N1 - Ethernet and switching

This course covers both IEEE802.3 (10, 100, 1000 Mbps) and IEEE802.1D/802.1Q

Objectives

- The course covers the following standards: 10BASE-T, 100BASE-TX, 1000BASE-X, 1000BASE-T and 1000BASE-KX.
- An architectural view of an Ethernet network is provided, highlighting the differences between repeaters, switches and routers.
- The Synopsys MAC is studied as an implementation example of a MAC.
- The course explains how the spanning tree algorithm works.
- Quality of Service through the VLAN tag is explained.
- The course details the operation of the PHY-to-MAC bus and the management interface.
- The course describes the transmission protocol according to the medium.
- Layer 3 and 4 TCP-UDP/IP protocols are studied through packet capture.
- Ethernet related standards, such as PoE and EEE are included in this course.
- Note that AC6 offers a separate course on 10G Ethernet.
- This course has been delivered several times to companies implementing Ethernet in embedded systems, such as defense systems, railway equipments and avionics systems.

A more detailed course description is available on request at training@ac6-training.com

Course Environment

- Theoretical course
  - PDF course material (in English) supplemented by a printed version for face-to-face courses.
  - Online courses are dispensed using the Teams video-conferencing system.
  - The trainer answers trainees' questions during the training and provide technical and pedagogical assistance.
- At the start of each session the trainer will interact with the trainees to ensure the course fits their expectations and correct if needed

Target Audience

- Any embedded systems engineer or technician with the above prerequisites.

Course Outline

Introduction to Ethernet

- Protocol layers
- Topology, equipments: hub, switch and router
- Collisions, backoff algorithm
- Flow control mechanisms (back pressure and pause packet)

MAC Layer

- Ethernet frame
- Addressing
- Transmit and receive errors detected by the MAC layers

- Description of Synopsys Ethernet IP

Management Layer

- RMON registers
- Simple Network Management Protocol

10 Mbps Networks

- Differential mode transmission
- AUI operation, differential Manchester coding
- 10Base-T
- Repeater

100 Mbps Networks

- Media Independent Interface
- Clause 22 and Clause 45 interfaces
- 4b/5b coding
- Scrambling
- 100Base-TX, MLT-3 modulation
- Auto-negotiation

1000 Mbps Networks

- Medium types
- Gigabit Media Independent Interface

1000Base-T

- Convolutional encoder
- Trellis, Viterbi decoder
- 4D-PAM5, constellations
- PMA layer, PAM-5 modulation,
- Electrical interface, testing transmitter and receiver

1000Base-X

- PCS layer
- Scrambling
- PMA layer
- Auto-negotiation

Power over Ethernet

- Operation
- Protocol
- Software aspects

Precision Time Protocol

- PTP summary
- PTP in the Ethernet MAC layer
- PTP in switches

Switch Operation, 802.1D and 802.1Q

- Switch architecture

- Filtering services
- Spanning tree
- Rapid Spanning Tree Protocol
- Management protocol
- Port mirroring
- Multiple Spanning Tree Protocol
- Frame tagging
- Quality of Service

Introduction to TCP/IP

- The TCP/IP protocol stack
- IP
- ARP
- RARP
- ICMP
- UDP
- TCP
- DOS/UNIX TCP/IP commands

Energy Efficient Ethernet

- Studying the sequence to enter LPI
- Studying the wake-up sequence