

TECHNICAL NOTES ON SYSTEM DESIGN

Designing radio systems to meet or exceed performance objectives requires good planning and attention to detail. Any aspect of the system left to chance, including its physical or electrical environment, is likely to reduce its performance.

Although each segment of the communications industry has its own peculiar set of problems, one can generalize about system design in terms of good engineering practice and common sense.

DEFINITION OF A SYSTEM: A COLLECTION OF RELATED ELEMENTS FUNCTIONING TOGETHER AS A WHOLE.

While this might seem both fundamental and trivial, many difficulties with system debugging derive from the designer's failure to consider all of the "related elements." Among factors that can affect system performance: the influence of the tower leg upon a side-mounted antenna, carrier frequency or power output instability due to line voltage fluctuations, temperature and humidity variations, nearby sources of RF whose intermodulation products land in your receiver's pass band, dangerous weather phenomena, atmospheric "skip" conditions, the sunspot cycle, the related propagation characteristics of each frequency band. These factors, and a host of others can have an impact upon your actual system performance.

THERE ARE THREE MAIN GROUPS OF SYSTEM INFLUENCES THE DESIGNER MUST CONSIDER: VARIABLES, PARAMETERS AND CONSTRAINTS.

Variables can be changed at the will of the designer. Parameters may change but are not under the designer's direct control. Constraints are dictates of the system design objectives or the demands of the system owners. Variables require offensive planning, parameters require defensive strategies, and constraints demand accommodation. Variables include: transmitter power level, receiver gain, antenna gain, antenna height, site location (sometimes), and other elements generally subject to the designer's choosing.

Parameters include the direction of the wind, the amount of snowfall and ice accumulation, presence of other RF sources at a community tower site, frequency assignment issued by the FCC and coordinating agency, and other circumstances pre-dating your system installation.

Constraint examples include the system's coverage area, the requirement to avoid interfering with another nearby co-channel system, availability of channels for expansion, area height restrictions for antennas, and the budget for equipment and labor.

BASIC QUESTIONS

The following questions are a good starting point in the design of a new radio communication system: Who are the users of the proposed system? What is their activity profile? How many are there? How geographically widespread are they? Do they need to communicate among themselves directly, or through a central point? Do they require information security? Should they be individually licensed? Does their airtime need to be tracked for billing? Do they need to interconnect with other systems?

Answers to these questions lead the designer to hardware and regulatory decisions. Identifying the user community as to type and category directs the designer to the applicable part of the FCC Rules and Regulations under which they may qualify: business, government, personal, common carrier, etc. This step also leads to a range of choices concerning available frequency bands. The estimated activity profile and number of users instructs the designer about the number of channels required, and whether co-channel interference can be tolerated.

Estimated geographical disbursement dictates the required coverage of the system and, to some extent, the frequency band, because of differing propagation characteristics of available bands. The employment of a simplex or duplex repeater system will be dictated by user requirements: Do they need to talk to a central point only, or also among themselves? If information security is a concern, consider frequency allocations that permit digital modulation. The licensing question is complex and generally a predetermined constraint for the designer. If time billing is critical to revenue generation, hardware must be selected to perform this task. The need for interconnection with the private switched telephone network or other radio systems may also be subject to regulatory restraints.

