless LAN

In order to implement the precise Time Stamping, the uncertainty of the time stamp delay when transmitting should be removed. In this paper, in order to remove this uncertainty of the time stamp, we put one Time Processing Unit between the MAC and PHY layer to do the time stamping. TPU is an independent unit with the processor and RF transmitter. In order to do the time stamp, a special hardware should be used. In this paper a kind of this added hardware is proposed.
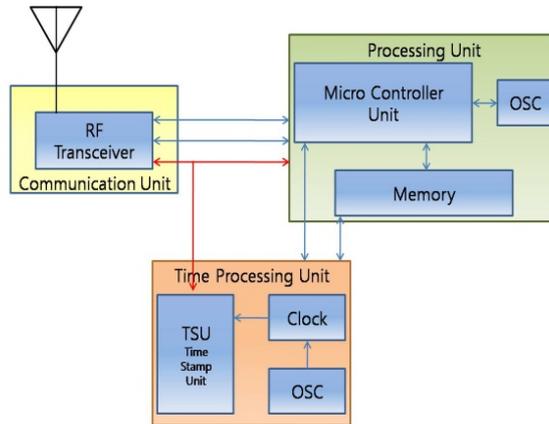

Fig. 1: Structure of TPU

The proposed TOA positioning based precise Time Stamp in this paper is shown in Fig. 1, the TPU is added on the existed RF System to provide the time stamp information.

Fig. 2 is the time concept map of the time stamp action. The existed Time Stamp which was used in the WLAN MAC layer is using between the MAC and PHY layer to remove the uncertainty of the transmitting delay.

In order to do the message transmitting time stamping for the location positioning between AP and ND, the frame structure of the WLAN's PHY layer should be known firstly. When WLAN PHY gets a message from its up layer, it will generate a 12 byte preamble and 4 byte header. Among these bytes, when the SFD's final bit has been transmitted, the communication unit will make the SFD ping single as the rising edge. In
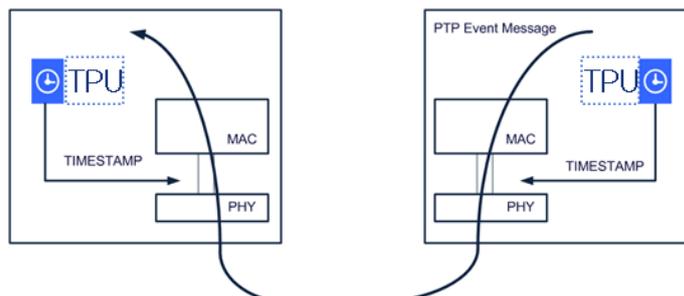

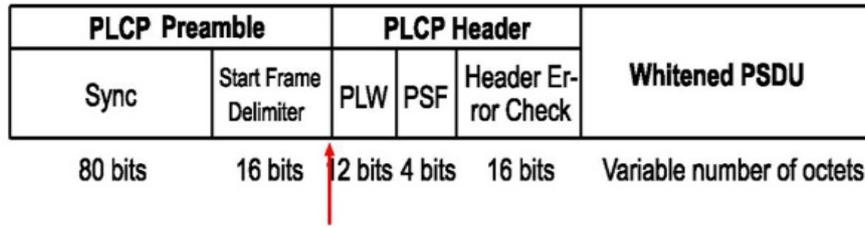Fig. 2: Time Stamp Action Time
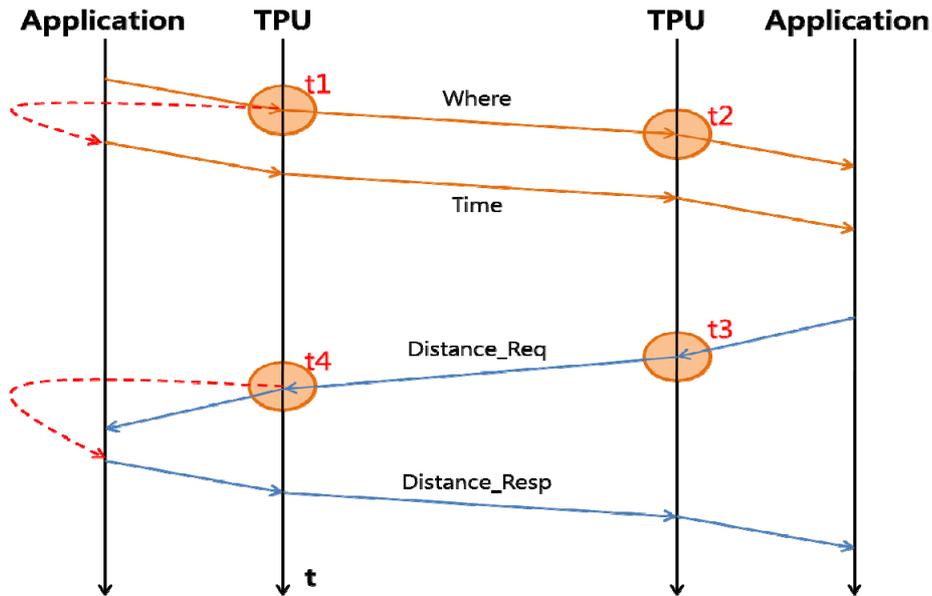
Fig. 3 : Time stamp in the message

Fig. 4 : the message exchanging between AP and ND for calculating the distance

In fig. 4, an example is shown to explain how the time stamp has been done at TPU and how does it to be delivered.

When AP transmits the Where message, SFD will capture the transmit ion time and stored it in the memory as t1. At this time, the Where message has already been transmitted out, so this time value cannot be written in this message, but it will be written in the next Time message, and transmitted out. When ND receives the Where message, it will detect the time point when it receives this message, and save this time value in its hardware as t2. If only know the Where message, it cannot know the time point when AP transmitted this message. Because AP has written the real t1 in Time message, if ND get the Time message, it can calculate when AP has transmitted the Where message.

The different between t1 and t2 is the value of message's RTT. Because the crystal oscillator's error has not been thought about, the uncertainty is still existed. Though the crystal oscillator's error cannot be removed totally, but it can be reduced in one message exchanging procedure. When ND gets the Time message from AP, it will transmit the Distance_Req message to AP, and saved the transmitted time point as t3 in its hardware. When AP gets this Distance_Req message, it will save the time point t4 in its hardware and give a response to ND. When ND gets this Distance_Resp message, it will use t3 and t4 to calculate the distance between AP and ND.

$$distance= \frac{(t_2-t_1)+(t_4-t_3)}{2}$$

d1=distance $\times$ c(3 $\times 10^2$ m/sec)

As the same way, when communicate with two APs, the ND's location can be calculated out.

3. Conclusion

The real time tracking technology which is used in order to collect and process different information of the pedestrian and provide the appreciated real time information to them has been researched. But until now, the developed commercial technology which is applied for several services has a wide error in different device and environment. Moreover, though that technology indicates that it only have 1m error, when it had been tested in the testbed (Gimpio airport), it has much bigger error. It is difficult to be used in the transport connection and transfer service directly. Of course the developer of that technology may has much better test result when tested in a better environment and use a better setting method. But latter, this project will be applied to a much worse environment which has a lot of iron infrastructure facilities. So we proposed this precise Time Stamp based TOA location positioning technology which has little influence from the environment. Later, we will compare the different accuracy of the proposed method with the existed WLAN Time Stamp, and have a real examination to calculate the distance between AP and ND in the real environment.

4. Acknowledgements

5. References

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