Estimation of Network Type Based on The Response Delay Property

Rui Teng*, Kazuto Yano*, and Yoshinori Suzuki*

* *Wave Engineering Laboratories, Advanced Telecommunications Research Institute International*

Kyoto 619-0288, Japan

teng@atr.jp, kzyano@atr.jp, yoshinori.suzuki@atr.jp

***Abstract*— The large number of Internet of things (IoT) terminals increases the cost and difficulty of IoT network management such as network scan. Some wireless IoT networks that have low transmission data rate especially require low overhead for network management to avoid interruption. Hence, it is important to make automatic identification of network type for effective network management. In this study, we at first carry out laboratory experiments of network scan to wireless terminals in wireless LAN (WLAN), Long Term Evolution (LTE) and Low Power, Wide Area (LPWA) networks that include Wi-SUN and LoRa network. From the result of response delay obtained from each network in the experiments, we then examine the basic property of the response delay, especially about the minimum response delay. Finally, we propose a scheme of network-type estimation based on the property of the minimum delay in different networks. The performance of the proposed scheme of network-type estimation is evaluated regarding the network objects of WLAN, LTE and LPWA networks. The evaluation results show that the scan response delay is a useful factor for successfully identifying different types of IoT networks.**

***Keyword*— Internet of things, network estimation, response delay**

Rui Teng received the Ph.D. degree in Information and Communication Engineering from the University of Tokyo. He was a senior researcher in National Institute of Information and Communications Technology, Japan. He is now with the Advanced Telecommunications Research Institute International (ATR). His research interests include wireless LAN, wireless sensor networks, and Internet of things. He received Bionetic2010 Best Paper Award, IEEE WF-IoT 2018 Best Paper Award - First Runner-Up, and IEEE ICACT2020 Outstanding Paper Award. He is a member of IEEE and IEICE.

Kazuto Yano received the B.E. degree in electrical and electronic engineering, and the M.S. and Ph.D. degrees in communications and computer engineering from Kyoto University in 2000, 2002, and 2005, respectively. He was a research fellow at the Japan Society for the Promotion of Science (JSPS) from 2004 to 2006. In 2006, he joined the Advanced Telecommunications Research Institute International (ATR). Currently, he is a principal researcher at Wave Engineering Laboratories, ATR. His research interests include space-time signal processing for interference suppression, MIMO transmission, and PHY/MAC cross-layer design of wireless communication systems for ISM bands. He received the IEEE VTS Japan 2001 Researcher's Encouragement Award, the IEICE Young Researcher's Award in 2007, the Ericsson Young Scientist Award 2007 and the IEICE 2007 Active Research Award in Radio Communication Systems. He also received 2010 Young Investigator Award in Software Radio from IEICE Technical Committee on Software Radio. In addition, he received IEICE Communications Society Best Tutorial Paper Award in 2017, and ICAIIC 2019 Excellent Paper Award in 2019. He is a member of IEEE and IEICE.

Yoshinori Suzuki received the B.E., M.E. and Ph.D. degrees from Tohoku University, Sendai, in 1993, 1995 and 2005 respectively. He joined NTT Wireless Systems Laboratories in 1995. Since then, he engaged in researching microwave signal processing techniques for satellite onboard applications and onboard multiple beam antenna feed techniques. He worked as a part-time lecturer at Niigata University in 2012 and 2014. From 2013 to 2014, he was in charge of sales engineering of satellite communication services in NTT Software Corporation (currently NTT TechnoCross Corporation). Since then, he was a research engineer in NTT Access Network Service Systems Laboratories working on future mobile satellite communication systems. From June 2018, he has been engaged in the research of innovative radio communication systems at ATR Wave Engineering Laboratories, Kyoto, Japan. He received the Younger Engineer Award from the IEICE Japan in 2003.