NRIC V - Focus Group 3
Wireline Network Spectral Integrity **NRIC5FG3/2001-058R3**
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C O N T R I B U T I O N

TITLE: **UPDATED FG3 Recommendation #1 – Frequency Planning**

SOURCE*: **Focus Group 3**

TOPIC: **New technology (Frequency Planning)**

DISTRIBUTION: **NRIC V Focus Group 3 Plenary – For Information**

NRIC V Steering Committee – For Information

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ABSTRACT

This document contains an UPDATED Recommendation from NRIC V Focus Group 3 on Frequency Planning. It is provided for distribution to the members of the NRIC V full council in preparation for its approval at the February 27, 2001 NRIC Council meeting.

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Background:

The construction of the telephone loop plant cables results in the coupling of signals from one pair to another. This coupling, known as crosstalk coupling, is one of several factors that limit the information delivery capacity of the twisted-pair loop plant. Spectrum Management is the name given to the complex problem of managing the effect of crosstalk coupling in a manner that results in effective use of the loop plant.

In the lower-frequency portion of the loop plant (less than approximately 1 MHz) the spectrum management process accommodates several overlapping ways of using the spectrum: frequency division duplexed (FDD), full-duplex echo-canceled (EC), time-division duplexed (TDD) and their various combinations.

FDD systems achieve their rates and performance by splitting the available frequency spectrum into portions reserved for upstream transmission and other portions reserved for downstream transmission, thereby effectively eliminating self Near-End Crosstalk (self-NEXT) as an impairment, and leaving the lower self Far-End Crosstalk (self-FEXT) as the dominant impairment. With FEXT limited systems, power backoff mechanisms are required to keep FEXT below the design limit when transmitters on nearby pairs are not all co-located. Because of the allocation of frequencies to either upstream or downstream, FDD frequency plans are optimal only for a particular service data rate.

EC systems use roughly the same spectrum for simultaneous transmission in both directions on the loop. They are usually employed to deliver symmetric service. In the US, Basic Rate ISDN, SDSL, HDSL and HDSL2 are examples of widely deployed EC systems. EC systems are usually performance limited by self-NEXT when all systems deployed in nearby loops are using approximately the same transmit power.

TDD systems transmit in the different directions on the loop at different times, thus minimizing self-NEXT. Therefore, they become performance limited by FEXT and crosstalk from other systems.

While simultaneous deployment of systems employing the various duplexing methods has been accommodated when using the lower frequency portion of the loop plant, this becomes more difficult at the higher frequencies, where the crosstalk coupling is greater. VDSL, which has been identified by the industry as a viable means for delivering multi-megabit advanced services over relatively short local loops, transmits in these higher frequencies. The industry has selected a FDD approach for transmitting data bi-directionally over a single pair. In order for these systems to attain their designed data rates, all transceivers which share nearby pairs in a cable must adhere to the same basic frequency plan.

The T1E1.4 working group of Committee T1 has spent considerable effort trying to develop a VDSL band plan to accommodate the wide range of potential service offerings made possible by the technology. In the end, it was decided that consumer video delivery was the most important application and that the VDSL band plan should emphasize asymmetric data rates to best accommodate video delivery, while also allowing a reasonable rate of symmetric service as well.

It should be noted that an area of current research is that of treating the loop plant as a multiple-input multiple-output system and using the additional knowledge to cancel a substantial amount of the crosstalk between systems. These techniques are of substantially lower complexity when all of the transmit symbol clocks are frequency locked to a common reference.

Recommendations:

1) T1E1 has selected a single high-frequency band plan (known as FSAN 998) for frequencies from 0.138 to 12 MHz for use in the VDSL draft trial use standards, after substantial efforts to optimize it for multiple service types. FG3 acknowledges the selection of this plan and recommends that this good work be recognized and supported by the FCC as the default high-frequency band plan for use in the United States.
2) We recommend that T1E1 define PSD levels, transmit power limits, and spectral compatibility criteria for signals that support this default band plan (FSAN 998). These parameters should be specified for both the central office and customer premises locations.
3) FG3 further recommends that T1E1 include the determined PSD levels, transmit power limits, and spectral compatibility criteria in the second issue of the SM standard for protecting systems using frequencies 1.1 MHz to 12 MHz from harm. The development of the spectral compatibility criteria should assume that only Plan 998 systems utilize frequencies 1.1 to 12 MHz.
4) The following pertains to systems that do not follow the default band plan (FSAN 998) in the frequencies from 1.1 to 12 MHz.
    - Frequency agile technologies may deviate from this plan if they continuously monitor and default to the FSAN 998 plan if they are coupled to technologies adhering to the plan.
    - Systems not complying with the default band plan must show spectral compatibility per a compliance criteria (see #3 above) determined for the default plan. This requires that Annex A in the next issue of the SM standard contain the compatibility criteria of item #3 to show spectral compatibility in the frequencies of 1.1 to 12 MHz.
5) FG3 is evaluating the use of an alternative band plan under controlled or limited deployment scenarios.