



HISTORY OF PERSONAL MEDIA TERMINALS: From Walkman to Apple Watch

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They say

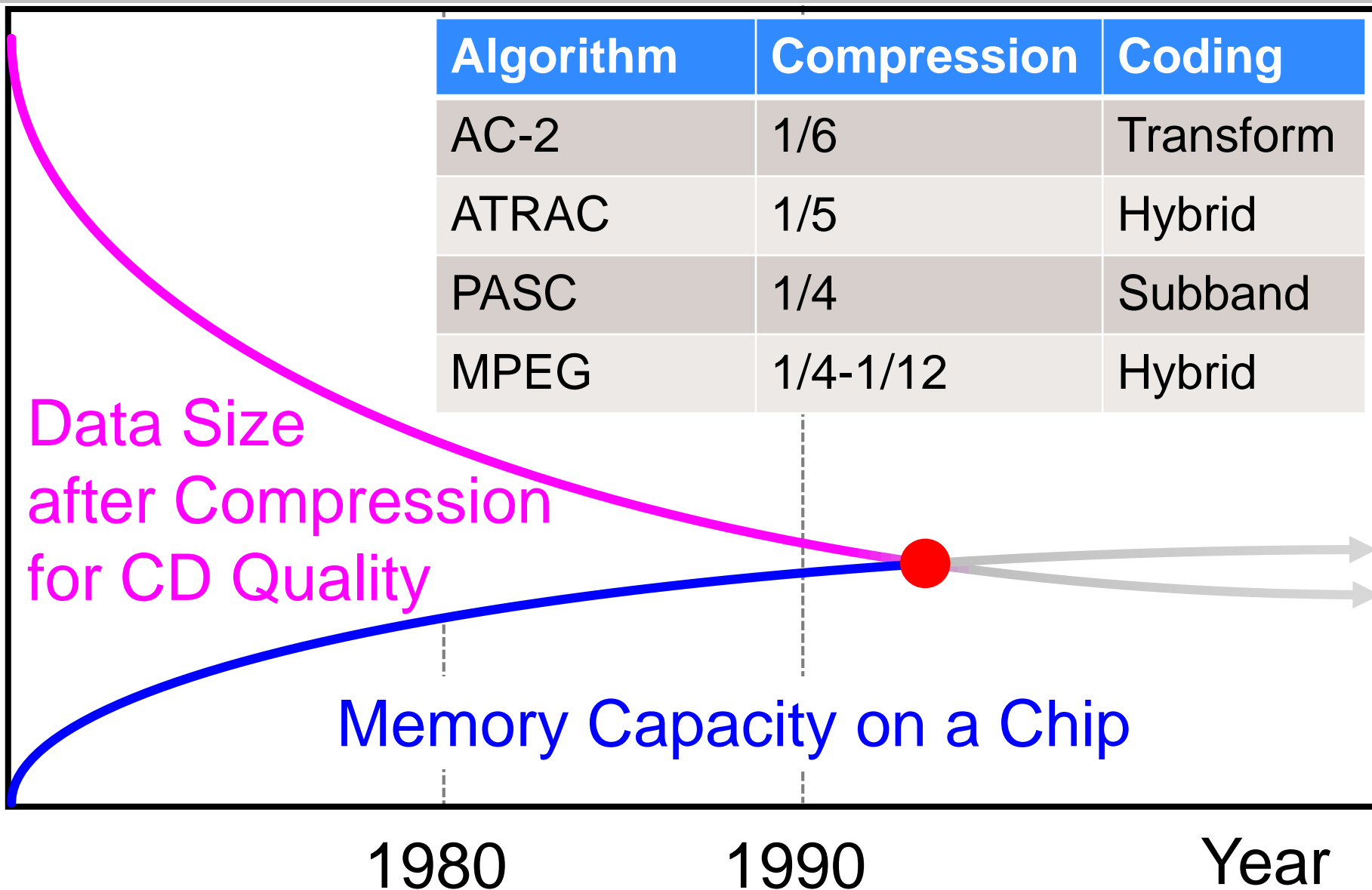
The fool learn from experience

The wise learn from history

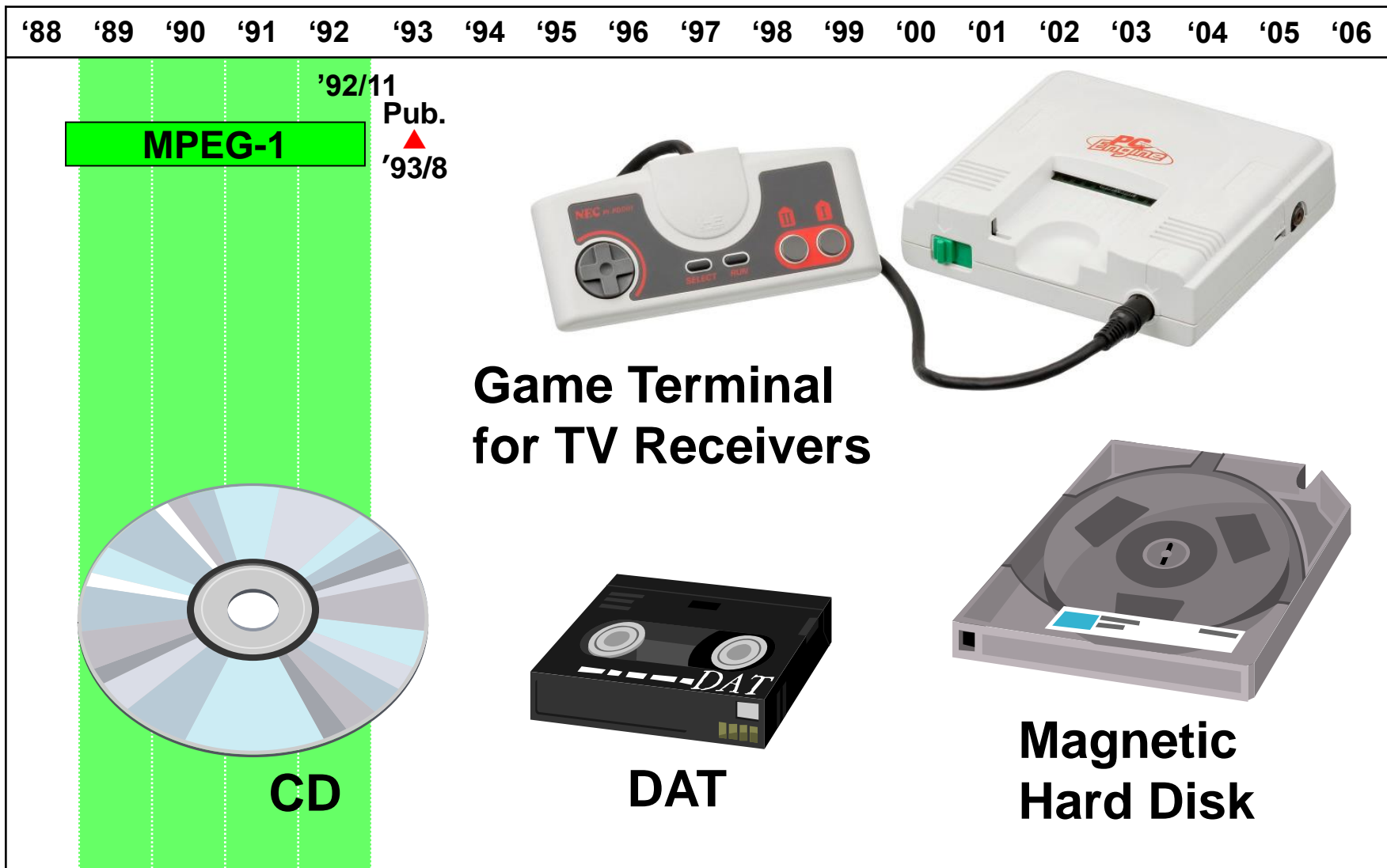
愚者は経験に学び

賢者は歴史に学ぶ

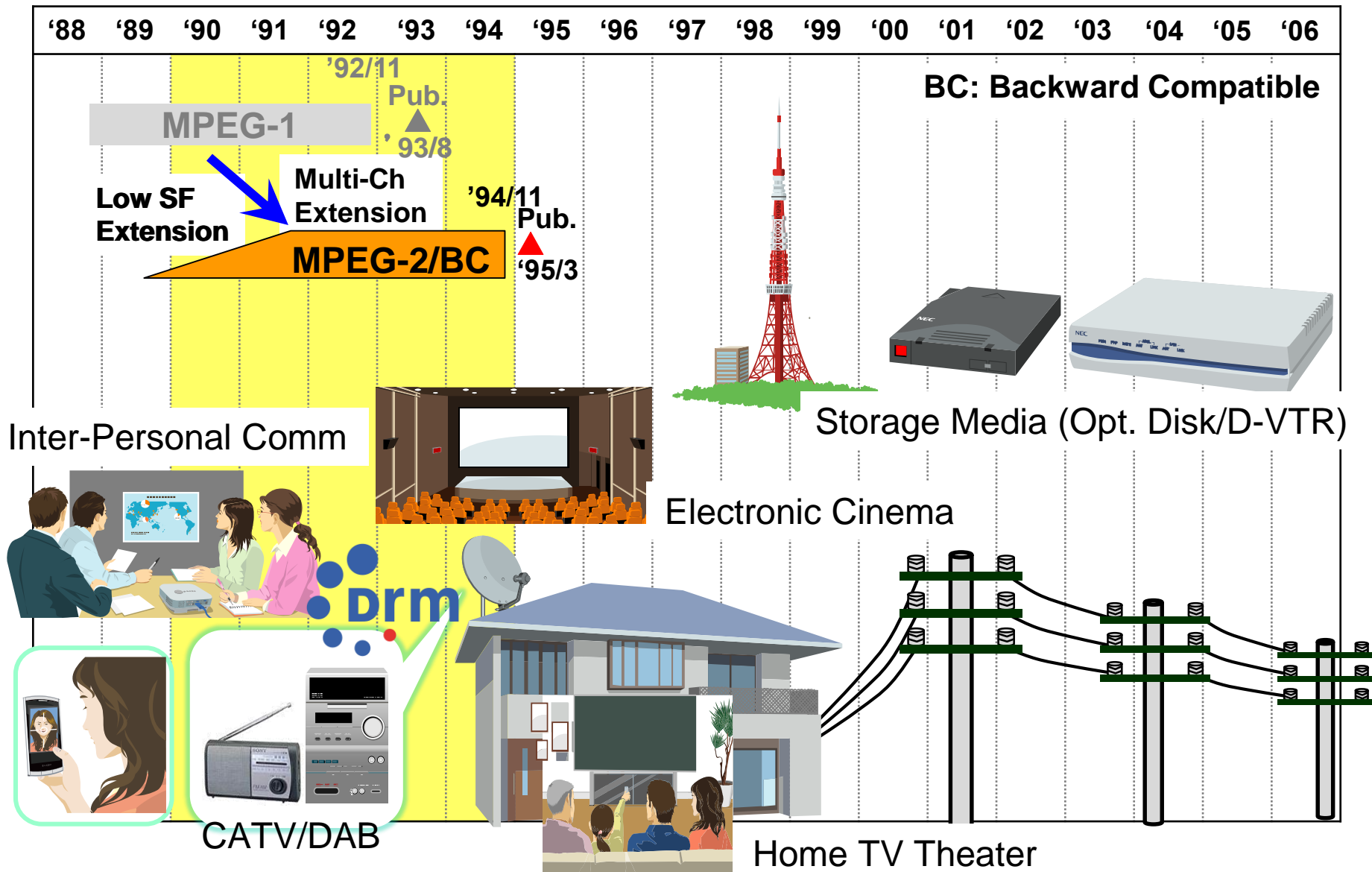
Chip Capacity vs. Data Size after Compression



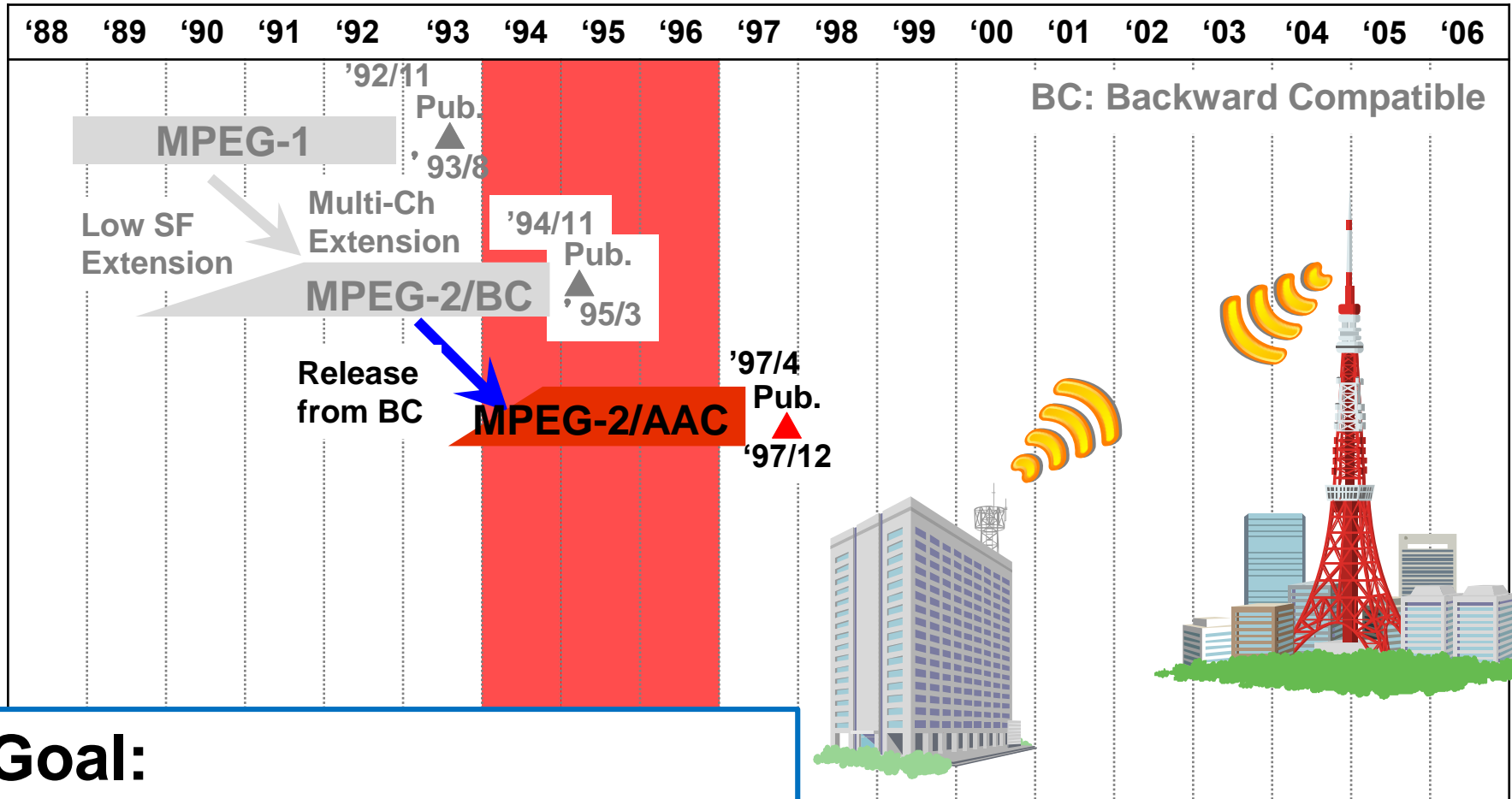
MPEG-1: for Storage Media



MPEG-2: More Applications



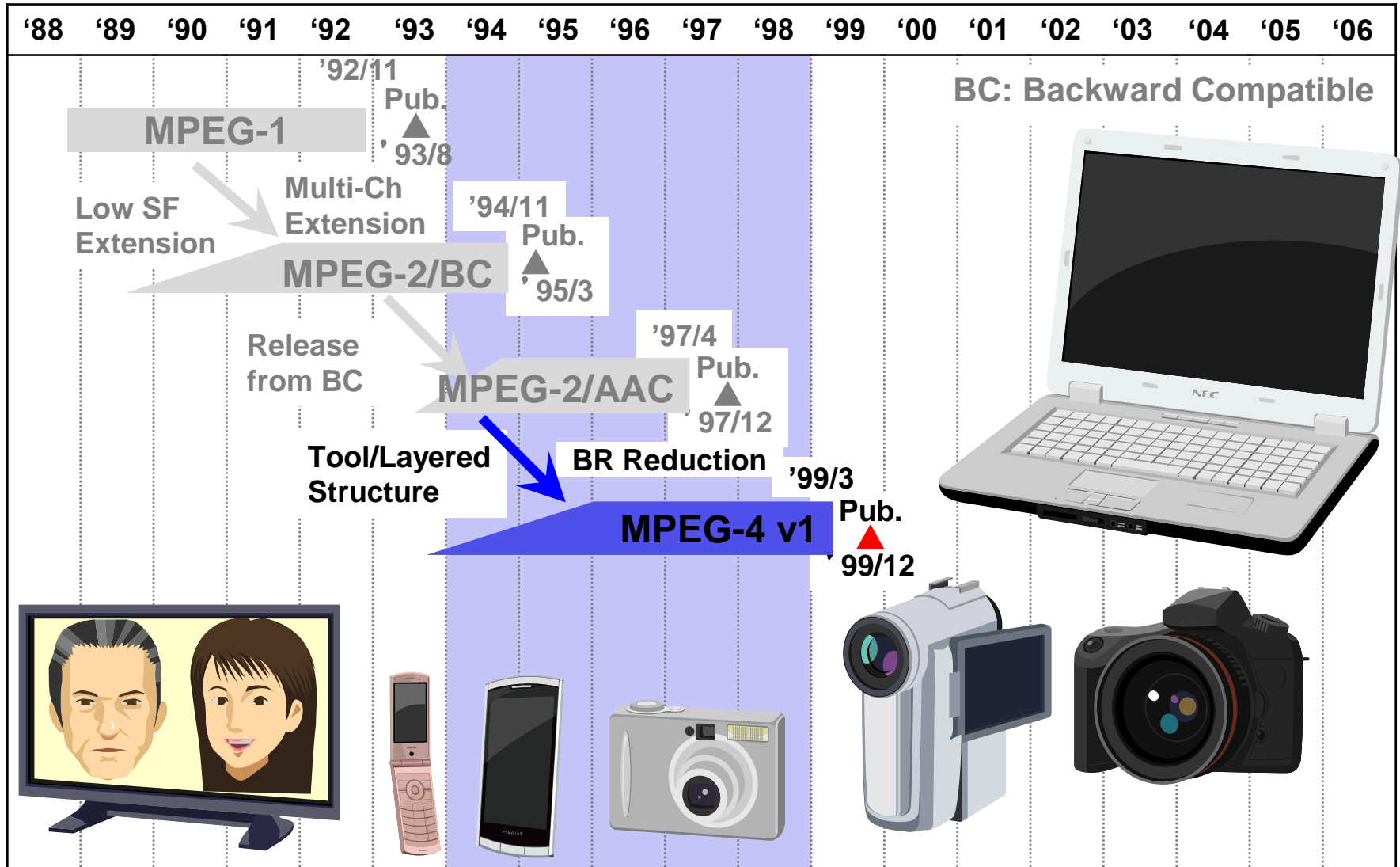
MPEG-2/AAC: Transparent@Mch



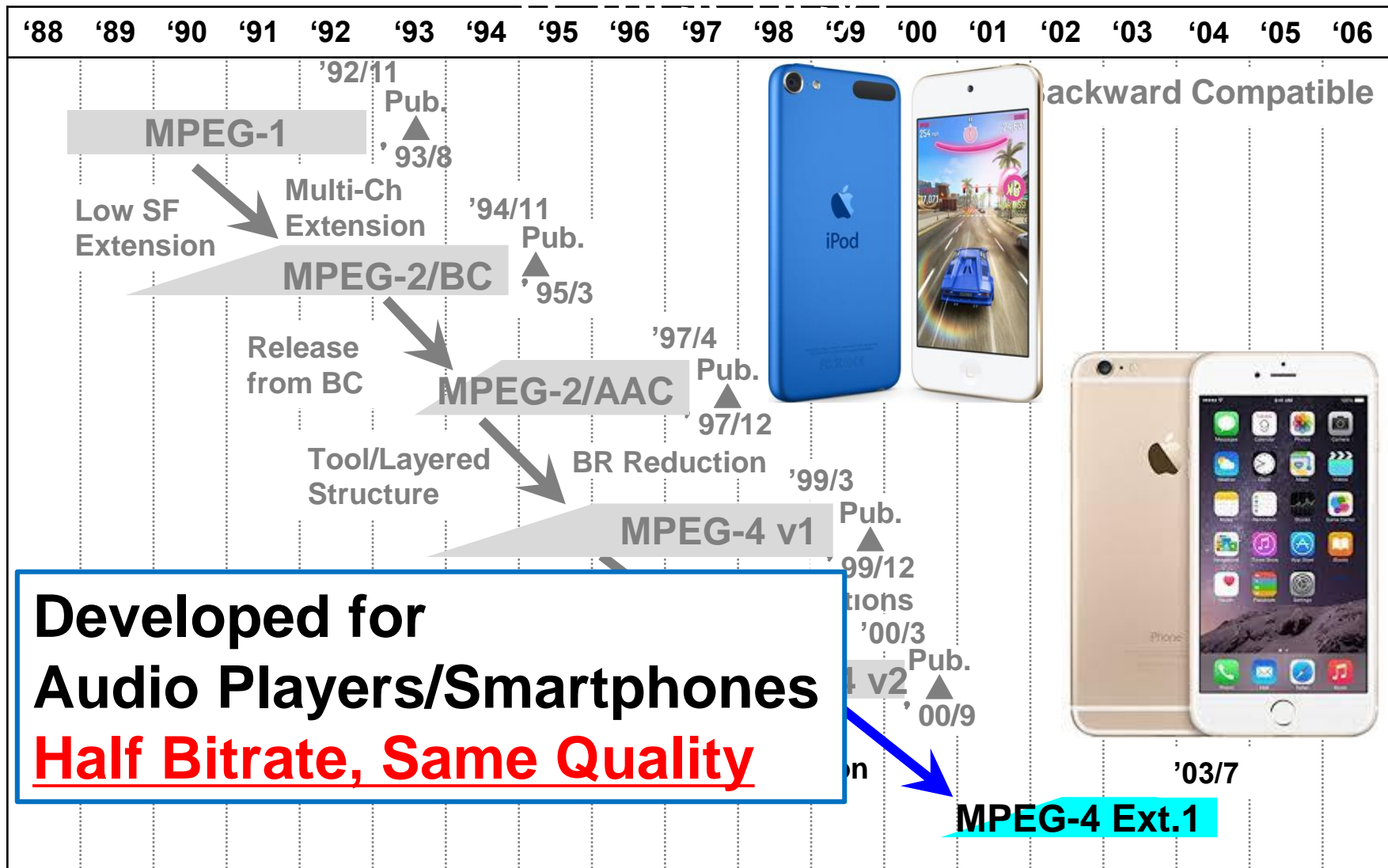
Goal:
Transparent @ 320 kbit/s/5-ch
Indistinguishable from Source

**Media Contents Distribution
Between Broadcasting Stations**

MPEG-4: Versatile Coding for Mobile Apps



MPEG-4 HE-AAC: BW Extension



Birth of MPEG Audio Standards

MPEG-1 Finalists (June 1990)

Best Subj. Score

ASPEC (AT&T, DTB, FhG, CNET)

ATAC (Fujitsu, JVC, NEC, Sony)

Best Obj. Score

MUSICAM (IRT, Philips, CCETT, Matsushita)

SB-ADPCM (NTT, BTRL)

Layer I/Layer II---SB Coding, Psycho.Acoust. Model 1,
Intensity Stereo

Layer III---Hybrid (SB+Transform) Coding (MDCT+BS),
a.k.a MP3 Psycho.Acoust. Model 2, Intensity+MS Stereo

MPEG-2 AAC

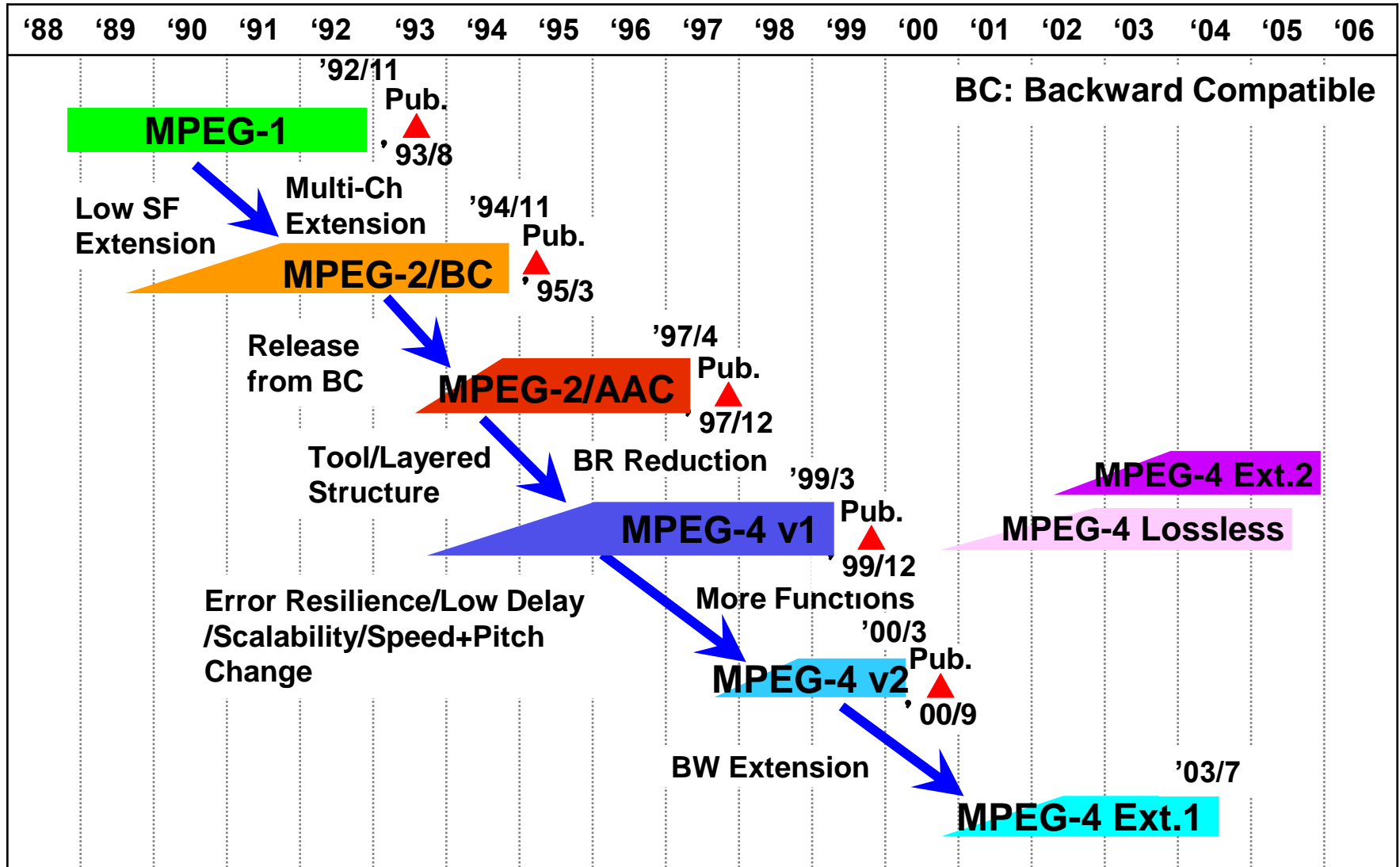
MPEG-4 AAC (+LTP)

MPEG-4 HE-AAC (+HQ-SBR/LP-SBR)

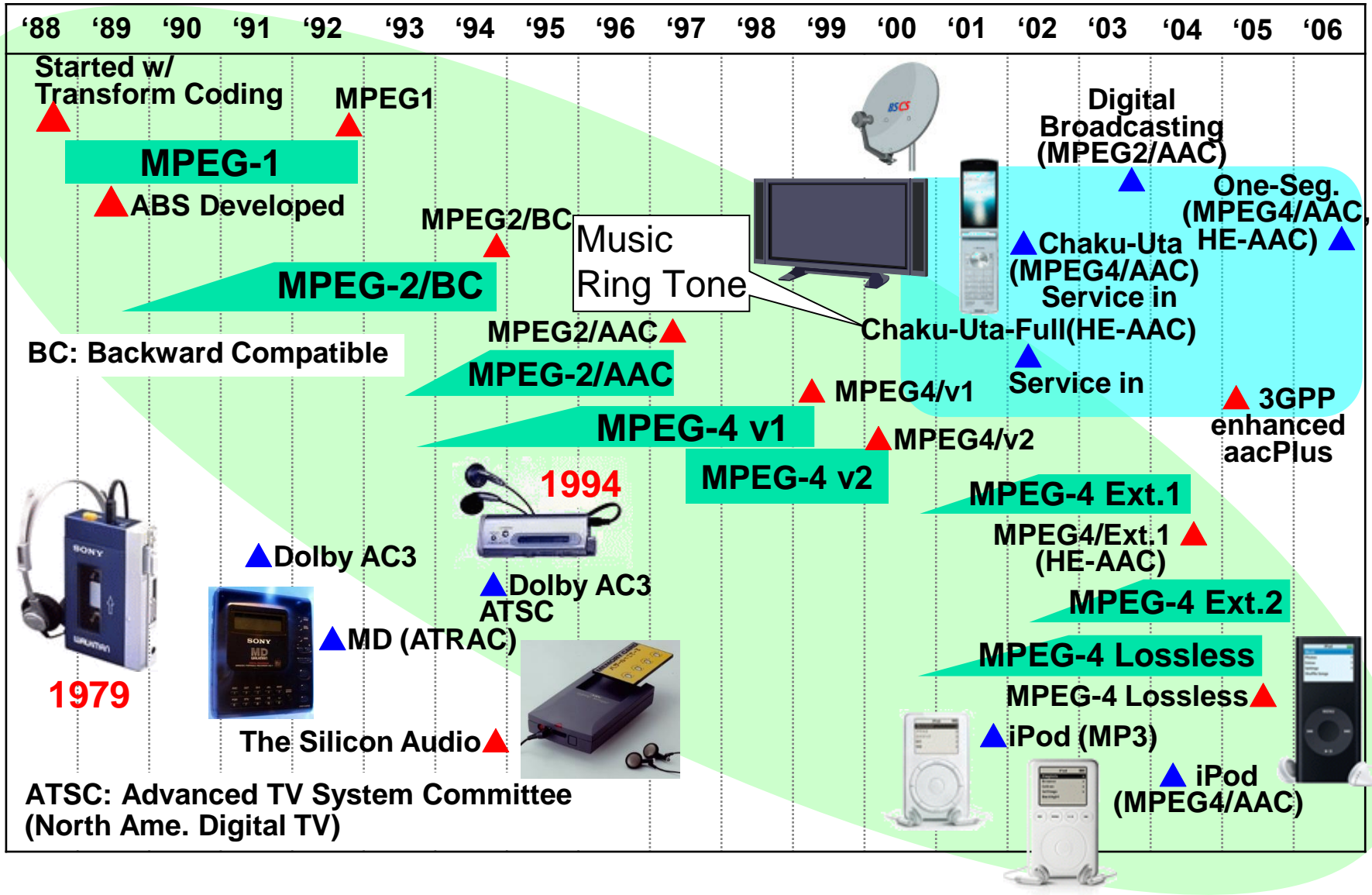
MPEG-4 HE-AAC v2 (+Param. Stereo)

MPEG Surround; MPS (AAC+Panning Param.)

Evolution of MPEG Audio Standards



Applications of MPEG Audio



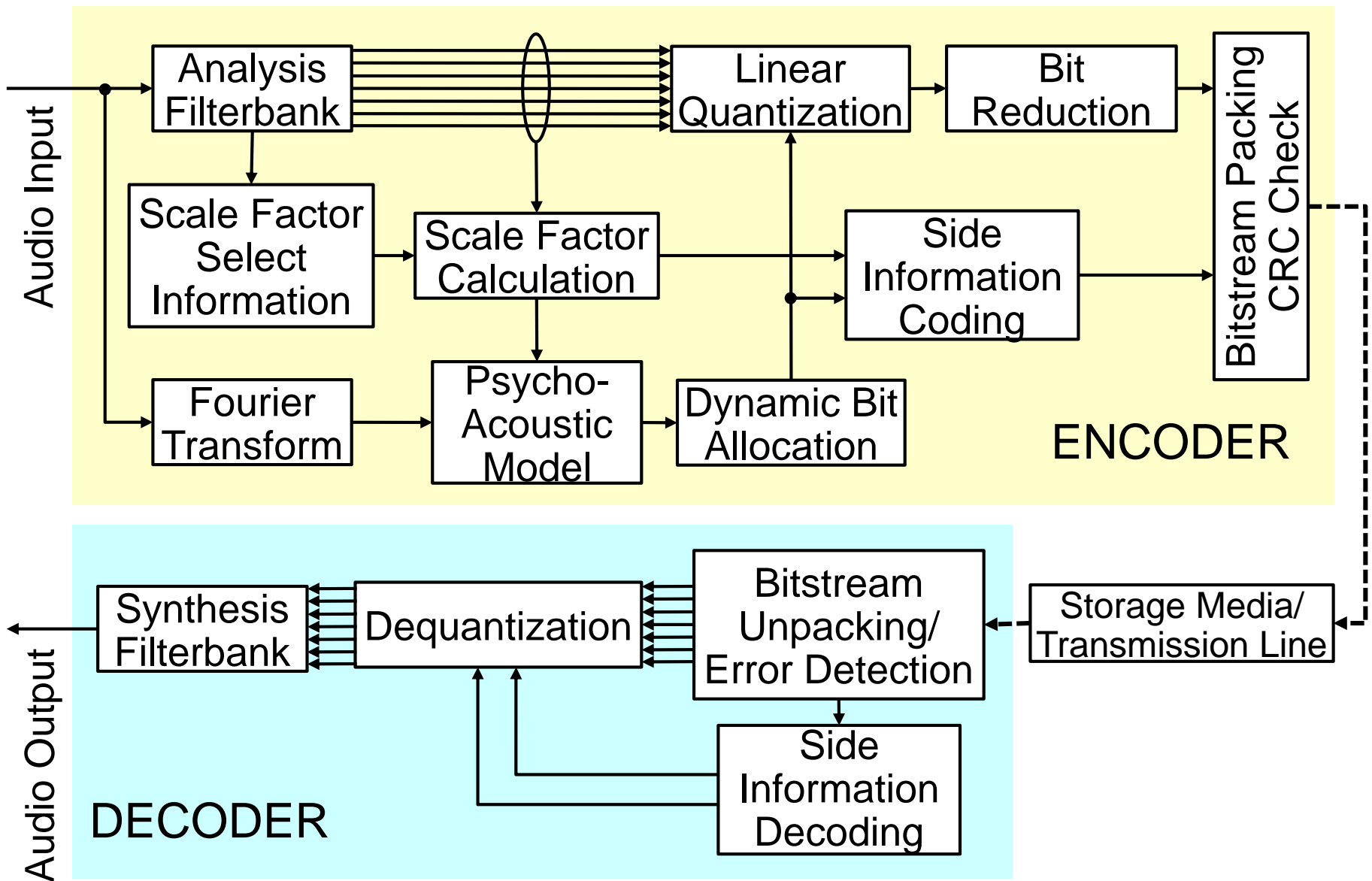
Conventional Audio Players (- 1990)

- Sony: Walkman release (**1979**), personal entertain't
Analog sig proc/recording, suffer from noise
- CD Players (all-digital, **early 1980s**)
20 kHz bandwidth + random access.
Mech mov't causes skips by shakes and vibrations
- DAT in **late 1980s**, lack of random-access capability
(still magnetic tape as storage)
Rewind/Fast-fwd to skip contents
- ◆ Drawbacks: weight, size, power, reliability

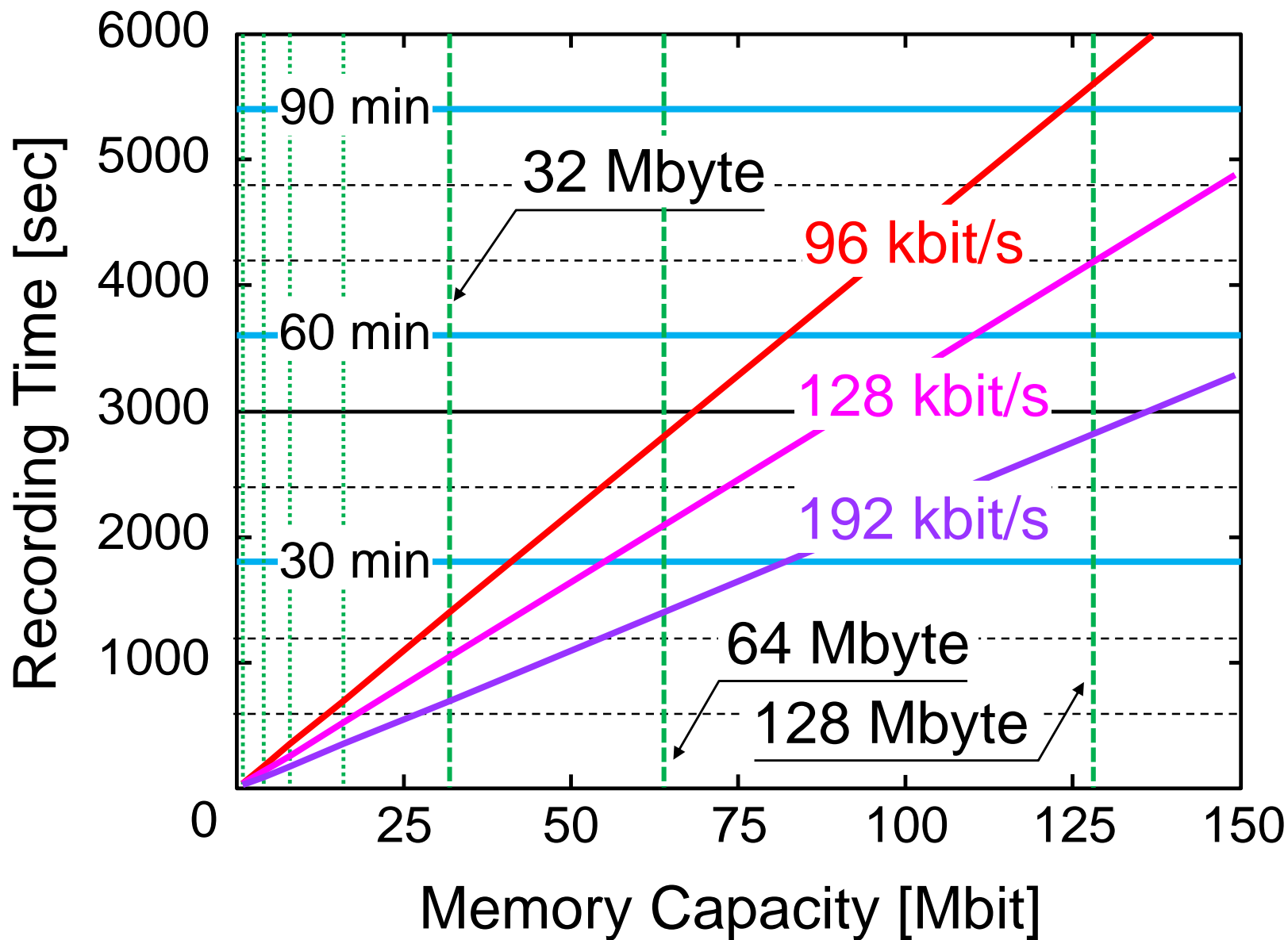
Audio player with semiconductor memory :
potential to solve all these problems.

Silicon Audio

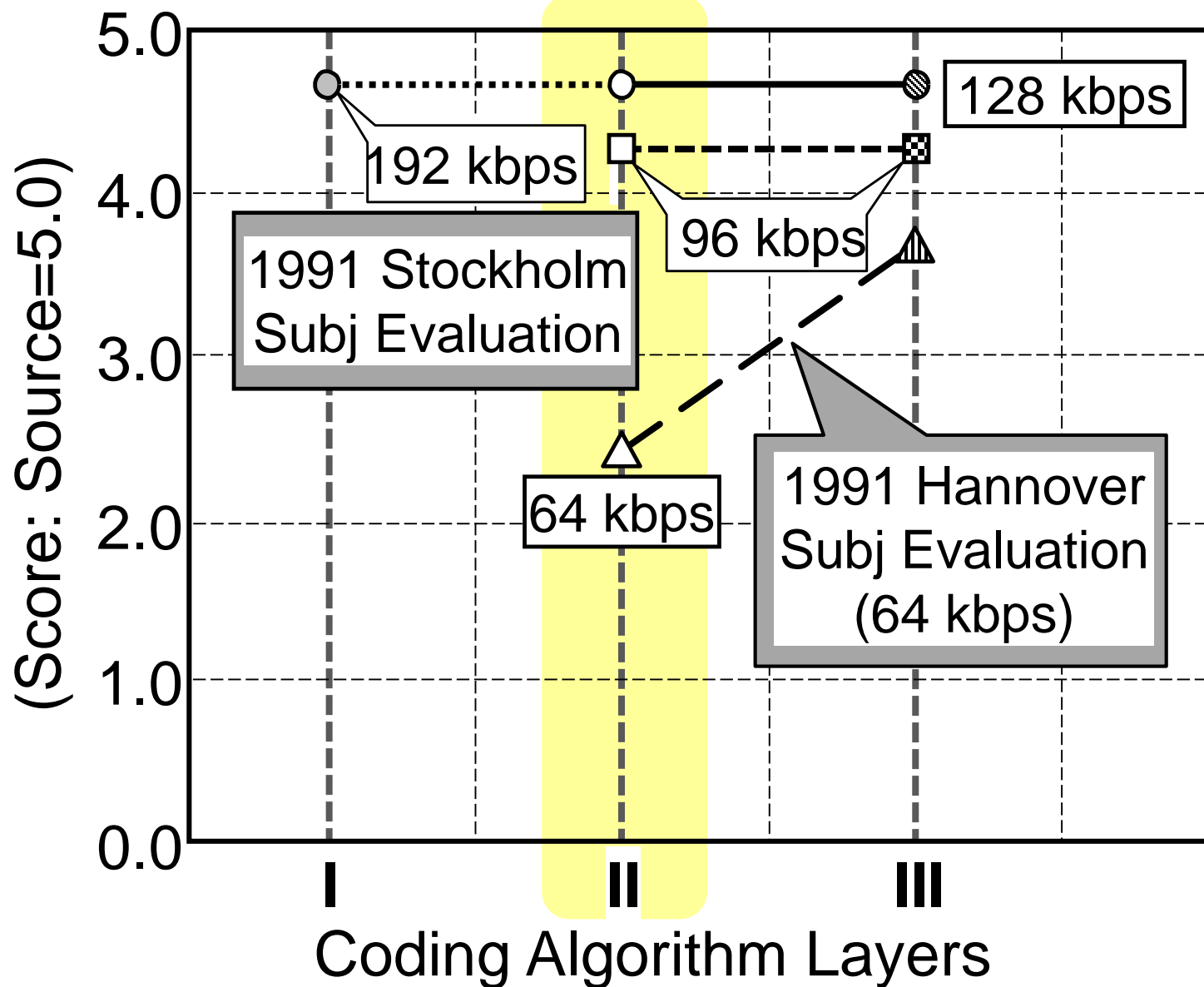
Encoding/Decoding Process, MPEG-1, LII



Memory Capacity vs. Recording Time



Subjective Evaluat'n Results, MPEG-1 Audio



Three Generations of the Silicon Audio



Early 1994

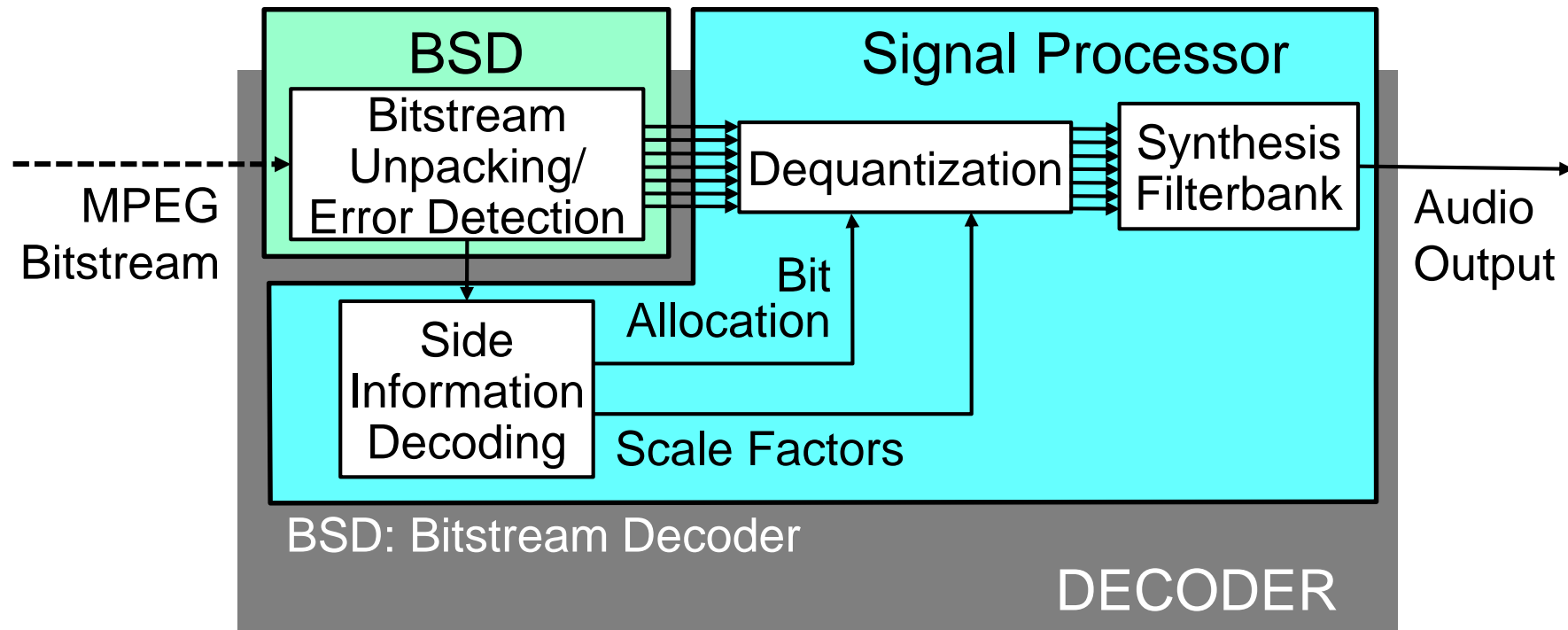
Late 1994

1997

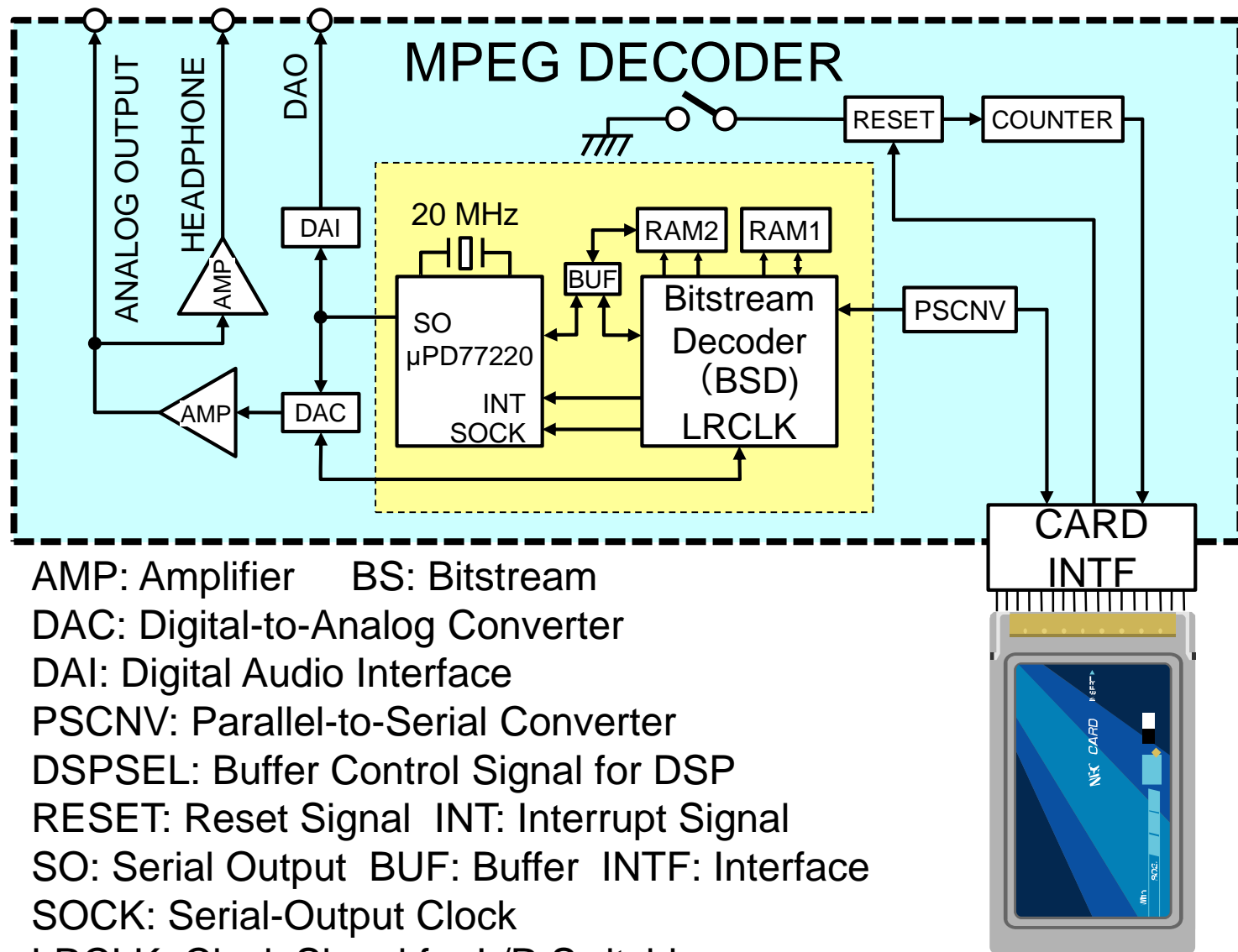
The Silicon Audio and Its Promising Apps



Task Distribution between BSD and Sig Proc

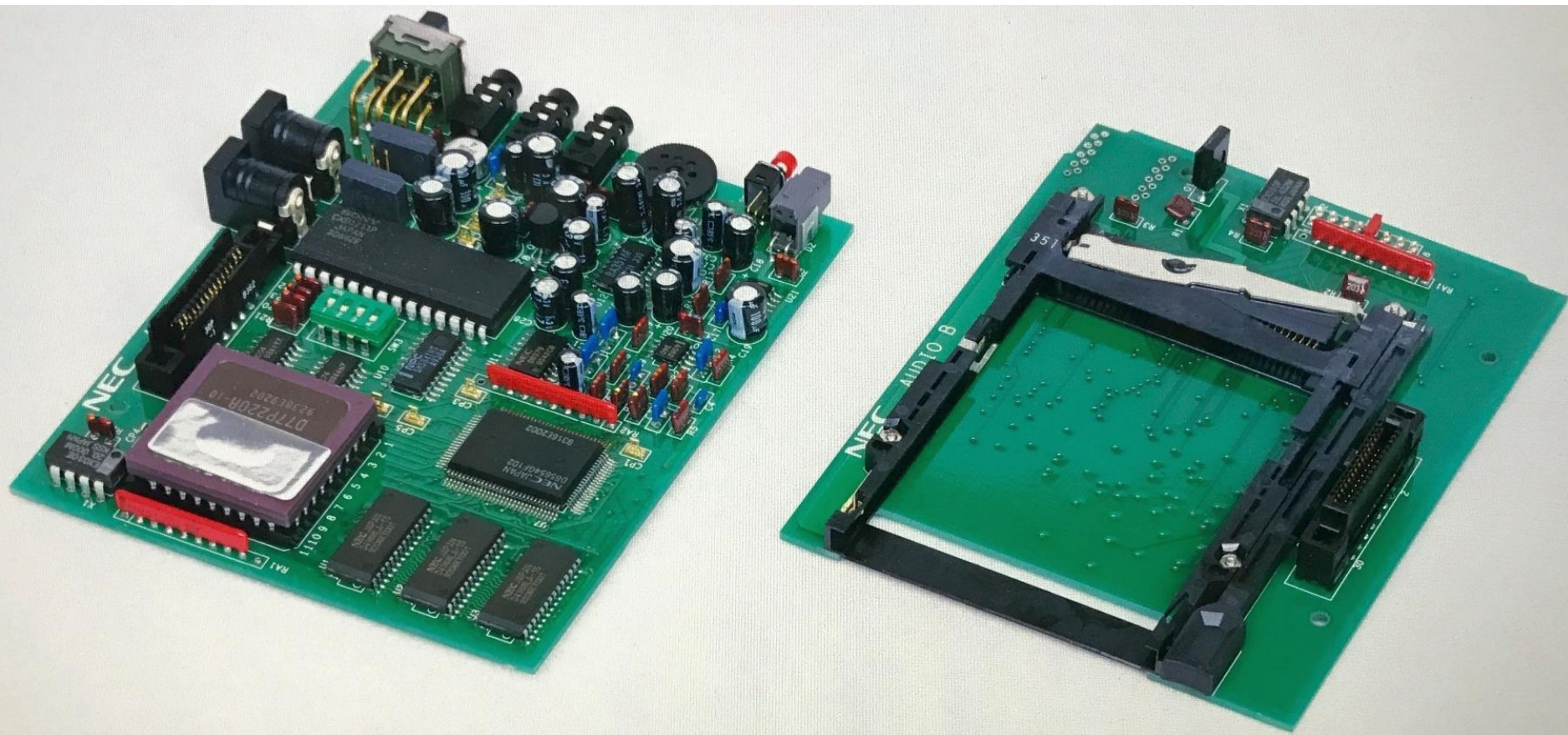


Block Diagram of the Silicon Audio (1st Gen)



AMP: Amplifier BS: Bitstream
 DAC: Digital-to-Analog Converter
 DAI: Digital Audio Interface
 PSCNV: Parallel-to-Serial Converter
 DSPSEL: Buffer Control Signal for DSP
 RESET: Reset Signal INT: Interrupt Signal
 SO: Serial Output BUF: Buffer INTF: Interface
 SOCK: Serial-Output Clock
 LRCLK: Clock Signal for L/R Switching

PCB of the Silicon Audio Decoder, 1st Gen



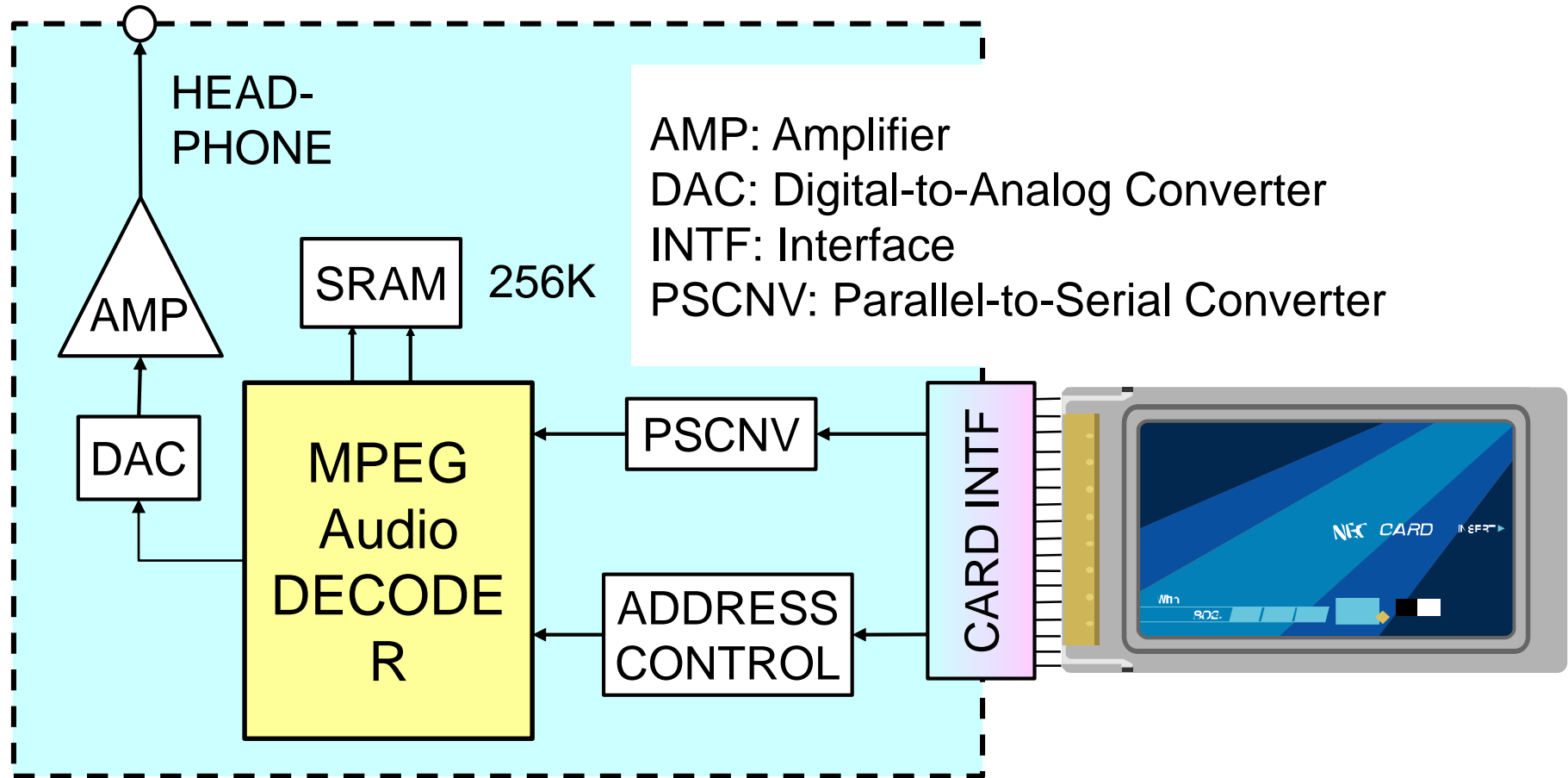
Top View

Bottom View

Specifications of Silicon Audio Player, 1G

Algorithm	MPEG/Audio Layer II
Bitrate	96 kbps/ch
Realization	1 DSP+G/A, 24-bit FixPt
Dimension	127 x 98 x 33 mm
Recording Time	12 min/16 Mbyte

Block Diagram of the Silicon Audio (2nd Gen)



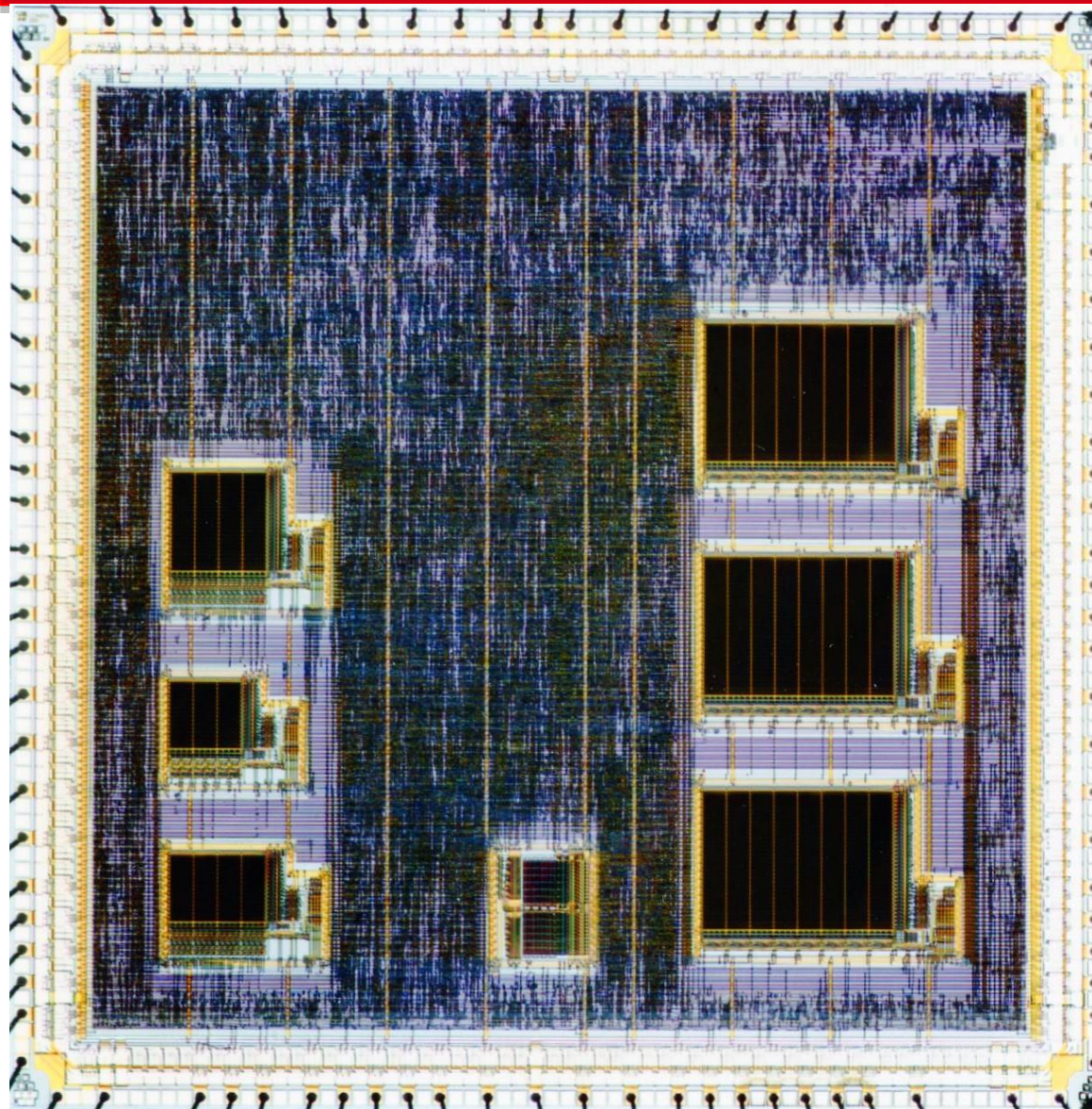
Specifications of Silicon Audio Player, 2G

Algorithm	MPEG/Audio Layer I/II
Bitrate	All except free format 96 kbps/ch recommended
Realization	uPD60312+Peripherals
Dimension	131 x 78 x 22 mm
Recording Time	24 min/32 Mbyte

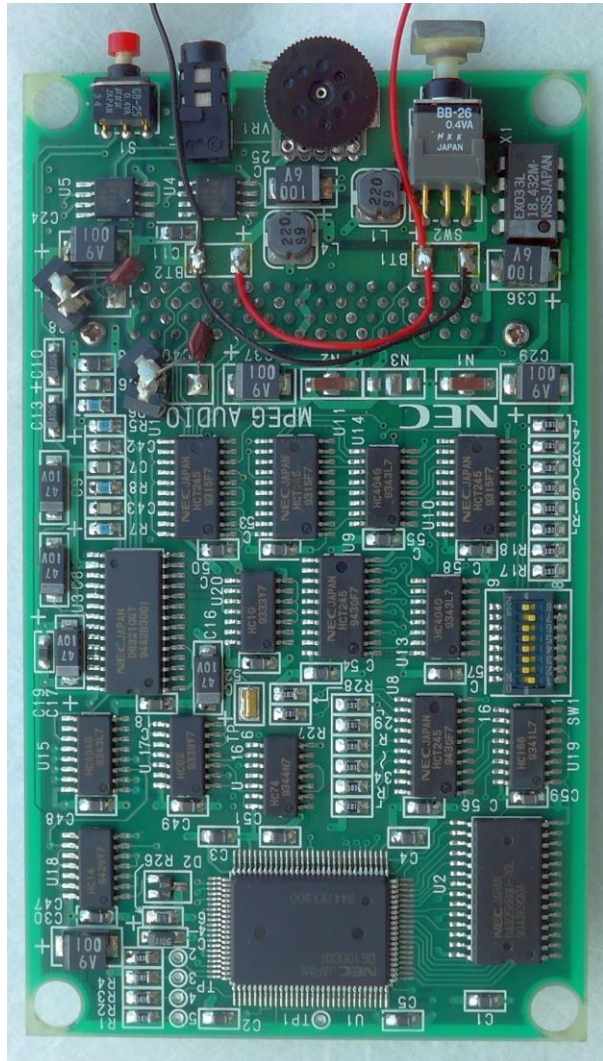
Features of the Decoder LSI

Algorithm	MPEG-1/Audio Layer I/II MPEG-2/Audio LSF Layer /II
Bitrate	All bitrate except free format
Sampling Frequency	16, 22.05, 24, 32, 44.1, 48 kHz
Mode	Stereo, Dual-Ch, Joint St, Mono
Input Bitstream	Serial/Parallel Selective
Max Operating Freq	24.576 MHz
Package	100-pin QFP
Power Supply	5 V
Power Consumption	350 mW

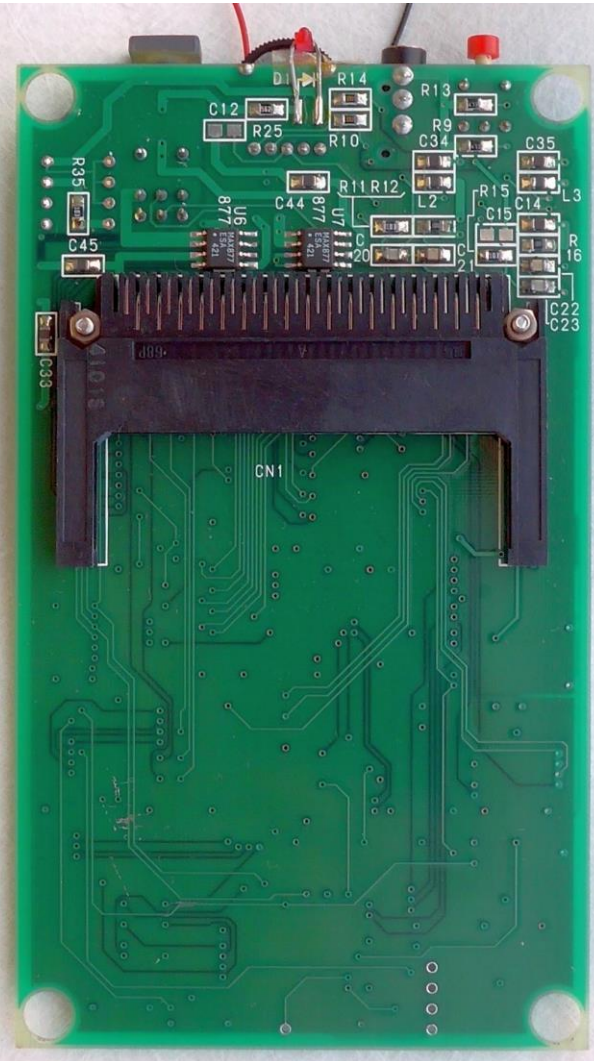
Photomicrograph of Decoder Chip μ PD60312



PCB of the Silicon Audio Decoder, 2nd Gen



Top View



Bottom View

Challenges Toward Successful Product

1. Memory price: \$30 @ 1Mb EEPROM,
\$0.625 @ ROM

Continuous price decline + MP3

Saehan Information Systems, Diamond Multimedia, DigitalCast (Rio), ReignCom (iRiver), Creative (late 1990s), Sony, Aiwa, Toshiba, Matsushita (Panasonic), Sanyo followed

2. Copyright protection

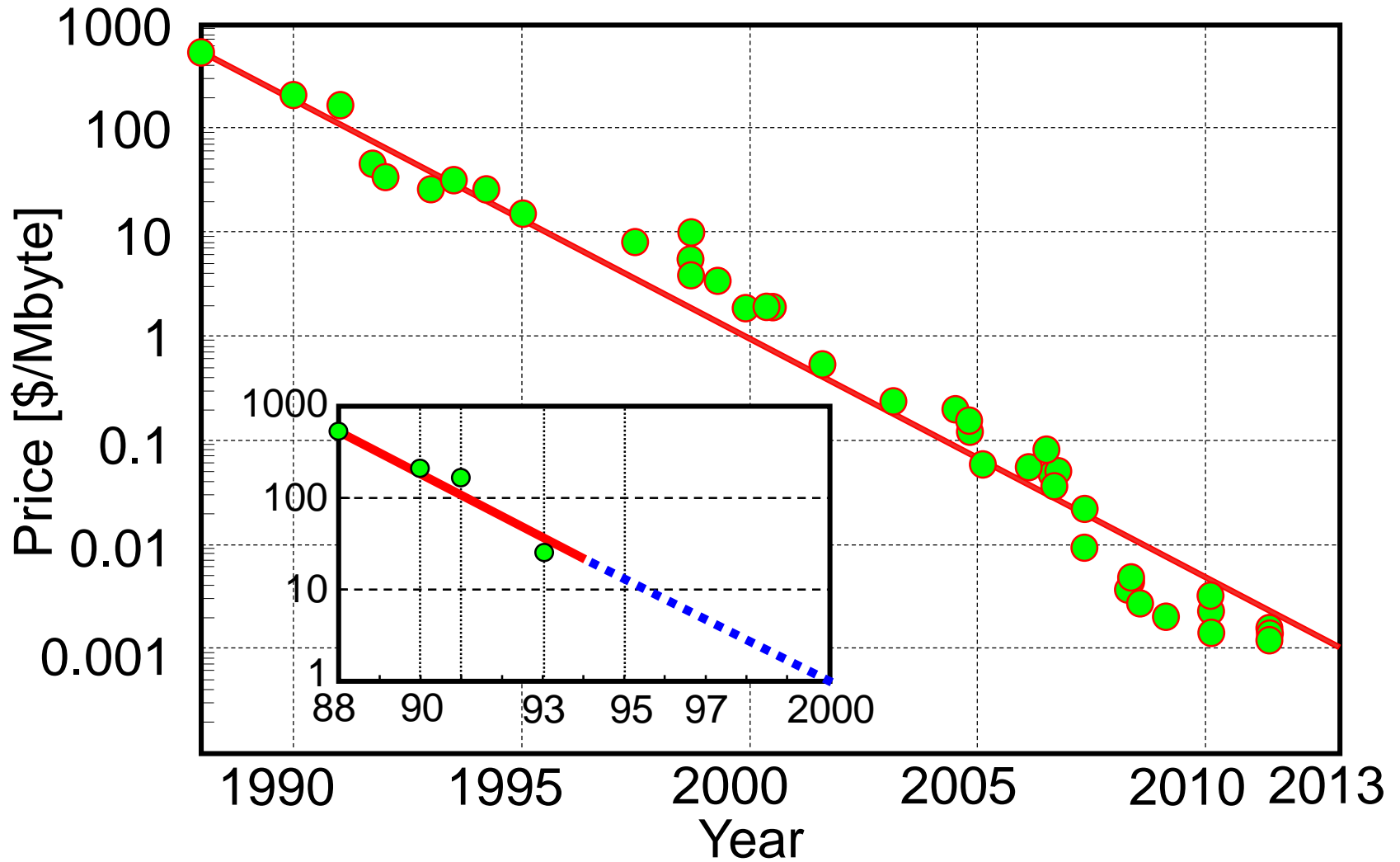
Hard to negotiate w/ many providers on common DRM

In-house competition (Sony, JVC)

Apple tried one-on-one, first to succeed, one-stop shopping (iTunes Music Store)

3. Contents distribution

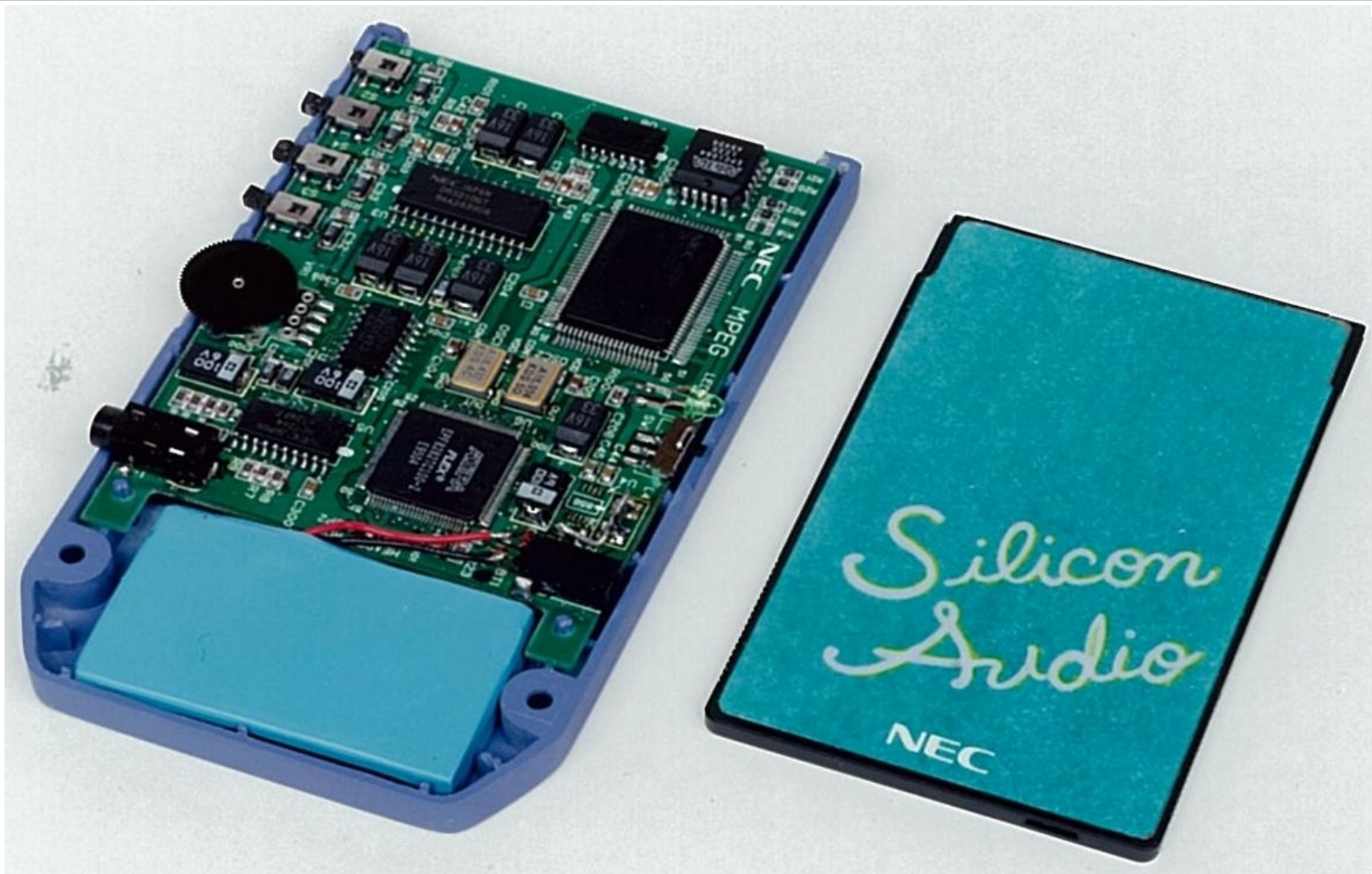
Memory Price in 1990s and 2000s



July 17th, 1995 Issue of Time



Silicon Audio, the 3rd Generation



Silicon Audio: A See-Through Model



AudioKey MP3 Player by Packard Bell, 2005

Packard Bell

AudioKey 256MB

*With you wherever you go!**

- MP3/WMA Player
Voice Recorder
- Lecteur MP3/WMA
Dictaphone
- 256MB
- 16 colours Backlight
Rétroéclairage
16 couleurs
- Data transfer
Transfert de données
- USB 2.0

• Partout avec vous !

www.packardbell.com

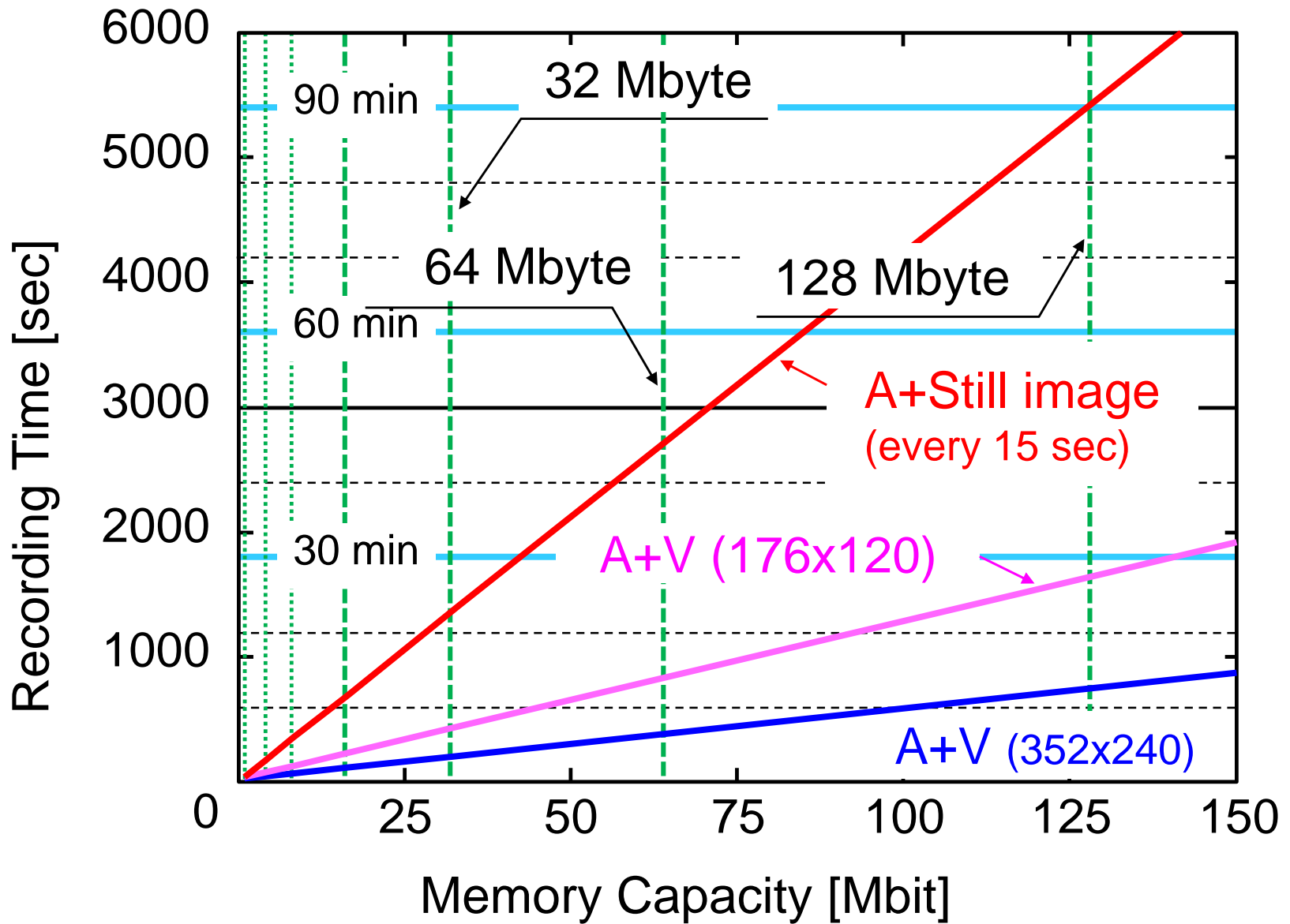


Released in 2003

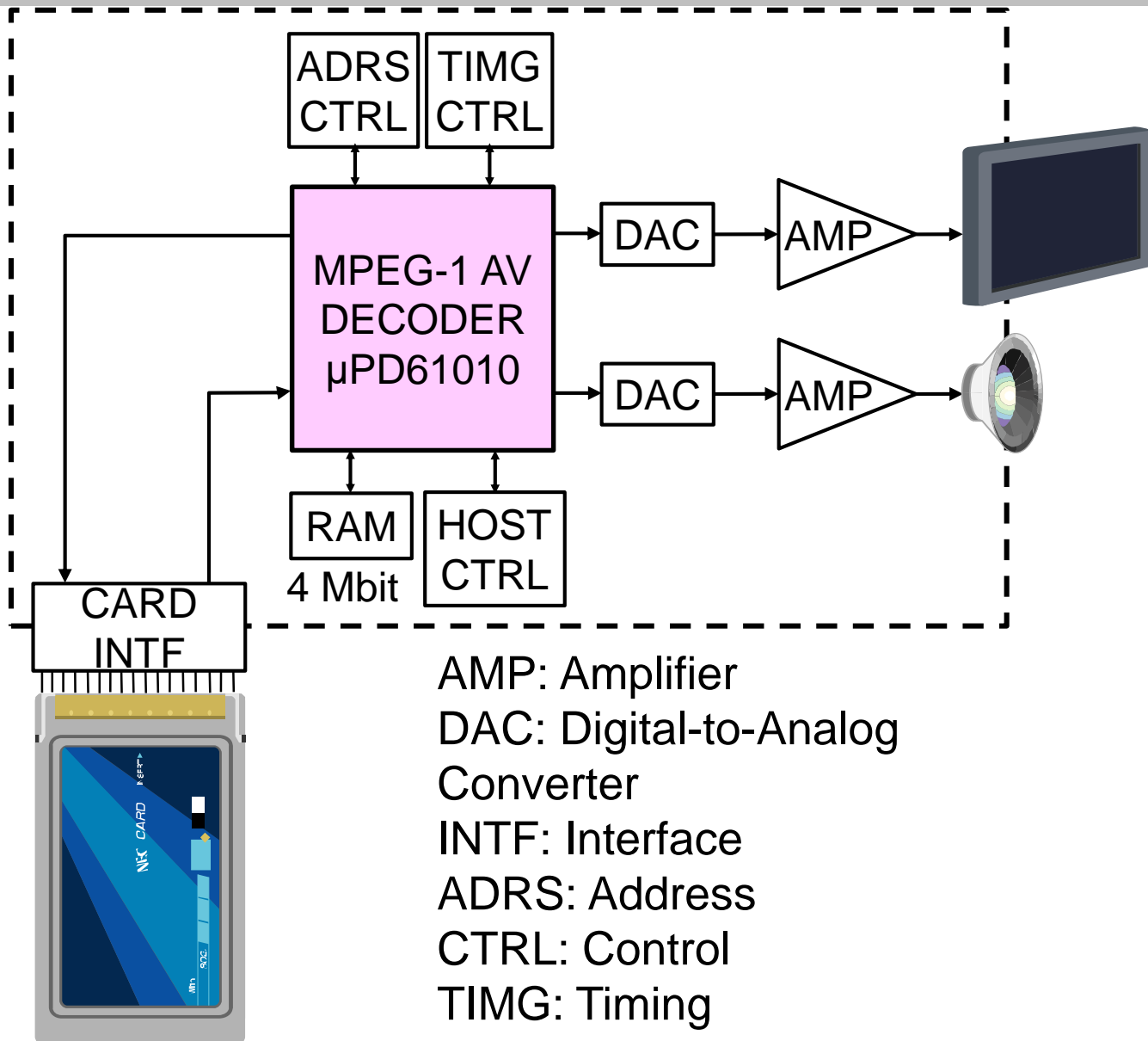
Extension to Video: Silicon View

Model	Portable	Hand-Held
Algorithm	MPEG-1 Video	ditto
Pixels	352 x 240	ditto
Implementation	uPD61010	ditto
LCD	5.5 in TFT	2 in TN
LCD Resolution	320 x 240	312 x 230
Power Consump	5V, 800 mA	5V, 600 mA
Power Supply	External Adapt	3.6 V Lithium Ion, 1300mA
Dimension	222x125x62 mm	147x76x37 mm
Weight	1000 g	295 g
Record Time	4 min@40Mb	ditto

Memory Capacity vs. Recording Time (Video)



Blockdiagram of Silicon View



Silicon View Family (1996)

Portable Model



Hand-Held Model



AV Decoder LSI Specifications μ PD61010

Video Decoding

352 x 240 @ 30 Hz

352 x 288 @ 25 Hz

high-resolution still image

704 x 480 or 704 x 576 pixels

Audio Decoding

Stereo at 32, 44, or 48 kHz sampling

Max Operating Freq

27 MHz

Package

160-pin PQFP

Power Supply

5 V

Power Consumption

1.7 W

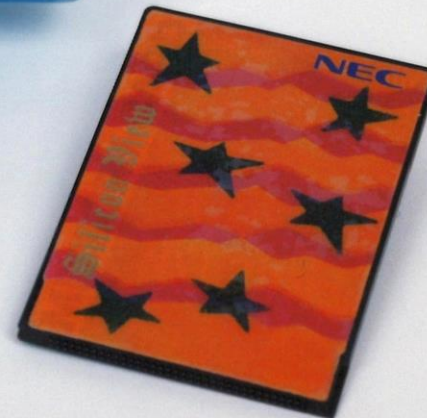
Applications: Silicon Guide Terminals (1997)



Hand-Held AV Model



Audio-Only Model



Shopping Navigation (1996)

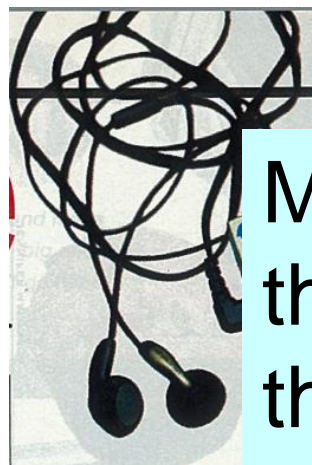


- Main program A, B, and C
- Press a button for a program to start

Impact of the Silicon Audio on Feasibility

Goodbye CDs?

More reports in JP, US, UK
the Asahi, the Nikkei
the Financial Times
the International Herald Tribune
and more



scorecard

THE KEY TO NEC'S P...
Silicon Audio compa...
player, a teeny-wee...
state sound system, i...
conductor memory c...

size of a credit card, the 32-megabyte device holds 24 minutes of CD-quality recording, with a possible extension to 90 minutes. NEC is hoping for a commercial release of the technology by the year 2000 and plans further applications, including audio books, study guides, portable guide devices for museums and art galleries and, with TV-screen hookups, perhaps even recorded television programming. It could even be a big little step toward a potential replacement for the morning newspaper on crowded commuter trains.

INTERNATIONAL
GLOBAL AGENDA
THE FUTURE IS WOW!
Ten technologies that will change our lives
July 17, 1995

could from a good old scratchy LP. Then there were the digital competitors. DAT was going to be the next big thing - sound multiv as good as CD. you could trace on I remember, back in 1990, falling for

FUTURE MUSIC
MAKING MUSIC WITH MODERN TECHNOLOGY
GOODBYE CD's?
EXCLUSIVE
NEC's Silicon Audio player. Is silicon chip the music format of the future?

FEATURED ARTISTS:
• 808 STATE
• ANNE DUDLEY
• GLOBAL COMMUNICATION
plus the first ever cyber band

WIN A 4000 XS worth \$750

the first, chip-music idea to reach a working level, albeit in prototype form at the moment. The first two things that you notice about Silicon Audio are its design and lack of controls. It's coloured like some west-coast American beachwear product, and you can just imagine it swinging on some roller-skating beach babe's hips while David Hasselhof looks on. There is just one button, which acts as a play and stop, but bear in mind that this is all a prototype needs to do. In use, Silicon Audio feels just like a normal Walkman in terms of build, al-

the idea of the form or another years, with in a synth's sleek up com-think about it, works on a silial 'next step' arts means no e it's on chip, cess to tracks

the first, not

FUTURE MUSIC MARCH 1995 **39**

Silicon View and its Family

Silicon View (1996)



Silicon Guide (1997)



Shopping Navigation (1996)

Full Page Ad on the Nikkei

Ver.2.0 (1997)

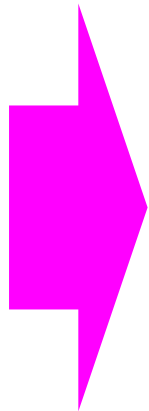


First in the world
No tape, no motor
The future portable video

世界初です。
テープもモーターも使わない未来の携帯ビデオ。

Impact of the Silicon Audio on Production

Decoder (+ Encoder later) = Peripherals + LSI (purchase)



Less parts: Early
Assembly: Parts
No integral pro
assembly exper

Manufacturing
Anybody can st
New companies

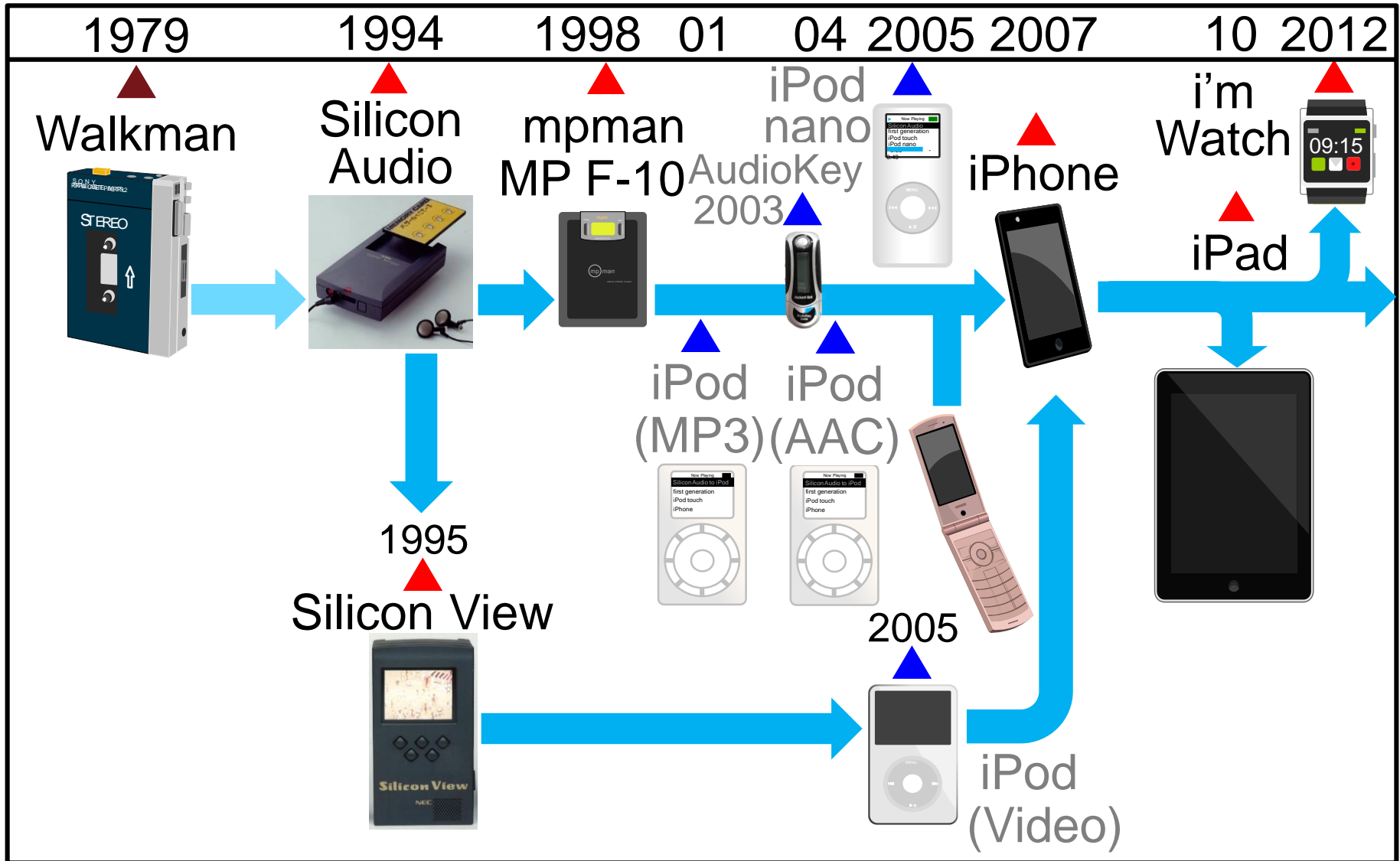


Fossil fuels (gas /diesel) vs. Batteries

Impact of SA on Personal Information Devices

- mpman (1998) : 1st Commercial Solid-State Audio Player
- iPod (2001): MP3+HDD
- iPod (2004): MPEG4/AAC + HDD
- iPod nano (2005): MPEG4 + Flash Memory
- iPhone (2007):
Aud Player+Mob Phone+PC+UI = Smartphone
Smartphone : Commodity, Most promising
- Tablet PC (iPad, 2010):
Upscale iPhone w/ Large Display
Compromise between Smartphone & PC
- Smart Watch (i'm Watch 2012):
iPhone – Display – Keyboard

From The Silicon Audio to a Smart Watch



Summary

The Silicon Audio: Origin of personal information devices,
Developed in **1994 (25 yrs!)** upon encounter of
compression ratio and memory capacity

Matured LSI technology for codec on a single chip



Essential to the Silicon Audio family

Robust against vibrations, suitable for personal carriage
and in-vehicle use

Precursor of mpman (1998) and iPod (2001)

Changed manufacturing process and players therein

Evolved into iPod, smartphones, tablet PCs, and smart
watches

Widespread applications i.a.t. players, such as video
players and shopping guide on the shelf

YAHOO!
JAPAN

