Railroad Telecommunication Planning

Amtrak station at Niles, Michigan (image courtesy of G.E. Transportation Systems).

Outputs

- Demonstration of advanced radio technology and infrastructure along the Midwest passenger rail corridor, in support of the Federal Railroad Administration's high-speed rail pilot program.

The incremental train control system (ITCS) is a radio-based signaling system designed by G.E. Transportation Systems whose purpose is to facilitate high-speed passenger rail transportation along the Midwest rail corridor between Chicago and Detroit. The current ITCS demonstration system "overlays" on an existing legacy track signaling system of approximately 70 miles in length. It provides enforcement of signal indications and civil speed limits, as well as advanced start of highway crossing gates, in a high-speed rail environment. The overlay design supplies system redundancy, so that in the event of data communication failure between ITCS components, passenger safety is not compromised, as train control will revert to the legacy signaling infrastructure.

At higher track speeds, the status of highway crossings and signal lights must be made known to the locomotive at further distances from the crossing and signals, as compared to traditional track speeds, and highway crossing gates must be activated when the locomotive is further distant from each crossing. Monitoring and notification over these greater distances is accomplished by radio frequency (RF) data links.

ITCS monitors the status of "wayside" devices (signal lights, highway crossing gates, etc.) via an RF data link, and relays these statuses to the locomotive via a second RF data link. A computer onboard the locomotive evaluates the status information from these devices in conjunction with local sensory information (speed, GPS location, etc.) and other pertinent data (track profile, computed braking distances based on track profile, and so forth), and then determines permissible locomotive actions, so as to facilitate efficient high-speed rail travel.

During the course of this pilot program, operational system anomalies, believed attributable to radio propagation, have been experienced on a

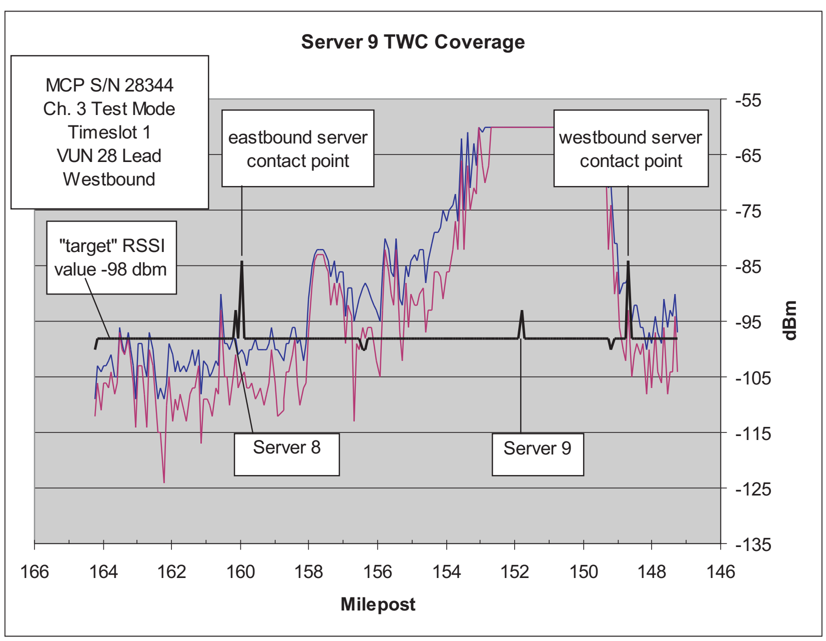

Figure 1. Measured signal strength – Server 9; Amtrak locomotive at track speeds.

number of occasions. While these anomalies have always resulted in restrictive “fail-safe” modes of operation, with ITCS functioning exactly as it should under these degraded conditions, these anomalies have resulted in sub-optimum transit time performance of passenger trains traversing the territory. Consequently, the Federal Railroad Administration (FRA) asked the Institute to provide technical representation to the ITCS program on their behalf.

Empirical evidence collected thus far suggests that log-normal shadowing phenomena is deleteriously affecting the propagation of the 900-MHz RF data link signals. Figure 1 shows typical receiver response curves (average and minimum received power levels) as measured by G.E. Transportation Systems.

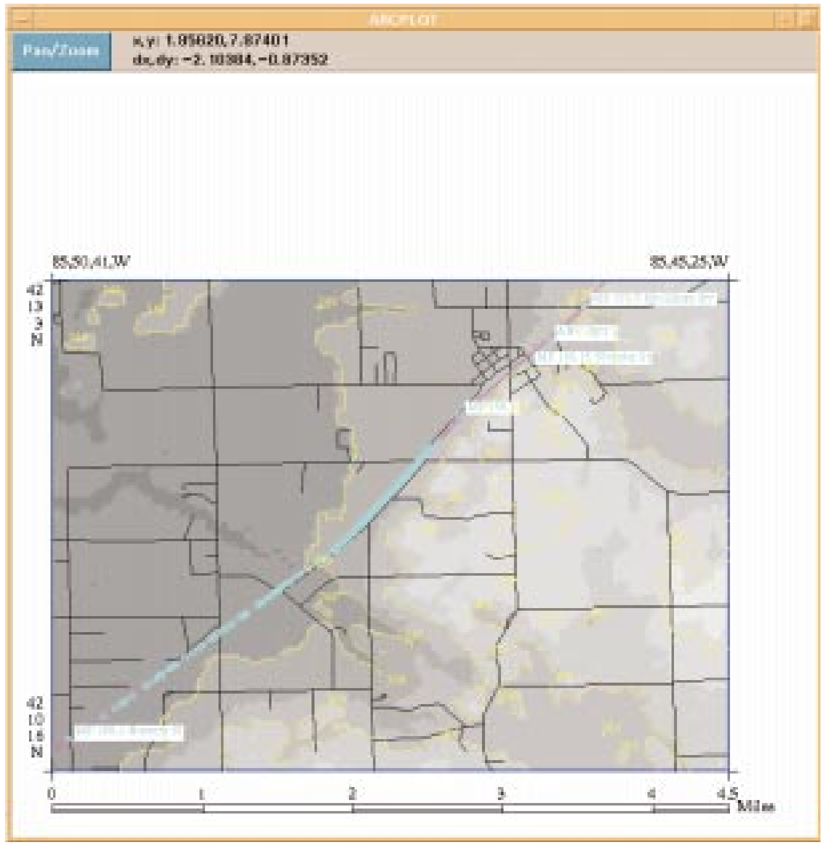

Figure 2. Successfully received ITCS data packets; Hy-Rail vehicle at 5 mph.

What this plot shows is that on eastbound moves (although this measurement was actually taken traveling westbound), the signal strength would not have been sufficient to allow the locomotive’s ITCS equipment to have acquired the signal from wayside server 9 by the time milepost marker MP 160 had been reached. Even though MP 160 is still in server 8 territory, having acquired server 9 by this time ensures that an RF data link is established and that advance gate crossing activations and other critical actions can be triggered just as soon as the locomotive would enter server 9 territory at MP 156.

Further investigations by the Institute determined representative areas of successful data communication. Figure 2 shows the locations of successfully received ITCS packets over a portion of the same track territory, indicated by the turquoise-colored dots on the (magenta-colored) tracks. It is to be noted that this data was collected in a single pass while driving along trackside in an ITCS-equipped Hy-Rail vehicle, at speeds of about 5 mph, as opposed to a number of data sets collected at typical (faster) locomotive speeds, as was done in Figure 1.

What is apparent is that near MP 160 (lower-left corner) and west, successful packet reception in this fringe area appears to be less reliable than further east, a region more centrally located to the track section. During this data collection activity, the Institute noted that the tree line was on the same order of height as the 900-MHz antennas, a very likely cause of the shadowing phenomena being experienced. The Institute is currently exploring whether apposite solutions could be as simple as raising the heights of wayside antennas, or whether an entirely new approach to system design and/or deployment of the underlying infrastructure may be more appropriate.

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