

Benedikt Christoph Wolters

Principal Systems Engineer | Creator & Lead Developer of Turnstile and Precursor

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Principal Systems Engineer at Cloudflare with more than 10 years of experience developing distributed and complex software systems. Creator of Turnstile and Precursor, and technical lead for the Client Side Detection Platform. Experience spans browser-based detection, privacy-preserving anti-abuse products, edge mitigations, and security analytics pipelines processing millions of events per second.

Selected impact

- **Turnstile:** Created Cloudflare's privacy-preserving CAPTCHA alternative and led Challenges and CAPTCHA work. Turnstile was running nearly 3 billion times per day by July 2026, according to Cloudflare's published figures.
- **Precursor:** Created the continuous client-side detection system launched in July 2026, connecting browser behavior collection with edge evaluation, session-level signals, and downstream bot protection.
- **Security data infrastructure:** Built a firewall events analytics pipeline processing millions of events per second, alongside work on firewall offerings and edge mitigations.

Cloudflare experience

Principal Systems Engineer

April 2026 - present | Remote

- Technical lead for Turnstile, Precursor, and the Client Side Detection Platform; lead development of browser-based bot detection systems.
- Created Precursor to extend detection across the user session. Its architecture combines dynamically injected JavaScript, buffered behavioral streams, edge-side evaluators, and a shared detection registry.
- Co-authored the Precursor launch article, explaining session integration and privacy choices, including collecting keyboard timing without capturing the keys pressed.

Technical Lead

October 2022 - April 2026 | Munich, Germany

- Led Challenges and CAPTCHA work, with responsibility for removing Cloudflare's CAPTCHA footprint and improving performance through alternatives including Managed Challenge and Turnstile.
- Conceived Ephemeral IDs for fraud detection beyond IP addresses, using short-lived client identifiers derived from browser signals.
- Co-authored the Turnstile general availability and WAF integration announcements, documenting how browser verification extends to fetch and XHR requests through pre-clearance.

Distributed Systems Engineer

October 2020 - October 2022 | Munich, Germany

- Worked on the Anti-Bot and Edge Mitigations team; created Turnstile, which launched in public beta in September 2022.

Systems Engineer

May 2018 - July 2020 | London, United Kingdom

- Built high-throughput firewall event analytics and developed and maintained firewall offerings, including CAPTCHA and JavaScript challenge mitigations.

Earlier engineering and research

Student Research Assistant | RWTH Aachen University

March 2014 - February 2018 | Aachen, Germany

- **COMSYS, October 2015 - February 2018:** Researched HTTP/2 performance, kernel-accelerated packet processing, and Internet-wide network measurements in the Network Architectures Group.
- **Theory of Hybrid Systems, March 2014 - September 2015:** Developed and evaluated vehicle control strategies using genetic algorithms and machine learning; developed reachability-analysis tools and taught bachelor's and master's laboratory courses.

Software development and consulting

2007 - 2013 | Cologne and Brühl, Germany

- **NK Logistik Köln, January 2011 - December 2013:** Developed a web-based, multi-tenant, full-stack logistics platform.
- **BPP, 2010 - 2013:** Developed and maintained professional photography platforms and CRM systems, including server administration.
- **Freelance, 2007 - 2013:** Delivered web development and server administration services.

Technical expertise

Systems and security: Distributed systems, high-volume event analytics, edge mitigations, browser-based bot detection, behavioral signals, fraud detection, HTTP/2, web performance, and privacy-preserving verification.

Languages and tools: C++, C, JavaScript, Python, Java, Linux, Docker, Git, MySQL, and Elasticsearch. Maintainer of GeneiAL, an open-source C++ genetic algorithm library.

Education

MSc Computer Science | RWTH Aachen University | 2014 - 2018

Thesis: Demystifying the Performance of HTTP/2 Server Push. Minor: Medicine.

BSc Computer Science | RWTH Aachen University | 2010 - 2014

Thesis: Distributed Authorization Management for Secure Sensor Data in the Cloud. Minor: Medicine.

Selected publications and patent

Let The Right One In: Attestation as a Usable CAPTCHA Alternative. Co-author, SOUPS 2022.

Is the Web ready for HTTP/2 Server Push? Co-author, ACM CoNEXT 2018.

Distributed Configuration, Authorization and Management in the Cloud-based Internet of Things. Co-author, IEEE TrustCom 2017.

US Patent 10,733,307: Transparent inspection of responses from origin servers to identify protected data. Co-inventor, granted August 2020.

Selected recognition

KuVS Master Thesis Award, 2018 | FOLKS Best Thesis Award, 2017

Univention Bachelor Thesis Award, 2016 | Google Security Hall of Fame, 2011

Selected technical writing

Precursor launch and architecture (2026) | Ephemeral IDs for fraud detection (2024)

Turnstile and WAF integration (2023) | Turnstile launch (2022)