Modeling of Licensed PCS Co-Channel Interference for Use in the Simulation of PCS Traffic Loading and Interference as a Result of Cell Damage or Failure

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(Enhanced) ABSTRACT

While personal communications service (PCS) systems offer an attractive and necessary form of data and voice communications following a natural or man-made disaster, the system itself is not immune to damage. As base stations are removed from service, the traffic load patterns are altered and the resultant system performance and availability is negatively affected. In addition to the loss of base stations, as the availability of the existing land-line infrastructure declines, more users migrate to wireless communications. As is the nature of any emergency, the need for communication increases beyond levels experienced during non-emergency periods.

In addition, government agencies and emergency services have become increasingly dependent on commercial wireless services. As a result, system capacity becomes an important concern. Spectral efficiency, in terms of spectral density and spectral re-use, is one of the priorities existing and future technologies of personnel communication systems (PCS) must take into account. As the demand for a limited amount of spectrum increases, co- and adjacent-channel interference between dissimilar or incompatable systems will affect their efficiency and usability.

Future developments (2.5 and third generation) in PCS technology have concentrated on code division multiple access (CDMA) whose 2G implementation follows the ANSI/TIA/EIA 95B standard. In CDMA systems, capacity is limited by co-channel interference.

Co-channel interference is a real and acknowleged problem in both urban and rural areas. If left unresolved, it can impact the quality of service and system capacity. Co-channel interference is of particular interest to the commercial PCS industry as more systems are being developed and implemented in already saturated areas. Since commercial PCS services are being considered for use in national security/emergency preparedness (NS/EP) situations, co-channel interference is becoming a concern of government and military agencies.

Using a co-channel interference model developed at the Institute for Telecommunication Sciences (ITS), the effects of system damage, load shifting, and increased traffic, can be studied, allowing emergency service providers to anticipate system availability and the need for supplemental emergency communications equipment.

The model consists of an hexagonal array of circular cells with a base station positioned in the center of each cell and a random number of mobile stations randomly positioned throughout each cell. As base stations are removed from operation, the mobile stations are picked up by the remaining base stations. Additional mobile users may be added and their locations can be changed to reflect the nature of the emergency.

This model characterizes the co-channel interference by producing a multiple-channel multiple-base station air interface signal with a variable number of base stations and channels per base station. The model also includes power control for individual signals which is an important aspect of the interference level existing in the spectrum. When unacceptable levels of interference occur, most power control schemes simply increase the power level of the system's signal to maintain an acceptable error-rate, which is a short term solution at best. The study of co-channel interference helps to develop more useful schemes to reduce the interference levels; this is another purpose of the ITS model.

The change in the aggregate air-interface spectrum is calculated and the resultant signal to interference (C/I) values can be used to determine the change in service quality and the probability of service availability. Any number of scenarios can be developed, depending on the configuration of the system under study and the level of detail desired.

Since the model produces a cumulative baseband signal for both the forward and reverse directions, it can be implemented in a real-time hardware channel simulator, or as a component of a higher-level software simulation and modeling. Predicted C/I values can be used in software-based network models to anticipate system limitations, traffic bottlenecks, and the probability of overall system failure. The baseband signal produced can be used to generate a simulated traffic signal for the testing and evaluation of commercial equipment. The model is particularly well-suited for independent PCS system evaluation by other Federal agencies, system manufacturers, and service providers.