VideoQ

Technologies & Products

March 2020

VideoQ Philosophy of Media Data & Metadata Processing

1. Automatically generated Technical Metadata and Reports are must be and must cover:
   Image aspect ratio, contrast, sharpness, sound loudness, noise and other unwanted components levels are among the most critical parameters affecting the subjective estimation of AV content quality.

2. Traditional professional image & sound QA/QC methodology, based on the usage of large number of high-grade video & audio monitors, etc, is no longer the answer, but we learn that QA/QC is still needed.

3. In this automated environment a smaller number of human operators should focus only on optional final checks and/or complicated cases.

4. And these operators must be equipped with appropriate software tools and indicators presenting all relevant parameters in a time-saving “easy to spot at a glance” way.

   The VideoQ VQPT modules answer the need for such automatic tools. Combination of VQPT suite modules with other VideoQ tools, such as VQV – Viewer-Analyzer and/or VQMA – Matrix Test Analyzer, will result in further increase of workflow efficiency.
VideoQ Tools & Streaming Technologies

VideoQ exploits at least two crucial cloud-based technologies aimed at significant improvement of Quality of Experience to Content Delivery Cost ratio by up to 30% reduction of average VOD/OTT bitrate (and CDN cost) while preserving the image quality score.

This goal is achieved thru the application of unique VideoQ tools.

For more details, see slides about the VideoQ VQPT technology and tools later in this presentation.

ViDiChoice Technology

VideoQ ViDiChoice™ (VDC) technology is a major advance in AV content delivery. It provides an efficient solution for well-known critical viewing/listening environment issues.

User or player manually or semi-automatically selects the stream with desired (subjectively optimal) video and audio levels profiles.

For more details, see slides about the VideoQ ViDiChoice™ technology later in this presentation.
VideoQ & Media Ambits

What it is:

- [me·dia am·bit] noun: **Technical and semantic metadata** about moving **images**, **sounds**, and **timed text**; **embedded** in files or **externally centralized**.
- An application example: Streaming system using VideoQ **media ambits data** to automate/improve ingest and delivery.
- For example: **Video Ambit**, **HDR Ambit**, **Audio Ambit**, **Timed Text Ambit**, etc.

Ambit’s Role for Automated and Automation-Assisted Workflows:

- Robot-assisted human decision-making tools.
- Robots-learning-from-people tools.
- Ambits repositories and machine services optimized for automation, web services, and directed acyclic workflows.
- Automated and manual control of optimized video and audio processing/conversion
- Automated and manual quality assurance and quality control tools
- Measure, annotate and automatically modify files to match target ambits.
- Notify machines, people and dashboards in automated workflows.

*For more details, see slides about the VideoQ **Media Ambit** technology later in this presentation.*

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VideoQ Product Lines

- **VQDM** – Video Latency & AV Sync Analyzer
- **VQL** – Comprehensive Library of sophisticated test patterns
- **VQMA** – Video Quality Matrix Analyzer
- **VQPT** – Suite of Productivity Tools for cloud transcoding & streaming
- **VQTS** – Complete Video Quality Test Systems
- **VQV** – Video Files Viewer-Analyzer
**VQDM – Video Latency & AV Sync Analyzer**

- **VQDM Features:**
  - Combination of Test Generator and Delay Analyzer to measure AV latency and AV sync errors
  - Self-contained hardware/software solution allows measurement in normal work conditions without any interference into the System Under Test
  - Windows SW Application with multi-channel GUI, revealing in real time: AV delay time profiles, AV sync errors and AV delay statistics
  - Two reporting modes:  
    a) Machine-readable .txt or .csv file for test automation QA/QC applications  
    b) Windows GUI and detailed multi-page PDF document print-out for engineers
  - Provides for calibration and prequalification of System Under Test using built-in subset of VideoQ test patterns library

- **VQDM Components:**
  - VQDM-100 – Main Video Capture and Conversion Unit
  - VQDM Executable (Windows Application) – AV Delay Analyzer SW
  - Saleas Logic (Windows Application) – Preview, Capture and Scope Utility

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**VQL – Test Patterns Library**

- VQL files are designed to be compatible with all commonly used software or hardware codecs and media players.

- Static and dynamic video test patterns are available in a variety of resolutions, interlace modes, aspect ratios and frame rates from 192x108 up to 4K/UHD

- All test patterns remain suitable for accurate measurements even after low bitrate coding, heavy scaling and/or cropping, e.g. after down-conversion for mobile devices

- Full custom compressed and uncompressed test files and application-specific live video clips are available on request
**VideoQ Approach to Test Patterns Usage**

VideoQ approach combines “classic”, “digital” and “cloud” methodologies, sharing same test patterns and covering all 3 levels of video quality control:

- **Instant visual-aural quality estimation**
- **Objective measurements of video and audio parameters**
- **Fully automated Quality Control**

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**VQL for Software and Hardware Applications**

- **VideoQ Players**
- **VQL Compatible Hardware**
- **Players/Generators**
- **Software Coders, Transcoders, Players, Analyzers**
- **Other (3rd party) Players**
VQL Test Patterns by Categories

1. Color Space, Gradations and Linearity Tests – GradTracker™ series
   1.A Special HDR (High Dynamic Range) Tests

2. Geometry, Scaling, and Sharpness Tests – ScalTracker™ series

3. Motion Portrayal Tests: Frames Continuity, De-Interlacing, and AV Sync – ChronTracker™ series

4. Compression Quality Tests – StresTracker™ series

5. Static and Dynamic Multi-purpose Test Charts, including widely used VQMPC test

6. Live Clips

7. Audio Tests

VQL Test Patterns by Categories

VQMPC – Dynamic Test Pattern with AV Sync Components

Set of test pattern video and audio files to check:
- Geometry and Aspect Ratio
- Video Levels and Color Rendition
- Scaling distortions or proof of no-scaling
- Frames continuity and AV Sync Errors
- Compression artifacts

Variety of video formats:
- Frame sizes from 720x480 to UHD & 4K
- Frame rates from 23.976 to 60.0 fps

AV Sync Reference: “Beep-bop” burst

VQMPC test is used world-wide by a number of major companies.
**VQMA – Video Quality Software Analyzer**

- Camera Under Test
- VQMA-C Chart
- Reference Player
- VQMA Test Pattern Sources
- VQMA Test File
- Video Processor
- Video Encoder
- Reference Decoder
- Video Player
- Capture Device
- VQMA Analyzer
- Media File/Stream: Y4M, MP4, MOV, etc.
- Captured YUV/RGB Data or Captured .YUV/.BMP File
- VQMA Test Reports

**VQMA Features**

- 4th generation of VideoQ best-selling software product, suitable for any video format, any frame size (from 192x108 to 4096x3072), any frame rate
- Software executable under Windows™ (XP, 7, 8, 10)
- USB dongle copy-protected, dongle-per-workstation
- Auto-analysis on the companion VQMA Matrix Test Pattern
- Variety of VQMA Test Pattern formats: Optical Chart, File, Signal, Stream
- Unique patented algorithms for accurate & fast measurements (typically 2-5 seconds)
- Built-in Software Scope: YUV/RGB waveform monitor
- Noise Measurement and Scope work on any static image
- Windows GUI Mode for R&D and product verification
- Command Line Interface (Batch) Mode for automated QA/QC operation
VQMA – Analyzed Parameters

- **Geometry**: Scaling, Aspect Ratio, Position, Tilt, Keystone
- **Levels**: Black, White, Color Bars, RGB Balance, Gamma
- **H & V Shading** (Levels Spatial Uniformity)
- **Frequency Response**: in dB vs. scalable tvl, including aliasing levels
- **UV vs. Y Gain** (Color Saturation)
- **K-rating** on needle pulse
- Comprehensive **Noise Analysis**

VQMA checks video data against the target tolerance values contained within customizable VQMA.INI file

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VQMA Test Pattern Composition

All-In-One: Single pattern allows automatic measurement of multiple video image parameters

<table>
<thead>
<tr>
<th>Test Components:</th>
<th>Parameters:</th>
</tr>
</thead>
<tbody>
<tr>
<td>H Wedges 0</td>
<td>Visual Estimation</td>
</tr>
<tr>
<td>V Wedges 0</td>
<td>YUV/RGB Levels, Color Space Matrix</td>
</tr>
<tr>
<td>Color Bars 1</td>
<td>Black &amp; White Levels, RGB Balance, Y Gamma, Y Range Overload</td>
</tr>
<tr>
<td>Grayscales x2, Near-Whites, Near-Blacks 2</td>
<td>Frequency Response, Aliasing Levels</td>
</tr>
<tr>
<td>Multi-Burst 3</td>
<td>Y vs. UV Gain, Needle pulse K-rating</td>
</tr>
<tr>
<td>Multi-pulses 5</td>
<td>Geometry (Scale/Position/Tilt/Keystone) Markers x4</td>
</tr>
</tbody>
</table>
**VQMA-C Optical Chart**

- Precise color bars XYZ and grayscale densities
- Robust metal frame
- Abrasion-resistant low-glare glass
- Adjustable tilt to minimize reflections

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**Example of VQMA-based QA/QC Sub-System**

**A Large Transcoding Facility, Los Angeles**

- **Content Files**: 100+ titles per day
- **Variety of Input Formats**: 4:3, 16:9, 169LB, 169AN, 235
- **Output Frame Sizes**: 1920x1080, 1280x720, 720x480
- **FPS**: 23.976, 59.94

**70+ Transcoding Processors**: Up to 20 output formats

**MAM**: Transcoding Profile

**Output Package (Folder)**

**VQMA Test Clip 8s**

**70+ Transcoding Processors**: AVI, MOV, MXF

**MP4, AAC, BIF, MXF**

**QA/QC Sub-System (Analyzers)**: Output: QC Report

**Output**: QC Report

**MAM Package Approval based on QC Report**

- **AV Data**
- ** Thumbnails**
- **Metadata**

**QA/QC Sub-System**: MP4, AAC, BIF

**MAM**: Transcoding Profile

**LAN**

**VOD/OTT Server**

**VOD/OTT Customers**

**Player**

**Internet**

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**A Large VOD/OTT Service Facility, Toronto**

- **Content Files**: 100+ titles per day
- **Variety of Input Formats**: 4:3, 16:9, 169LB, 169AN, 235
- **Output Frame Sizes**: 1920x1080, 1280x720, 720x480
- **FPS**: 23.976, 59.94

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**LAN**

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VideoQ developed essential tools for Ambit-based Automated and Automation-Assisted Workflows:

- **VQPT** - VideoQ Productivity Tools, unattended program modules for Windows/Mac/Linux platforms that make Media Ambit metadata, plots, and images required for databases & orchestrators.


- **VQCP** - Video QC player for human review and supervision, compatible with Media Ambit tools and practices.

- **VQV** - Media Files Player/Viewer/Analyzer/Converter for deep analysis QA/QC applications.
VQPT Core Foundations

1. **VideoQ Productivity Tools** are designed “by engineers, for engineers”
2. An ever higher number of channels/programs/titles
3. And a permanently growing number of formats, frames sizes, bitrates, etc.
4. Human resources required for input QC and output QC has escalated
5. A new approach and **new tools** are needed *as demanded by our customers*
6. Hence VideoQ has changed the focus from our traditional T&M tools to **Automated Productivity Tools**
7. Automation is essential, but …
8. Human intervention cannot be excluded
9. Thus, our slogan is: “**Robot-assisted human decisions**”

VQPT Suite Entry Level Modules

- **VQMINF**O – Media File Info Report Generator
- **VQBF** – BIF (Base Index Frames) Files Verifier
- **VQBLA** – Bitrate Ladder Analyzer
- **VQCF**A – Captions Files Analyzer
- **VQFTC** – Frame Types Classifier
- **VQLM**N – Loudness Meter & Normalizer
- **VQLPC** – Loudness Profiles Correlator
- **VQPL**A – Picture Levels Analyzer
- **VQTS**F – Transcoding Segments Finder
**VQPT and Media Ambit Metadata Acquisition Workflow**

- **Media File(s)**
- **Optional Settings**
  - Command Line Interface
  - Flags & Values
- **VideoQ Productivity Tools**
  - Set of unattended program modules, suitable for in-house and cloud computing
- **Content Data**
- **3rd Party Libraries**
- **Media Ambit Metadata**
  - Standard machine-readable JSON files
- **To**
  - Decision-making Engine and/or QC Workstation
  - Optional Media Ambit Metadata: Plots & Images for Database & Operator/Manager
  - Optional Content Data: extracted/converted/modified Media Files, e.g. normalized audio WAV

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**VQPT Tools & Adaptive Bit Rate Optimization**

VideoQ Productivity Tools provide for up to 30% reduction of average VOD/OTT bitrate (and CDN cost) while preserving the image quality score.

This goal is achieved thru the application of optimized encoder settings based on the analysis reports generated by VQFTC, VQTSF, and VQBLA tools.
**Media Ambit Data Usage Workflow Example**

- **Media Package:** MOV/MXF/MP4, WAV, BIF, VTT/TTML
- **Original Media Files:** Extracted & Normalized Files
- **Processor:** Transcoder
- **CDN:** MP4, BIF, VTT/TTML
- **Internet:**
- **VOD/OTT Customers:**
- **LAN/WAN:**
- **Decision-making Engine:**
- **Automated Job Request:**
- **Orchestrator:**
- **Database:**
- **Player:**
- **VQCP:** Software for Media Ambit
- **Secure Video QC Player:**
- **Remote Access to Database:**
- **Management Dashboard:**
- **Ambit Metadata:**
- **LAN/WAN:**
- **Bitrate Ladder:**
- **Quality Score, %:**
- **Bitrate, kbps:**
- **Encoding with bitrates lower than critical results in compression artifacts, usually described as “Noticeable and annoying”, bitrates above critical – as “Noticeable, but not annoying”**

**Example of Video Activities by VQBLA**

**Activity, %**

**Intra-frame Activity (Static Details)**

**Inter-frame Activity (Dynamic Details)**

**Activities Statistics Bargraphs**

**Quality Score, %**

**Bitrate, kbps**

**Encoding with bitrates lower than critical results in compression artifacts, usually described as “Noticeable and annoying”, bitrates above critical – as “Noticeable, but not annoying”**
Example of Audio Ambit Data by VQLMN

Integrated Loudness and Momentary Loudness Timeline Profile are within specs, but two Segments and one Parameter are out of specs:
- 60s long Test Tone at timeline start, then 60s long Mute, then regular audio, and True Peak value is too high.

Example of HDR Video File Ambit by VQPLA

Video Volume and Light Volume Global Statistics & Timeline Profiles: No serious problems found.

Warnings:
- a) Frame Average Light Level varies too much: from 2% to 62%.
- b) for one episode FALL goes above 600 nit – too much for some displays.
VQTS4K – Complete Video Quality Test System

Test Pattern Generator

Camera
Test Chart Option

Capture & Analysis Tools

Network
Connectivity
Options

Test Samples &
Test Reports

BMD Playout Card
HDMI or SDI

System
Under
Test

HDMI or SDI

BMD Capture Card

VQV – VideoQ Viewer-Analyzer

A rendered image with the unique VQV readout and VQV filters/meters overlays

SDI/HDMI

Video
Capture
Card

Media File

Raw YUV/RGB File

VQV

Converted
YUV/RGB Files

OpenGL
Renderer

FFMPEG
Decoder

UHD HDR10 sample video – courtesy of newswide.co.uk
VQV Features 1

- An offline (non-real-time) video player with sophisticated viewer-analyzer functionality
- Covers a wide range of frame sizes and formats, up to DC and UHD, including variety of HDR formats (PQ, HLG, and LOG, several user-selectable rendering modes)
- VQV displays frame by frame:
  - XY positions, YUV & RGB Levels and expected (as by selected model) Light Levels of every pixel, line, frame or segment
  - GOP structure, frame type, bitrate statistics for the selected frame or selected timeline segment
  - Light Levels (LL) values in perceived nits (= cd/m^2 only on shades of Gray) or % of the selected LL range limit
- Uses fast intuitive controls for timeline position, zoom, signal gain, filter mask size and position
- Contains built-in high-gain spatial and temporal high-pass filters revealing even hardly visible artefacts
- The user can choose:
  RGB, Y, UV, R, G, B or LL view channel, color space, level scheme and SDR/HDR Rendering Mode
- A right-click submenu allows fast creation of snapshots or thumbnail .BMP images
- VQV also contains a powerful "Export as" file and data format converter
- Provides for quick frames/profiles comparison and benchmarking by running multiple VQV instances

VQV Features 2 (continued)

- For R&D and product verification work, VQV can be launched in a Windows GUI Mode
- For semi-automatic QA/QC operation VQV provides multiple GUI instances via Command Line Mode
- VQV opens and decodes any wrapped/compressed video file (all formats supported by ffmpeg)
- VQV opens static image files in a variety of formats – JPG, PNG, TIF, etc.
- VQV opens single frame file, folder with numbered frame files, or large multi-frame RAW video files
- Video data export processing provide for:
  - Frame cadence change: N:1 decimation, 3:2 repeat, 1:N frame repeat, and/or A-B fragment repeat
  - Color space and pixel format conversion: SDR ⇨ HDR, YUV ⇨ BMP/RGB, YUV ⇨ Y4M, UYYYY ⇨ Planar YUV
- Resolutions supported:
  from 192x108 to 4096x3112, 8, 10, 12 or 16 bits per component
- Repeat full duration (loop) or selected fragment (A-B loop) playout
- Shuttle/Jog playout modes, variable forward and backward playout speed (VideoQ ‘Videola’):
  Actual frames-per-second speed depends on CPU/GPU power and video frame size
**VQV Features 3 (continued)**

- **SDR / HDR (Standard Dynamic Range / High Dynamic Range) Modes supported:**
  - **SDR** – Conventional YUV/RGB data format, selectable rendering modes
  - **HDR-PQ** (Perceptual Quantizer), selectable rendering modes, including RAW video data image
  - **HDR-HLG** (Hybrid Log Gamma), selectable rendering modes, including RAW video data image
  - **HDR LOG** (Camera LOG and DPX LOG), selectable rendering modes, including RAW video data image

- Auto and manual selection of YUV ⇔ RGB and XYZ ⇔ RGB **matrices** and color space **primaries**:
  - **UHD** (BT.2020/BT.2100, DCI-P3)
  - **HD** (BT.709, BT.2020, DCI-P3)
  - **SD** (BT.601)

- Switchable YUV ⇔ RGB levels mapping:
  - **Full Range (FR)**, e.g. 8 bit YUV 16-235 to 16-235 RGB rendering
  - **Narrow Range (NR)**, e.g. 8 bit YUV 16-235 to 0-255 RGB rendering, or 0-255 RGB to YUV 16-235 export

- Variety of Input and output YUV / RGB formats:
  - Interleaved, e.g. 422 UYVY (default raw data YUV format) or BGR48 – interleaved 16b RGB
  - Planar 444 RGB and YUV, 422, 411 and 420 YUV (.YUV raw data file format or .Y4M file format with header)
  - Proprietary VideoQ YUV or RGB interleaved 444_16LE 48bpp, accommodating up to 16b per component raw data

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**VQV Tools & Meters**

- VQV analyzers and meters can be sorted out into 3 categories:
  - **YUV & RGB Levels Analyzers**, providing for several secondary analyzers, such as Frame Lines RGB Range Profile, Video Volume Meter, VectorScope, ChromaScope, etc.
  - Intra-frame Activity and Inter-frame Activity Analyzers, also providing for Noise Level Meter
  - Bitrate Statistics Analyzers

- For all 3 categories the analysis results are presented in two formats:
  - **Graphical overlays** – Bargraphs, Waveforms and VectorScope Display formats
  - **Numerical readouts**, shown as Title Bar Message and/or Text Overlay

- Some analyzers, filters and overlays can be combined, some others are mutually exclusive

- See separate VQV presentation for detailed description of:
  - Active Image Size Meter
  - Video Volume Meter – **VV-Bars™**
  - VectorScope
  - ChromaScope
  - RGB Frame Profile Monitor – **FrameScope™**
  - RGB/YUV Line Parade Waveform Monitor
  - RGB/Light Levels Histograms
  - RGB/Light Levels Frame Statistics Analyzer – **L-Bar™**
  - Bitrate Analyzer – **C-Bar™**
  - Noise Meter
ViDiChoice (VDC) Technology

VideoQ ViDiChoice™ (VDC) technology uses cost-effective automated software tools for AV content post-processing and transcoding. It provides an efficient solution for well-known critical viewing/listening environment issues.

Original dynamic range Video

Processed subjectively brighter Video

Original loudness range Audio

Processed subjectively louder Audio

User or player manually or semi-automatically selects the stream with desired [subjectively optimal] video and audio levels profiles

Who needs VDC Technology?

**Customers:**

Their TVs, desktop computers and mobile devices are operating in unpredictable ambient light and acoustic noise environment.

VideoQ ViDiChoice™ (VDC) technology provides the customers with a range of content versions.

Each customer can select the content version better matching the current viewing/listening conditions.

**Content Distributors:**

More happy viewers, less churn, marketing edge advantage.

And these goals can be achieved in a relatively short time without massive investment and significant changes of the existing workflow.

**Content Originators:**

More happy viewers, better ratings.

No need to prepare and release special “broadcast” and/or “web” versions of the content.
**How it works?**

1. **Original Content**
2. **Statistics Analyzer**
3. **Mapping Decisions List**
4. **Processor Transcoder**

**User menu options:**
1. Original Video, Original Audio
2. Brighter Video, Original Audio
3. Original Video, Louder Audio
4. Brighter Video, Louder Audio

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**VDC: Ambient Illumination & Video Image Dynamic Range**

When the ambient illumination light level goes up, the logarithmic range of visible gradations does not increase nor decrease, it moves upwards. Therefore, to provide the best viewing comfort all gradations of the rendered video image must also go up, following the visible range. It is relatively easy to fit the smart TV with the ambient illumination sensors, but for mobile devices it is not so easy, so manual control is preferred. The challenge is to find the optimal light levels re-mapping algorithm, i.e. to provide ambient light adaptive EOTF functionality.

1. **Ambient Illumination**
2. **Light Levels Gain**
3. **Light Levels Gain & Lift**
VDC: Video Content Viewing Comfort

Whilst caring about the maximum viewing comfort (aka QoE - Quality of Experience) we should be guided by two principles:

- **Consistency is more important than performance.** I.e. a consistent ‘4’ quality mark all the time is better than ‘5’, ‘3’, ‘5’ up-down-up variation.
  
  E.g. in the DC industry sweetening means adjustments for consistent colors, voice pitches, loudness, etc. – all movie segments from start to finish.

- **A Happy Viewer is the only measure of success.**

The list of parameters for consistency checks should include video and audio levels statistics.

**Example of inconsistent light levels timeline profile**

![Example of inconsistent light levels timeline profile](image)

**Video images – courtesy of newadjs.co.uk**

VDC: Audio Content Listening Comfort

**A Happy Listener is the only measure of success.**

*Some* audio segments are *below* the Noise Level

**Original audio loudness timeline profile**

![Original audio loudness timeline profile](image)

*The same Integrated Loudness*

**Processed audio loudness timeline profile**

![Processed audio loudness timeline profile](image)

*All processed audio segments are above the Noise Level*

Original audio is good *only* for low noise environment.

On average the processed audio sounds louder.
For more details – see other VideoQ presentations

Thank you

About VideoQ

Company History

- Founded in 2005
- Formed by an Engineering Awards winning team sharing between them decades of global video technology.
- VideoQ is a renowned player in calibration and benchmarking of Video Processors, Transcoders and Displays, providing tools and technologies instantly revealing artifacts, problems and deficiencies, thus raising the bar in productivity and video quality experience.
- VideoQ products and services cover all aspects of video processing and quality assurance - from visual picture quality estimation and quality control to fully automated processing, utilizing advanced VideoQ algorithms and robotic video quality analyzers, including latest UHD and HDR developments.

Operations

- Headquarters in Sunnyvale, CA, USA
- Software developers in Silicon Valley and worldwide
- Distributors and partners in several countries
- Sales & support offices in USA, UK