MPEG-4 Demystified

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Overview

- What is MPEG-4?
- How does MPEG-4 work?
- Recent Developments in MPEG-4
- Why use MPEG-4
- Deployment of MPEG-4
- About M4IF

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What is MPEG-4?

- The Media Standard
  - Set by ISO/IEC
- An interoperable cross-platform ecosystem
- An architecture and coding methods for representing rich multimedia content
  - beyond video and audio, supporting synthetic content, raster and vector graphics
- Designed for **all** digital multimedia platforms

Where does it come from?

From Moving Picture Experts Group, who also did:

- MPEG-1: Standard for Video CD, CD-I, web, digital photo cameras
  - MPEG-1 Layer III audio codec (MP3)
- MPEG-2: the DVD and digital TV standard

And also:

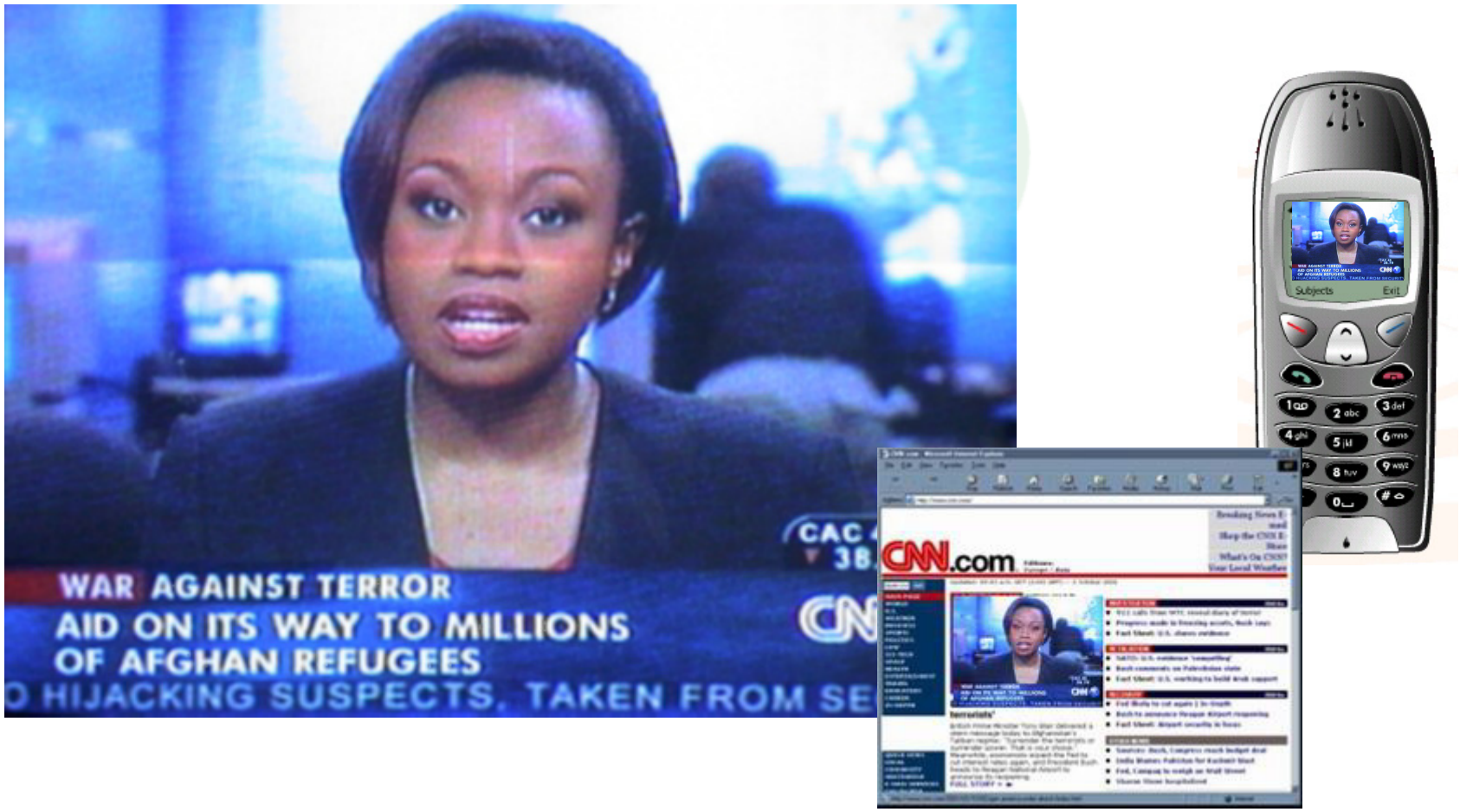
- MPEG-7: standard for description of content
- MPEG-21: framework for interoperable use and exchange of digital media

MPEG-4 Vision

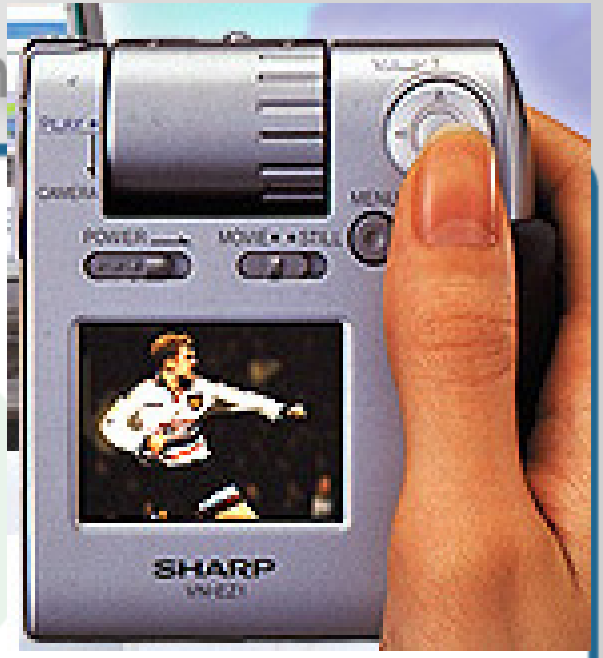
- No **convergence**, but **proliferation** of multimedia over different networks, terminals.
- **Common** multimedia technology necessary that supports:
  - Broadcast
  - Communication
  - Retrieval
    - online
    - packaged media

One Single Technology for …

Write once - Play everywhere



Applications of MPEG-4



- Mobile devices
  - Low datarates, errors, scalability
- Broadcast
  - New, on-demand services
  - HD broadcast
  - ‘MPEG-4 over MPEG-2’
- Streaming services
  - Scalability, low to medium datarates, interactivity
- Packaged Media (DVD)
  - Interactivity,
  - HD through higher compression rates

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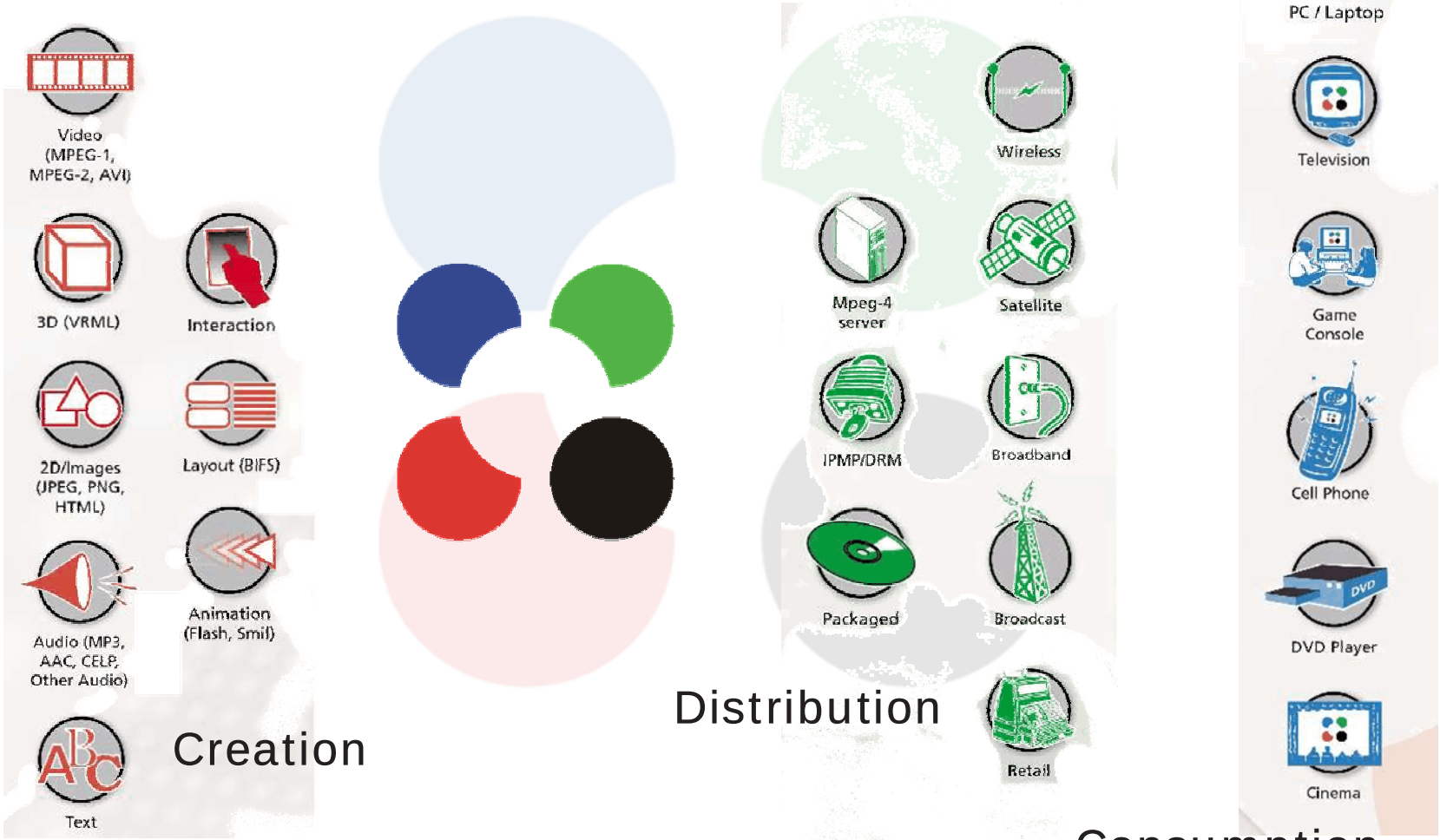
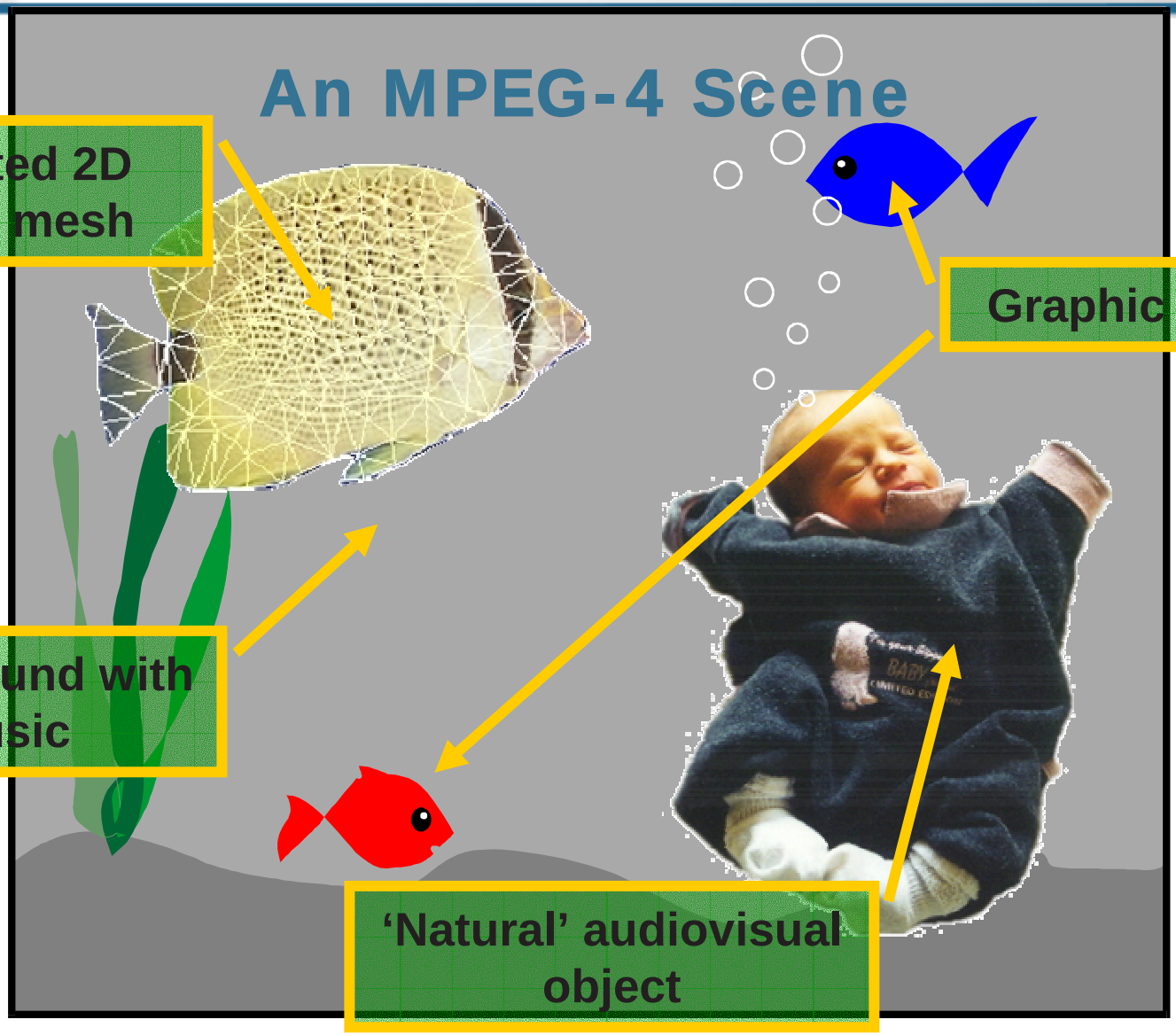
The Nature of MPEG-4

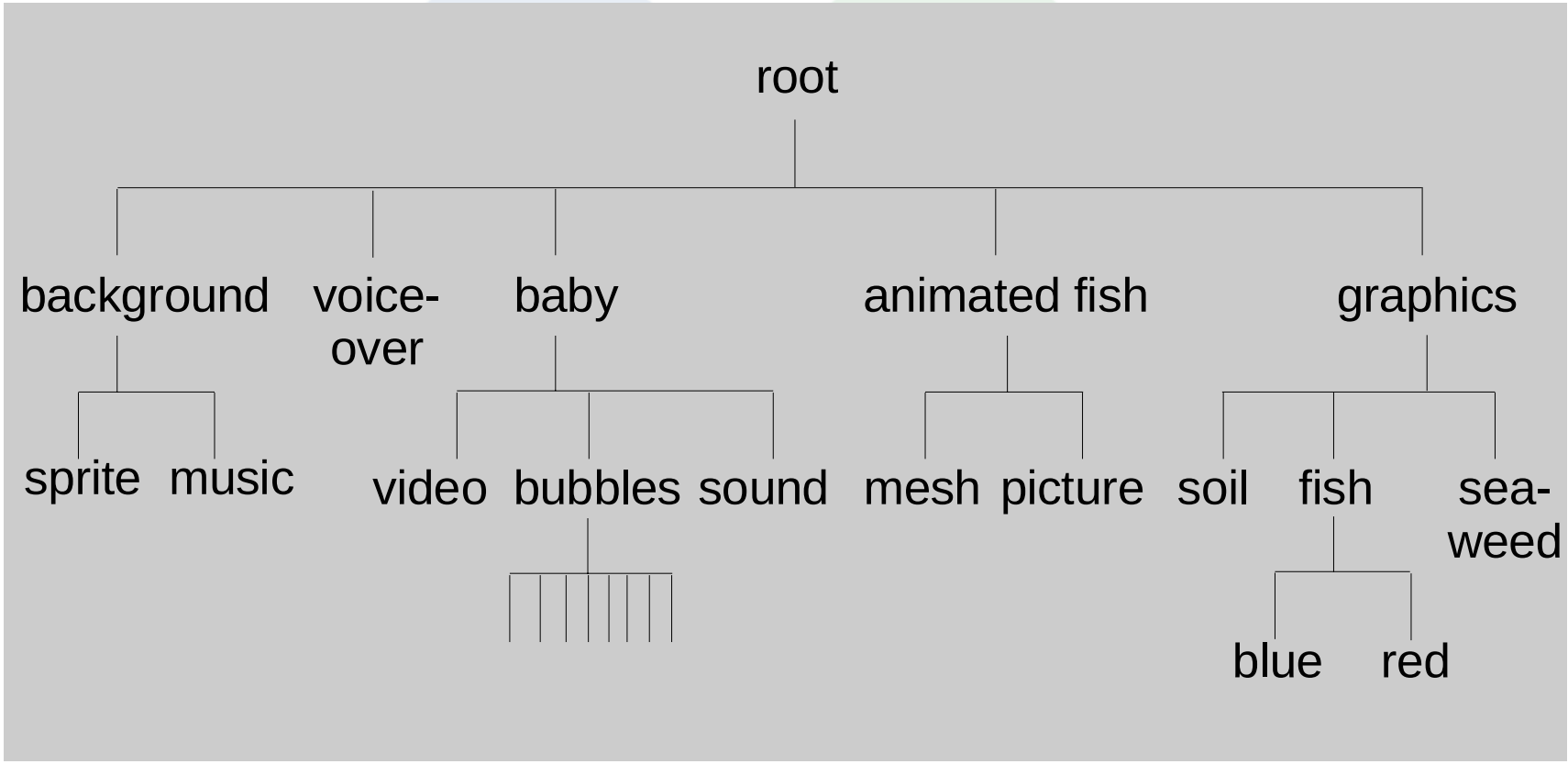
- Object-based multimedia content representation standard
- Revolutionary Systems Layer
- State-of-the art coders, responsibly upgraded
- Profiles and Levels restrict complexity and guarantee interoperability

The MPEG-4 Ecosystem





The Scene Tree



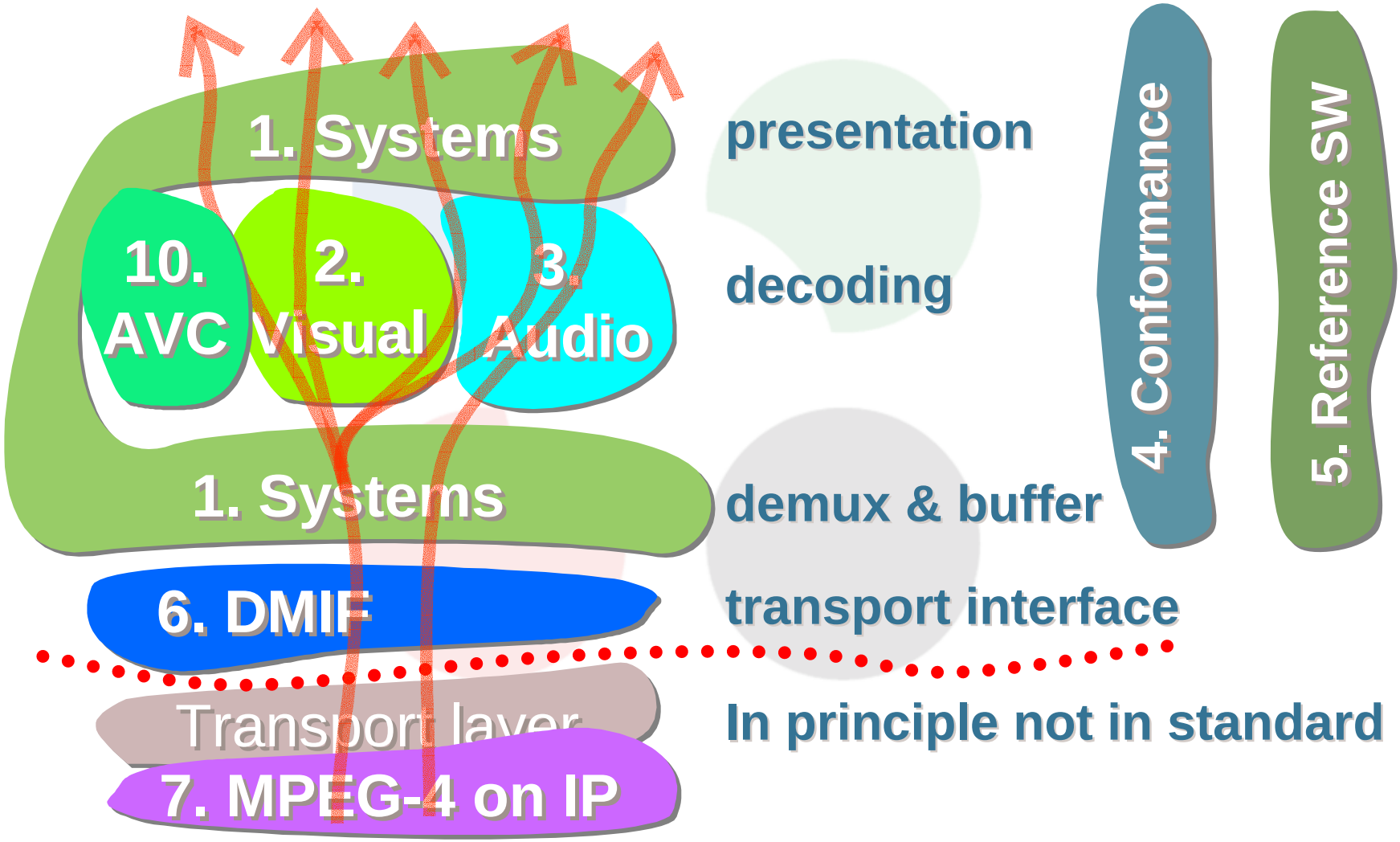
Recapping: MPEG-4 is about the Coding of Audiovisual Objects

- Audiovisual **Scene** is with ‘objects’
- These **Objects** can be of different nature
- **Compositor** puts objects in scene
- Efficient, Real-time Binary **scene description language** (BIFS)
- **Coding** scheme is optimal for object type
- Principle is fully **independent** of bitrate

MPEG-4 Supports a Variety of 'Objects'

- Visual
  - Video
  - Animated face & body;
  - 2D and 3D animated meshes
  - Text and Graphics
- Audio
  - General audio – mono - 5.1 channels
  - Speech
  - Synthetic sounds ('Structured Audio')
  - Text-to-speech
  - 'Environmental spatialization'

The Parts of the MPEG-4 Standard



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Visual Media Object Types in MPEG-4

- Video from 10 – 1,000,000 Kbit/s
  - Multiple rectangular or arbitrary shape objects in the scene
  - Scalable – Interlaced and Progressive
- ‘Sprites’ (e.g. backgrounds): send once, then warp
- Computer-generated visual information
  - Synchronized graphics & animated text
  - Face and body animation,
  - animated meshes with moving texture,

Audio Media Objects in MPEG-4

- Audio from 4 kbit/s to 64 kbit/s/channel
  - Arbitrary number of objects in the scene
  - MPEG-4 AAC, TWINVQ
  - > 4kbit/s: Harmonic and Individual Lines plus Noise' (HILN)
- Voice from 2 kbit/s to 24 kbit/s
  - 2-4 kbit/s: HVXC (Harmonic Vector eXcitation Coding)
  - 4-24 kbit/s: CELP:
- Large step + Fine Grain Scalability
  - 1 kbit/s steps through Bit-Sliced Arithmetic Coding

MPEG-4's Synthetic Audio Objects

- Structured Audio
  - SAOL (SA Orchestra Language)
  - SASL (SA Score Language)
  - Great 'music' at very low bitrates
- Coded form of MIDI
- Wavetable synthesis for simple decoders
  - Including effects
- Text-To-Speech (interface!)
  - To complement face/body animation

MPEG-4 Systems

- Binary Scene Description
  - VRML concepts + Streaming + Real Time + Efficiency
  - Support for content in scene from different sources
  - Allows interaction (local/remote)
  - 2D and 3D
  - Dynamic scene updates and scene animation
- XMT: eXtensible MPEG-4 Textual Format
  - Textual format for BIFS
  - Includes some SMIL harmonization

MPEG-4 Systems

- Predictable behavior of a decoder and decoded content:
  - Tight synchronization of A, V, synthetic, graphic elements
  - Buffer management
- Flextime
  - Spring-like timing model (a-la SMIL)
- IP management and protection (IPMP) Interface
  - Standard interface to proprietary DRM Systems
  - MPEG-21 to bring more interoperability in DRM
- File format MP4 (based on QuickTime)

MPEG-4 Systems (cntd.)

- MPEG-J(ava)
  - API for complicated content behavior,
  - API's to network / terminal / UI resources
  - 'Application Engine'
- Audio Rendering
  - Specify downmix from arbitrary number of channels
  - Environmental spatialization
    - modeling of environment for spatial sound reproduction
      - Physical and perceptual model

Profiles & Levels

- Conformance points are “Profiles@Levels”
  - A bit like in MPEG-2
- Profiles determine tool set
  - E.g. B frames, ¼ pel Motion Compensation
- Levels limit complexity
  - E.g. MacroBlocks/sec, Complexity Units in Audio
- Profiles are convergence point for Industry Standards built on MPEG-4
  - vehicle for market decisions and uptake
  - e.g. Internet Streaming Media Alliance

Profile Dimensions:

- Visual (natural, synthetic, natural + synthetic)
- Audio (natural, synthetic, natural + synthetic)
- Graphics

} **Media Profiles**

- Scene Description (Scene Graph)
  - Tools to describe and manipulate scene
- MPEG-J (Main and Personal)
- Object Descriptor (Synch and Buffers)

- MPEG does not prescribe how to combine these
  - That's what other industry fora do

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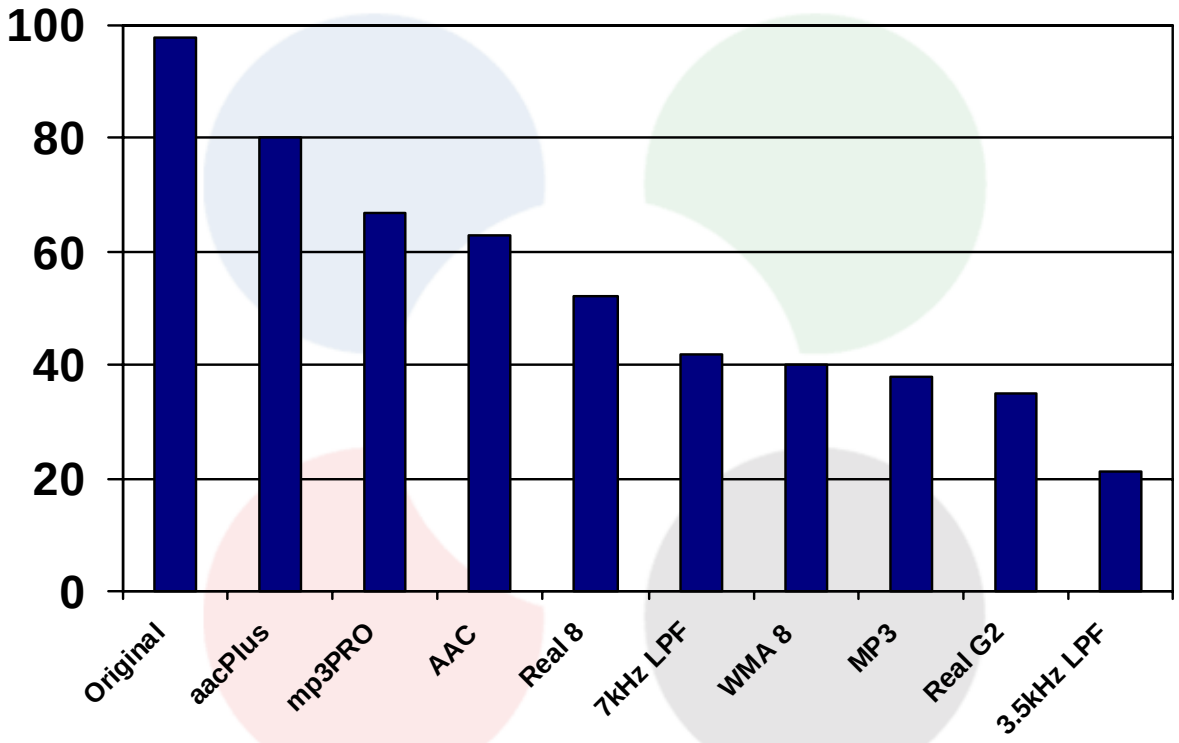
MPEG-4 Advanced Video Coding

- Also standardized as ITU-T H.264
  - Part 10 of MPEG-4 standard
  - Also known as the “JVT codec”
- Built by world’s top video coding experts from ITU and MPEG in Joint Video Team (JVT)
- Best quality/complexity trade-off
  - Better than WM9, according to industry leader LSI Logic
  - Improvements will continue
- Significantly further reduces video bitrates
- Fits into the MPEG-4 framework
  - Will coexist with MPEG-4 part 2 in market

High Efficiency Advanced Audio Coding

- CD quality @ 48kbps; High quality @ 32kbps
  - Achieved through “Spectral Bandwidth Replication”
  - predict upper half of spectrum from lower half
  - Forward and backward compatible with ‘normal’ AAC
- Amendment (addition) to MPEG-4 Audio
- Already operational in XM radio, chosen for Digital Radio Mondiale (“DRM”)
- Tested as best codec by EBU (European Broadcasting Union) over Windows, Real

EBU listening test results for 48Kbps stereo



LPF = Low Pass Filter.
aacPlus is brand name for High Efficiency AAC.
mp3PRO is brand name for MPEG-1 Layer III with Spectral Band Replication
EBU = European Broadcasting Union

Other developments

- Animation Framework eXtension (AFX)
  - Unified framework for interactive animation and graphics
- Work on 3D Video coding is in Requirements phase
- Work on lossless audio coding is entering development phase

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Standards Make Sense. They ...

- ... fuel **innovation** (GSM, WLAN/802.11, ...)
- ... **survive** the test of time (PAL, NTSC, MP3, ...)
- ... prevent expensive **format churn** (VHS, CD, ...)
- ... help markets **mature** (CD, DVD, MPEG-2, ...)
- ... provide an **interoperable ecosystem** of tools and equipment: different providers make what they excel in

- No **vendor lock-in** - avoid channel conflicts
- Market-based **price control** mechanisms
- **Multi-vendor** sourcing of equipment
- No monopolies - no single vendor **controls** the format

MPEG-4 has Clear Benefits

- Code once, use across platforms and players
- Users pick their favorite players, devices
- Content producers pick their favorite tools
- Providers only need to stream in one format
- Competition drives quality up

(R)evolution

- A **revolution** in functionality
  - Designed from the start for interactivity
  - State of the art compression; responsible upgrades
  - Object-based = intrinsic flexibility
  - Profiles, Levels limit complexity, guarantee interoperability
  - Offers synthetic content
  - Local rendering of 2D & 3D graphics and audio
- An **evolution** in infrastructure
  - Allows all types of 'casting': unicast, multicast, broadcast…
  - on all network types, no need for new networks or transports
  - Leverage existing MPEG-2 and other infrastructures

Business Benefits

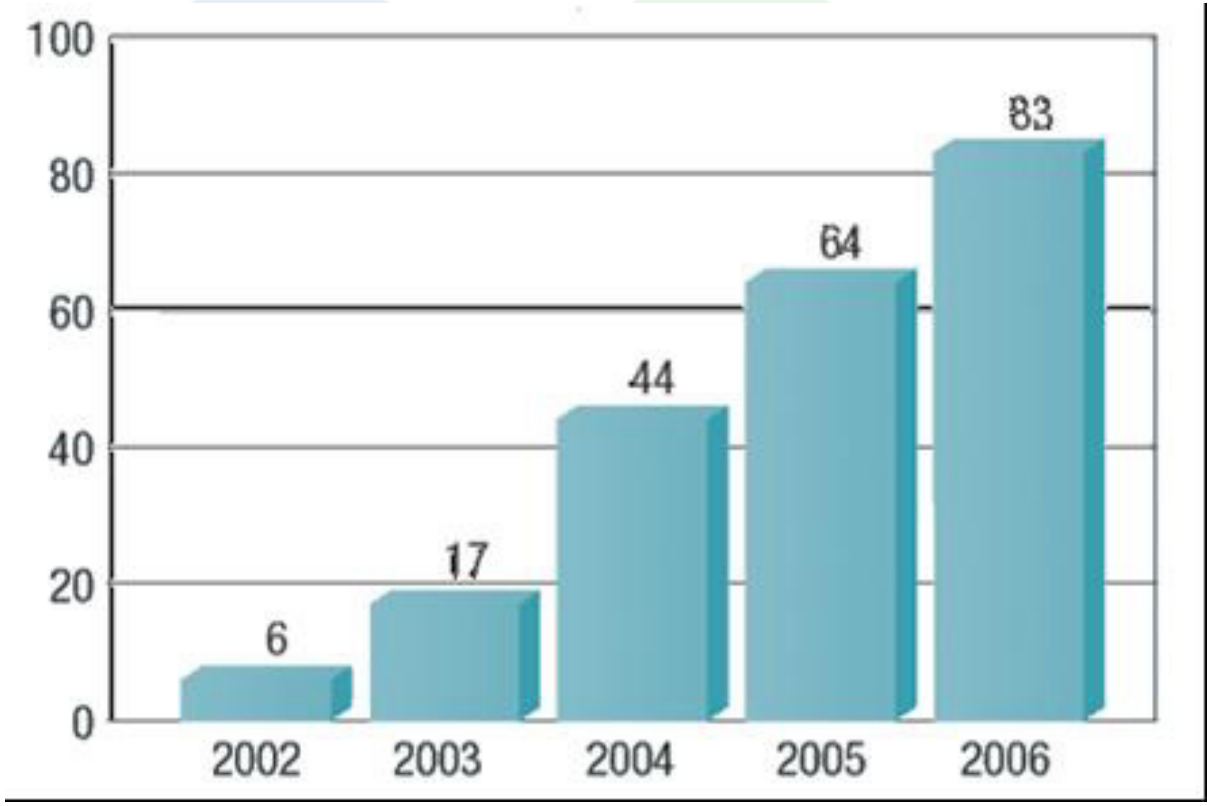
- MPEG-4 **saves** money
  - More efficient use of bandwidth
  - Repurpose existing content
  - No need to duplicate work when adding value to assets
  - Integrate into existing MPEG delivery environments
  - Used on all types of network, including IP
- MPEG-4 **makes** money
  - Use existing content and infrastructure in new ways
  - Add new dimensions to content, including interactivity
  - Low-risk / high-return path for new entrants

Risks of Proprietary Technology

- Third party business and pricing models
- Proprietary, confidential 3rd party technology roadmaps
  - May change without warning
- Potential channel conflicts
  - Supplier also competitor
  - License includes more “bundled features" than required
- Single sourcing problems

Worldwide MPEG-4 Forecast

Shipments in millions of units*



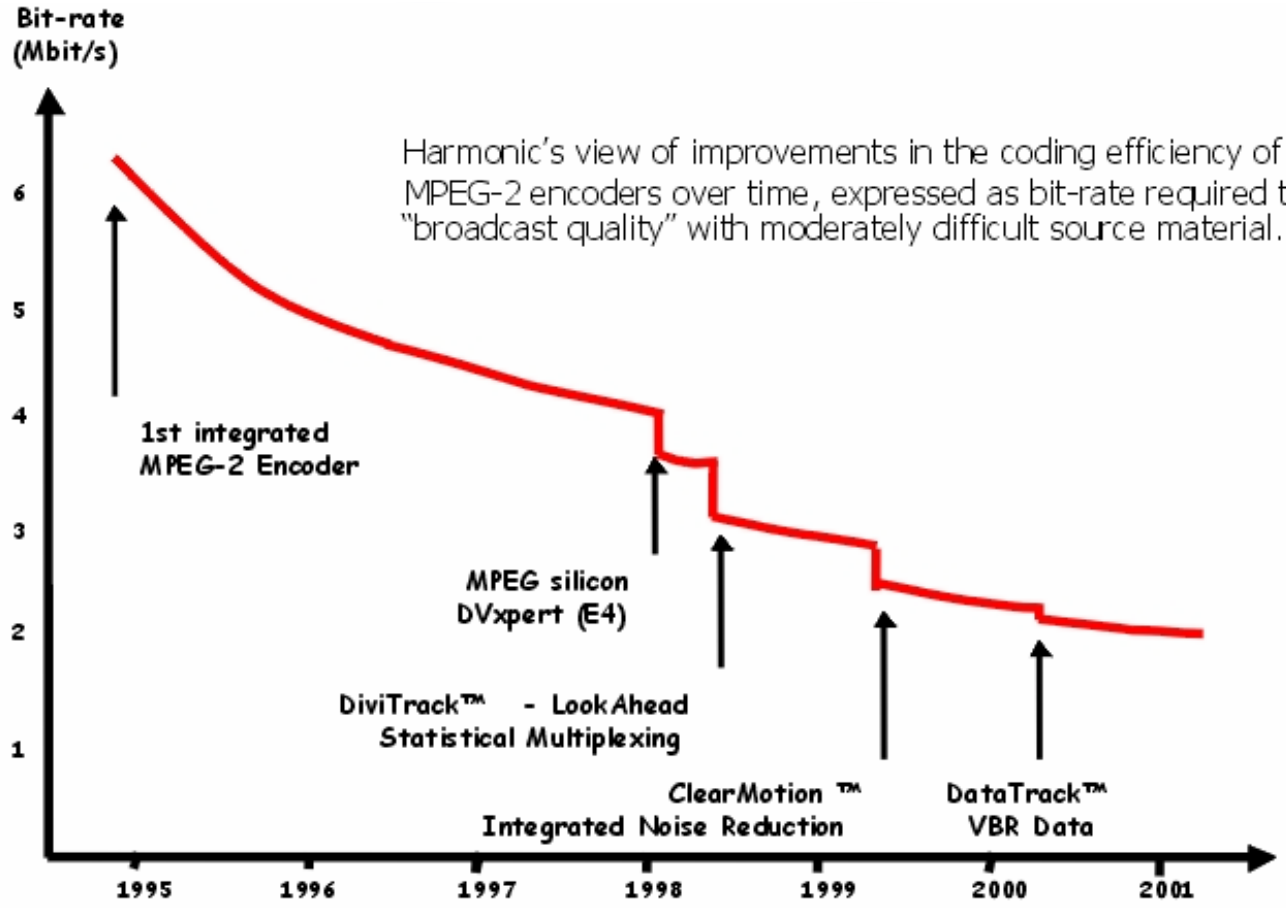
*Includes standalone MPEG-4 chips and cores embedded in processors

Source: ISUPPLI CORP.

Improvement Through Competition

- Proprietary vendors underrate MPEG-4 quality:
  - Comparisons with early, non-optimized codecs
  - 'Industry-standard' video quality does not exist!
- MPEG standardizes the minimum: only **de**coders
  - Competition on **en**coding and post-processing
- MPEG-2 bit-rates have **reduced** by over 50%
  - **after** the standard was frozen in 1996
  - **without** upgrading decoders
- Competition between the 'experts' will:
  - Drive MPEG-4 quality up after deployment of decoders
  - Drive functionality of tools
  - Make AVC beat all proprietary codecs, including WM9

MPEG-2 Coding Efficiency – Harmonic, Inc.'s view



Harmonic's view of improvements in the coding efficiency of their MPEG-2 encoders over time, expressed as bit-rate required to give "broadcast quality" with moderately difficult source material.

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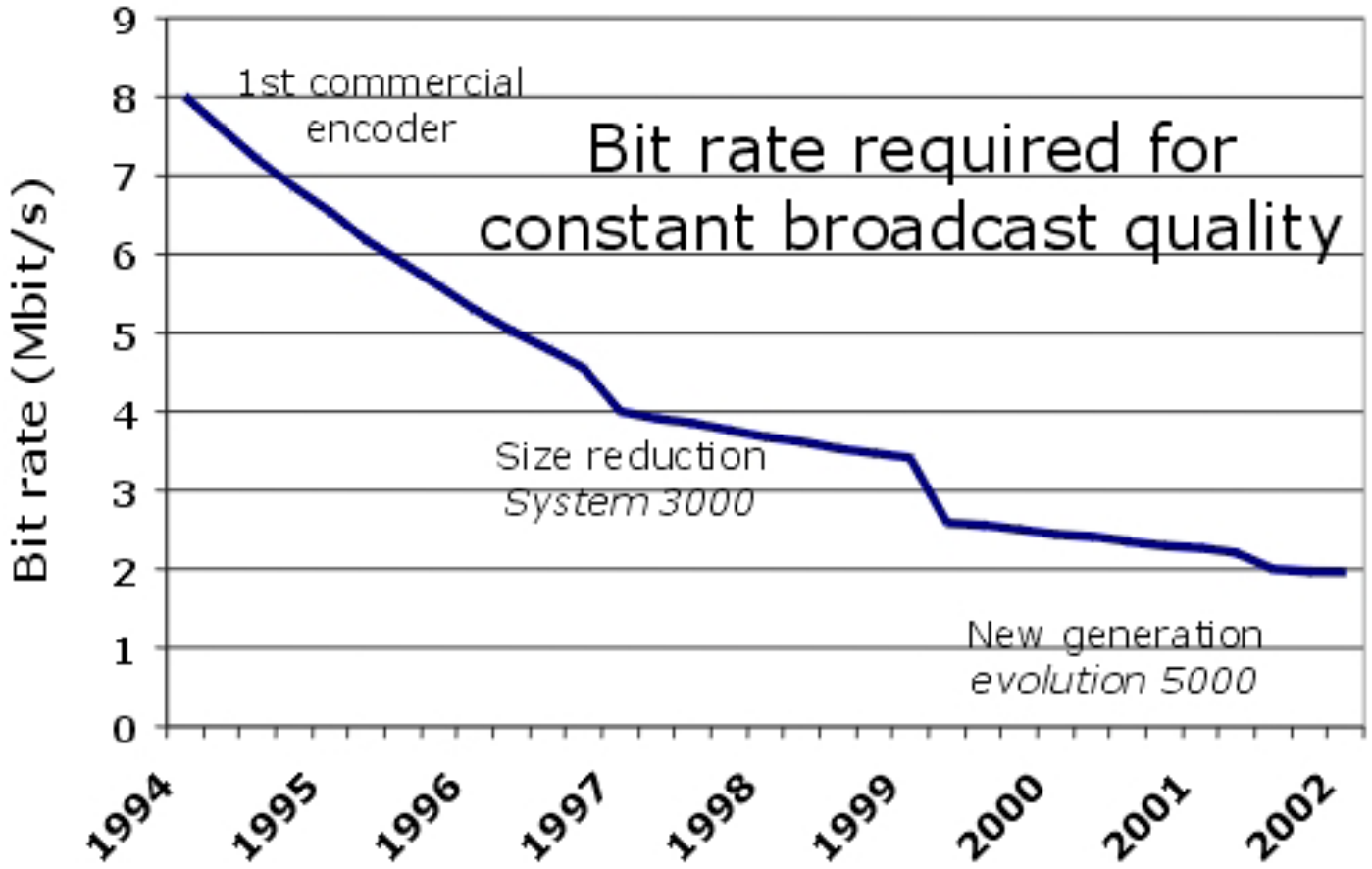
MPEG-2 Coding Efficiency – TandbergTV's view



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Widely adopted and supported

- Industry wide PC media player support
  - QuickTime 6
  - RealOne Player / Helix (Envivio plug-in)
  - DivX: Millions of downloads weekly
  - Windows Media Player: several MPEG-4 plug-ins
- MPEG-4 is part of the standard for 3G and 2.5G mobile phones
  - 3GPP, 3GPP2 adopted MPEG-4 Profiles for video to mobile
  - AAC is the optional audio codec in 3GPP
  - File format is adaptation of MP4
  - QuickTime 6.3 supports 3GPP

Widely adopted and supported

- Recommended by Internet Streaming Media Alliance (ISMA)
  - Vertical spec using horizontal MPEG-4 standard
  - Founded by Sun, Kasenna, IBM, Apple, Cisco, Philips
- MPEG-4 AVC to be adopted by DVB for DVB over IP
- Becoming de-facto standard for security, surveillance
- Supported in emerging Home Media Centers

Recent announcements and releases

- MPEG-4 HD-based video camera (Samsung)
- Solid state video cameras (Panasonic, Divio)
- DVD players that read MP4 (Toshiba, Kiss)
- HDTV Chips (Sigma Designs)
- PDA's (Sony's Clie, Sharp's Zaurus)
- Video 'jukeboxes' (e.Digital, Archos)
- Home entertainment gateways (e. Digital, Equator, Sigma, ...)
- Mobile phones that decode and stream MP4 (Nokia, Motorola)

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About the MPEG-4 Industry Forum

History

- First Meetings 1999
  - What do we need to do to get MPEG-4 adopted?
- Officially Established June 2000
  - Not-for-Profit Organization in Switzerland
- Now approximately 100 members
  - Worldwide
  - Across Industries – IT, Telecoms, CE, Academia, content and service providers

Membership includes

- AMD, Agfa Monotype, AOL Time Warner, Apple Computer, Canon, Cisco, DivXNetworks, Dolby, Envivio, Fraunhofer, Fujitsu, Fuji-Xerox PAL, Harmonic, Hitachi, IBM, Intel, InterTrust, iVAST, Matsushita, Microsoft, Mitsubishi, Motorola/GI, MPEG LA, NEC, NTT, Nokia, Oki, PacketVideo, Philips, RealNetworks, Scientific-Atlanta, Siemens, Sony, STMicroelectronics, Sun, TandbergTV, TDK, Tektronix, Thomson, Toshiba, Xilinx and many others (~100 members)

Goal

- Getting MPEG-4 widely adopted
- Doing the things that MPEG does not and can not address
  - Bootstrapping licensing
  - Product interoperability
  - Compliance Program
  - Education, Information Clearinghouse
  - Marketing, Exhibitions

Membership

- 3,000 US$ per year for full membership
  - Access to meetings, documents,
  - Interop Program
  - Speaking opportunities and co-exhibiting with M4IF
- 300 US$ for associate membership
  - Same rights, except voting rights

Licensing – the Responsibilities

- MPEG Standardizes
  - And collects Patent Statements
  - But as a rule does not discuss licensing terms
- M4IF initiates, discusses, encourages, suggests, catalyzes, bootstraps
  - But never licenses, determines, decides, …
  - And does not recommend specific licensing terms (although it may suggest alternative approaches)
- Licensors determine, decide, sell licenses
  - In discussions with the market
  - Usually in patent pools (joint licensing schemes)

Thank you

Further information:

www.m4if.org (website M4IF)

mpeg.tilab.com (website MPEG)

www.apple.com/mpeg4 (Apple's MPEG-4 Pages)