A Single Chip DTV Media Processor

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Philips Semiconductors

Trimedia - DTV

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Trimedia CPU Generations

- TM-1000: 100 MHz VLIW CPU
  - Co-processors: VLD, ICP
  - Silicon Status: In production
- TM-1100: 133MHz VLIW CPU
  - New Co-processor/Bus: DVD de-scrambler/PCI-XIO
  - CPU Enhancement: six new operations to enhance CPU power
  - Silicon Status: Sampling now

Trimedia CPU Generations (Cont'd)

- **TM-2 (DTV): Single chip DTV media processor**
  - **Major new/modified Co-processors:**
    - Slice-level MPEG2 video decoder
    - High definition video display pipe (HDVO)
  - **Concurrent SPDIF audio output**
  - **64-bit memory interface**

Key DTV Set Functions

- Transport Demux
- MP@HL all 18 resolution video decoding
- AC-3 or MPEG audio decoding
  - AC-3 5.1ch@384Kbps and 2ch@192Kbs
- 2D,3D graphics generation (GUI, browser, ...)
- Display chain (scaling H&V, alpha blending, chroma keying, de-interlacing)
- PIP, Closed Caption decode
- Modem

Optional DTV Functions

- Decode discretionary format (Datacasting etc.)
- Improved rendering of NTSC (Natural motion etc.)
- Browser and push content display
- Video conferencing (with external camera)
- Mid performance 3D (VRML, games)

Defining the ATSC Standard

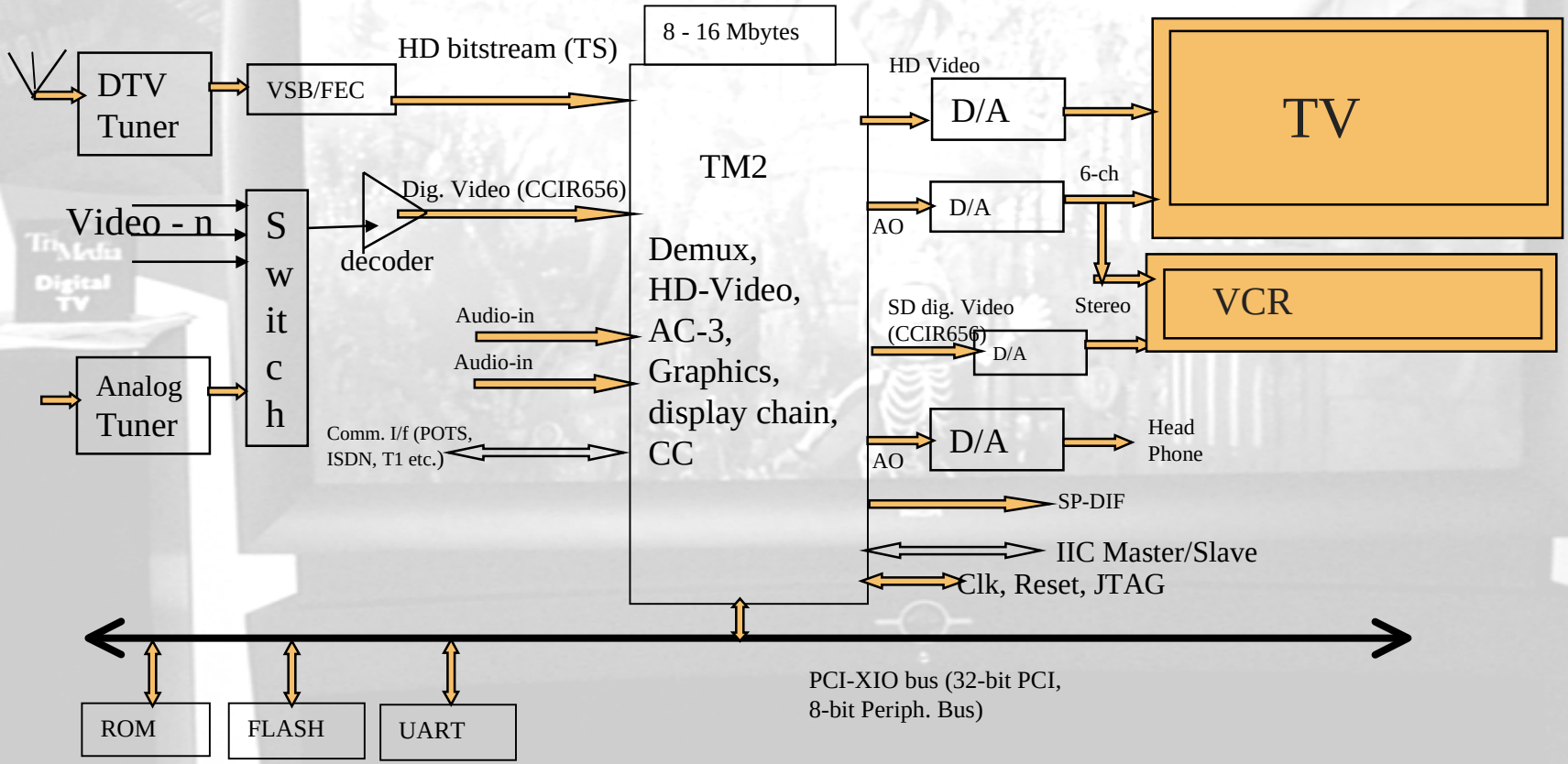
ATSC specification optional standards for DTV

All 18 formats refer to input and output configurations

	vertical lines	pixels	aspect ratios	picture
HDTV	1080	1920	16:9	60I, 30P, 24P
	720	1280	16:9	60P, 30P, 24P
SDTV	480	704	16:9, 4:3	60P, 60I, 30P, 24P
	480	640	4:3	60P, 60I, 30P, 24P

Source: ATSC

1999 DTV System Block Diagram



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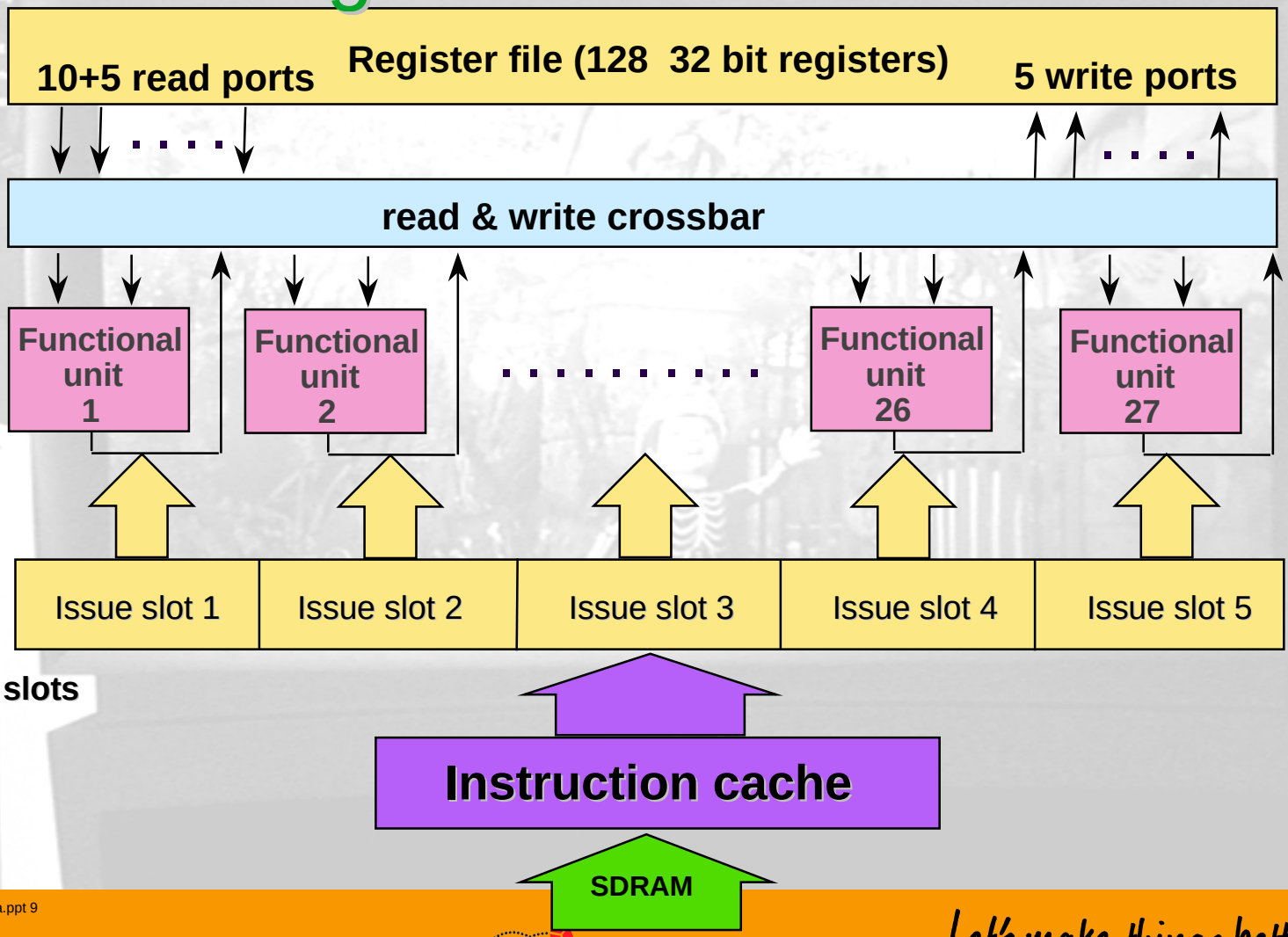
CPU block diagram

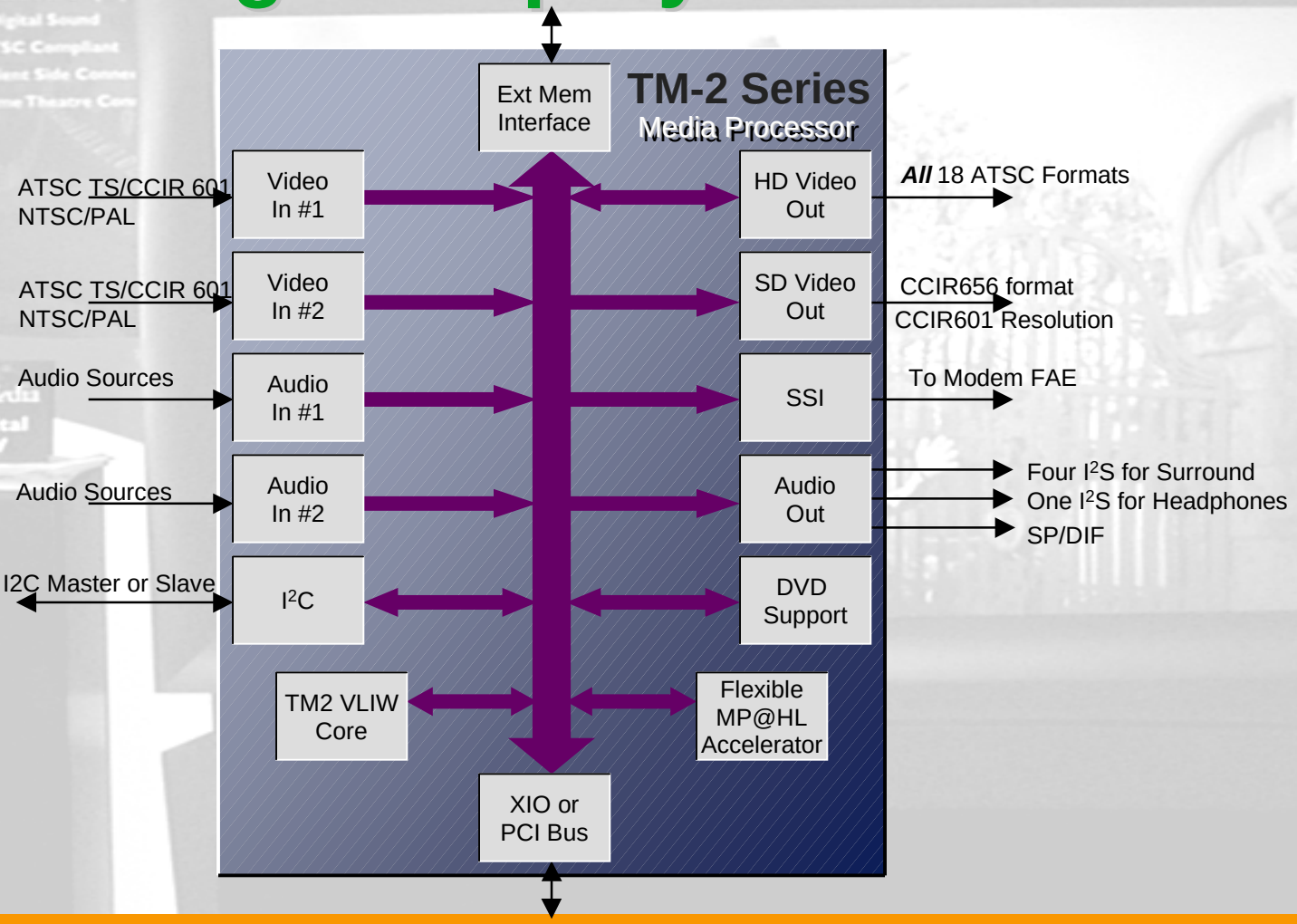


Instruction issue register
- five issue slots

CPU Functional Units

Functional Unit	Quantity	Latency	Recovery Time
constant	5	1	1
integer ALU	5	1	1
load/store	2	3	1
DSP ALU	2	2	1
DSP MUL	2	3	1
shifter	2	1	1
branch	3	3	1
int/float mul	2	3	1
float ALU	2	3	1
float compare	1	1	1
float sqrt/div	1	17	16

DTV Single Chip System IC



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Key Features of TM2 based DTV System

- **Audio Output**
  - **6-ch main audio; 2-ch stereo for VCR; 2-ch stereo for PIP audio;**
    - 20-bit Dolby digital compliance
  - **Concurrent SPDIF output of main audio**
- **Audio Input**
  - **Two audio ports (IIS interface); receives PCM or SPDIF data through external glue logic**

Key Features of TM2 based DTV System (Cont'd)

- **Video-In**
  - **Two video-in units in order to receive two NTSC channels**
- **Transport Stream Input Unit**
  - **PID filtering in HW in order to reduce the CPU load for the ATSC demux function**
  - **Remaining demux functions are implemented in software**
  - **Shares the video-in pins**
  - **Two transport stream input units**

Key Features of TM2 based DTV System (Cont'd)

- Video Out
  - High Definition Video out rgb 10-bit each
    - HD capable: 1920X1080 @ I60 fields/Sec or P30 frames/Sec, 74 Mpixels/Sec
    - Arbitrary Hor. And Vertical scaling,
    - PIP window, VCR output of main video
    - Graphics overlay
    - Aspect ratio conversion, interlacing, de-interlacing
  - Standard definition video-out in CCIR 656 format
    - Used for VCR recording

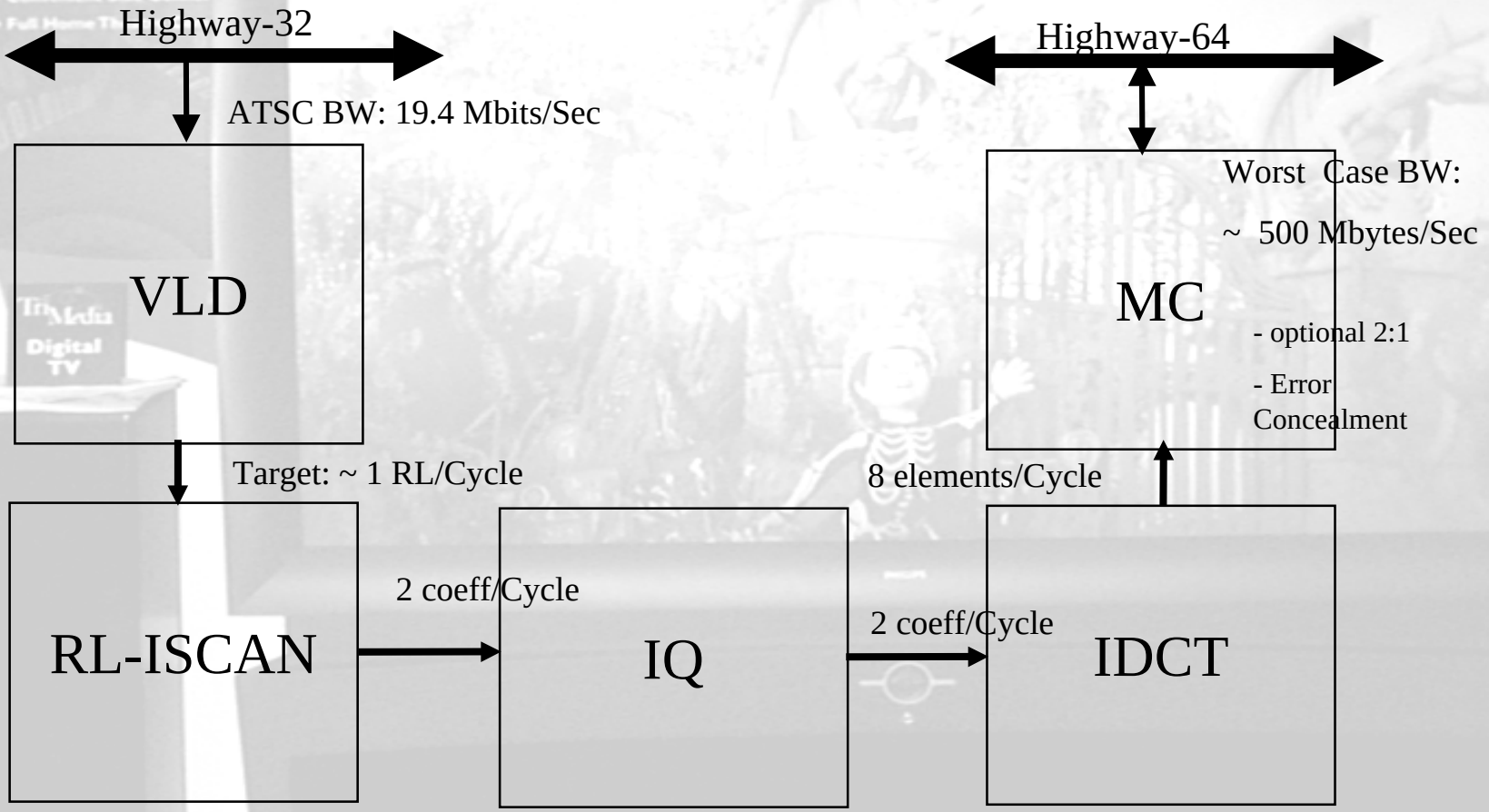
Key Features of TM2 based DTV System (Cont'd)

- **MPEG2 co-processor for slice-level decoder**
  - **Capable of decoding MP@HL video bitstream**
  - **2:1 compression mode in order to save memory**
  - **Error concealment in order to re-construct the region of image lost due to bitstream errors**

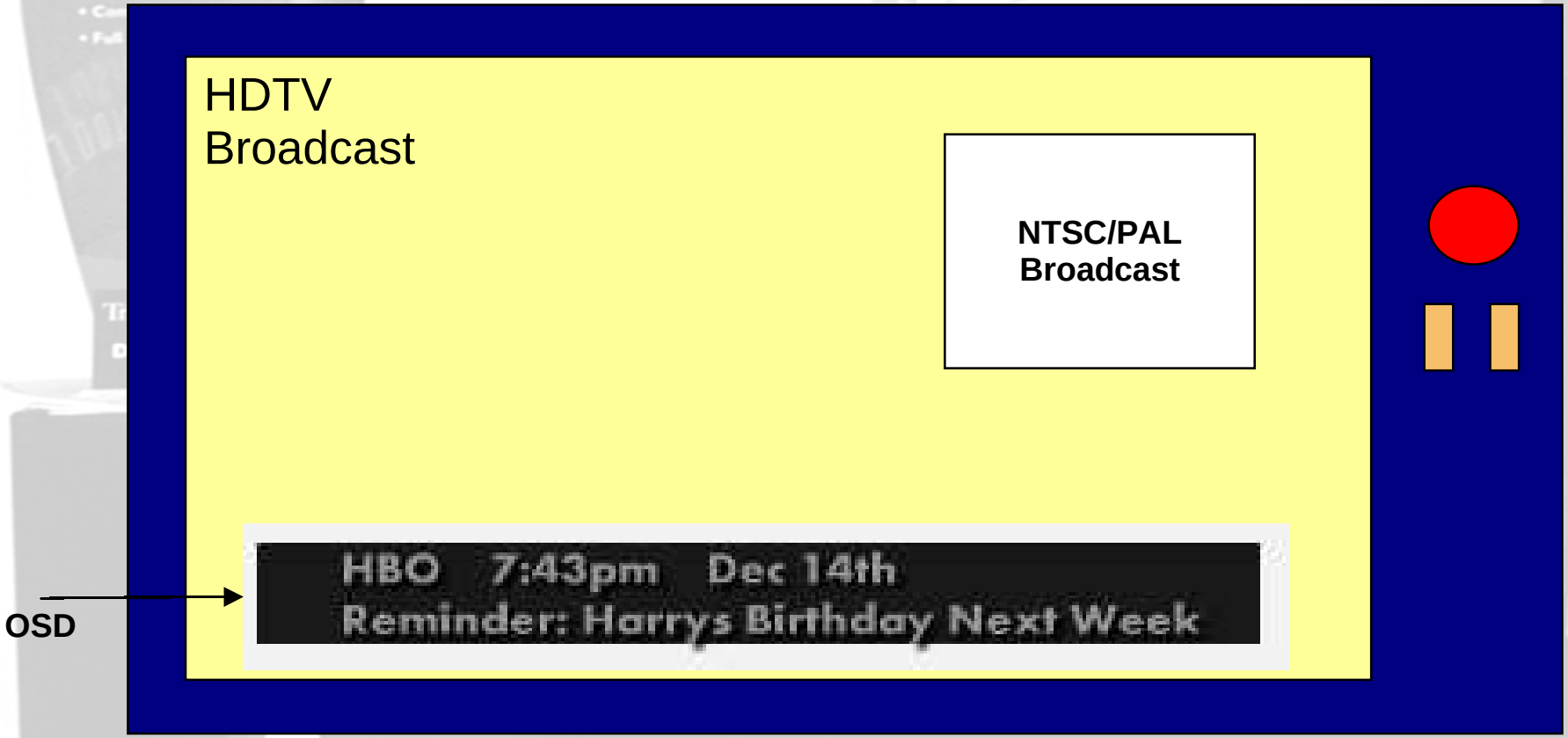
Key Features of TM2 based DTV System (Cont'd)

- **Memory/Hwy**
  - **64-bit main memory interface**
  - **64-bit Hwy for MPEG2 and HDVO; 32-bit highway for the remaining units**
  - **2D read/write from MPEG2 co-processor**
  - **Supports 4Mbytes to 64 Mbytes of main SDRAM memory**

MPEG-Pipe


Highway-32
ATSC BW: 19.4 Mbits/Sec
VLD
Target: ~ 1 RL/Cycle
RL-ISCAN
2 coeff/Cycle
IQ
2 coeff/Cycle
IDCT
8 elements/Cycle
Highway-64
Worst Case BW:
~ 500 Mbytes/Sec
MC
- optional 2:1
- Error Concealment

TM2 Broadcast PIPs



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NTSC Movie

- Fifty percent of Program content originates from movie
- Movie frame rate is 24 frames/sec (48 field/sec)
  - NTSC is 60 fields/sec
- One field is repeated for every four fields in order to show a movie in NTSC TV
  - Field repetition causes jerkiness in the objects in motion (= Eye strain)

NTSC Movie Display Improvements

- **Natural motion algorithm has been developed in order to generate new (in-between) frames**
  - **24 frames/sec => 60 frames/sec or 60 fields/sec**
  - **The result is a smooth motion while watching movies**
- **Natural motion algorithm will run in TM-2 CPU**
- **The SD resolution movie will be optionally scaled to HD display using high quality Hor. And vertical polyphase filters**

Summary

- **TM2000: high performance DTV media processing chip**
  - **Includes MP@HL video decode**
- **Status: Silicon will be sampled in 4Q 1998**
- **Project Experience:**
  - **Display processing consumes a significant amount of chip area**
  - **It is an exiting experience to work with HD video and AC-3 audio based DTV project**

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