Fraunhofer IIS

5G Testbed Industry 4.0 – Testing

5G Measurements Under Realistic Conditions

As the deployment of 5G networks gains more importance, it becomes crucial to evaluate and understand the capabilities and performance of these networks in real-world scenarios. This is where the 5G Testbed Industry 4.0 plays a vital role. The following shows an excerpt from a measurement campaign on the topic of delay, serving as a representative example of our measurement capabilities. With this measurement campaign, you can get a brief insight into the customizable testing possibilities of the 5G Testbed Industry 4.0.

Insights Into the Network Performance of 5G and WLAN

In the last years, 5G campus networks have been deployed in form of testbeds and productive networks. However, detailed information on performance of those networks is relatively rare. This excerpt from our white paper presents End-to-End (E2E) delay and One-Way-Delay (OWD) measurements obtained within our 5G Testbed Industry 4.0. The tests were executed within 5G Stand Alone (SA) and Wi-Fi 6 networks. Both networks are based on commercial grade equipment. The Wi-Fi 6 network was using 80 MHz wide channels in the 5 GHz band.

The 5G SA network is a 3GPP Rel. 15 system based on Open RAN architecture and was configured to operate in campus network frequency band 3700-3800 MHz with a channel bandwidth of 100 MHz.

To perform the measurements for the 5G TDD patterns, an Uplink (UL) and a Downlink (DL) heavy pattern were examined. The UL-heavy TDD pattern DSUUU differs from the DL centric pattern DDDSU of commercial large scale mobile networks by an increased number of UL slots as presented in Figure 1.

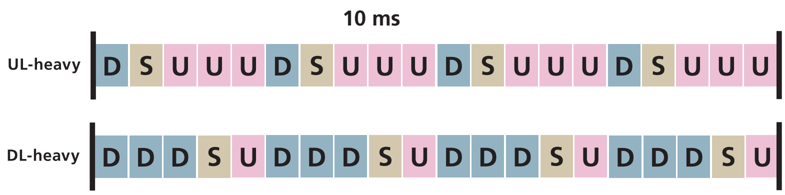

Figure 1: Considered 5G TDD patterns

Measurement Setup

In order to measure E2E delay and OWD we have used our all-in-one dual-100 GBits/s network tester. It allows us to precisely measure both delays within the same test run under defined and configurable traffic. We have executed measurements using two connectionless (UDP) measurement traffic patterns: General-purpose constant bitrate and process automation like. Parameters of those patterns are presented in Table 1.

Traffic pattern (UDP)	Bitrate (Mbps)	Frame size (Bytes)	Frames (per s)
Constant bitrate (c.b.)	15.	1450	1300
Process automation (p.a)	0.5	100	625

Table 1: Measurement traffic patterns

The measurement setup is shown in Figure 2. Depending on the wireless access technology used for the particular test, either 5G SA or WLAN devices and networks were used. The network tester was acting as a traffic initiator, as endpoint and in addition as a reflector for E2E delay measurements. As a client device we used two standard 5G routers (5G dev. A and B) and two WLAN client devices: A Wi-Fi 5 access point in client mode and a Wi-Fi 6 android based mobile phone with activated ethernet tethering, called WLAN device C and D, respectively.

5G systems are using built-in mechanisms (e.g. 5G QoS identifiers) for providing the required quality of service for various types of traffic in a network. In our case we were using the non-guaranteed bitrate 5QI of 79 with a packet delay budget of 50 ms. To verify that the correct 5QI was set, we decoded the respective signaling messages between the 5G access device and the network with our test platform for mobile network engineering, network optimization and troubleshooting.

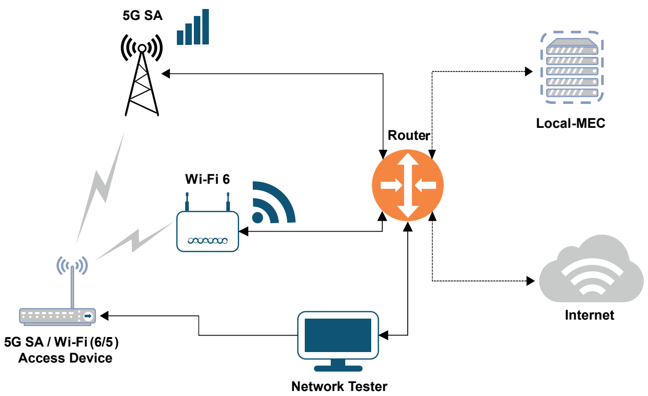

Figure 2: Measurement setup

Results: TDD DL-heavy vs. UL-heavy Comparison

Many applications in campus networks will require the usage of uplink centric TDD patterns. Once we activate the UL-heavy pattern, we observe lower OWD in comparison to the DL-heavy pattern. This improvement is however weakened if E2E delay is considered. Especially for results above the 95 percent quantile, an increased delay is observed. Results of the Wi-Fi 6 and 5G SA comparison are presented in the white paper.

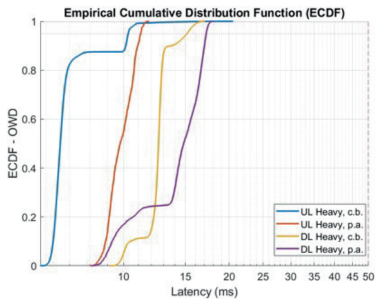

Figure 3: One Way Delay (OWD)

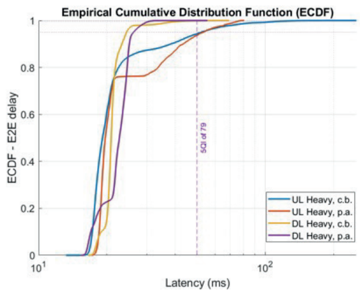

Figure 4: E2E delay

Outlook Into the Future

This excerpt of our measurement campaign presents a brief insight to one of the various testing possibilities in our 5G Testbed Industry 4.0. Should you require further information on our testing possibilities, which can be tailored to your requirements or wish to receive the full content of this white paper, we encourage you to reach out to us. Our team is available to provide you with the necessary details and address any questions you may have. Together, let's unlock the full potential of 5G testing.

Contact

Karin Loidl
Technology Advisor
Positioning and Networks
Cell +49 160 5840487
5g-testbed-industry@iis.fraunhofer.de

Nordostpark 84
90411 Nürnberg, Germany
www.iis.fraunhofer.de