

Final Report — Intelligent Long-range Wi-Fi

Qing Wang

Delft University of Technology (TU Delft)
Delft, The Netherlands

Yang Miao, André Kokkeler

University of Twente (UTwente)
Enschede, The Netherlands

Qingzhi Liu, Bedir Tekinerdogan

Wageningen University and Research Centre (WUR)
Wageningen, The Netherlands

Nirvana Meratnia

Eindhoven University of Technology (TU/e)
Eindhoven, The Netherlands

The overarching objective of this 4TU.NIRICT project “Intelligent Long-range Wi-Fi” is to position 4TU to an European central hub in intelligent long-range HaLow research and exploitation, with great visibility in research, education, and valorization. We have combined the unique expertise of the RS Group of UTwente (radio wave propagation), the ENS group of TU Delft (networked system design), the INF Group of WUR (AI-IoT), and the IRIS Group of TU/e (Interconnected Resource-aware Intelligent Systems) to make 4TU become a front-runner HaLow community for next-generation IoT. In this context various activities have been performed.

RESEARCH

We have researched different aspects of WiFi HaLow in various smart city related scenarios. In particular:

TU Delft has proposed to use the tiny LEDs on the HaLow or other IoT devices to receive light information, allowing devices to be connected to the network. For such a purpose, a joint RGB LED-to-LED communication and sensing system is researched, prototyped, and validated.

TU/e has focused on performance evaluation of the IEEE 802.11ah standard in terms of quality of service guarantees and developed solutions to increase network performance. TU/e has also studied and compared performance of WiFi HaLow against other long-range communication standards such as LoRa and NB-IoT for a number of applications within dense and urban city areas, among others.

WUR has explored a low-code solution to greatly simplify the deployment procedure of HaLow for various agricultural scenarios. At the same time, WUR and TU/e together have designed an AI solution to control the data aggregation in IoT wireless mesh networks, which is a typical deployment architecture of WiFi HaLow.

UTwente has studied the contact-free localization and tracking of animals/human using multi-band radio signals. Wi-Fi HaLow is in sub-GHz frequencies; we combined it with higher frequency radios that have smaller wavelength and higher sensing resolution, for achieving sensing via communication devices.

These research efforts have already resulted in two master theses. Two papers are also planned to be submitted in 2022.

4TU WORKSHOP ON WIFI HALOW

We organized a 4TU workshop on WiFi HaLow on 16 December 2021. To the best of our knowledge, this workshop is the first-ever workshop in the world that is dedicated to WiFi HaLow research and development. Four well-known experts and market leaders in the field of European WiFi HaLow delivered invited talks and shares their latest research findings, insights, experience, open research challenges, as well as commercial and open-source WiFi hardware and prototypes. The workshop brought together researchers from seven countries to discuss and brainstorm the future opportunities and challenges of the promising long-range WiFi HaLow technology. The link to the workshop’s website: <https://wifi-halow.github.io/>

The workshop was organized online using Zoom and had in total 33 participants. Some screenshots from the workshop can be found in **Figures 1–6**. The details of the workshop program were as follows:

- 9:00–9:05 am CET
Opening by Nirvana Meratnia, TU/e
- 9:05–9:35 am CET
The role of Wi-Fi HaLow in Industrial IoT
Jeroen Hoebeke, Professor at the IDLab
Ghent University & imec
- 9:35–10:05 am CET
The launch of Wi-Fi CERTIFIED® HaLow™ and Methods2-Business Wi-Fi Certified IP solutions
Marleen Boonen, CEO of Methods2Business
- 10:05–10:10 am CET *Short break*
- 10:10–10:40 am CET
On the scalability and energy efficiency of Wi-Fi HaLow for dense IoT deployments
Jeroen Famaey, Professor at the IDLab
University of Antwerp & imec
- 10:40–11:10 am CET
Openwifi: the open-source WiFi chip and it’s applications
Xianjun Jiao, Senior Researcher at imec
- 11:10–11:15 am CET
Closing and concluding remarks by Qingzhi Liu, WUR



Figure 1: Workshop opening by Nirvana Meratnia, Eindhoven University of Technology

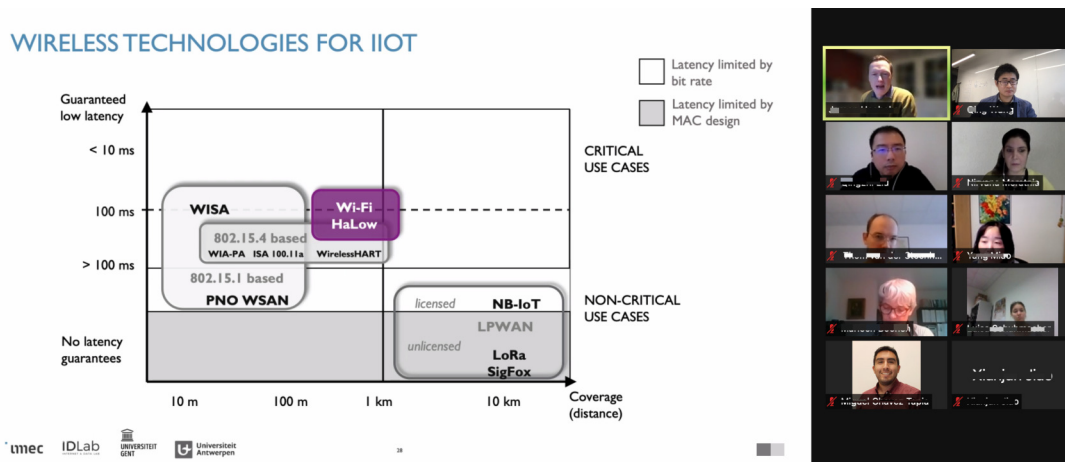


Figure 2: Workshop talk by Jeroen Hoebeke, Professor at the IDLab, Ghent University & imec

4TU ROUNDTABLE WITH INDUSTRY ON WIFI HALOW

We also organized a roundtable on commercial aspects of WiFi HaLow and various initiatives towards it in relation to the WiFi Alliance. The roundtable had nine participants: six researchers from 4TUs and three industrial leaders on HaLow from the Dutch startup Methods2Business. The purpose of the meeting was to bridge the gap between Dutch industry and academia, to discuss academic requirements on performance research in the area of WiFi HaLow, and to boost the growth of Dutch R&D on WiFi HaLow. Various opportunities for research collaboration between 4TUs and Methods2Business were discussed. We set the target to prepare a joint proposal on WiFi HaLow and have internship and master students at the company, and to write a joint research paper to introduce the latest research on WiFi HaLow with contributions of both 4TUs and the company. A screenshot from the roundtable event can be found in **Figure 7**.

GRANT PROPOSAL INITIATIVES

Thanks to this 4TU project and the community built around it, and as a result of various brainstorming sessions, we submitted a joint 4TU proposal to the NWO Open Competition Domain Science.

OTHER DISSEMINATION

A video on introducing the 4TU research activities and outcomes on HaLow is currently being prepared. We will release it on our website and YouTube channel when it is ready.

Based on the research results of 4TUs on WiFi HaLow, we are aggregating the researching results from industrial partners and 4TU universities to write a survey paper about WiFi HaLow. To the best of our knowledge, the survey paper related to HaLow is very limited. Therefore, we expect our publication could contribute to the HaLow community and increase the impact of 4TU in this area.



Figure 3: Workshop talk by Marleen Boonen, CEO of Methods2Business

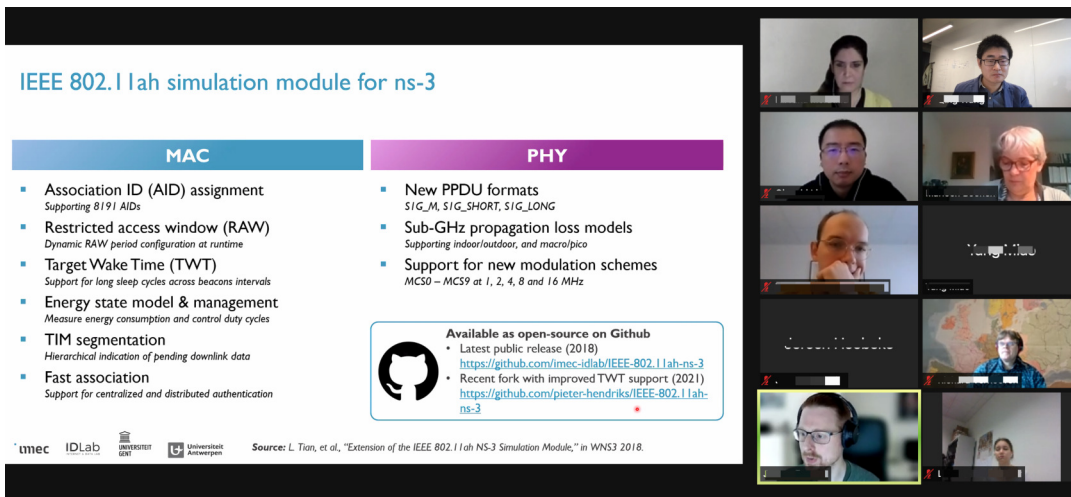


Figure 4: Workshop talk by Jeroen Famaey, Professor at the IDLab, University of Antwerp & imec



Figure 5: Workshop talk by Xianjun Jiao, Senior Researcher at imec

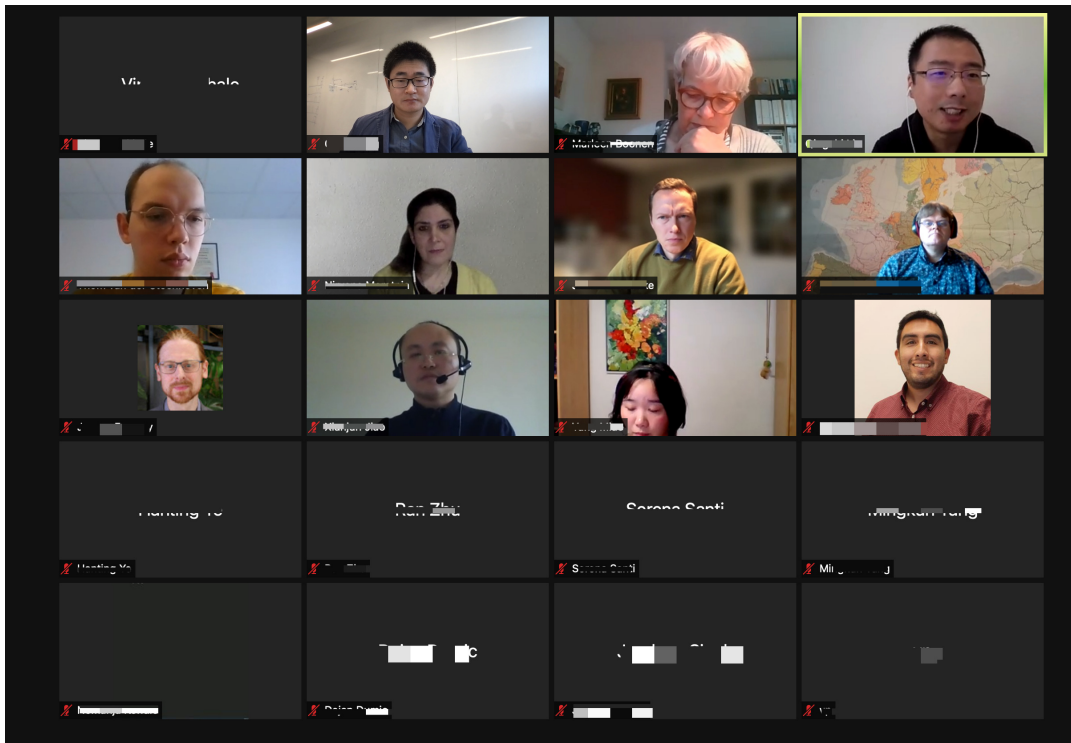


Figure 6: Workshop closing by Qingzhi Liu, Wageningen University and Research Centre



Figure 7: Roundtable on WiFi HaLow between 4TUs and Methods2Business