ATI REDEFINES INNOVATION AND CHALLENGES
THE BOUNDARIES OF WHAT'S POSSIBLE
IN THE CONNECTED VISUAL WORLD

CONNECTED
visual world

Digital Television Architecture and Front-end considerations

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US DTV Industry

- ATSC standard was catalyst
- FCC Mandate defined the timeline
- ‘til now DTV’s mostly high-end
  - Projection, Plasma, LCD large screens
  - All traditional major brands participating
- New co’s/brands entering, e.g. HP & Dell
- Next:
  - Mid-range and low-end DTV’s
  - Integration of DTV w/ home networking/PC’s

SONY Mitsubishi SAMSUNG Hitachi SHARP PHILIPS Panasonic THOMSON

FCC Digital Tuner Mandate /Cable "Plug and Play"

FCC Digital Tuner Mandate

- TV manufacturers to include digital terrestrial tuners inside TVs according to this schedule:

36" +	50% by mid-2004 100% by mid-2005

25" to 35"	50% by mid-2005 100% by mid-2006

13" to 24"	100% by mid-2007

VCR DVD	100% by mid-2007

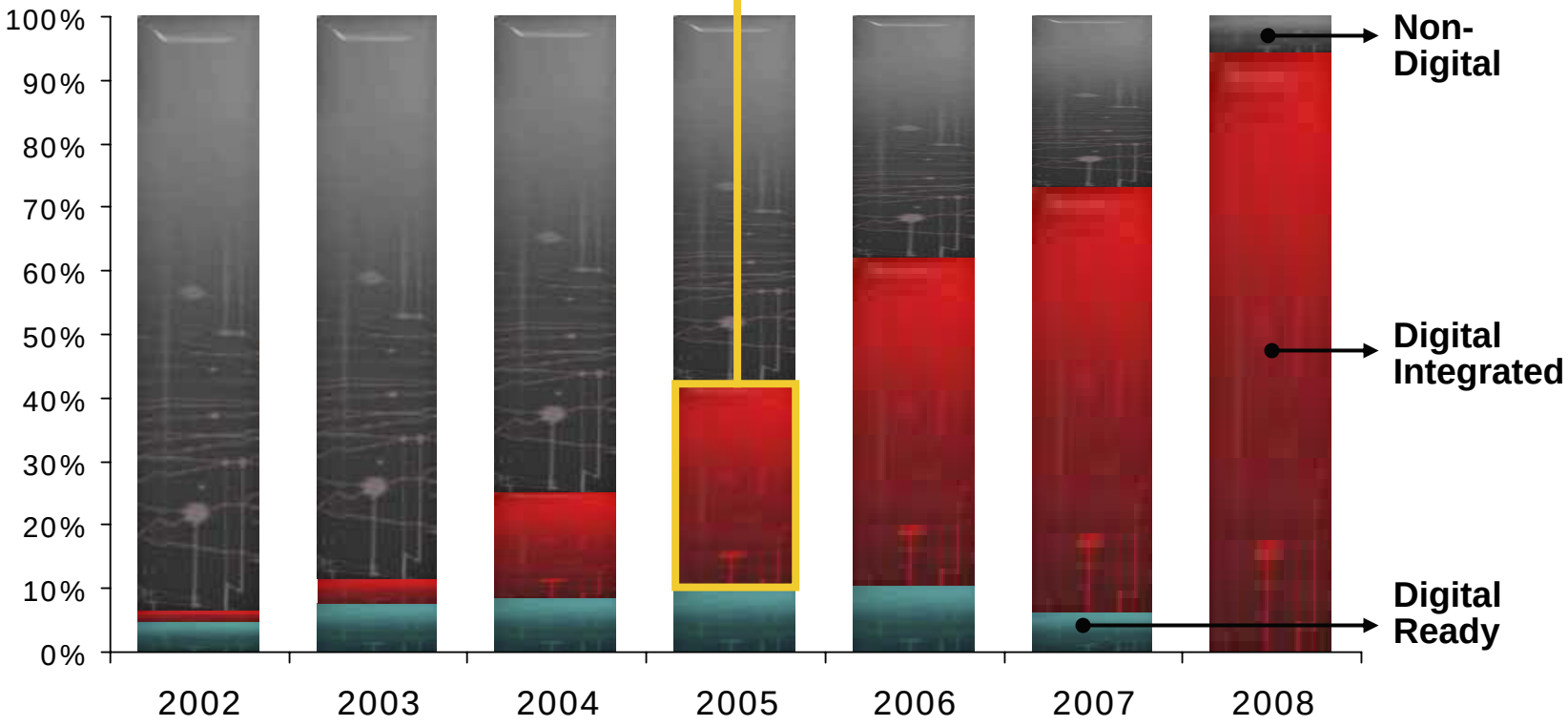
Digital Cable-Ready

- TV manufacturers and cable companies have agreed to integrate digital cable functionality directly inside TVs
- No need for an external STB
- Takes effect in mid-2004
- 70 percent of US households receive primary transmission through cable
- All major consumer electronics companies are now planning to build Cable "Plug and Play" TVs

The USA DTV market continues to be driven by mandates and the P&P agreement

US ATSC Market Size

High growth drivers in '05 are FCC Mandate, dropping prices, and HD content



US TVs. ~35 Million TVs Sold Annually.

Source: Stanford Resources & ATI

Market Segmentation

	LCD	Plasma	DLP,LCOS,Proj	CRT
High-end Primary TV Attributes: >Dual HD MPEG Decode >Dual Analog Decode >Up to 1920x1080P Display				
Mid-range Primary TV Attributes: >Combo of features & cost >Single HD MPEG Decode >Single/Dual Analog Decode				
Low-end Primary TV Attributes: >Pure Price focus >Single HD MPEG Decode >Single Analog Decode				

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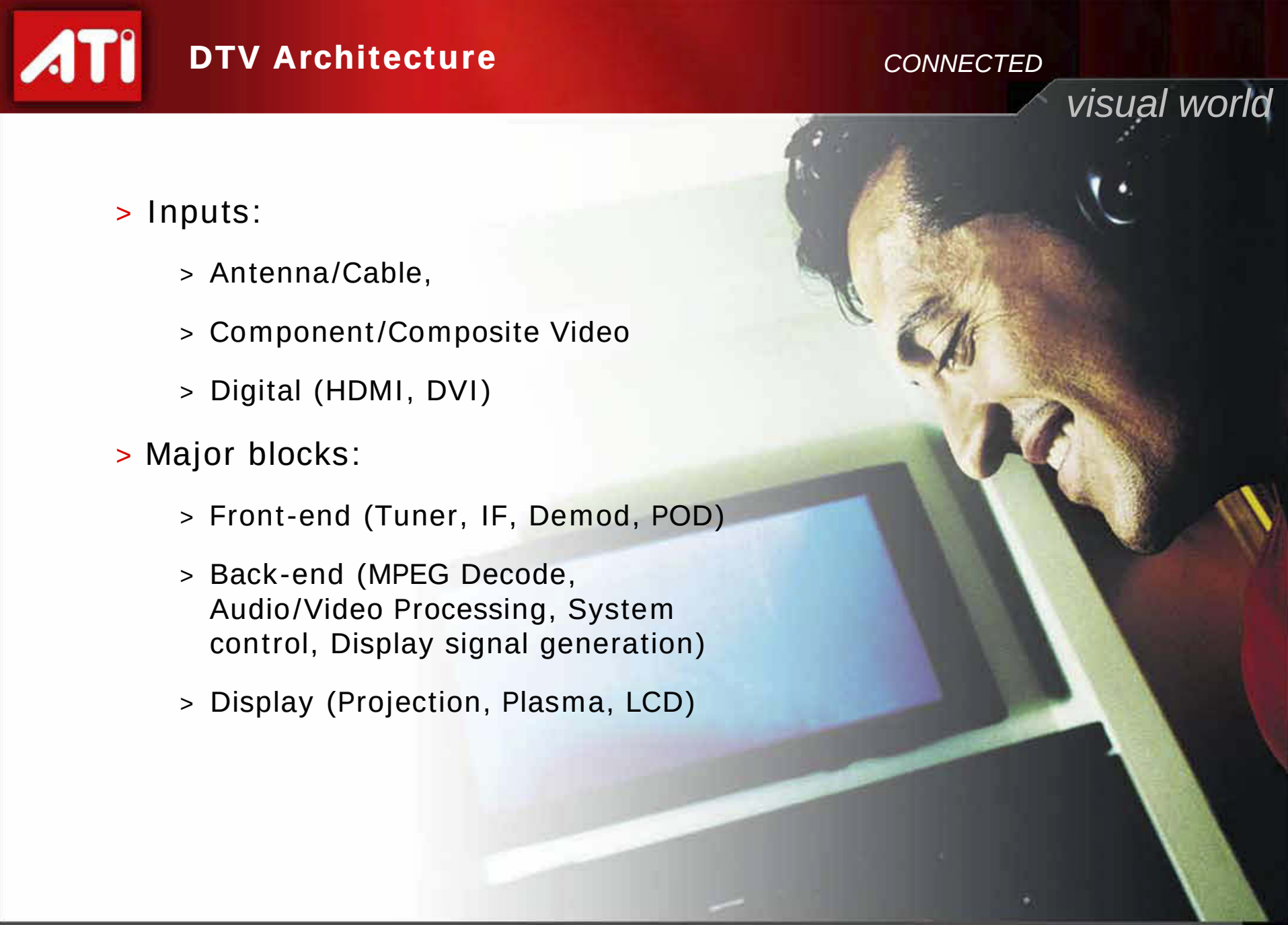
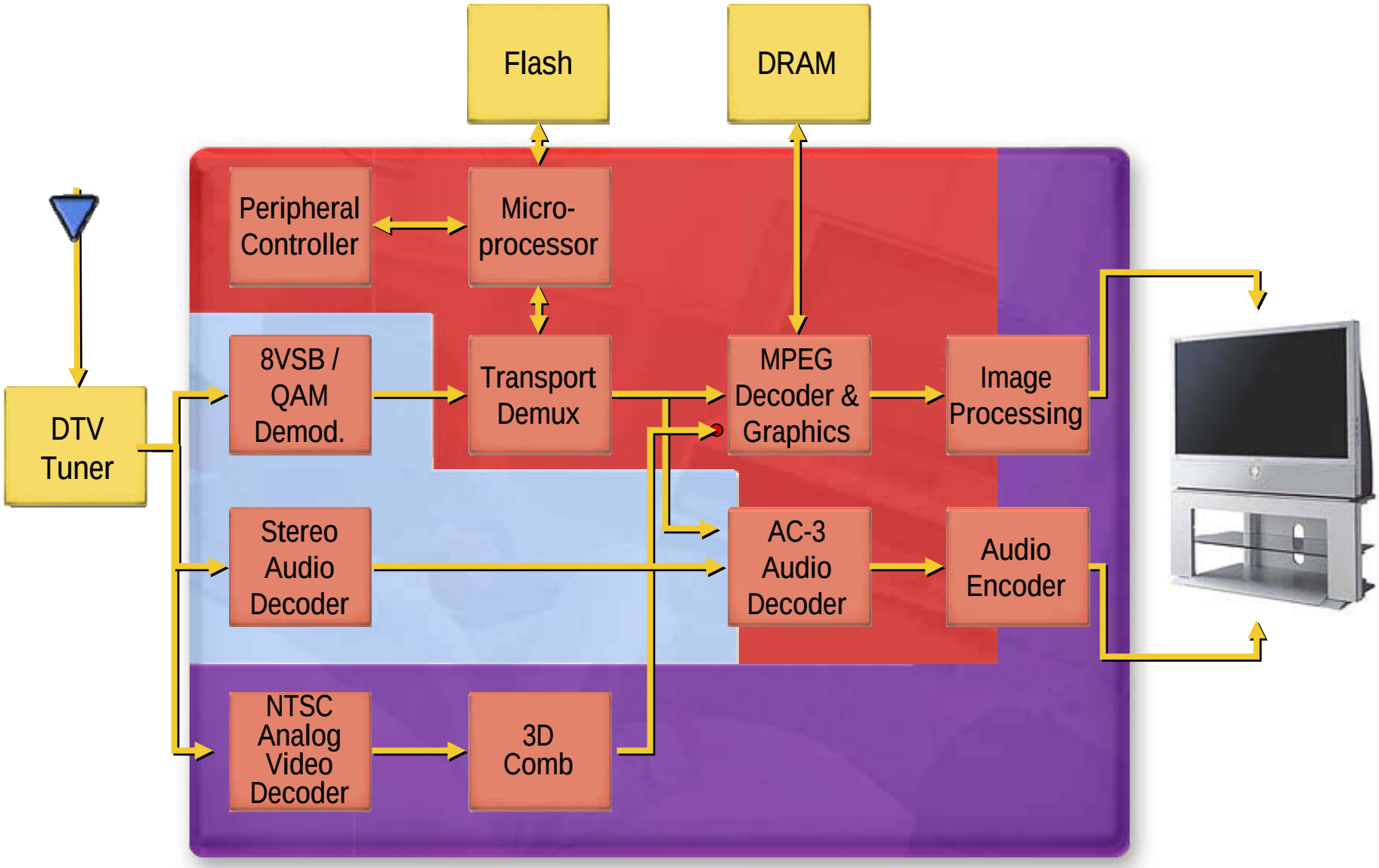
DTV Architecture

DTV Architecture



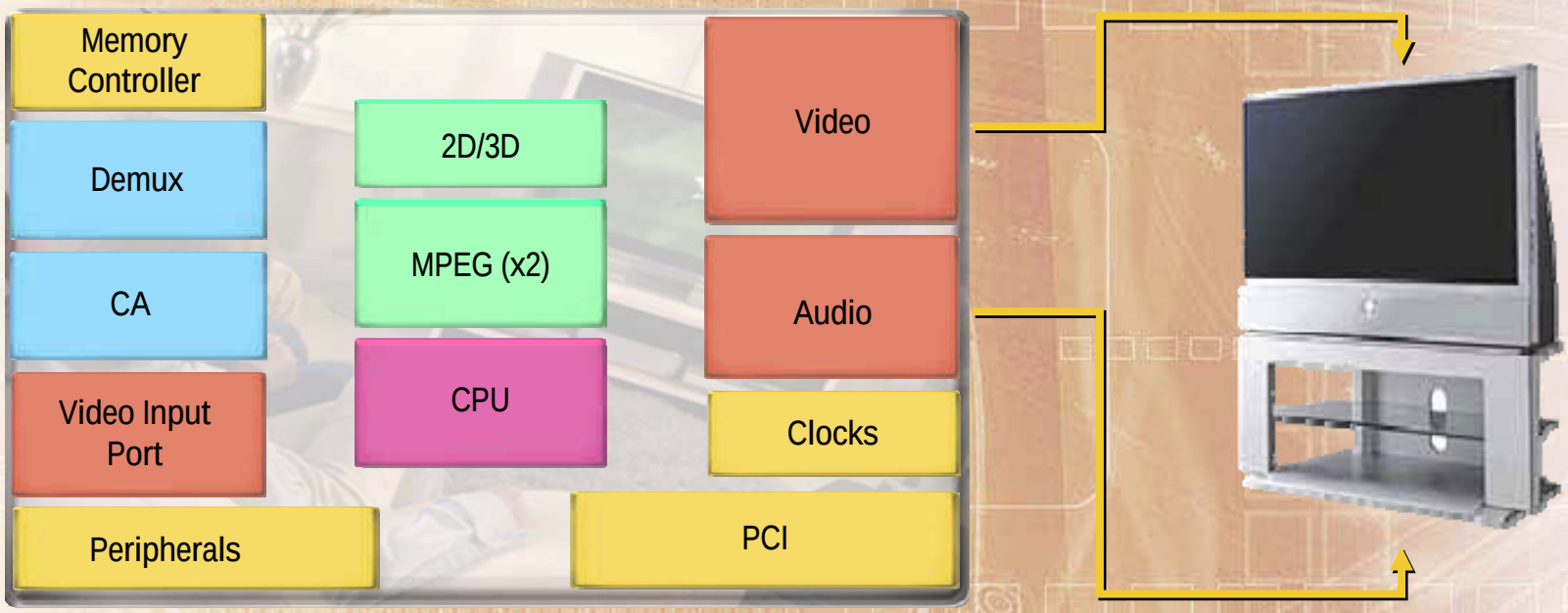
- Inputs:
  - Antenna/Cable,
  - Component/Composite Video
  - Digital (HDMI, DVI)
- Major blocks:
  - Front-end (Tuner, IF, Demod, POD)
  - Back-end (MPEG Decode, Audio/Video Processing, System control, Display signal generation)
  - Display (Projection, Plasma, LCD)

High level DTV architecture



Backend – Integrated IC

- HD MPEG video decoder (x 2)
- Video scalers & deinterlacers
- Picture-in-picture
- True color graphics menus
- HDTV & VCR outputs
- JPEG decode (cameras)
- Dolby AC-3 audio decode
- Hard drive interface (PVR)
- 300 MHz CPU
- Descrambling (cable)
- Peripheral interfaces



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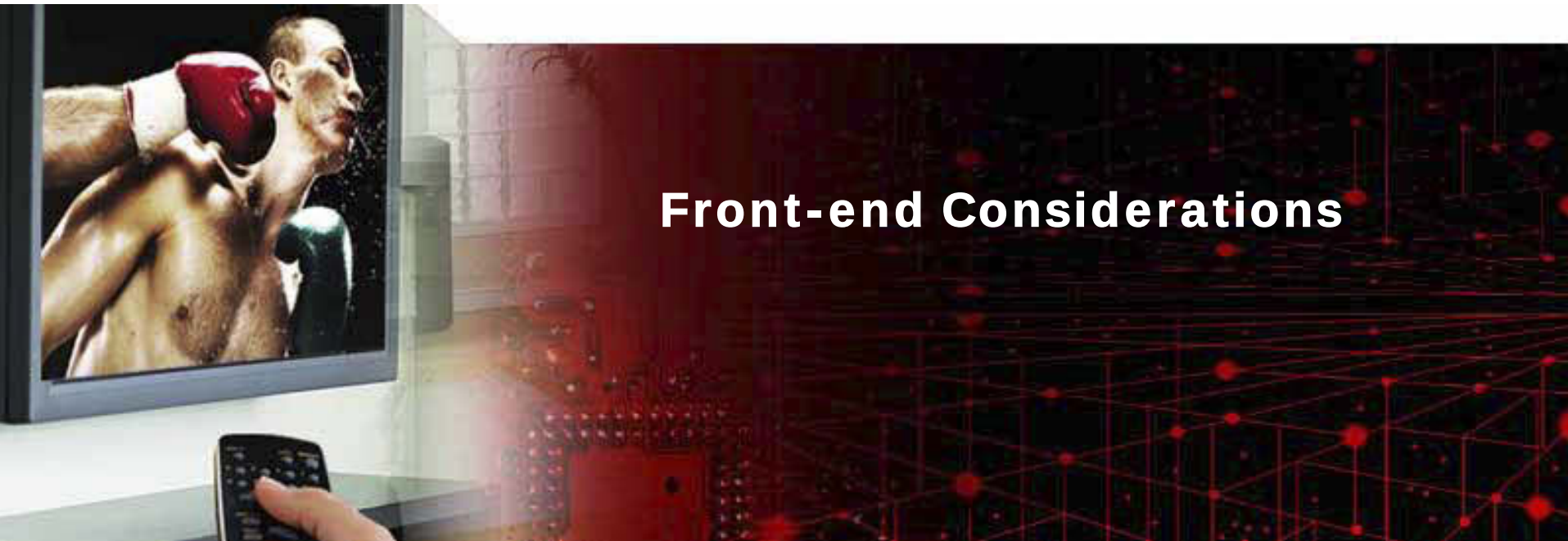
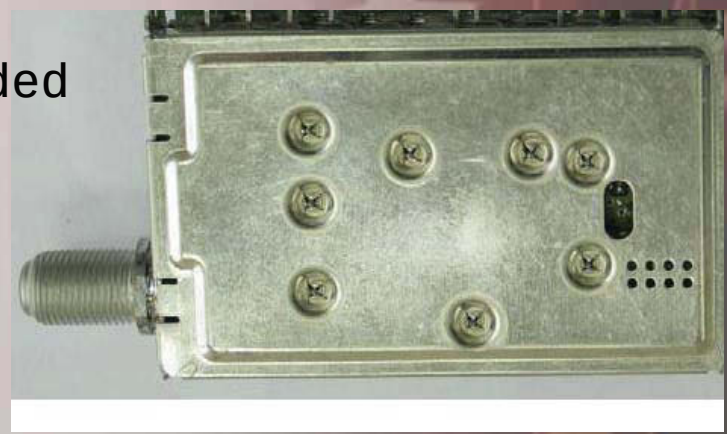


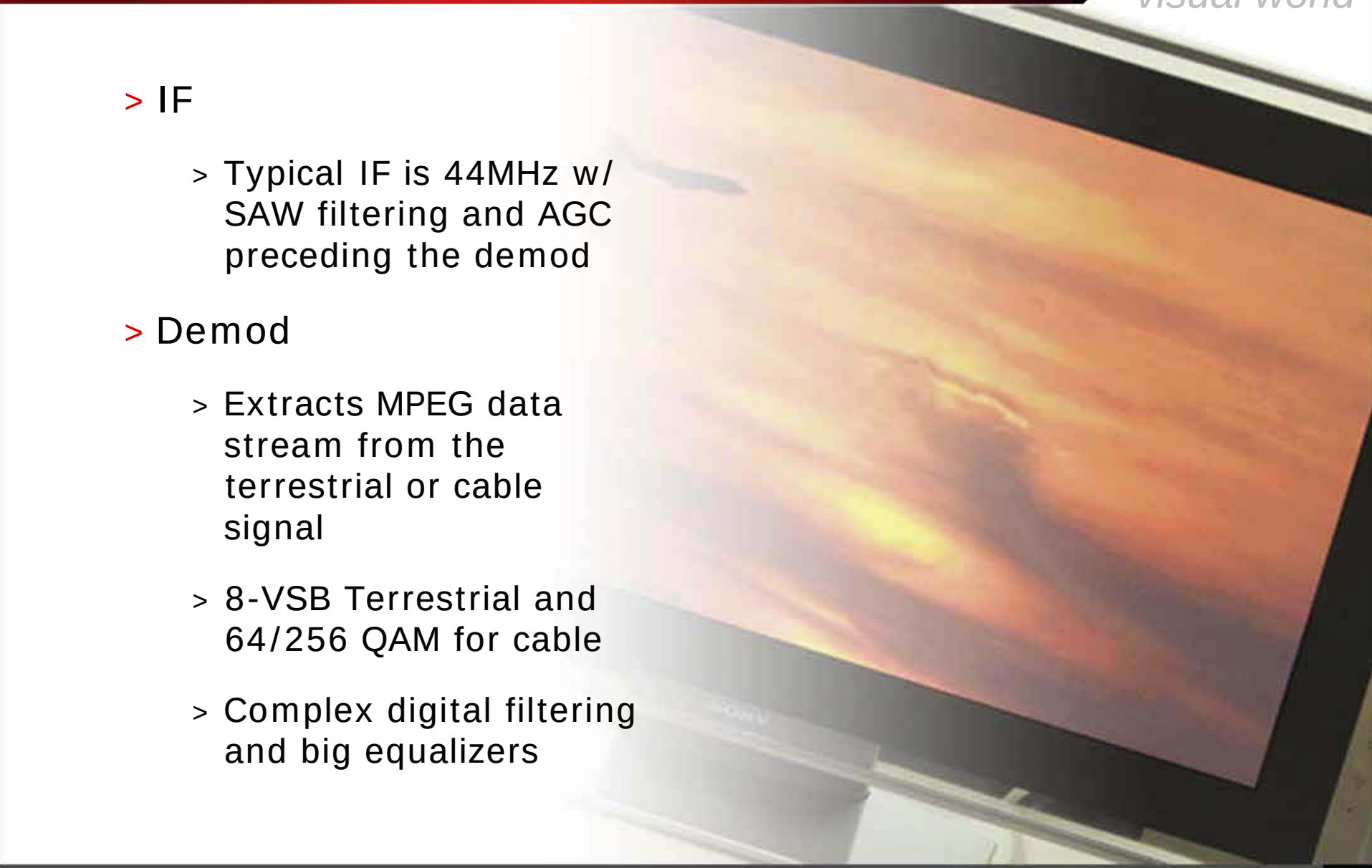
Front-end Considerations

DTV Front-end considerations

- Tuner
  - Sometimes includes Demod (aka NIM or ITD)
  - Tunes a channel between 54MHz and 860MHz
  - LNA, RF AGC, Mixer, Filtering, IF AGC, VCO, LO Synthesizer, Serial control interface (I^2C)
  - Traditionally a module enclosed in sheet metal ("tuner can") w/ threaded F connector and thru-hole pins
  - Some integrated IC tuners finally starting to meet TV performance demands



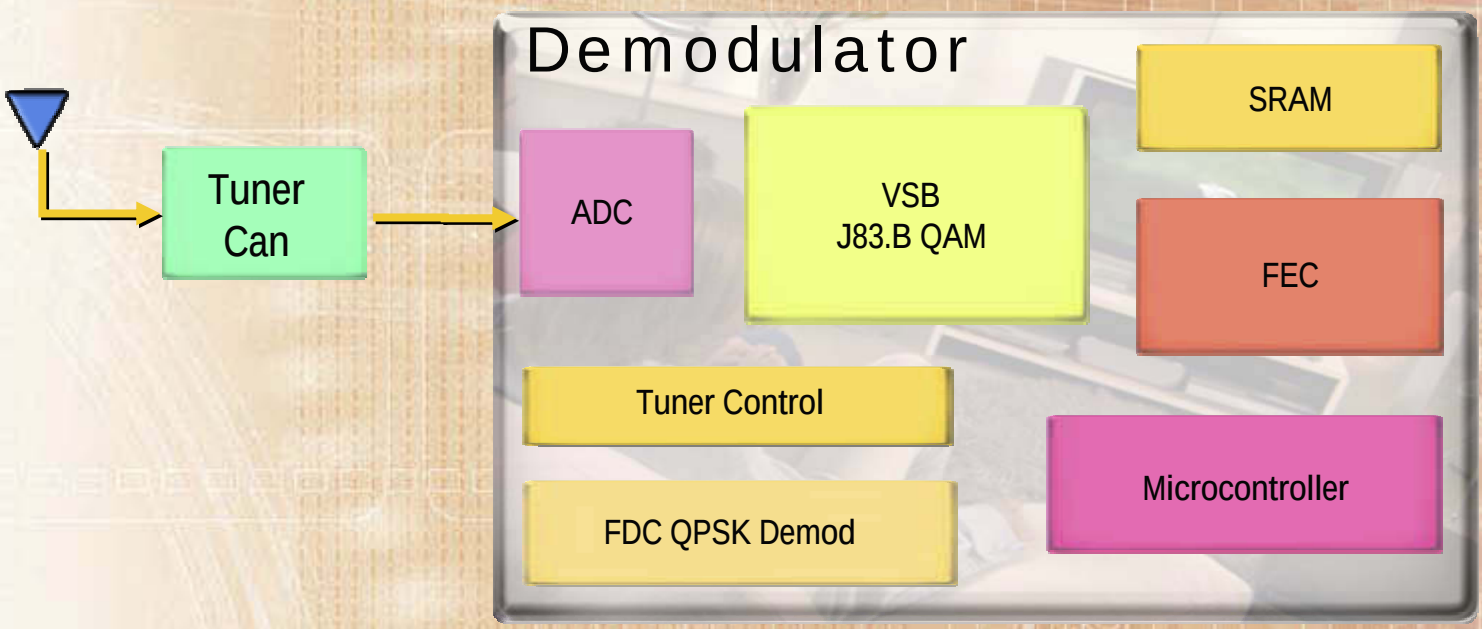
Front-end - Demodulator



- IF
  - Typical IF is 44MHz w/ SAW filtering and AGC preceding the demod
- Demod
  - Extracts MPEG data stream from the terrestrial or cable signal
  - 8-VSB Terrestrial and 64/256 QAM for cable
  - Complex digital filtering and big equalizers

Front-end – Demodulator

- 8-VSB demodulation (terrestrial)
- 64/256 QAM demodulation (cable)
- QPSK demodulation (OpenCable)
- Error Correction
- RF/IF AGC Control
- A/D converters



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ATSC A/74 Overview

- ATSC "T3S10" committee created in '03 at request of FCC and NAB. Participants include…
  - Broadcasters, CE Manufacturers, and Component Providers (ATI, Zenith, Broadcom, Panasonic, LINX)

- Charter: Generate ATSC Performance Guidelines/Recommendations
  - "What are the signal conditions under which receivers should operate?"
  - Applies to the RF front end and VSB demodulator
  - Generate set of vectors for ATSC performance testing

- Vectors are used to assess performance of CE manufacturer's TVs

Vectors : real-world performance

Building

- Urban, suburban, rural
- High rise, single family home, apartment buildings
- Wood, brick, metal, concrete construction

Environment

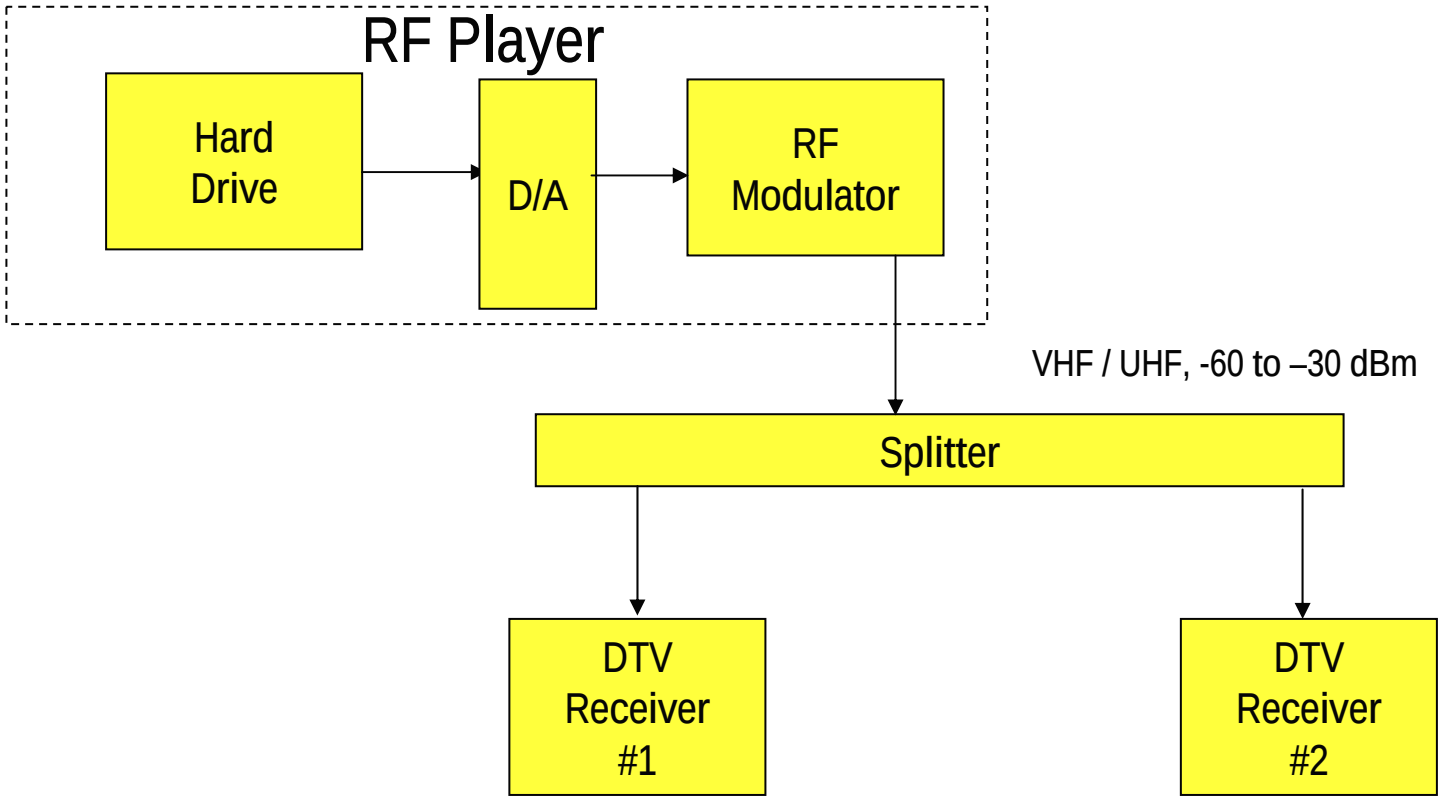
- Flat, trees, hills
- Moving vehicles – cars & planes
- Sunny, cloudy weather

Antenna

- Indoor, outdoor antenna
- Bow tie, rabbit ears, Yagi, silver sensor
- Close to tower (2 miles), far away (50 miles)
- Adjacent channels (NTSC & VSB)

Total of 50 vectors. Some vectors too difficult for any demodulator to receive.

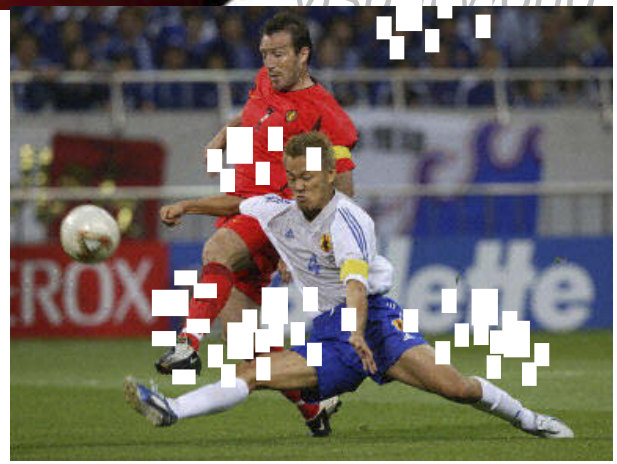
Vector Comparison Test Diagram



Video Performance Criteria

4 – Error Free
(no visible reception problems)

3 – Mostly Error Free
(viewable video with single defect)



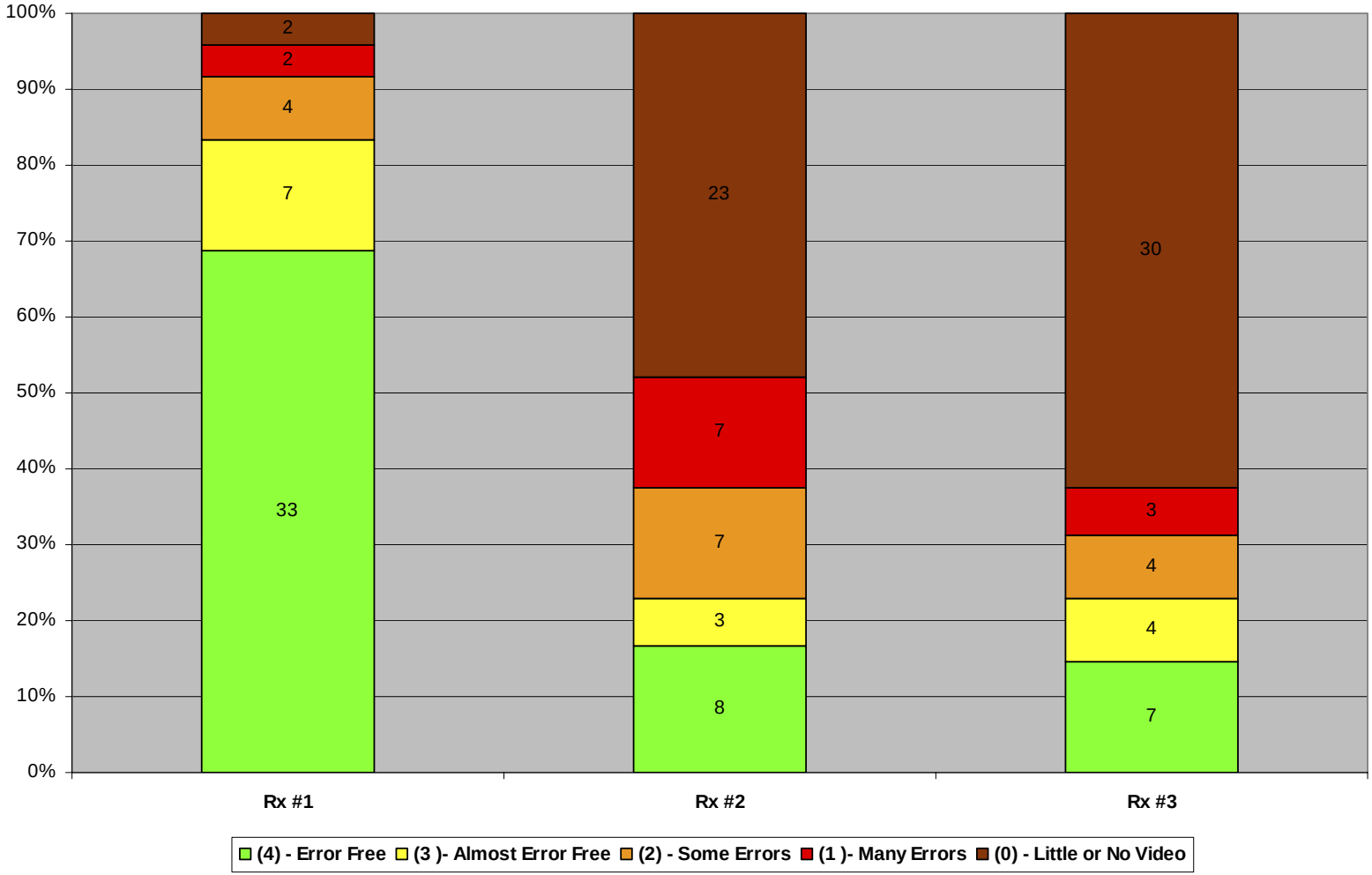
2 – Some Errors
(semi-viewable with >50% video)

1 – Many Errors
(un-viewable, <50% video)

0 – Little or No Video
(un-viewable or no picture)

Japan 2 x 2 Belgium

T3S10 RF Vector Performance



Field Testing – Spring 2004

- **Goal:**
- Evaluation of demodulator performance in <u>difficult</u> field conditions. Several difficult sites selected from prior studies:
  - Philadelphia, PA (12 channels, 15 outdoor sites, 8 indoor sites)
  - Baltimore, MD – Washington DC (11 channels, 8 outdoor sites)
  - Raleigh, NC (8 channels, 7 outdoor sites)
- Focus
  - Ability to handle multipath
  - Ability of the receiver to demodulate the signal with non optimal antenna bearing

Side-by-Side Video Test

(N, S, W, E)

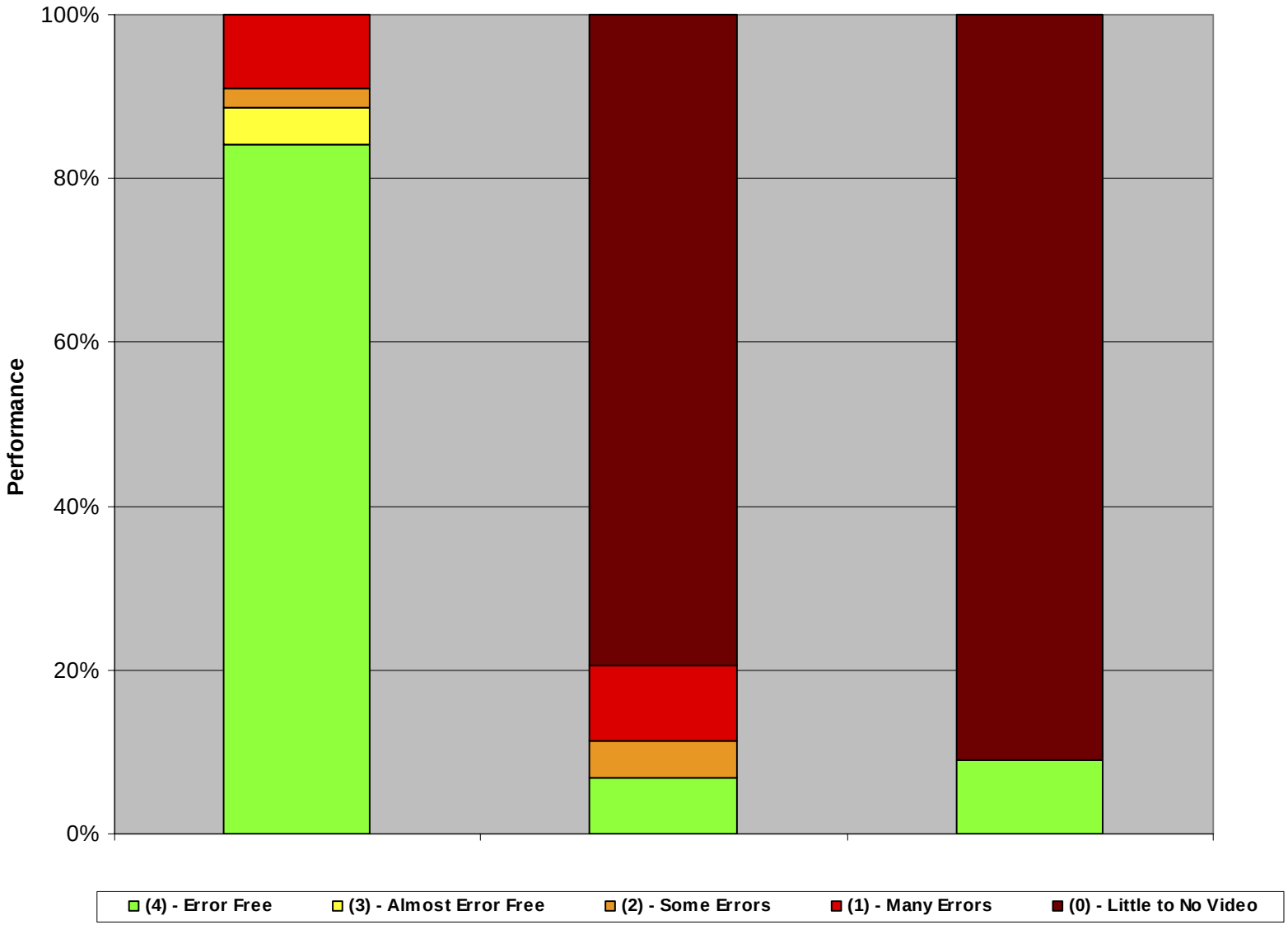
Prior gen. EVB

Demod EVB

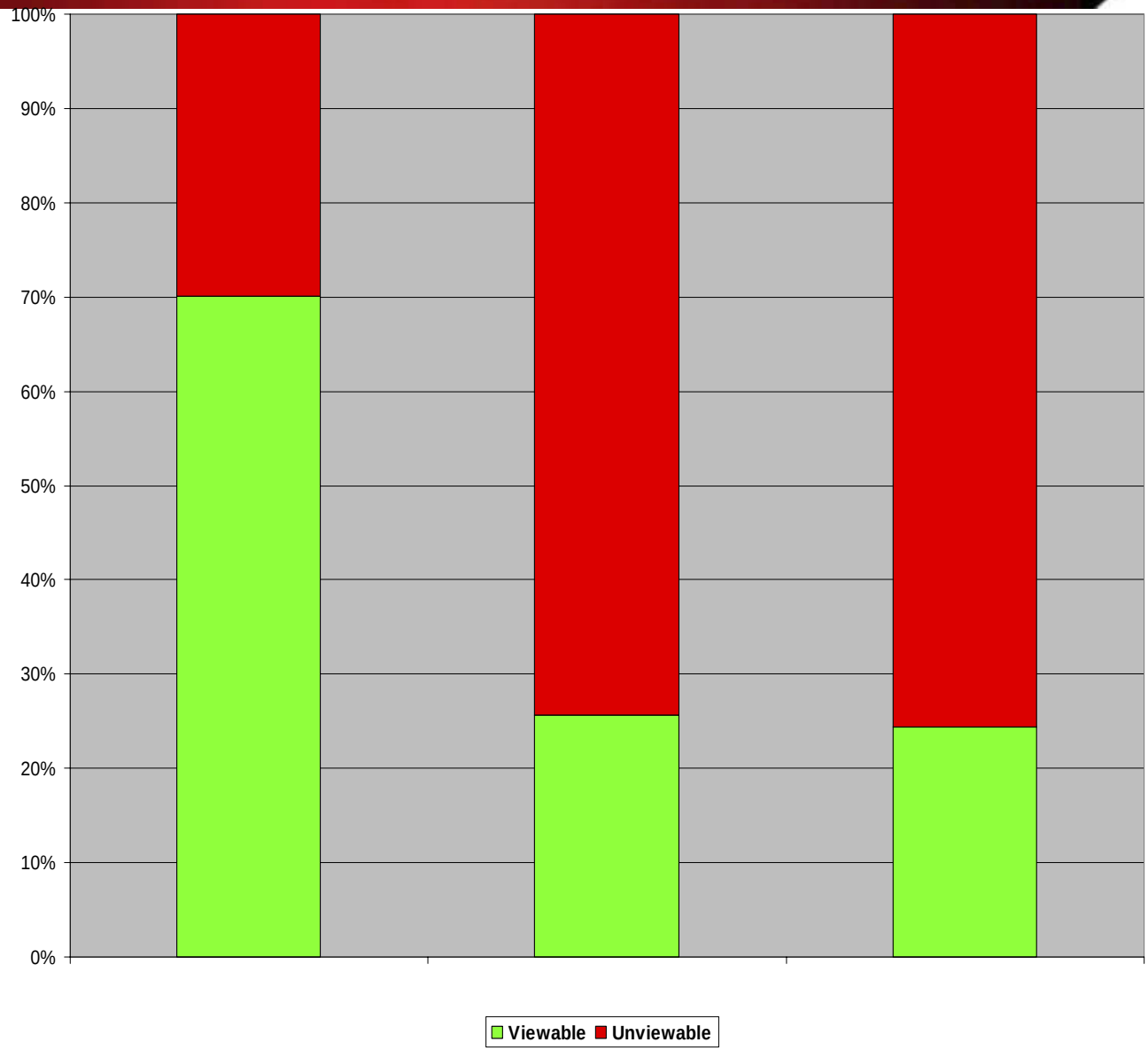
Comm'l product w/ different demod

Field test results

Philadelphia (Center City) PHL-10A DTV Reception
(Alternative Site, Ritz Carlton Parking Lot at 15th St. and Chestnut St.)



Summary Baltimore / Washington Outdoor Sites



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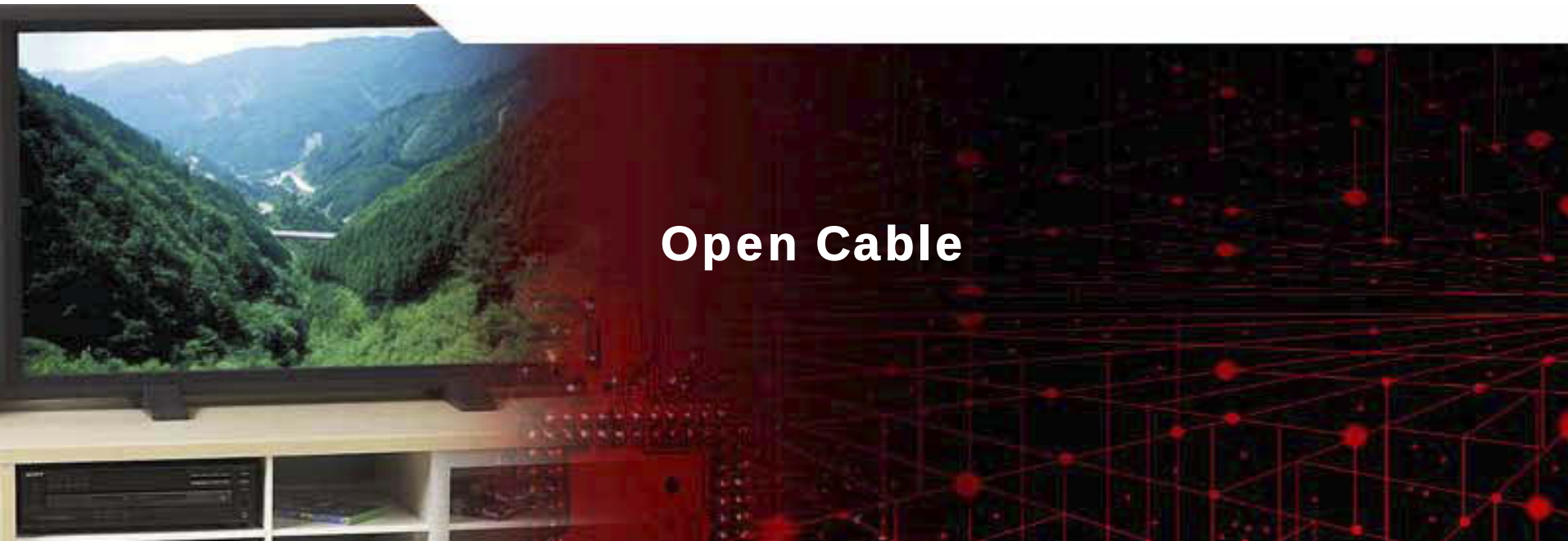
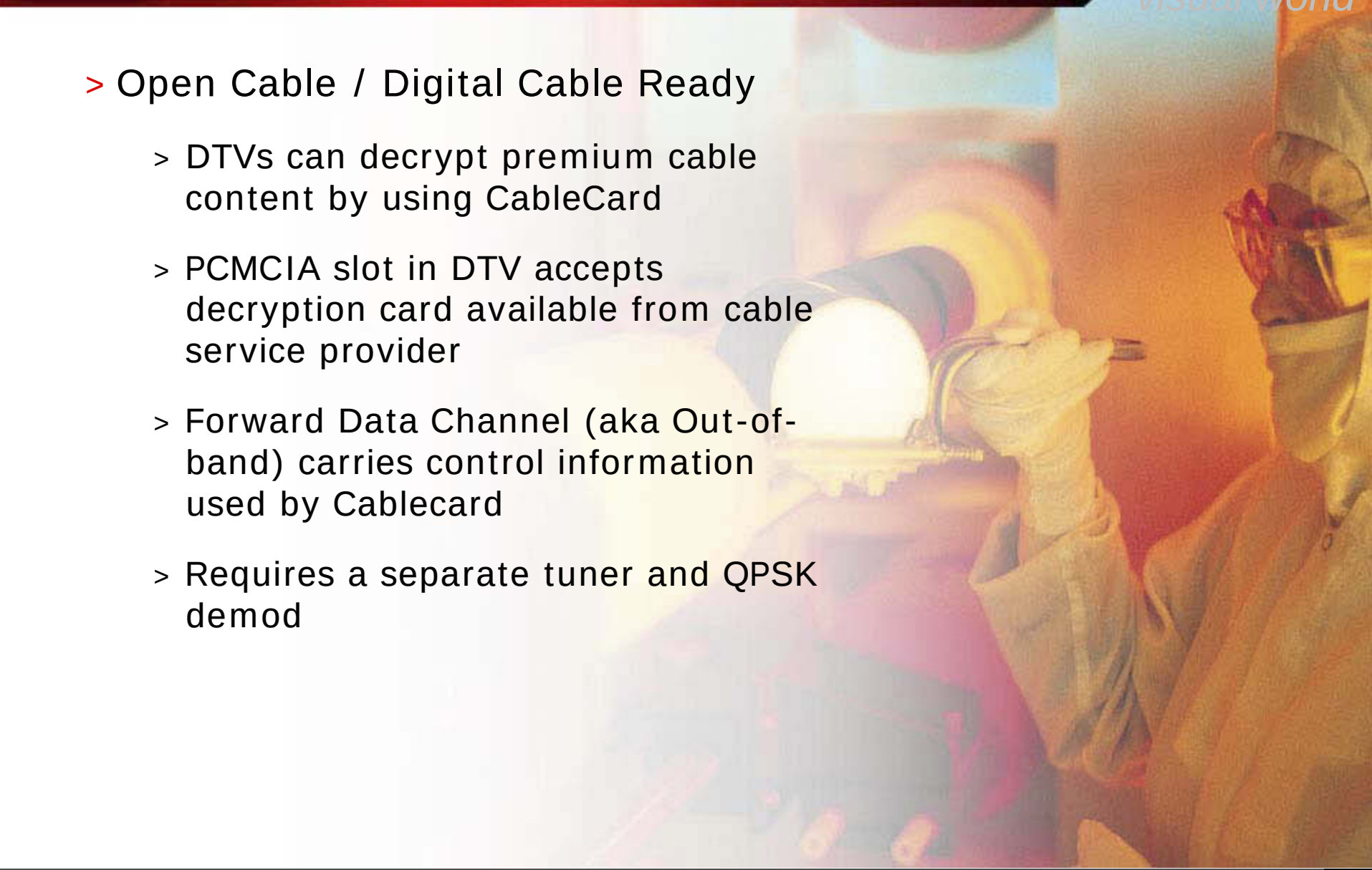


Front-end – Open Cable



- Open Cable / Digital Cable Ready
  - DTVs can decrypt premium cable content by using CableCard
  - PCMCIA slot in DTV accepts decryption card available from cable service provider
  - Forward Data Channel (aka Out-of-band) carries control information used by Cablecard
  - Requires a separate tuner and QPSK demod

Concluding points

DTV presents a significant technology challenge:

> High performance, very complex electronics at consumer-acceptable price points

Front-end technology has advanced rapidly, new demod front-end solutions approach near-theoretical performance

Interesting challenges remain

> How will DTV's integrate with home network / media PC ?

> Can Digital Cable-ready TV's replace digital cable set-tops ?

> What is the DTV of the future? PVR? Media Center? Media server?

> What is the role of Mobile Digital Television ?

Have fun addressing these and other DTV opportunities !