Wideband Channel Measurements and Analysis in High-Speed Railway Environments

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In the past few years, there has been an increasing interest of wideband wireless communications of High-Speed Railways (HSRs), which have plenty of specific propagation scenarios. Wideband channel modeling of HSR is important for system design of the next generation of HSR communications. However, there is a lack of deep understanding regarding the characteristics of wideband channels in the complex environments such as railway cuttings and stations.

We conducted wideband channel measurement in the realistic HSR cutting and station scenarios in Datong-Xian HSR line in China. Static measurements were conducted at 950 MHz with a bandwidth of 150 MHz. We use a channel sounder developed by Technical University of Madrid. The transmitting signal is modulated with a narrow pulse with a width of 30 nanoseconds. The receiver is a single conversion system with a logarithmic amplifier used as demodulator. The demodulated signal is acquired using a digital oscilloscope, which allows to acquire power delay profile on real time. HG72107U-PRO omni-directional antenna with 9 dBi gain is used at receiver and HG72714P-090 panel antenna with 14 dBi gain is used at transmitter.
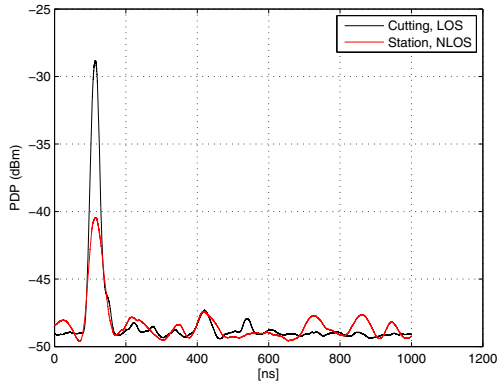

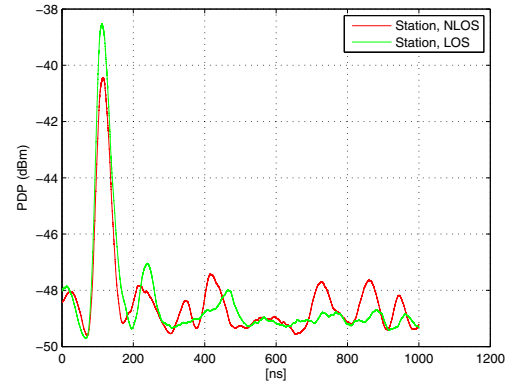Fig. 1 Measured PDPs for cutting and station NLOS scenarios.

Fig. 2 Measured PDPs for station LOS and NLOS scenarios.

Fig. 1 shows a plot of the measured power delay profiles (PDPs) for the cutting and station scenarios, where in cutting measurements, we have LOS component; whereas in station measurements, it is NLOS propagation. It is found that generally LOS leads to stronger direct path, and for station NLOS case, a lager delay spread is observed, e.g., around 700 to 1000 ns. This is caused by the close structure of station, which results in more reflections and scatterings. Fig. 2 shows a plot of the measured PDPs for the station LOS and NLOS scenarios, where two curves are generally close to each other. It is also found that the NLOS case has a lager delay spread, which is similar to other wideband measurements. Moreover, we calculate the Root Mean Square (RMS) delay spread of each case, using a threshold of noise floor plus 6 dB. It is found that the RMS delay spread is 277.7, 302.8, and 286.0 ns for the cutting LOS, station NLOS, and station LOS scenarios, respectively. The delay spread in above scenarios is generally larger than the cellular system, which is caused by the special structure of railways, e.g., the steep walls on both sides of cutting and the roof of station lead to close structure of environments, and result in more reflections and scatterings. The large delay spread should be carefully considered in the design of HSR systems.