**The University of New Mexico**

**School of Engineering**

**Electrical and Computer Engineering Department**

**ECE 535 Satellite Communications**

**Student Name: Scott Nguyen**

Module # 14: Problems 14.9, 14.14, 14.16, 14.17, 14.18, 14.38, 14.48

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**Prof. Tarief Elshafiey**

14.9. A satellite transponder has a saturation EIRP of 25 dBW and a bandwidth of 27 MHz. The transponder resources are shared equally by a number of FDMA carriers, each of bandwidth 3 MHz, and each requiring a minimum EIRP of 12 dBW. If 7 dB output backoff is required, determine the number of carriers that can be accommodated.

14.14. Determine how many carriers can access an 80-MHz transponder in the FDMA mode, given that each carrier requires a bandwidth of 6 MHz, allowing for 6.5-dB output backoff. Compare this number with the number of carriers possible without backoff.

14.16. Describe the general operating principles of a TDMA network. Show how the transmission bit rate is related to the input bit rate.

A TDMA (Time Division Multiple Access) network works by dividing time on a single carrier into distinct time slots, with each earth station assigned one or more of these slots for transmission. Instead of sharing frequency like in FDMA, TDMA users take turns using the same frequency channel but at different times. This helps avoid interference and allows many users to share the same transponder efficiently. During its assigned time slot, a station transmits a burst of data at a much higher bit rate than the original input rate to ensure that all its data fits into its short time window.

14.17. Explain the need for a reference burst in a TDMA system.

In a TDMA system, a reference burst is essential for keeping all the users in sync. Since multiple earth stations transmit in different time slots on the same frequency, timing must be incredibly precise so that the bursts don’t overlap. The reference burst acts like a timing anchor; it’s sent by a master station or timing source and helps all other stations adjust their transmissions to line up correctly in the overall frame. Without the reference burst, stations could drift out of sync, leading to interference between time slots and a breakdown of the whole system.

14.18. Explain the function of the preamble in a TDMA traffic burst. Describe and compare the channels carried in a preamble with those carried in a reference burst.

In a TDMA system, the preamble at the start of each traffic burst plays a critical role in getting everything ready before the actual data arrives. It contains things like burst identification, timing information, and station address, which help the receiver lock onto the signal, align timing, and know who the data is coming from.

The reference burst also includes a preamble, but it usually carries extra information. In addition to the basics found in regular traffic bursts, the reference burst’s preamble often includes network synchronization information that helps all other stations adjust their timing. So, while both types of preambles handle identification and timing, the reference burst’s preamble also acts like the “clock” for the entire TDMA network, making sure everything stays in sync.

14.38. (a) Describe the general features of an on-board signal processing transponder that would allow a network to operate with FDMA uplinks and a TDMA downlink. (b) In such a network, the overall BER must not exceed 105 . Calculate the maximum permissible BER of each link, assuming that each link contributes equally to the overall value.

(a)  
To support FDMA uplinks and a TDMA downlink, an on-board signal processing transponder must be able to demultiplex and regenerate the incoming FDMA signals before reassembling and transmitting them in TDMA format. On the uplink, different earth stations transmit on different frequencies, and the transponder separates each signal and digitally processes or switches the data. Once all the incoming signals are decoded or buffered, the satellite then re-times and re-encodes them into time slots for the TDMA downlink. This requires frequency-to-time conversion, digital baseband switching, and precise timing control. The result is a more efficient downlink that can handle burst-mode transmissions to multiple users over a single shared channel.

(b)  
The overall BER (Bit Error Rate) must not exceed:

Assuming the system has two major links, uplink and downlink, and each contributes equally to the overall BER, we model the total BER as the sum of the two independent error sources:

If both are equal:

Then:

14.48. Explain the principle behind spectrum spreading and despreading and how this is used to minimize interference in a CDMA system.

Spectrum spreading in a CDMA system works by taking a narrowband signal and spreading it across a much wider frequency band using a pseudorandom code. This process, called spreading, makes the signal look like low-level noise to anyone not using the correct code. At the receiver, the same code is used to despread the signal. This technique has two big advantages: it reduces interference between users (since each user has a unique spreading code) and makes the system more resistant to jamming and noise.