# TRANSMITTERS INTERFERENCE TO VICTIM RECEIVERS AND RADIATION HAZARD TO HUMAN: ARE THEY CORRELATED?

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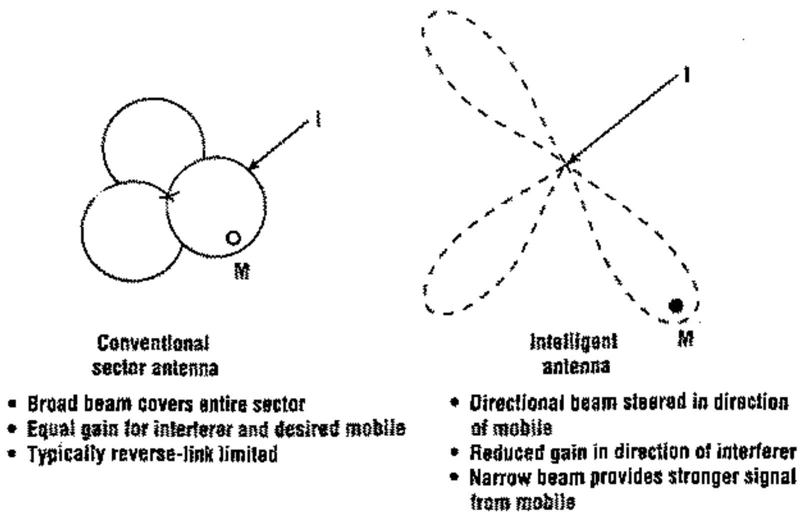
Nowadays, radio systems transmitters (Tx) harmful interference and radiation effects are significantly important and complex. The main reasons are the tremendous growth of users and wireless equipments approaching the 1000 millions which will exceed the number of wired telephones. A very important issue is the requirements for coexistence of transmitters (Tx) and receivers (Rx) on the same site (cosited), where radio mutual interference effects are significantly more harmful than internal natural and industrial artificial noise [1,2].
The quality factor of a transmitting (Tx) system can be described by the Effective Isotropic Radiation power EIRP or the Effective Radiation power (ERP) referred to a half wavelenght dipole

$$EIRP = P_t.G_z or\ (EIRP)_{dBw} = P_{T(dBW)} + G_{T(dBi)} \quad (1)$$

This quality factor favorise the desired Rx to obtain a maximum signal to noise or a best Bit Error Rate (BER) ever at long distances . However it defavorise the other of millions of Rx which may be victim to the stronger Tx interference power levels. [2; 3]
It is better to reduce $P_t$ and increase $G_t$ in order to reduce the probability of interference and the number of victim Rx [4]. This approach can be obtained: by only one directive one antenna for fixed static radio links between two point. For mobile radio links which are the majority todays are required intelligent antenna arrays as shown in figure 1. For broadcasting systems with a multitude of desired Rx the smart antenna solution is not effective [3].

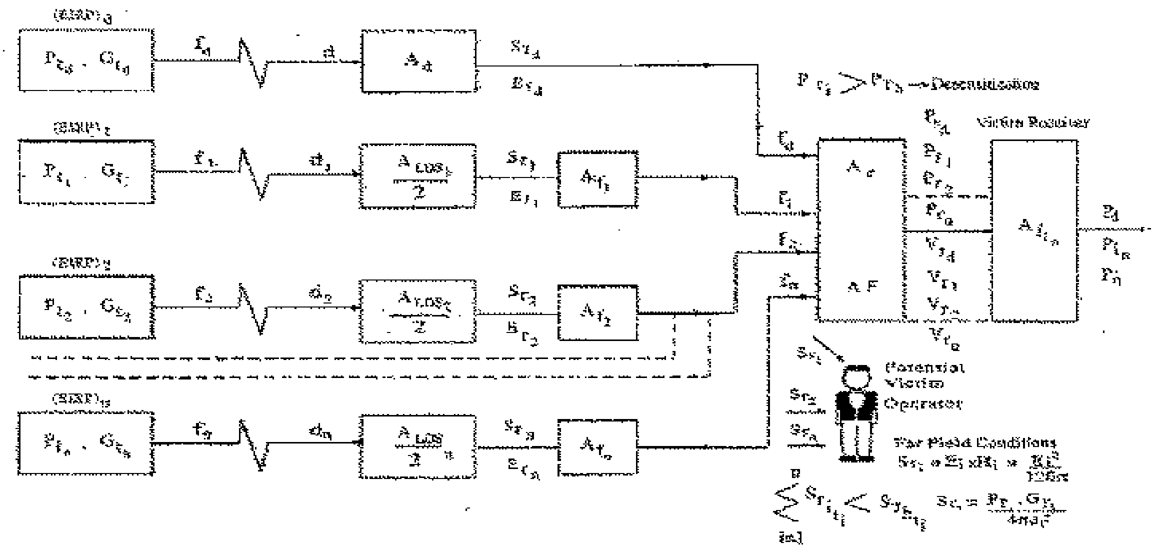
Fig. 1




**3. An intelligent antenna in a cellular system is better than a conventional one since it can collect information that is used to adjust the system configuration to improve performance.**

We shall analyze especially short distances cases to victim Rx's when cosited conditions occur often followed by strong interference effects. For instance Personal Area Networking (PAN) involves the use of multiple short-range transceivers to form a small area of communications and data networking between the PAN devices. The range of communications is normally within 3 meters. PAN is mostly based on the Bluetooth short-range wireless technology, which works in the ISM 2.4 GHz band [6]. Several handset manufacturers are building Bluetooth functionalities into their arrays of multi-mode (GSM/GPRS/UMTS/CDMA) mobile handsets for the next generation . The market for Bluetooth devices is forecasted to reach more than 2 billion devices by 2005. PAN devices usually operate within the personal workspace of the user and could be made into accessories to be worn on the body in the form of wearables smart clothing, based on contactless Radio Frequency Identification (RFID) technology as the connectivity mechanism for inter-device communications, could become the future telecommunications platform [7].
Global System Mobile, General Packet Radio Service, Universal Mobile Telecom System Code Division Multiple Access.
The cosited Tx interference affecting very near victim Rx are especially non linear broadband desensitization due to preamplifiers saturation, reciprocal mixing due to frequency converters or for less power level spot frequency intermodulation (IM) [2]. Cosited Tx and Rx parameters simulation computation tools are used to estimate the Rx interference power levels under worst case realistic conditions, considering the Tx power positions and distances between the respective antennas [3,4]. For very short distances between the Tx's and the victim Rx's the interfering power density $\overline{S}$ and the electrical field intensity $\overline{E}$ are converted to an input power level $P_s$ and Voltage $V_s$ at the Rx front end stage. These conversions depend on the Rx antenna effective area Ae and antenna factor (AF) and when the intensity are very high the Rx can be blocked or strongly desensitized as shown in figure 2 for a cellular base station. In case of far field conditions the effects of the interfering Tx radiated Electromagnetic Field (EMF) components are relatively simple. It is enough to compute or measure $\overline{E}$ and efficient semi-empirical computation methods were developed for calculating desensitization effects in the victim Rx due to the strong non linear excitations from the interfering Tx.[3,4]

Fig. 2



Desired and Interference Signals Synoptic Diagram
For a Cosited Situation

However, for near field and especially reactive near field conditions occurring in the vicinity of the interfering Tx, the EMF components are very complex to compute. E and magnetic field intensity $\overline{H}$ components have to be computed or measured separately, sometime in 3 dimensions and excessive EMF intensities may occur due to spatial spot effects. These strong $\overline{S}$ , $\overline{E}$ , $\overline{H}$ intensity field components may block victim Rx or affect people who are located in proximity to the interfering Tx. In case of several interfering Tx operating simultaneously, the sensitivity of cosited victim Rx's or exposed people are affected by the sum of the power density generated by the interfering Tx's as shown in figure 2. In this case, complex numerical methods are useful such as the statistical Monte-Carlo technique. [2;3]
Actually, the spectrum frequency range of 30 MHz to 3 GHz is the most crowded and vulnerable to interference. This frequency range is also the most vulnerable to radiation hazards absorbtion due to the resonance frequencies of the human body and head. The resonance range extends from 30 MHz for not grounded tall body people up to 600 MHz for a children head. Radio standard organizations radiation threshold power density and thermal specific Absorbtion Rate (SAR) limits are related to these resonant effects.[8,9]. At very short distances from Tx the security threshold standard limits may be exceeded and protection measures are required.
Mitigation technique to protect victim Rx from blocking and excessive desensitization were described in details [1,4]. Here will be described the special mitigation techniques useful both for victim Rx and exposed maintenance people of Tx stations and users of cellular phones.

1. Power control by reducing power of interfering Tx manually or by automatic remote control when Rx or people are operating in the proximity of Tx. This method is simple but may affect the quality of service of desired radio links.
2. Artificial shielding to decrease the coupling between the antennas of the interfering Tx and victim Rx or special clothes including metallic shielding to protect maintenance people or headset users. Shielding is more costly but has only minor effects on the quality of service.[11]
3. Selective filtering in case of strong interference of the victim Rx vulnerable stage which will be protected by an attenuator or a selective filter which will reduce moderately the sensitivity for the desired signal. In case of exposed person can be used special shoes or an helmet to decrease the radiation absorption by reducing the frequency resonances of the human body.
4. Special signal processing (SP) methods are very efficient for victim Rx protection [2,4]. For instance a (SP) sub system and an auxiliary antenna shown in figure 3 can provide 40 to 50 dB reduction of the desensitization level. This is an expensive but very useful method. A similar method is developed for special Headphone where an auxiliary antenna provide in the near field a significant deep of radiation towards the user head with a minor effect on the useful far field radiation pattern towards the base station.

Fig.3

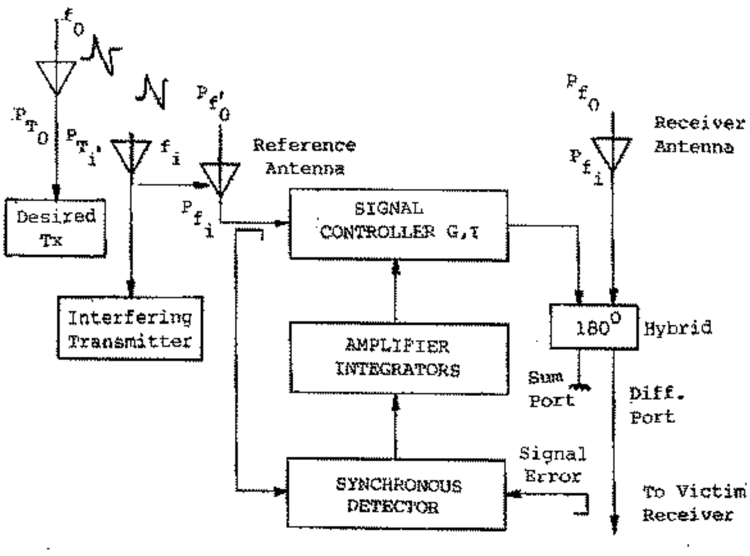



Fig 12/ Illustration of operating principle of interference suppression using Signal processing and an auxilliary antenna.

Far field exposure conditions will be analyzed and computed, especially for base stations Tx radiation. More complex reactive near field exposure conditions will also be analyzed and described new statistical methods especially for mobile headphone affecting users head [12].
Computation, simulation and measurement results show that under some cosited scenarios when victim Rx are blocked or strongly desensitized by high power interfering Tx. Person located in the proximity of the Rx may be affected by radiation intensity which may approach the standard threshold limits.[12] Thus, we can conclude that in special cases, described in this paper; a correlation exists between Tx's interference to victim Rx's and radiation intensity level to exposed human However the sensitivity of Rx to Tx high interference is significantly higher than the sensitivity of exposed people to radiation effects.

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