broadcast communications

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Training Course Description

Course: **IP and Networking for High Bitrate Broadcast Systems**

Course code: **BTC183**

Duration: **5 days**

Format:

Classroom explanation, demonstration and practical work.

Supporting materials:

Each delegate completing the course will receive the following:

- A full set of course notes, including hands-on exercises
- Supporting diagnostic software
- Sample files and demonstration material used during the class

Overview:

The course provides delegates with an understanding of the vocabulary, techniques and troubleshooting methods used in network delivery of HBRMT (High Bit Rate Media Transport) in a broadcast environment, covering the key standards, implementation of both the media and network.

Who should attend:

Technical staff working with high bitrate broadcast technologies who need to become familiar with the specific methods, concepts and terminology used in this field.

Prerequisites:

A working knowledge of broadcast audio and video, and UHD/HD/SDI video is assumed for this course.

Key benefits:

At the end of the course delegates will be able to:

- Describe the configuration and functionality of IP based network systems
- Understand the issues for network systems caused by HBRMT stream
- Describe the multicast Ethernet and IP processes
- Understand the requirement for, and use of, RTP (Real-time Transport Protocol)
- Describe the relationship of the AES-67, TR-03/04, ST2022 and ST2110 standards
- Understand how to work without time code and video/audio reference signals
- Understand PTP (Precision Time Protocol) and RTP synchronisation
- Troubleshoot system faults using standard network tools

Course Content

IP and Network Layer in HBRMT

Networking Concepts
- Network models, four layer vs. seven layer
- OSI Open Systems Interconnection (OSI seven layer model)
- TCP/IP four layer model)

Ethernet
- Coaxial, UTP and optical Ethernet physical implementations
- Unicast addressing
- Multicast addressing
- Broadcast addressing
- VLAN and tagging
- Ethernet Frames and Jumbo Frames
- Repeater, Bridges, Hubs & Switches
- Layer 3 switches
- Mega bit and Giga bit rates Ethernet
- Blocking and non-blocking switches
- Issues for broadcasters with link aggregation and hashing
- Broadcast and Multicast network storms
- Spanning tree
- Issues for broadcasters using Spanning Tree
- Spine and leaf network topology
- L2 issues of aggregation and hashing for broadcasters
- Issues at L2 with HBRMT wide and narrow media senders, gapped senders
- HBRMT issues for non-blocking switches, L2 switch derating for broadcast traffic
- Frame accurate switching of L2/L3 carried video
- Make before break, and break before make, and video aware L2 switching

Internet Protocol
- Internet Protocol RFCs (Requests for Comment)
- IPv4 vs. IPv6
- The IP Datagram
- Network MTU and Fragmentation
- Network Frame size limitations
- IP Address classes
- Unicast addressing
- Multicast addressing
- Broadcast addressing
- Addresses for Private Internets
- Link Local Addressing
- IP communication over Ethernet
- Address Resolution Protocol (ARP) {RFC 826}
- NAT - Network Address Translation

IP Routing
- Simple IP Routing and Multiple hop routing
- Sub nets and subnet masks
- Segmenting network traffic
- Hostnames and Aliases

TCP and UDP
- Sockets, Ports and Services
- Port numbering
- Transmission Control Protocol (TCP)
- Universal Datagram Protocol (UDP)
- Issues of TCP in broadcast applications and systems

Multicast
- IP Multicasting and IGMP
- Use of L3 multicast vs. unicast
- Need for, and use of, UDP/multicast in a broadcast environment
- IGMPv2 vs. IGMPv3
- Source specific multicast
- IGMP join requests, leave requests and group membership requests
- Use of, and need for IGMP snooping switches
- Multicast at L2
- Multicast MAC addressing and issues
- Multicast L2 flooding
- IPTV and Video over IP
- Use of UDP vs. TCP

Realtime Transport Protocol
- The need for RTP in broadcast systems
- RTP Timestamp
- RTP Sequence number
- Static and Dynamic payload types
- Use of RTP marker bit
- Non-standard use of RTP by broadcast systems

Name Systems
- Services file naming
- Hosts file naming
- The Domain Name System (DNS)

Use of IP commands
- arp
- ping, pathping and tracert
- ipconfig
- netstat
- telnet

HBRMT Introduction

- Overview and relationship of the HBRMT (High Bit Rate Media Transport) standards
- The involved standards bodies, and what they do
  AES, ASPEN, AIMS, IEEE, IETF, SMPTE, VSF
- IETF RFC 4175
- VSF TR-03, TR-04
- AES-3 and AES-67 audio
- SMPTE ST2022 suite
- SMPTE ST2110 suite
- SMPTE 2059 timing
- IEEE 1588 PTP (Precision Time Protocol) standard
- NMOS (Networked Media Open Specifications)

PTP / SMPTE 2059 / IEEE 1588

PTP / SMPTE 2059 System

- How RTP/PTP/STPTE 2059 replaces reference video and timecode
- PTP and SMPTE 2059 Epochs
- Relationship of PTP to RTP timestamp in broadcast systems
- Achievable timing accuracy and jitter
- TAI (Temps Atomique International) and UTC
- PTP Ordinary Clock
- PTP Grand Master
- PTP Boundary Clock
- PTP Transparent Clock
- Slave Clock

PTP Function

- Frequency Lock
- SYNC and SYNC follow-up messages
- Phase Lock
- Delay Request, Delay Response and Delay Response follow-up messages
- Time Values
- PTP Domains
- Redundancy and Best Grand Master Selection

Non SMPTE Media Carriage Standards

DVB standard A086 MPEG-2 TS Services over IP Networks

- Encapsulation of MPEG-2 TS (Transport Stream) packets in RTP
- TS packet number limitations
- Do not fragment at l3

Pro MPEG Forum CoP3.2

- Use of 2D FEC (Forward Error Correction)
- Error correction strategy
- Error correction power and scope
- Use of L4 port numbering
- Media delay considerations vs. correction power

IETF RFC 4175 RTP based Uncompressed Video

- Relationship of IETF RFC 4175 and VSF TR-03
- RFC4175 RTP container
- RFC 4175 extended RTP header
- Extended sequence number and roll over periods
- Line and pixel numbering
- Field and frame modes
- Pgroups (Pixel groups) and packing
- Subsampling modes 4:2:2, 4:2:0, et al
- Sample word lengths 8. 10, 12 et al

VSF TR-03, Transport of Uncompressed over IP

- Carriage multiple media elementary streams over IP
- Timing synchronisation through PTP and RTP timestamps
- Synchronising of different media RTP clock rates
- Managing framerate/1001 frame rates
- Use of PTP/ST-2059
- IP L3 Fragmentation considerations
- IP multicast and unicast considerations

SDP (Session Description Protocol)

- SAP (Session Announcement Protocol)
- Understanding an SDP message
- Session description
- Connection information
- Lipsynch groups
- Media attributes
- Use of RTP dynamic payload types

VSF TR-04, ST2022-6 in a TR 03 environment

- The modified SDP message
- RTP dynamic payload type

SMPTE Media Carriage Standards

ST 2022-1

- Forward Error Correction for Real-Time Video/Audio Transport Over IP Networks
- FEC blocks and Interleave

ST 2022-2

- Unidirectional Transport of Constant Bit Rate MPEG-2 Transport Streams on IP Networks
- ST2022 relation to DVB086 transport

ST 2022-3

- Unidirectional Transport of Variable Bit Rate MPEG-2 Transport Streams on IP Networks
- Considerations for transport of VBR (Variable Bitrate) content

ST 2022-4

- Unidirectional Transport of Non-Piecewise Constant Variable Bit Rate MPEG-2 Streams on IP Networks
- Extensions to the RTP header
- Timing data and clocks

ST 2022-5

- Forward Error Correction for Transport of High Bit Rate Media Signals over IP Networks (HBRMT)
- Considerations and use of FEC with uncompressed video

ST 2022-6

- Transport of High Bit Rate Media Signals over IP Networks (HBRMT)
- Carriage of active video frame media
- Carriage of U/HD/SDI HANC and VANC timing and meta data
- Clock rates and FEC
- RTP header, use of marker bit and non-standard timestamp rate

- Frame counting
- SDI mode mapping
- Frame types, rates and sampling
- Time stamping
- Active video payload, EAV SAV and TRS

ST 2022-7

- Seamless Protection Switching of SMPTE ST 2022 IP Datagrams
- Stream duplication
- Network delay and jitter
- Receiver buffering
- Network packet loss
- Data recovery
- ST-2022 receiver grades Class A, B and C

ST 2110 2017

- Suite of standards unifying the transport of high bitrate media over IP as elementary streams

ST-2110-10 System and Network Timing

- RTP timestamp and PTP clock
- RTP/UDP Packet sizes
- Non-standard use of RTP time stamp
- Non-standard use of RTP start values
- Understanding the SDP (Session Description Protocol) object

ST-2110-20 Uncompressed active video over IP

- Video frame sizes
- Progressive, PsF and interleaved modes
- Video sampling modes, 4:2:0, 4:2:2 etc.
- Alpha/Key channel elementary stream
- RTP header and extended header
- RTP payload format
- Pgroup pixel modes
- Pgroup BPM and GPM packing structures
- SDP parameters

ST-2110-21 Traffic shaping and delivery of uncompressed video

- Narrow, Wide and Narrow Linear senders
- Network switch and receiver buffer modelling
- Cmax and VRXfull models
- HBRMT traffic issues for network switches

ST-2110-30 PCM digital audio over IP

- Relationship to AES67
- A to CX conformance levels

ST-2110-31 AES-3 Transparent Digital Audio

- The RTP container and header
- AMS324 encapsulation
- Ptime / packet time
- Conformance levels and modes

ST-2110-40 Ancillary Data

- ANC data formatting
- Carriage of SDI source and destination data
- RTP parameters

Hands-on Sessions

If hardware is available these will be conducted as hands-on by the course delegates, otherwise as demonstration.

Use of bespoke broadcast network analysis tools, where available

- Configuring and using IP networks, masks and subnets
- Use of standard network tools for troubleshooting and diagnostics
- Ping, ipconfig, route, arp, netstat, traceroute etc.

- WireShark is used hands-on on live, multicast, lower bit rate streams and on supplied recordings of multi gigabit per second ST2110 and ST2022-6 streams
- Configuring Wireshark for broadcast stream analysis
- Installing lua extensions/dissectors for broadcast stream analysis
- Configuring WireShark to analyse different RTP dynamic payload types
- Issues of recording HBRMT stream, understanding stream errors
- Display and capture filter rules
- Issues with recording high bit rate media streams
- Extracting and saving live media content to disc
- Extracting and saving control signalling in the presence of high bit rate media
- Viewing, dissecting and decoding PTP streams and conversations
- Viewing the key network stream configurations and parameters
- Viewing and understanding the key media stream configurations and parameters
- Using the RTP marker bit in video analysis
- Viewing video to RTP frame structures
- Extracting media stream information from packet analysis
- Dissection of Transport Stream, PTP, ST2022-6, ST-2110 media streams