NETWORK MAINTENANCE AND TROUBLESHOOTING GUIDE

FIELD-TESTED SOLUTIONS FOR EVERYDAY PROBLEMS

SECOND EDITION

FLUKE networks

Neal Allen

Praise for Neal Allen's *Network Maintenance and Troubleshooting Guide*

"This is one of the most informative and easy to learn books on networking basics and troubleshooting techniques. A must read for all new associates to the field of Networking."

—Javier Garcia, CCNA

"I can best summarize this book by quoting Arnold Glascow: 'Success is simple. Do what's right, the right way, at the right time.'"

—Heriberto Rebollo, Network Analyst

"The new version of the *Guide* brings hard-to-gather theory to bear on issues of practical importance."

—Dennis C. Frezzo, Ph.D.

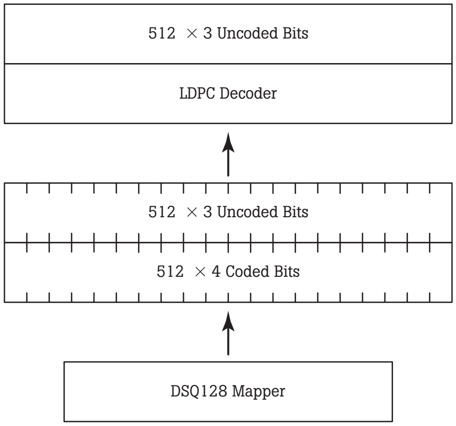

Figure 1-104. *DSQ128 unencoded on reception*

The group of 256 4D-PAM16 symbols are mapped back into 512 2D-DSQ128 symbols, and then the DSQ128 symbols and passed to the LDPC decoder (see Figure 4-104).

The PCS LDPC decoding process validates the received checksum and results in 50 65B blocks. Then each 65B block is descrambled (see Figure 4-105).

The Data/Control bit is removed, and the 8-octet block is passed back through the XGMII in two 4-octet transfers (see Figure 4-106).

As the Reconciliation sublayer handles the two 32-bit transfers it restores the first octet of Preamble in place of the /Start/ control code (see Figure 4-107). The data is restored to MSB order and represented in the hexadecimal from which it started in this example.

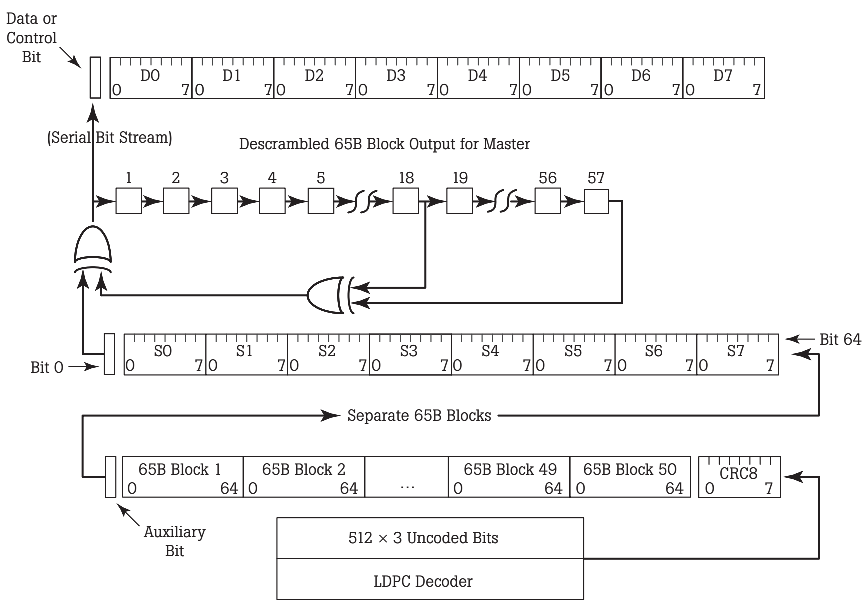

Figure 4-105. *Receive data block checksum validation, separation, and descrambling*

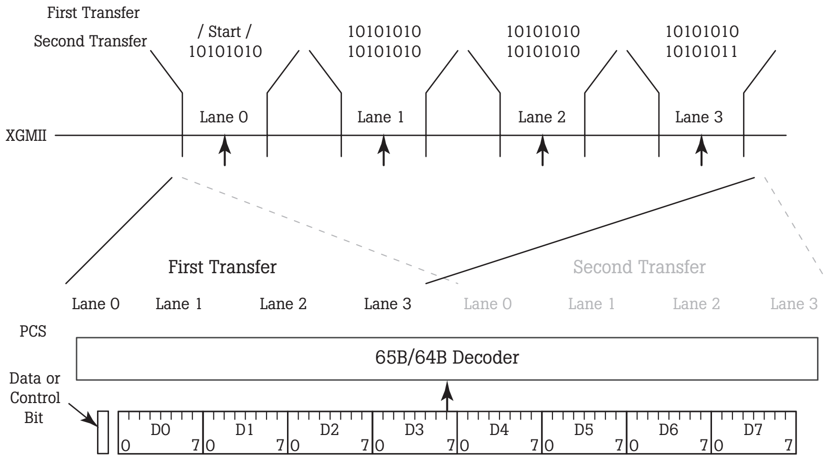

Figure 4-106. *65B/64B decoding and transfer back to the MAC Layer as octets*

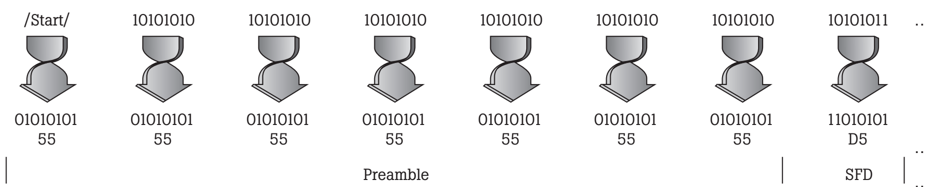

Figure 4-107. *Symbol substitution, reordering, and reconversion back to hexadecimal of the first two fields in the sample Ethernet frame at the receiver*

Architecture

No repeater is defined for 10 Gigabit Ethernet because half duplex is explicitly not supported.

As with 10Mbps, 100Mbps, and 1000Mbps versions, it is possible to modify some of the architecture rules slightly. Possible architecture adjustments are related to signal loss and distortion along the medium. Due to dispersion of the signal and other issues, the light pulse becomes undecipherable beyond certain distances. Refer to the technical timing and spectral requirements detailed in Clause 52 and Clause 53 of the current 802.3 standard, and the technical information about your hardware performance before attempting any adjustments to the architecture rules.

10Gbps Ethernet is specified for both multimode and singlemode fiber. Table 4-19 lists the maximum allowed cable lengths for each combination of R and W specifications, as well as the LX4 specification. Note that the modal bandwidth parameter is a key limiting factor in length. Modal bandwidth information is typically available from the cable vendor and cannot be field tested with the current generation of field test technology.

Table 4-19. *10 Gigabit Ethernet fiber optic implementations. Both R and W specifications are covered by each appropriate entry (i.e., 10GBASE-E covers both 10GBASE-ER and 10GBASE-EW).*

Implementation	Wavelength	Medium	Minimum Modal Bandwidth	Operating Distance
10GBASE-LX4	1310 nm	62.5 m MMF	500 MHz/km	2–300m
10GBASE-LX4	1310 nm	50 m MMF	400 MHz/km	2–240m
10GBASE-LX4	1310nm	50 m MMF	500 MHz/km	2–300m
10GBASE-LX4	1310nm	10 m SMF	N/A	2–10km
10GBASE-S	850nm	62.5 m MMF	160 MHz/km	2–26m
10GBASE-S	850nm	62.5 m MMF	200 MHz/km	2–33m
10GBASE-S	850nm	50 m MMF	400 MHz/km	2–66m
10GBASE-S	850nm	50 m MMF	500 MHz/km	2–82m
10GBASE-S	850nm	50 m MMF	2000 MHz/km	2–300m
10GBASE-L	1310nm	10 m SMF	N/A	2–10km
10GBASE-E	1550nm	10 m SMF	N/A	2–30km*

*The standard permits 40km lengths if link attenuation is low enough.

10GBASE-T and 10GBASE-CX4 maximum allowed cable lengths are specified in Table 4-20.

Table 4-20. *10 Gigabit Ethernet copper implementations*

<table>
<tr><th>Implementation</th><th>Cable Type</th><th>Operating Distance</th><th>Reference Standard</th></tr>
<tr><td>10GBASE-T</td><td>ISO Class E / TIA Category 6</td><td>55m to 100m*</td><td rowspan="3">ISO/IEC TR-24750
TIA/EIA TSB-155</td></tr>
<tr><td>10GBASE-T</td><td>ISO Class E / TIA Category 6 (unscreened)</td><td>55m</td></tr>
<tr><td>10GBASE-T</td><td>ISO Class E / TIA Category 6 (screened)</td><td>100m</td></tr>
<tr><td>10GBASE-T</td><td>ISO Class E_A / TIA Augmented Category 6</td><td>100m</td><td>ISO/IEC 11801 Ed 2.1
TIA/EIA 568-B.2-10</td></tr>
<tr><td>10GBASE-T</td><td>ISO Class F</td><td>100m</td><td>ISO/IEC TR-24750</td></tr>
<tr><td>10GBASE-CX4</td><td>Twinaxial cable assembly (or other cable type if test parameters are met)</td><td>Up to 15m</td><td></td></tr>
</table>

* Up to 100 meters if the alien crosstalk to insertion loss requirements from 802.3, Clause 55.7.3.1.2 and Clause 55.7.3.2.2 are met.

Ethernet for Subscriber Access Networks

Subscriber access network versions of Ethernet, sometimes referred to as *Ethernet in the first mile* (EFM), are not described here because they fall outside the LAN environment scope that this text is intended to support. EFM includes the implementations of: 2BASE-TL, 10PASS-TS, 100BASE-BX10, 100BASE-LX10, 1000BASE-BX10, and 1000BASE-LX10 at this time. These implementations are used by an Internet service provider (ISP) to provision an Internet connection to the home in place of older modem technology or more recent DSL technologies. The connection is typically between the home and the Telco central office (CO). A comparative analogy for the CO would be the switch closet nearest the user's desk in an office building.

Several aspects of EFM should be noted. First, only full duplex is supported. This full-duplex support comes in two operating modes: the normal full duplex and a simplified full duplex. Simplified full duplex is used with point-to-multipoint optical topologies where passive optical splitters may be used. Despite the requirement for full duplex, there is an allowance for copper links to use a version of half duplex defined in 802.3, Clause 61.

Other significant differences include support for copper at low speeds only (2 and 10Mbps), and only fiber optic media for 100 and 1000Mbps. The transmission distances supported on copper media are substantially affected by cable quality and performance.

The various EFM implementation maximum allowed cable lengths are specified in Table 4–21.

Table 4–21. *Maximum cabling distances for Ethernet in the first mile*

Architecture	Data Rate*	Maximum Distance*	Media
2BASE-TL	2Mbps	2,700m	One or more pairs of voice grade copper cable
10PASS-TS	10Mbps	750m	One or more pairs of voice grade copper cable
100BASE-LX10	100Mbps	10,000m	One pair of singlemode fiber
100BASE-BX10	100Mbps	10,000m	One singlemode fiber
1000BASE-LX10	1000Mbps	550m	One pair of multimode fiber
1000BASE-LX10	1000Mbps	10,000m	One pair of singlemode fiber
1000BASE-BX10	1000Mbps	10,000m	One singlemode fiber
1000BASE-PX10	1000Mbps	10,00 m	One singlemode fiber
1000BASE-PX20	1000Mbps	20,000m	One singlemode fiber

* Maximum defined distance or rate, depending on local conditions.

Summary

This chapter described Ethernet. The popular press, various expert opinions, and word of mouth contain bits and pieces of information about how Ethernet works. Some are mostly correct, most are somewhat correct. However, there are also a lot of misconceptions about how the rules and mechanics of transmitting data over Ethernet are implemented. Furthermore, as Ethernet evolves into ever-faster implementations, the built-in allowance for poor-quality installations diminishes. The Ethernet protocol can only compensate so much, and after that things break.

- The frame structure and field organization and definitions for various Ethernet frame types are provided.

  The basic framing remains constant for all implementations of Ethernet; however, there are differences found below the MAC Layer depending on the implementation. There are also different field additions depending on where within a broadcast domain the frame is found. Between bridges (switches) there are several frame modifications, such as VLAN tagging and MPLS, and although it is rare to see these additions on a station connection, it is possible for them to exist there.
- Ethernet uses CSMA/CD to handle routine signaling. The specific rules that govern access to the medium and error handling are provided.

  For half duplex collision domain operation, the sending station must learn about problems within the collision domain before a timeout value has expired. If a problem is discovered within this time limit, Ethernet manages error recovery and retransmission automatically and upper layers are not aware of the problem. If a problem is discovered after that time limit, Ethernet recovers from the error condition but abandons the current transmission. If the transmission is abandoned, upper layers must discover the loss and take action to retransmit. At higher layers, the recovery takes considerably longer to recover than if the error occurred within the time limit where Ethernet recovers and retransmits.

  For full duplex operation, the concept of a collision does not exist, although other types of error may still disrupt communications. Because collisions do not exist for full duplex, there are no error recovery and retransmission techniques employed. Any errored frame is lost, and upper layers must discover the loss and recover from the problem.
- A listing of the characteristics that identify the specific type and probable location for many Ethernet errors is provided.

  The specific characteristics for many types of Ethernet error conditions are described. Additional information is provided indicating differences which may be reported, depending on which definition for an error condition is used to describe the error condition.
- The mechanism and rules for Auto-Negotiation are described.

  Auto-Negotiation is a means for achieving the highest performance link from among the various capabilities that two link partners have in common. Full understanding of the operation of Auto-Negotiation helps prevent or detect situations where links may be operating suboptimally.
- The mechanism and power levels for Power over Ethernet are described.

  Power over Ethernet (PoE) provides a means for the network link to provide adequate power to sustain the operation of low-power network devices that may be deployed to locations far from the nearest AC power source. An understanding of the operation of PoE helps prevent or detect situations where links may experience problems obtaining adequate power from the network link.

- The process and encoding techniques for many common Ethernet implementations are described, including architecture design rules.

  At the MAC Layer, Ethernet is almost exactly the same regardless of implementation. At the Physical Layer, each implementation of Ethernet abides by slightly to greatly different rules and encoding procedures. Understanding the media limitations and the architecture limitations helps avoid, prevent, or detect situations where links may experience operational problems.

Chapter Review Questions

To aid in your comprehension of important concepts, the following questions are provided. Refer to this book's Introduction for a general legend that indicates the anticipated difficulty of each question. For answers to these review questions, see Appendix I, "Answers to Chapter Review Questions."

1. Where can an interested party obtain copies of current IEEE standards, which standards are available, and what is the cost for those standards? Include any other significant information which you feel is relevant in your answer.

2. What are the characteristics of the two most common methods employed by stations seeking media access on a network?

3. Under what conditions would a frame be sent back out the same port of a repeater on which it was received?

4. What behavior is exhibited by a repeater when noise is detected on a port?

5. When is a station considered to be on the same collision domain as another station, and when is it considered to be on a different collision domain? Specifically, what separation is required in order to make that determination?

6. Ethernet MAC Layer frame field definitions are the same at all speeds, true or false?

7. Ethernet signal encoding is the same at all speeds, true or false?

8. Define LSB and MSB and how that affects Ethernet.

9. List the order in which the defined fields in 802.3 Ethernet appear in a frame. Include the size (in octets) for each field.

10. What is the difference between 802.3 Ethernet framing and its predecessor, DIX Ethernet?

11. What other common names did the DIX Ethernet definition go by?