An overview of channel estimation technology in high-speed railway communications

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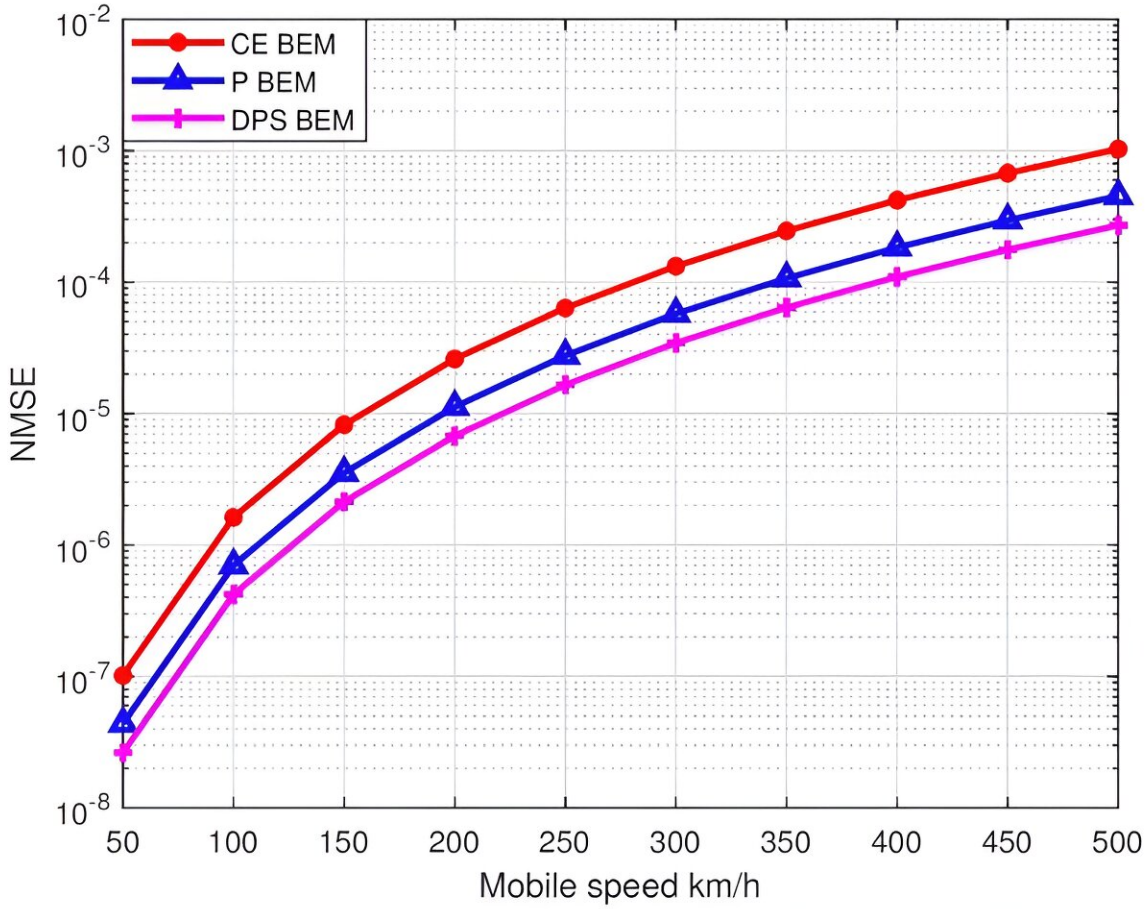

Influence of mobile speed on channel estimation error. Credit: Xuying Chen, et al.

To guarantee safe train operations and provide passengers with convenience, such as seamless internet service and robust entertainment options, there is an increasing need for high-reliability, high-data-rate wireless communications. Wireless communication technologies, for a significant part, heavily rely on the acquisition of channel state information (CSI), making channel estimation vital to their performance. However, offering satisfactory service to a large user base at high speeds presents various challenges.

In a study published in *High-Speed Railway*, a team of Chinese researchers has outlined the challenges, proposed solutions, and future development directions related to channel estimation technology in high-speed railway (HSR) wireless communication.

"The HSR signal propagation environment is complex due to reflections from physical objects that cause time dispersion. These reflected signals can combine destructively, resulting in multipath fading. High data rate broadband signals may encounter frequency-selective multipath effects, while high mobility can lead to Doppler spread, inducing a time-selective channel," explains co-corresponding author of the study, Wei Chen.

"Channel estimation in HSR confronts challenges such as high estimation overhead and inter-carrier interference (ICI) within the orthogonal frequency-division multiplexing (OFDM) system."

The team also explored these channel features to achieve channel dimensionality reduction, refine traditional algorithms based on channel characteristics, and eliminate ICI for OFDM, thereby improving channel estimation accuracy.

"Future communication systems should aim to advance the intelligent and digital progression of HSR, providing faster and more comfortable services to a multitude of simultaneous passengers at speeds reaching up

to 500 km/h or even higher," added Chen. "Orthogonal Time Frequency Space (OTFS) system and Reconfigurable Intelligent Surface (RIS) represent the most promising technologies to integrate with HSR."

More information: Xuying Chen et al, Wireless channel estimation for high-speed rail communications: Challenges, solutions and future directions, *High-speed Railway* (2022). DOI: 10.1016/j.hspr.2022.11.004

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