RECOMMENDATION ITU-R M.1077

MULTI-TRANSMITTER RADIO SYSTEMS USING QUASI-SYNCHRONOUS (SIMULCAST) TRANSMISSION FOR ANALOGUE SPEECH

(Question ITU-R 67/8)

(1994)

1. Introduction

Wide area coverage radio networks employing simultaneous transmission by multiple transmitters on a common frequency have been used for more than 30 years. Over this period, narrowing channel bandwidths and the increasing use of narrow-band FM has shown that a number of guidelines need to be closely followed to ensure successful performance.

Simulcasting is not simply a matter of putting up many transmitters on the same frequency and feeding the same modulation to each. It requires precise system engineering and accurate control of all controllable parameters. Single frequency simulcasting is not the only situation which presents the same information from multiple sources simultaneously to a mobile: multipath propagation does too with little, if any, distortion of the audio. Considering this fact, it must be possible to engineer simulcast systems to behave similarly, thus providing the enhanced coverages required.

2. Considerations

In developing this Recommendation the following factors were considered:

a) Question ITU-R 67/8;

b) that multiple transmitters using quasi-synchronous transmission are extensively used in the land mobile service;

c) propagation conditions, radiated power limits and the range and coverage of a single transmitter;

d) that there are both advantages and disadvantages in using multiple transmitters for quasi-synchronous operation;

e) that simultaneous transmission on multiple transmitters requires careful control of transmitter frequencies;

f) that simultaneous transmission of the same modulation on multiple transmitters requires careful matching of all aspects of the modulation circuit characteristics;

g) that actual field performance is difficult to measure and is very subjective;

h) that relatively consistent and acceptable performance can be attained by adhering to a number of guidelines;

j) that references should be made to tolerances and limits of essential parameters of the system;

k) that analogue systems are being employed in many parts of the world and are in the process of reaching saturation;

l) that two radio zone configurations need to be examined:

- allocation of different radio frequency channels and different control channel frequency for each of the radio zones (individual control zones);
- allocation of different radio frequency channels and identical control channel frequency for a group of adjacent radio zones whose number is determined from the system design objective (multiple control zone).

3. Recommendations

The ITU Radiocommunication Assembly recommends that the following requirements be made:

3.1 that the use of quasi-synchronous transmission techniques be limited to those applications where:

- an all-informed network is required;
- single point control access to multiple transmitters on multiple sites is required;
- a reduction in the number of RF channels is required to provide coverage over a wide area;

3.2 that careful propagation planning is undertaken prior to any physical placement of equipment to ensure:

- that sites are optimally placed to ensure mean signal levels in overlapping areas exceed the mobile sensitivity threshold by at least 20 dB;
- that sites are optimally placed to ensure, wherever possible, that overlapping areas do not coincide with principal areas of communication;
- that sites are positioned such that system modulation optimization and equalization procedures may be performed. This requires either:
  a) that all sites are within radio reception of a central node containing the equalization networks; or
  b) that the system is split into a number of groups of sites, where each group of sites must be within radio reception of the groups' central node and at least one site of each group must be within radio reception of a site in an adjacent group; or
  c) that each site must be within radio reception of adjacent sites and equalization networks are included at each radio site;
- that sites are located such that the coverage of the radio sites illuminates only those areas where communication is required and that coverage outside such areas is minimized. This requires sites to be positioned well within the boundaries of the required communication area and suggests that a larger number of low power, low-level sites situated within the principal communication areas is preferable to a smaller number of high powered hill-top sites;
- that the use of a small number of widely spaced very high power transmitters is avoided:
  a) for the previously itemized reasons;
  b) so that the area over which modulation equalization requires maintaining to ensure low levels of distortion in overlapping areas is not increased beyond practical levels;

3.3 that the RF carriers of transmitters in a common frequency simultaneous transmission system be accurately set and controlled at a fixed offset to each other to avoid degradation due to high frequency heterodynes;

3.4 that static RF carrier offset frequencies are set to avoid the syllabic rate of speech which for the majority of tongues falls between 7 and 15 Hz;

3.5 that carrier offsets are set to the values found by long term trials to afford the best intelligibility according to the mode and frequency of operation of the system viz.:

– mobile and portable systems at frequencies below 100 MHz	preferably between 0.5 Hz and 2 Hz but not more than 6 Hz
– mobile systems at frequencies between 100 MHz and 200 MHz	preferably between 0.5 Hz and 2 Hz but not more than 6 Hz
– portable systems at frequencies between 100 MHz and 200 MHz	fully synchronous or preferably between 0.5 Hz and 2 Hz but not more than 6 Hz
– mobile and portable systems at frequencies above 200 MHz	preferably synchronous or nominally 0 Hz but not more than 6 Hz

3.6 that cognizance be taken of the physical limitations on offsets due to the effect of "Doppler shift" which results in the static offsets being varied by mobile movement in direct relationship to vehicular speed and frequency of operation;

3.7 that the intrinsic differential final carrier frequency stability be < 0.5 Hz over the interval between adjustment or maintenance;

3.8 that transmission sites with widely differing environmental conditions be avoided;

3.9 that simple environmental control of the equipment site be applied to limit temperature excursions and differentials between sites;

3.10 that the static and dynamic amplitude and phase characteristics of the individual transmitter modulation circuits are matched to < ±1 dB and < ± 10°. This match includes amplitude-frequency response, limiter action, phase distortion, phase intercept and phase slope. The match should ideally be maintained over the whole of the 1 dB system bandwidth, but must be within these limits over at least the whole of the lower half of the 1 dB bandwidth;

3.11 that the initial optimization of the various modulation characteristics allows for equipment and environmental changes by initially matching as accurately as possible the static and dynamic characteristics, but in no case should the initial optimization setting use more than 50% of the aforementioned available tolerance;

3.12 that the site propagation delay equalization loci be optimized such that they intersect the principal overlap areas. Overlap areas are defined as areas where carriers from interacting transmitters are within 3 dB of each other.