BlitzFunk® Whitepaper

BlitzFunk is a novel wireless technology for highly reliable switched Ethernet communication with consistent low latency in the millisecond range. It serves as a drop-in replacement for existing wired installations and enables high-mobility applications with seamless handover. Ethernet-based protocols, including PROFINET, PROFIsafe and OPC-UA, are supported out of the box. The technology is built upon Wi-Fi and operates in unlicensed frequency bands. Even with minor interference from third-party Wi-Fi networks, latency is kept low by leveraging diversity. A carefully crafted proprietary protocol ensures that concurrent data streams within the network do not interfere with each other, and that all communication is secured by authenticated encryption with per-device key management.

Access Point AW22R

Client CW22R

Topology

A BlitzFunk network consists of access points and clients. The network establishes a star topology where all access points act as a joint coordinating entity. Application devices (controllers, machines, sensors, etc.) are connected via Ethernet. From the application's point of view, the BlitzFunk network constitutes a distributed Layer-2 switch.

Scalability

BlitzFunk features a modular system design that provides deterministic performance and allows the network to scale as needed. The system is built around channel sets. A channel set consists of two non-adjacent 20 MHz Wi-Fi channels. A BlitzFunk access point can serve one such channel set. As BlitzFunk clients are added to a channel set, they are multiplexed in time. The systematic latency multiplies with the number of clients. To reduce the latency and increase the bandwidth per client, several access points can be colocated to offer additional channel sets. If the application requires more coverage, additional access points can alternatively be configured to use the same channel set and be placed such that their individual coverage areas overlap. Given a Gigabit Ethernet backbone between the access points, the configured resource grid is synchronized across all access points and clients may roam between them with no interruption and only slightly increased jitter. Two configuration examples are discussed at the end of this whitepaper.

Time Behavior

BlitzFunk implements a deterministic time-frequency grid across access points with guaranteed resources per client. Logical frequency resources (channel sets) are slotted in time to multiplex clients and realize duplexing. The duration of a time slot is 2 ms by default and determines the systematic one-way latency in the system. As more clients are allocated to the same channel set, the latency multiplies with the number of clients. On top of the systematic latency, some jitter (up to 2 ms additional latency with 99.9999 % probability) is to be expected as shown in Figure 1. The sum of systematic latency and jitter is doubled for a round trip between access point and client as well as for communication between clients.

Spectrum

Built upon Wi-Fi technology, BlitzFunk is capable of operating across unlicensed Wi-Fi channels in the 2.4 and 5 GHz bands, including the less frequented SRD channels

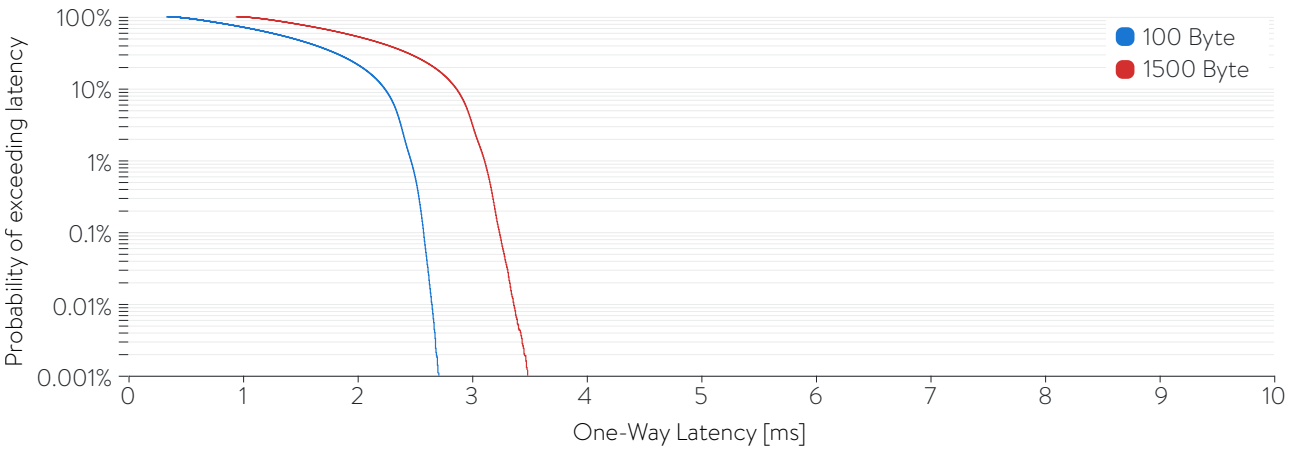

Fig. 1: Measured cumulative latency distribution for a single client in the lab (early 2024)

around 5.8 GHz. Support for 6 GHz is already under development. At a minimum, BlitzFunk requires one pair of non-adjacent 20 MHz channels for operation. To minimize latency, additional access points can be run on different channels and clients can be allocated to different channel sets.

Coexistence

BlitzFunk is designed to coexist with other Wi-Fi networks if necessary by adhering to CSMA/CA (Listen Before Talk). However, interference may lead to increased jitter and hence a higher functional packet error rate. In case of a small third-party network with minor load (e.g., condition monitoring), the impact on BlitzFunk will not be noticeable, but heavy load (e.g., video streaming) will deteriorate performance. On the other hand, a BlitzFunk network may have a significant impact on the performance of third-party networks.

Plug & Play

BlitzFunk has been designed with both performance and ease of use in mind. It aims to be plug and play for most applications with Ethernet-based traffic. BlitzFunk is fully transparent on the Ethernet level and supports the full standard MTU of 1500 Bytes per frame, which means maximum compatibility with existing applications. For system configuration and status monitoring, BlitzFunk access points offer a user-friendly web interface that can be accessed without the need to install additional software. Configuration changes and firmware updates are pushed wirelessly to the clients. If multiple access points are connected through a switch, the configuration is synchronized automatically across access points. Advanced users may leverage the HTTP API to integrate BlitzFunk into existing corporate configuration and monitoring solutions.

Security

Since BlitzFunk targets critical applications, security is paramount. All communication on a BlitzFunk network is authenticated and encrypted with protection against forgery, man-in-the-middle and replay attacks. Each client gets an individual key assigned which can be distrusted anytime if the device is lost or to be removed from the network. For maximum security, BlitzFunk devices feature a secure boot to prevent malicious tampering.

Physical Interfaces

The physical interfaces consist of a wide-range DC power input, an Ethernet port and several coaxial RF ports for external antennas. BlitzFunk devices are available with IP20 and IP65 connectors. All BlitzFunk devices come in rugged enclosures and are available with industrial-grade IP65-rated M12 connectors for power and data. Qualification tests for CE marking are currently in progress, further certification is planned for 2025.

Maturity

As of Q2/2024, a limited number of the latest prototype iteration is being sold for evaluation. CE-marked products are expected to launch to market by Q3/2024, with widespread distribution projected for 2025.

Example Configurations

An example configuration of one access point and six clients is shown in Figure 2. As clients take turns with a default slot duration of 2 ms, each client gets a transmit opportunity every 6 × 2 ms = 12 ms. Including 2 ms jitter, this yields a worst-case one-way latency of 14 ms. With up to 1500 Bytes per transmit opportunity, each client is granted a net bitrate of 1500 Bytes× 8 bit/Byte ÷ 12 ms = 1 Mbit/s.

Latency and throughput can be improved by adding a second access point operating on a separate channel set. This allows clients to be distributed across channel sets as needed. For example, if some clients are hooked up to machines with stricter latency requirements, these clients can be allocated to a separate channel set. An example configuration of four clients on one channel set and two clients on another is shown in Figure 3. On the first channel set, the one-way latency including jitter is at 4 × 2 ms + 2 ms = 10 ms and the achievable net bitrate per client is at 1.5 Mbit/s. On the second channel set, the latency is as low as 2 × 2 ms + 2 ms = 6 ms and the bitrate per client is increased to 3 Mbit/s.

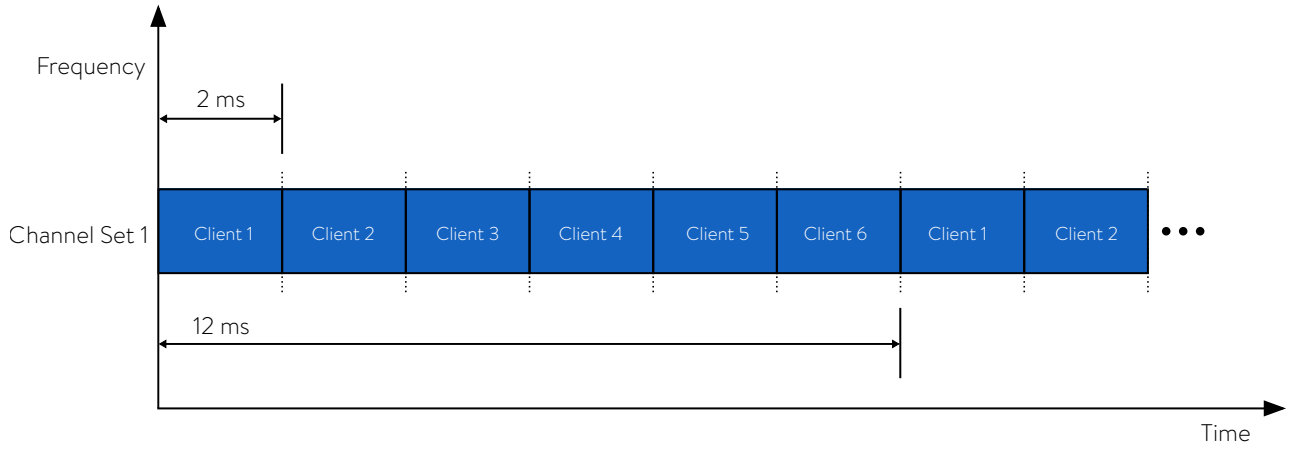

Fig. 2: Resource grid of six clients sharing one channel set

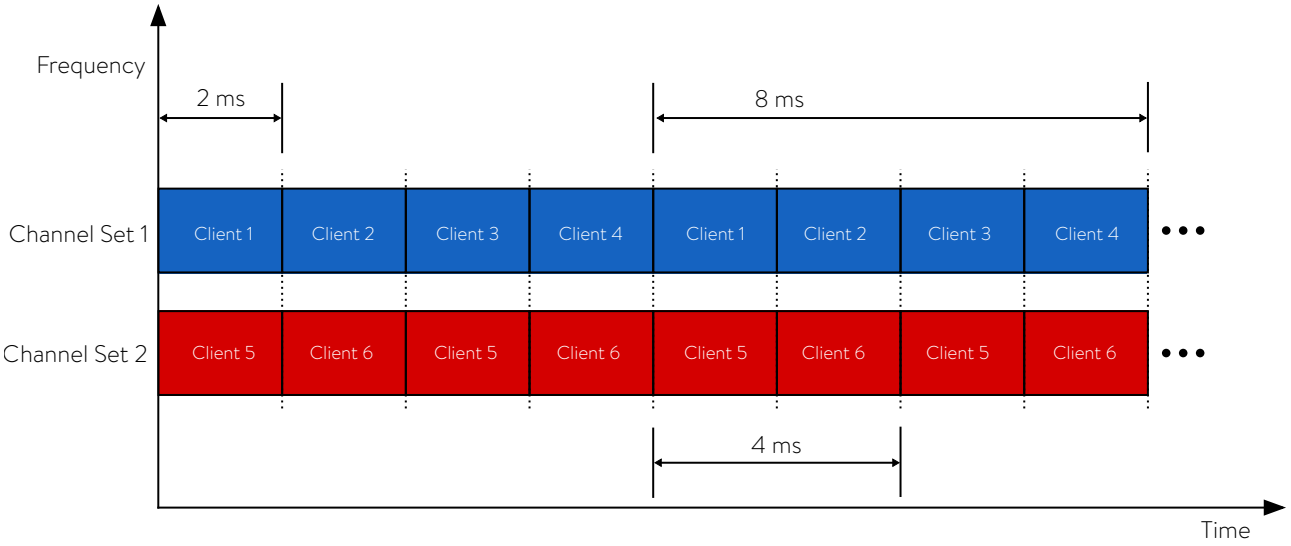

Fig. 3: Exemplary asymmetric resource grid of six clients sharing two channel sets

Authors

Dr.-Ing. Nick Schwarzenberg

Technology Development

nick.schwarzenberg@fuenfeinhalb.de
+49 173 9900454

Andreas Traßl

Product Management

andreas.trassl@fuenfeinhalb.de
+49 1523 4825585