# Recommendation Letter for Mr. Shubham Yadav
## (To whomsoever this may concern)

I am eager to endorse Shubham Yadav, a stellar final-year B.Tech student at IIIT Delhi, for a role on your Networking and Security Team. Supervising Shubham alongside my PhD student, Jithin, on a research project exploring Voice over IP (VoIP) performance over the Tor anonymization network, I witnessed his profound technical insight and relentless dedication. Shubham's incisive work on audio codecs and expansive network measurements reshaped our understanding of VoIP challenges, positioning him as a prime candidate for advancing networking and security solutions.

Our project built on prior research, including "The Road Not Taken: Re-thinking the Feasibility of Voice Calling Over Tor" (Proceedings on Privacy Enhancing Technologies, 2020), which reported that Tor delivers good VoIP quality (PESQ > 3, one-way delay < 400 ms) in over 85% of cases, citing low cross-traffic contention and sufficient bandwidth (> 1 Mbps in 90% of cases). Earlier studies, like Rizal et al. and Phonion, dismissed Tor for VoIP, blaming high latency and TCP limitations, with bandwidth as the presumed constraint. Shubham's work decisively refuted this narrative. Through meticulous measurements, he revealed that high jitter variance, a factor prior studies sidelined, was the chief culprit behind poor Perceptual Evaluation of Speech Quality (PESQ) scores. His codec analysis further demonstrated how encoding strategies could alleviate jitter's impact, dismantling the bandwidth-centric view of VoIP performance.

Shubham has acquired a solid understanding of VoIP codecs. He delved into codecs like Opus, G.711, Speex, and GSM, examining their encoding rates and robustness against network disruptions. Configuring our Freeswitch SIP server, he conducted 1000 calls per codec over Tor, discovering that lossy codecs like Speex and GSM (< 40 Kbps) sustained acceptable quality (PESQ > 3) on low-bandwidth circuits, outperforming higher-rate G.711 (84 Kbps) under jitter-heavy conditions. This finding challenged prior work's assumption that ample bandwidth guaranteed quality, as Shubham proved codec selection could preserve performance in constrained networks. His codec-driven insights offered actionable approaches for optimizing VoIP in anonymized systems, a capability crucial for secure, efficient communication platforms.

Shubham can handle and automate in large-scale network measurements with ease. He orchestrated experiments covering over 500,000 calls across 12 months, encompassing 6650 unique Tor relays—a scope dwarfing prior efforts like Rizal et al.'s 298 relays. He probed geolocation's role, theorizing that endpoints distant from most Tor relays encountered greater congestion, amplifying jitter and lowering PESQ. His tests across varied caller-callee locations validated this, yielding data to enhance relay selection for latency-critical applications. Shubham's skilled use of iperf and ping ensured accurate bandwidth and latency metrics, while his adept management of Tor circuits and SIP for VoIP calls reflected a robust command of anonymization and protocol stacks. This expansive approach exposed the limitations of prior work's narrow datasets, which misjudged Tor's VoIP viability.

Shubham has excellent teamwork abilites. He collaborated fluidly with Jithin, suggesting codec-centric experiments, honing measurement frameworks, and articulating precise, data-backed conclusions. His swift grasp of intricate topics—Tor's design, SIP signaling, and TCP/IP packet dynamics—was noteworthy.

Shubham's skill set is ideally suited for a networking and security role. His codec mastery, combined with his proficiency in large-scale performance analysis and anonymization systems, prepares him to bolster low-latency, secure communication platforms. His focus on privacy-preserving VoIP aligns with crafting resilient network architectures. His capacity to navigate vast datasets and extract meaningful findings equips him for data-intensive environments where network dependability and security are paramount.

I enthusiastically support Shubham for a position on your team. He is a distinctive talent whose technical insight, problem-solving acumen, and collaborative drive will yield substantial impact. Please contact me at for further details. I am certain Shubham will thrive in advancing innovative networking and security solutions.

Sambuddho, PhD

Associate Professor, Indraprastha Institute of Information Technology Delhi (IIITD)

New Delhi 110020, IN

Phone: +911126907478

Web: https://www.iiitd.ac.in/sambuddho                    Date: May 12, 2025, New Delhi, IN