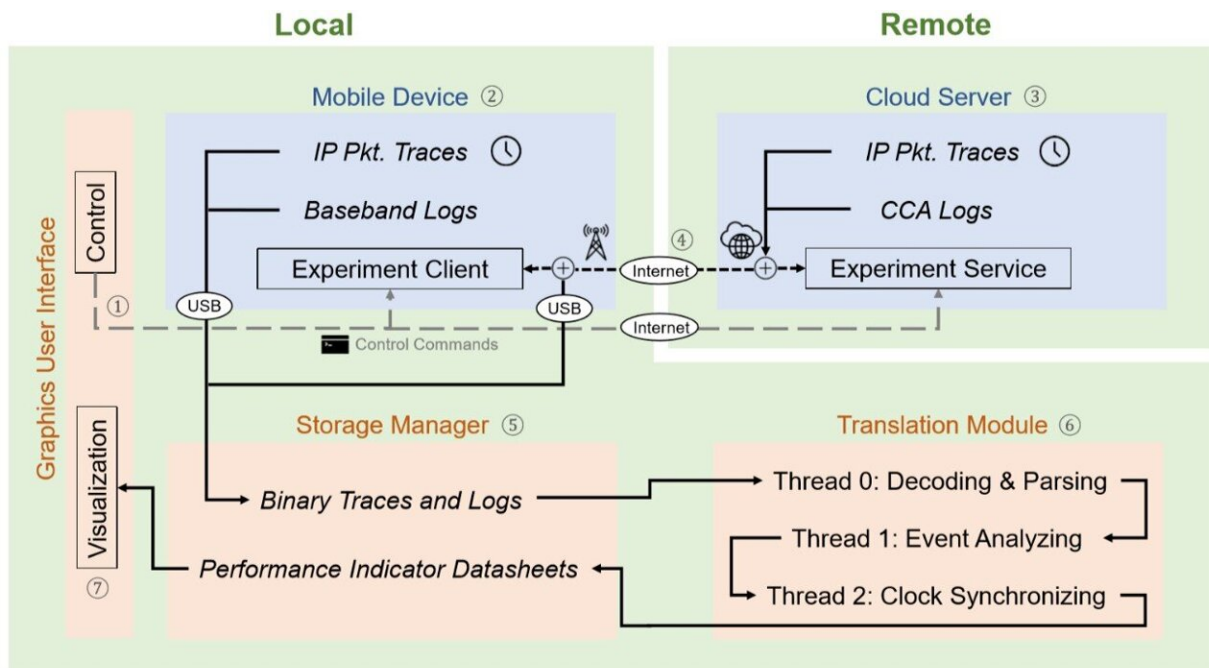# A graphical diagnostics tool for high-speed railway internet connectivity

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The black line with the arrow shows how traces and logs of carried network experiments are created, transferred, processed, and finally visualized as network performance indicators. Credit: Ruihan Li, et al

As the high-speed railway network in China extends beyond 40,000 kilometers, maintaining seamless internet connectivity for passengers is becoming increasingly challenging. The demand for consistent and reliable online access is particularly crucial for travelers who spend

extended hours on trains, relying on the expectation of undisturbed work, study, or entertainment. Addressing this need, a team of researchers from the School of Computer Science at Peking University has developed "HiMoDiag"—an innovative tool designed to enhance the understanding and management of network performance in extremely high-mobility scenarios.

"HiMoDiag stands out as a TCP-LTE/5G cross-layer performance analysis tool that enables full-stack real-time comprehensive analysis and visualization of network performance from the application layer down to the physical layer," explains Chenren Xu, corresponding author of the study. "It not only captures [performance data](link) across all layers of the network between user application and [service provider](link) but also visualizes it in a way that's actionable for network operators."

The team [published their results](link) in the journal *High-speed Railway*.

Notably, HiMoDiag is particularly useful in scenarios whereby passengers expect stable internet connectivity to support their work and leisure activities during travel. The tool's real-time analysis and visualization capabilities allow for immediate network performance diagnosis and performance optimization—an aspect that traditional diagnostic tools tend to fall short.

"By integrating cross-layer data analysis, we can now pinpoint and address issues much faster than before," Xu added. "This means less downtime for passengers and a more reliable service overall."
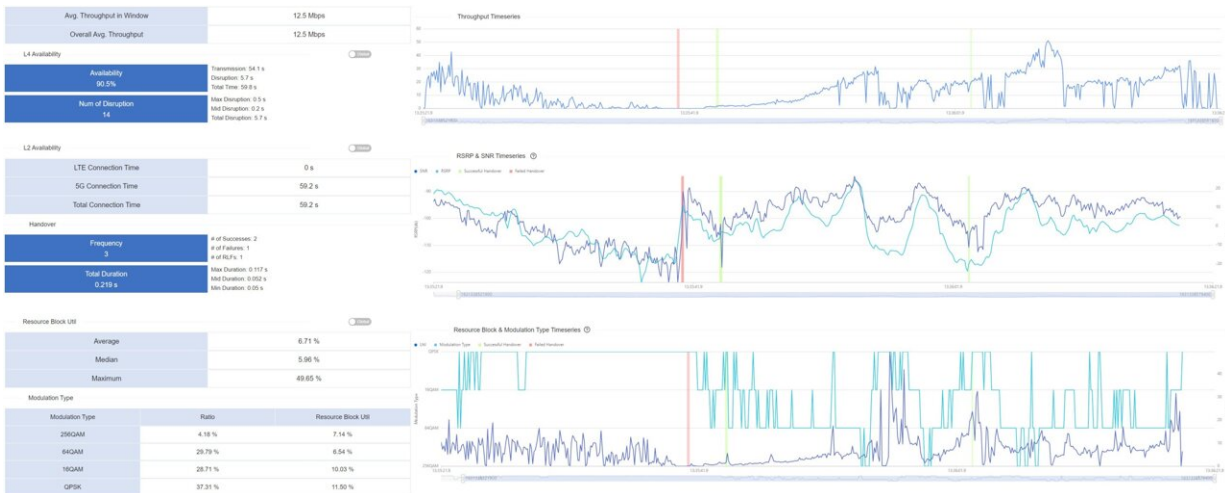
The top graph shows throughput metrics in the transport layer. The middle and bottom graphs prominently display variations in signal strength and resource allocation in the physical and data link layers. Handovers are included in all three graphs, providing a holistic view of network dynamics. Credit: Ruihan Li, et al

The design of HiMoDiag addresses several challenges, including clock synchronization across network layers and endpoints, managing the substantial data volume resulting from 5G's high bandwidth, and mitigating interference arising from performance indicator transmission.

Through its implementation and evaluation across an extensive dataset collected on trains with a maximum speed of 350 km/h, it has the potential to elevate network performance, thereby ensuring an enhanced user experience for passengers as well as quality of mission-critical service provided by LTE-R or 5G-R. HiMoDiag's experiment platform also allows for flexible control over mobile devices, facilitating various types of network experiments.

   More information: Ruihan Li et al, TCP-LTE/5 G Cross-layer performance analysis tool for high mobility data networking and a case

study on high-speed railway, *High-speed Railway* (2023).

Provided by KeAi Communications Co.