Case study #	1.9
Title	Electric railway interference
Type of trouble	Acoustic noise, degradation, abnormal operation, loss function.
Source of trouble	Electric railways within a few kilometres of telecom systems.
System affected	Customer's equipment.
Location	Customer premises, outdoors.
Keywords	Electric railway, common mode chokes, screening, filtering.
Version date	2004-01-01

System configuration

Normal PSTN line. Customers hear noise come and go, coincident with trains coming/going into sections of track. It can be determined from the noise level (and tone) if the train is accelerating or decelerating. If booster transformers are used on the electrification system, then the sudden cut-in/out of the noise is very evident as trains enter and leave the section.

Measurement/Searching techniques/Experiment

Customers suffer; noise creates audible and data problems, even to the extent that dialling out does not proceed. Railway noise tends to be different from normal power harmonic noise in that it tends to be at a low level when no trains are in the section and then varies dramatically when a train arrives. Having knowledge of the timetable or a view of the line helps in determining if it is due to the trains. The noise is typically due to the multi-pulse rectifiers used in the power conversion of the motor and the spread of the return currents. Very little of the noise can be attributed to airborne effects.

Even when good mitigation measures have been employed, noise can sometimes re-occur. In most instances, this has been found to be due to poor track cleaning practices, which have resulted in numerous damages to earth bonds between rail and the return wire, thereby increasing stray currents in the earth.

Mitigation method/Results/Conclusion
A number of mitigation methods are available, though ideally it is better to solve the problem at source. It is imperative that the telecom operator is consulted when the electrification system is being planned and auto or booster transformers are suitably positioned to minimize induction effects due to the return currents. The balance of the pairs affected should be checked (> 60 dB), such that induction effects are minimized in the network cable. Measures that can be taken by the telecom operator to reduce the noise problem are to use screened cables, well earthed at the end of the parallelism as well as at numerous points along its length. If a screened cable is not available, then spare pairs, an old cable or a copper strip, earthed in a similar way can be almost as effective. Other measures may be to use induction-neutralising transformers (INTs) if a large number of customers are affected, or for fewer customers the use of common-mode chokes and drain circuits or even pair-gain systems. Occasionally, none of the above appears to work; this has been traced to the noise being conducted to the power system and local earth, such that all the customer internal wiring has an induced voltage on it. Fortunately, these are not too common. There is currently no easy solution to this case.

References
Rec. ITU-T K.37; Annexes A and B.