DTV Compressed Video System & Test Solution
Video Compression - Purpose Of

What is the purpose of video compression?
- Reduce the amount of data required to be transmitted to create the picture at the receiver.
- MPEG2 (Moving Picture Expert Group) is one type of compression out of several selected for DTV.
- Being used by ATSC and DVB.
- 19.39Mb/s using 8VSB modulation can fit in 6MHz bandwidth.
- FCC is allocating 6MHz per terrestrial broadcast channel.

480 Viewable Lines

720 Pixels per Line

270Mb/s
What is the purpose of video compression?
MPEG2 Spatial Compression

- Based on Discrete Cosine Transfer (DCT) Process
  - 8x8 Pixel Group
  - In this example, all 64 pixels are the same, the color of the sky.
DCT Example

Picture

720 Pixels

480 Lines (Pixels)

8x8 Pixels

Sample Values

DCT Coefficients

<table>
<thead>
<tr>
<th></th>
<th>223</th>
<th>191</th>
<th>159</th>
<th>128</th>
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### Input DCT Coefficients
(a more complex block)

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### Quant Matrix Values
Value used corresponds to the coefficient location

### Output DCT Coefficients
Value for display only not actual results

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### Quant Scale Values
Not all code values are shown One value used for complete 8x8 block

<table>
<thead>
<tr>
<th>Code</th>
<th>Linear Quant Scale</th>
<th>Non-Linear Quant Scale</th>
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<td>88</td>
</tr>
<tr>
<td>31</td>
<td>62</td>
<td>112</td>
</tr>
</tbody>
</table>
IntRA-Frame Coding

Convert 4:2:2 to 8-bit 4:2:0
- Information lost
  - Data reduced
- No Loss
  - No Data reduced

DCT

Quantize
- Data reduced (information lost)
- Data reduced (no loss)

Entropy Coding

Buffer

Rate Control

Quantizing Data

Quantizing
- Reduce the number of bits for each coefficient.
- Give preference to certain coefficients.
- Reduction can differ for each coefficient.

Entropy Coding
- Variable Length Coding
  - Use short words for most frequent values (like Morse Code)
- Run Length Coding
  - Send a unique code word instead of strings of zeros

Compressed Data
MPEG2 Temporal Redundancies

- Frame to Frame redundancies
- New location same data
- New data uncovered

I Frame

P Frame
Motion Prediction

Temporal Redundancy

I Frame
Complete Frame Encoded

B Frame
Only Motion Encoded
Ball Bi-directionally from I & P
Revealed Knee from P frame

P Frame
Ball Encoded with Motion Vector
from I frame
Group of Pictures

- I pictures: Intra-coding only
- P pictures: Contain forward motion compensation
- B pictures: Contain forward, backward and bi-directional motion compensation

$m = \text{Distance between anchors}$

$n = \text{Distance between I pictures}$

Forward Prediction

Bi-directional Prediction
Time Sequence of Pictures

Rec 601 Video Frames

Elementary Stream

temporal_reference

I B B P B B P B B I B B B P
# MPEG2 Levels and Profiles

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>PROFILE</th>
<th>MAIN</th>
<th>SNR</th>
<th>SPATIAL</th>
<th>HIGH</th>
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<td>720 x 576</td>
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<td>4:2:0</td>
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<td>4:2:0.4:2:2</td>
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<td>4:2:0.4:2:2</td>
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<td>I, P, B</td>
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<td>4:2:0.4:2:2</td>
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<td>720 x 576</td>
<td>4:2:0</td>
<td>720 x 576</td>
<td>4:2:0</td>
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<td>HIGH</td>
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</table>
MPEG-2 Compression Process

- Encoder Generates Access Units
  - Video Access Unit is a Frame (I, B or P)

- A sequence of Access Units
  - Elementary Stream (ES)

- Split Into packets
  - Packetised Elementary Stream (PES)
  - Either all video or all audio
  - Variable length packets (64 Kbytes maximum)

- PES Header Contains Timing Information
  - Presentation Time Stamp (PTS)
    - when to display packet contents
  - Decoder Time Stamp (DTS)
    - when to decode packet contents
From ES to PES

- Elementary stream is just a stream of access units
- They are cut up, and headers added, every header has at least stream ID and maybe a lot more
- At this point, basic timing information is added to the stream in the PES header, PTS & DTS - the timestamps.
From PES to TS

PES STREAM

TS Header

PES Header

Transport Stream TS

188 Bytes
Transport Packet Header

188 Bytes

Minimum 4-byte header

<table>
<thead>
<tr>
<th>Sync Byte</th>
<th>Transport Error Indicator</th>
<th>Start Indicator</th>
<th>Transport Priority</th>
<th>PID</th>
<th>Scrambling Control</th>
<th>Adaptation Field Control</th>
<th>Continuity Counter</th>
<th>Adaptation Field</th>
<th>Payload</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Adaptation Field Length</th>
<th>Discontinuity Indicator</th>
<th>Random Access Indicator</th>
<th>Elem Stream Priority Indicator</th>
<th>5 Flags</th>
<th>Optional Fields</th>
<th>Stuffing Bytes</th>
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</table>

<table>
<thead>
<tr>
<th>PCR</th>
<th>OPCR</th>
<th>Splice Countdown</th>
<th>Transport Private Data</th>
<th>Adaptation Field Extension</th>
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<td>48</td>
<td>8</td>
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</table>
Reference Clock Synchronization

Video Encoder

PCR = X

Elementary Stream

Transport Stream Decoder

PCR = X plus the time of n bits

Video In

Transport Stream Formation

Compare

Local PCR

Low Pass Filter

27 MHz Clock

Load

27 MHz Xtal VCO

Receiver 27 MHz clock
Decoding the Transport Stream
Program Specific Information (PSI)

- **Program Association Table (PAT)**
  - PID = 0, must be present in every transport stream

- **Program Map Table (PMT)**
  - PID values assigned by transmission system (DVB, ATSC, etc.)

- **Conditional Access Table (CAT)**
  - PID = 1 (EMM = entitlement management message)

- **Network Information Table (NIT)**
  - PID values assigned by transmission system
  - DVB considers this part of System Information (SI)

- **Null Packets**
  - PID = 8191 (1FFF_{hex} = 13 \_\_  binary)
Program Specific Information (PSI) Tables

Programme Association Table (PAT) – PID 0

Programme Map Tables (PMT)

Network Information Table
MPEG-2 Transport Stream

1. Generate PES streams for audio, video, data…
2. Assign packet identifier (PID) to each PES
3. Split PES content into fixed size packets
4. Add Program Specific Information (PSI)
5. Add Service Information (SI with DVB) or Program and System Information Protocol (PSIP with ATSC)
6. Add system timing information to ensure synchronisation of audio and video
7. Output combined data stream at Constant Bit Rate (CBR)
Transport Stream As a Carrier

- DVB Transport Stream
- MPEG2 Programme
- Video PES
- Elementary Stream
- GOP
- Service Information
- Private CA Data
- Audio PES
- Elementary Stream
- DVB Service Information Tables
  - BAT, EIT, NIT, RST, SDT, TDT & TOT
- PAT
- PMT
- Data
DTV Broadcasting System

Video Subsystem
- Video Source Coding and MPEG2 / H.264 Compression

Audio Subsystem
- Audio Source Coding and MPEG2 Compression

Service Multiplex and Transport
- Ancillary Data
- Control Data

Service Multiplex

Transport

Channel Coding & Modulate

1. Telco
   a. SDH
   b. ATM
   c. SONET
2. Satellite
   a. DVB-S (QPSK)
3. Cable
   a. DVB-C (16, 32 or 64 QAM)
4. Terrestrial
   a. DVB-T (OFDM)
   b. ATSC (8VSB)
5. IP Internet - Streaming Video

ITU-R Digital Terrestrial Television Broadcasting Model
# Elements of the ATSC DTV System

<table>
<thead>
<tr>
<th>Video</th>
<th>Audio</th>
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<tbody>
<tr>
<td>MPEG-2 MP@HL Compression</td>
<td>AC-3 Compression</td>
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<td><strong>MPEG-2 Transport Stream</strong></td>
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<td></td>
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<tr>
<td><strong>Terrestrial broadcast mode</strong></td>
<td><strong>8-VSB Digital Transmission</strong></td>
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# Elements of the DVB DTV System

<table>
<thead>
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<th>Video</th>
<th>Audio</th>
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<tbody>
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<td>MPEG-2 MP@ML Compression</td>
<td>MPEG II Compression</td>
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<tr>
<td>MPEG-4 AVC 撮影格式</td>
<td>HE-AAC 音訊格式</td>
</tr>
<tr>
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<td></td>
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<tr>
<td><strong>MPEG-2 Transport Stream</strong></td>
<td></td>
</tr>
</tbody>
</table>

- Terrestrial broadcast mode, OFDM (2k or 8k)
- Satellite transmission, QPSK
- Cable transmission, 16, 32, or 64 QAM
Transport Stream Formation

Rec 601 Video

Video Codecs: MPEG2/ MPEG4/ H.264

Elementary Stream

PES packets
Generally defined length

Transport Stream
188 Bytes per packet

Not to scale
Bit-Rate Evolution

- 1st Generation Encoder: MPEG-2
- 2nd Generation Encoder
- 3rd Generation Encoder
- 4th Generation Encoder
- 5th Generation Encoder

- H.264 / MPEG-4 part 10
Evolution of the Standards

ITU
- H261
- H263, H263+

ITU / ISO
- H262, MPEG-2
- H264, MPEG4/AVC

ISO
- MPEG-1
- MPEG-4 Part-2

Timeline:
- 1980
- 1994
- 1998
- 2004
Use of Key H.264 Profiles

- **Baseline**
  - Cell phone/PDA
  - Has error-resilience tools

- **Main**
  - Broadcast, DVD+, CE apps
  - No error-resilience tools

- **Extended**
  - Streaming, wireless
  - Main – CABAC + Error Res.

- FREXT for HDTV in progress
- High Profile with Fidelity Range Extensions (FRExt, with High/10, High/4:2:2 and High/4:4:4)
IPTV System Overview – Physical

Head-end
- Network Management System
- Element Management System
- Video Head-end
- Router/Switch
- VoIP Gateway

Transport/Core Network
- DVB Stream
- Stored Digital Video
- VoD Server
- Application Server
- Internet
- PSTN

Aggregation/Access Networks
- FTTH
- xDSL

Customer Premise
- Multi-Dwelling Unit
- Residential
- TV+STB
- PC

Management Platform: NMS, OSS and Middleware
Protocol Stack & Layers relating to Video over IP

Video on Demand

- Session Description
  - HTTP
- Session Control
  - RTSP
- MPEG-2 Transport Stream
- Session Announcement
  - RTP (with RTCP)
  - SDP
  - SAP
- Session Control
  - Session Description
  - SDP
  - HTTP
- TCP
- UDP
- IGMP
- TCP
- IP layer
- Layer 1-2 Gig-Ethernet

Multicast Video

- RTP (with RTCP)
Typical Monitoring Points Terrestrial Hybrid System
Simplifying DTV & IPTV Monitoring . . . . . .
The MTM400A with *FlexVuPlus™* delivers

- Complete solution for real-time transmission monitoring of MPEG transport streams over RF, IP, and ASI interfaces.
MTM400A Remote User Interface Paradigm
Deep diagnostic with "One click"
FlexVu Plus™ for Cable with Seven Day RF Trending with unique "One click" Alarming
NEW Electronic Program Guide (EPG) view

FlexVu Plus™ for IPTV with Seven Day IP Trending

with unique Dual Level Alarming

Deep diagnostic with "One click"

MTM400A
MTM400 GigE Monitoring

- MTM400 GigE Monitoring
- IP Transmission

Priority 1, 2, 3

Permanently Monitored

Single TS Monitored

IP Transient Tests (Dropped, Out of Order, corrupt)

IP Timing Error Tests (Max PIT)

MPEG Transient Tests (CC & Sync loss)

Simultaneous Multisession KPI with Full MPEG Monitoring

Priority 1, 2, 3

Priority 1, 2, 3

Priority 1, 2, 3

Priority 1, 2, 3

Priority 1, 2, 3

MPEG Protocol Compliance

Optional Configurable Polling

Session 1

Session 2

Session 3

Session 4

Session 5

Session n

GigE feed

TR 101-290 Priority 1, 2, 3
Propriety Extensions

TR 101-290 Priority 1, 2, 3
Propriety Extensions

TR 101-290 Priority 1, 2, 3
Propriety Extensions

TR 101-290 Priority 1, 2, 3
Propriety Extensions

TR 101-290 Priority 1, 2, 3
Propriety Extensions

Note when printed this slide may be interpreted incorrectly as implying that the MTM400 can do Wide & Deep monitoring. The MTM400 can do Wide & Shallow with simultaneous Narrow & Deep monitoring. The Narrow and Deep tests may be polled with the channel polling option.
Multisession KPI monitoring

Critical Key Performance indicators that are permanently monitored across IP and MPEG layers

- Ethernet Frame Check Sum
- IP Header Check Sum
- Dropped packets
- Out of order packets
- Packet Inter-arrival Time (PIT)
- Sync byte
- Sync Loss
- Continuity Counter (4 bit counter & header)
DTV Video Testing Concepts

Front End
- Tuner
- Demodulation
- Error Correction

Back End
- TS - DeMUX
- TS - PSI Decode
- EPG Decode
- ES Extract
- CA Descramble
- Decode

Device Under Test
- Video/Audio Encoder
- MTX100B MPEG2 Player
- MTS430 / MTX100B MPEG2 Recorder/Generator/Monitor/Analyzer
- Video Measurement VM700T / VM6000

TV Transmitter (Digital Mod. - DVB T/C/S)
- RF
- TS

Video Output (CVBS / YPbPr)
- TV Monitor
MPEG Test & Analysis Software

- Product Summary
  - MTS430/415/400P/MTS4SA MPEG Analysis
  - MTS4EA Elementary Stream Analyzer
  - Vclips and Tclips Test Streams
Transport Stream Compliance Analyzer (TSCA, TSCR)

- TSCA combines a high-speed analysis engine with built-in intelligence (CaptureVu™), which allows ultra-fast pinpointing and debugging of intermittent faults in MPEG Transport Streams.

- TSCR is a Real-time version of the TSCA analyzer operating on Transport Streams received through the PC’s Ethernet port.

- TSCR includes Cross Layer time-correlated IP and TS measurements, alarms and error logging together with stream recording.

- Both the TSCA and TSCR offer the CaptureVu™ technology and PCR measurement and graphing capabilities.

- Video thumbnail decode of video streams and associated ES header information, including H.264.
Platform MTS430/415 & 400P

MTS415 Outline Spec
- Includes TSCX, TSCA, Buffer Analyser, PES Analyser, MTS4CC (inc CODEC options), Player & Tclips as standard
- Optional Multiplexer

Storage:
- 2x72 GB SCSI for Stream Storage
- 80GB system IDE HDD
- SCSI Bus Extension – unlimited storage

MTS400P Outline Spec
- Includes TSCX (real-time analyzer as standard
- Options for TSCA, Multiplexer, Buffer & PES Analysers, Player and IP Video interface

Storage:
- 182GB for Stream Storage
- 20GB system IDE HDD
Making Sophisticated Analysis more affordable

- **MTS4SA**
  - Standalone Software for Windows™ NT, 2000 and XP

- **Options:**
  - Real Time MPEG over IP Analyzer with CaptureVu™
  - Deferred Time Analyzer with CaptureVu™
  - PES & Buffer Analyzer
  - Carousel Analyzer
  - Carousel Generator
  - Multiplexer
  - Elementary Stream Analysis
Transport Stream compliance Analyzer

- Same User Interface for Real Time and Deferred Time Analysis
  - Highlights errors on specific Programs
  - Visual indication of stream occupancy
  - Direct access to errors including ISDB-T, ISDB-TB (Brazil), DVB, ATSC

- Brings expert power to the novice user
Real Time MPEG Timing Analysis

- Same functionality as Real Time ASI Transport Stream Analysis including:
  - CaptureVu™
  - Time Stamped PCR Analysis (OJ, Accuracy, Arrival Time, Drift and Frequency Offset)
  - PTS timing Analysis
  - Bit Rate Analysis
PTS – PCR Graph

- Useful for detecting encoder timing problems likely to cause receiver T-STD problems.
- Plots the PTS to PCR time difference for each PTS.
- The graph is independent of CODEC type.
- It is located in the Available Graphs tab for every ES carrying PTS data.
- Also included in MTM400A v3.1.
H264 Detailed thumbnails

Program 2 (0x2) Test2

- Stream type: 27 (0x1B) (AVC - H264 video stream)
- Video Attributes:
  - Coding Mode: CABAC
  - Profile and Level: Main @ 4
  - Horizontal Size: 1280 (if 16x16 macroblock)
  - Vertical Size: 720 (if 16x16 macroblock)
  - Pixel Shape: 1:1 (Square)
  - Chroma Format: 4:2:0

Program 3 (0x3) Test3

- Stream type: 27 (0x1B) (AVC - H264 video stream)
- Video Attributes:
  - Coding Mode: CABAC
  - Profile and Level: High @ 4.1
  - Horizontal Size: 1280 (if 16x16 macroblock)
  - Vertical Size: 720 (if 16x16 macroblock)
  - Pixel Shape: 1:1 (Square)
  - Chroma Format: 4:2:0
H.264 TSDT Buffer Analysis Details
Major Features - Provide Information not Data

- **Real Time & Deferred Time EPG**
  - ISDB-T, DVB, ATSC

- **Meaningful Graphical Displays**
  - TDT Table Information
Video Over IP Analysis

- IP Network Performance Statistics
  - Packet Arrival Interval Histogram
  - delay factor (DF)
  - media loss rate (MLR)
  - displayed as a single result; “DF:MLR”

- IP Session Capture and deferred time IP file analysis
  - De facto standard PCAP file format compatible with Wireshark (Ethereal)

- IP measurements and stats available in real time and deferred time
  - Packet Loss, Out of Order Packets, Checksum
  - Instantaneous PIT – Mean, Max, Min
  - MDI, PIT Histogram

- Can be used simultaneously with ASI or RF interface
Video over IP Generation

Features

- Error Insertion Capability
  - Packet Drops
  - Checksum Errors
  - Sequence Errors and Jitter
  - Manual error generation capabilities
- Support for Parametric playout - Burst mode
  - both timing and packet number based
- Advanced Mode with Protocol header customization capabilities
  - Source and destination ports and addresses
  - MAC address, transport checksum, network checksum
  - User editing of any packet header field parameters
- Session replication to simultaneously encapsulate and play a TS over many IP sessions
- Single session playout up to 240Mbps and multi session playout up to 300Mbps

Benefits

- Combination of IP (UDP & RTP) playout and analysis enables easy compliance verification of DUT
- Error insertion capabilities ensure designs are reliable on real world networks

Continuously loop stored streams and create errors to ensure quality of products
Multiplexer

- Use the **Multiplexer/Re-multiplexer/De-multiplexer** application to create and modify multi-program Transport Streams with custom SI/PSI/PSIP information.
- **Multiplex video and audio Elementary Streams** into a Transport Stream.
- **Create your own test streams** to validate and debug your designs more quickly.
- **Create errored streams** to perform parametric stress testing.
- Create or modify test streams containing **H.264 content**.
- Support for all types of H.264 stream timing – the most powerful H.264 stream creation application available.
- Easily provide flexible test sequences for quality assurance of solutions and for compliance test against standards.
- Multiplexes test streams from the Tclips or VClips test stream libraries.
Software Updates: Multiplexer

- New ISDB-TB and One Segment regions to the ISDB base standard.
- Supports the mandatory MPEG-4 AAC CODEC for stream generation
  - Includes Main, High Efficiency (HE) and Low Complexity (LC) profiles
  - Includes LATM Multiplex and LOAS Transport formats
  - All channel configurations up to 5.1
- Consistent with other CODEC support
  - Import MPEG-4 AAC ES and Pes streams
  - Export MPEG-4 AAC ES and Pes from a source Transport Stream
- Integrated playout
  - User option to play out generated stream directly through Player, rather than save to disk

![Tektronix Multiplexer screenshot](image)
T-STD Buffer Analyzer

- Verifies conformance of a stream to the T-STD buffer model
  - based upon the DTS values within the PES header
- Determines if any of the internal buffers will be caused to either underflow or overflow.
- Consequences of these conditions will be freeze frames and receiver resets.
- Testing of next generation codec designs to ensure conformance to TS buffer requirements
  - Supports H.264 video and MPEG-4 AAC audio codecs
Packetized Elementary Stream (PES) Analyzer

- Verifies conformance of the PES header contents to the MPEG, DVB and ATSC standards.
- Verifies the header and identifies errors associated with each PES packet which contains the decode and presentation timestamps (DTS and PTS) for the contained Elementary Stream.
  - Verifies errors in these timestamps may cause resets or picture freeze problems at the receiver in extreme cases.
  - They are more typically the cause of lip sync problems where the timestamps of associated video and audio streams are not synchronized.
- Shows major ES layer parameters for each frame, such as frame rate and aspect ratio
MPEG-2 Elementary Stream (ES) Analyzer

- Views the moving picture from within a PES stream and carries out a whole range of sophisticated tests on the lower layers of an Elementary Stream within a Transport Stream.

- Analyzes and displays a range of extended media formats, including audio, ATSC Closed Captions, DVB Subtitles and Teletext associated with video Elementary Streams.

- For analysis of MPEG-4, AVC/H.264 and VC-1 as well as MPEG-2 Elementary Streams, please refer to the MTS4EA.
Carousel Analyzer

- Verifies the content of both Data and Object Carousels in a Transport Stream file for:
  - compliance with the relevant standards (MPEG-2 DSM-CC, DVB (including MHP), DTT (MHEG-5) or ARIB
  - optimizing the settings between transmission bandwidth and responsiveness of the user experience.
Carousel Generator

▶ Creates object carousel contents within an output Transport Stream.

▶ Useful in test situations where the effects of varying parameters, such as individual repetition intervals, may be quickly ascertained.

▶ Creates object carousels conforming to the MPEG-2, DVB, DTT (MHEG-5) or MHP standards.
Elementary Stream Analyzer

MTS4EA / MTS4CC
Compressed Video Analyzer
MTS4CC Overview

- Supports Next Generation and legacy Codecs
  - VC-1, H.264/AVC (incl. FRext), MPEG-2, MPEG-4, H.263, H.263
  - TS, PS, ASF, MP4 and 3GPP Files
- Simultaneously display and check encoded video streams (dependant on PC performance)
- Frame-by-Frame decode
- MB overlays including encoder statistics
- Batch mode for automated testing
- Audio decode and waveform display
- ES extraction from TS
MTS4CC Capabilities

- Comprehensive Error Notification and Alerts
- Buffer Analysis
- Video & Audio decode & playout
  - Audio waveform displays video frame markers
  - Selectable video overlays with color key.
    - Number of Bits and Quantizer values
MTS4CC Capabilities

- Batch / command line mode to allow automated testing
- Fidelity Analysis (option)
  - PSNR Measurements
  - Visual Differencing
- Hex View
- Extract Elementary Streams directly from MPEG2 Transport Stream
- Can analyse up to 1 Exabyte ($10^{18}$ B) video file
# MTS4CC Supported Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>History / application</th>
<th>Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>H.264/AVC</td>
<td>New video standard; best compression Mandated for new DVD standard, incl FRext</td>
<td>ITU plus MPEG</td>
</tr>
<tr>
<td>SMPTE VC-1</td>
<td>New video standard, derived from WMV-9.</td>
<td>SMPTE</td>
</tr>
<tr>
<td>H.263</td>
<td>2\textsuperscript{nd} generation; video conferencing plus in 3GPP MANDATORY FOR MOBILE APPLICATIONS</td>
<td>ITU</td>
</tr>
<tr>
<td>MPEG-2</td>
<td>DVD standard Main and 4:2:2 Profile</td>
<td>MPEG</td>
</tr>
<tr>
<td>MPEG-4</td>
<td>Applications in mobile and Internet Simple Profile and Advanced Simple Profile</td>
<td>MPEG</td>
</tr>
</tbody>
</table>
DTV MPEG/ RF Signal Generation w/ IP Generation
MTX100B/ RTX130B/ RTX100B

Interface:
ASI (TS) / SPI(TS) / Ethernet port (IP/RTP/UDP)
Stress Test Features

- Parametric Playout Capabilities
  - Error Insertion Capability (Packet Drops, Checksum Errors, Sequence Errors and Jitter)
  - Burst mode (both timing and packet number based)
  - Manual error generation capabilities

- "Stress Test, not Load Test"

- Simultaneous Play/Rec can be used
  - Adjust priority
  - Non-deterministic timing
Advanced Playout Features

- **Advanced Mode**
  - Protocol header customization capabilities for source and destination ports and addresses,
  - Advanced mode for setting MAC address, transport checksum, network checksum
  - User editing of any packet header field parameters

- **Session replication to simultaneously encapsulate and play a TS over many IP sessions**
Tclips : New Suite of Test Streams

- >300 Video Test Streams
- >50 Audio Test Streams
- Source of repeatable test patterns
- Playout streams to test decoders
- Use as source material for creating new streams with software Mux
- Not just a stream player
- "Stream Creation and Generation Toolkit"

- TG700, VM700 and PQA Test Patterns
- Motion and Static
- Encoded as H.264 and MPEG-2
- SD and HD
  - 480
  - 576
  - 720
  - 1080
- DVB and ATSC Service Information included
POA200-300 folder

- 2 Video Test Streams, multiple scenes (15 per stream)
- With SI/PSI and Audio Tones
- Use for PQA300 PQR tests at the analog or SDI output of the decoder.
TSG130A-131A-VM700 Matrix folder

- 2 Video Test Streams
- With SI/PSI and Audio Tones
- Use with VM700T Auto mode for more complete analog test coverage of decoder.
- Use as source material for creating new streams with software Mux
Vclips

- Series of Video clips for test, optimisation and demonstration of video compression. Supplied by Vqual

- Encoder series – YUV clips for encoder testing, includes difficult to encode sequences for ‘stressing’ encoders.

- Decoder series – MPEG 4 and H264 clips for decoder testing, includes functional tests and error tests. Syntax switching to test for decoder tolerance of bitstream errors.

QCIF-CIF-D1-720p-1080i
Picture Quality Analyzer PQA500

- The successor of PQA300
  - Support the all measurement capability, PQR/PSNR
  - Expands the application area
    - Multi resolution, Multi rate
    - Variety of viewing situation

- New Extended HVS model algorithm for the predictive DMOS
  - High correlation with PQR numbers on the same setting
  - New 8 patents in the algorithm

- Provide the Engineering tool
  - New Summary Viewing Displays
  - Less limitation on the video sequences
  - Supports easy regression testing.

- Running on latest HW platform
PQA Measurement Application – STB Testing

- Reference YUV File (Vclips)
- MTS4CC Software (Extract MPEG Video To YUV file)
- Reference Video
- LCD Monitor
- MPEG Encoded File
- I/O Interface Conversion To SDI
- Test Capture SDI Video
- PQA500
- D.U.T
- MTX100B (MPEG Player)
- RTX130B (ATSC/QAM)
- RTX100B (ISDB)
- Adaptor HDMI -> SDI
- Analog CVBS/YPbPr -> SDI
- (Set-Top-Box)
User Interface

Reference
Pre-Calculated Measurements
Graphs
Maps
Test
Measurements Types

- **Double-Ended**
  - Require both a Reference and Test sequence of the video material
  - DMOS
  - PQR
  - PSNR

- **Single-Ended**
  - Require a test sequence of the video material
  - Attention Model
  - DC Blockiness
Picture Quality Measurement – Picture Quality

Measure A

Measure B

Measure C

Measure D
Picture Quality Measurement – Broadcast Lab

- Broadcast Material converted to various video formats

HD Broadcast

1920x1080 or
1280x720

HD to SD Down Conversion

720x576 or
720x486

SD Broadcast

Down Conversion & MPEG Conversion

320x180

Mobile Phone Broadcast

- Broadcast Applications
  - Up / Down Conversion
    - HD to SD & SD to HD
  - MPEG Codec Evaluation
    - Suitable Bit Rate
  - Mobile Broadcast Analysis
Technical Challenges for Content Verify

- Ingest and Playout are in transition
  - Analogue to Compressed Digital

- Methods of storing video are changing
  - Tape to File based stored on Server

- Many different new formats
  - Terrestrial, Satellite, Cable, VoD, IPTV
  - QCIF, CIF, SD, HD,
  - MPEG-2, MPEG-4, H.264/AVC, VC-1
  - Different bitrates, GOP, Audio etc

- There has been no off-the-shelf way to rapidly test stored compressed file-based media content
File Based video Quality Control

File Based Video QC Application Challenges

- Traditional video T&M only checks baseband (luma/chroma/signal) levels in analog and digital video streams
- File-based video is different. It must be checked for
  - **Correct Encoding Syntax** – at digital level, audio/video must be encoded without errors, so it plays out correctly at the Customer’s STB / playout device
  - **Correct Parameters** – audio/video bitrates, GOP structure, Color-space, Color depth, Frame size, Frame rate, Aspect ratio, Quantization levels
  - **Correct Baseband and Quality levels** - analog parameters for Signal levels, Luma, Chroma, Gamut and Quality levels of Black frames, Blockiness, Loss of audio, Audio clipping, Video/Audio playtime
Product Portfolio

- **CerifyLite**
  - For post production / content suppliers
  - Software only, PC standalone test
  - Manual operation
  - Single user

- **Cerify CYC200, CYS200, CYM200**
  - For Broadcasters (Terrestrial, Sat, Cable, VoD, IPTV etc)
  - Integrates into workflow
  - Automatic operation
  - Includes site install, integration & user training
  - 1, 3 or 5 years hardware & software support options

- **Automated verification of compressed digital media**
  - All formats: QCIF, CIF, D1, SD, 720p, 1080i/p, etc
  - Wrappers: MPEG TS/ PS, MXF, GXF, MP4, MOV, ASF, 3GPP
  - Video: MPEG-2, IMX, D10, MPEG-4, H.264, H.263, VC-1/WMV, DV25
  - Audio: MPEG-1/2, AAC, HE AAC, PCM, WMA, AC3, Dolby-E
See and Solve Test Results

- Details of results are displayed in levels
- The amount of detail increases as you “drill down” to lower levels

Test summary for each file in “Job”

Details for each file within the “Job”

Alerts for each error within the file

Video thumbnails and audio waveform shown in frames surrounding the alert

Details of a specific error alert

Thumbnail of errored frame
Tektronix Compressed Digital Video Product Portfolio

Solving today’s digital video delivery and quality challenges

- MPEG Test Systems & Software
  MTS415/430/400P/4SA

- Next Generation Compressed Video ES Analysis
  MTS4EA/MTS4CC

Analysis

- MPEG Generators
  MTX100B/RTX100B/RTX130B

- Test Streams
  Vclips/Tclips

Generation

- MPEG Monitors
  MTM400A

- File-Based Video Content Analysis
  Certify™
  CertifyLite

Operations
Demonstrations & Q&A

▶ Questions ?