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Monitoring Digital Picture Quality

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What is Monitored?

- Analog Errors
  - Generational Errors
  - Transmission Noise
  - Black frames, lost content
- Digital Errors
  - Compression Errors
  - Black frames, lost content

Digital Compression Artifacts

‘Expected’ Artifacts

- Blocking, Contouring of gradients
- Quantization Noise, Mosquito Noise
- Loss of resolution
- Edge busyness
- Jerky motion

Digital Compression Artifacts

‘Surprising’ Artifacts

- Loss of pixel depth
- False motion
- Frozen frames, black frames, lost content
- Non-MPEG-2 Encoding Errors

Monitoring Matters More Now

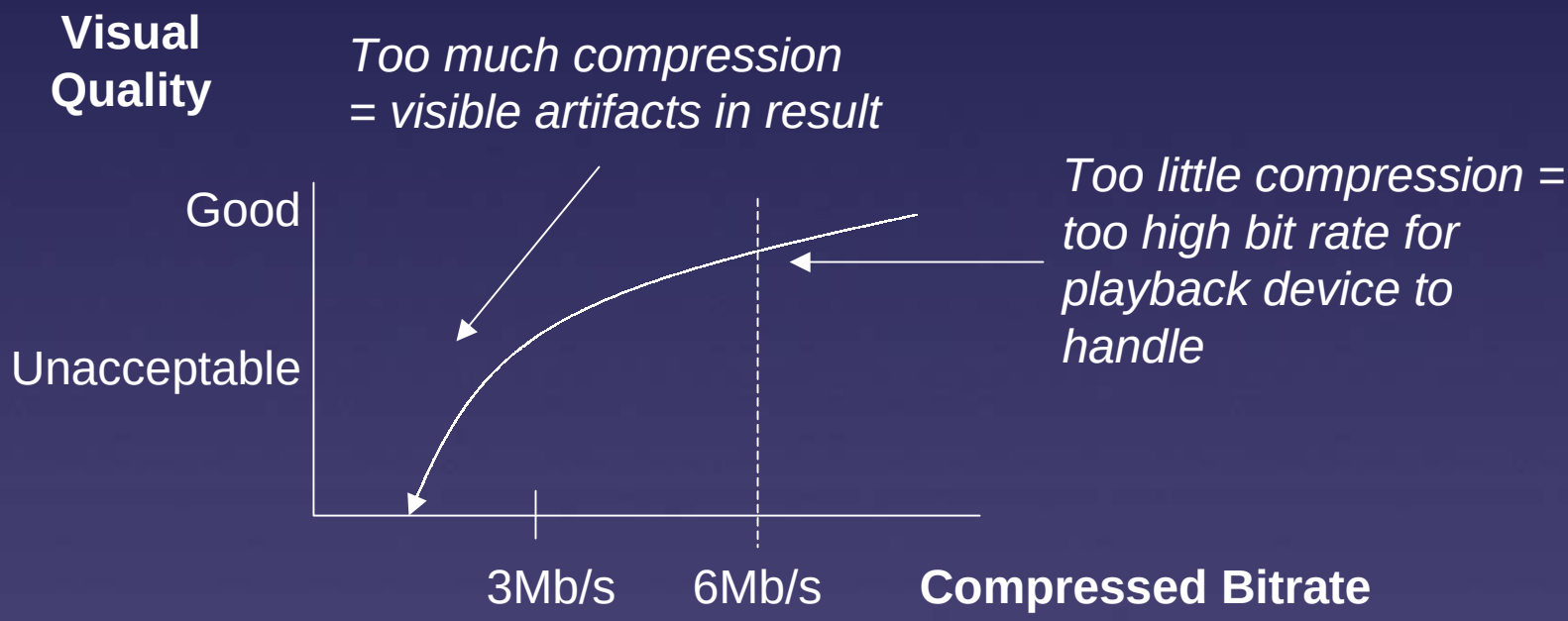
- With analog processing, errors can be introduced at each step.
- Digital error correction ensures *perfect delivery*; errors are only introduced at the transmission source.
- Digital compression puts new types of errors in new places
- Replacements for MPEG-2 invalidate MPEG-specific techniques

Challenges

- Continuous monitoring requires automated machinery: humans are not reliable
- Consistent, repeatable results are difficult to obtain
- False readings degrade the value of the monitoring process

Case Study: DVD Processing

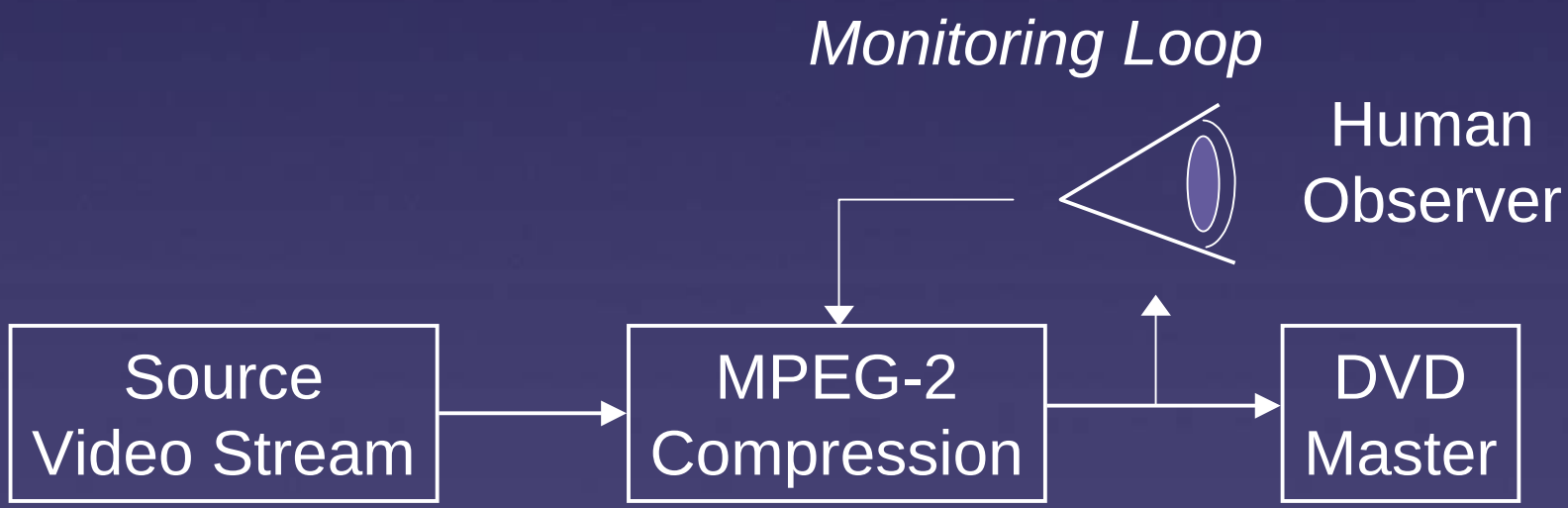
Balance perceived quality vs. available bit rate



Case Study: DVD Processing

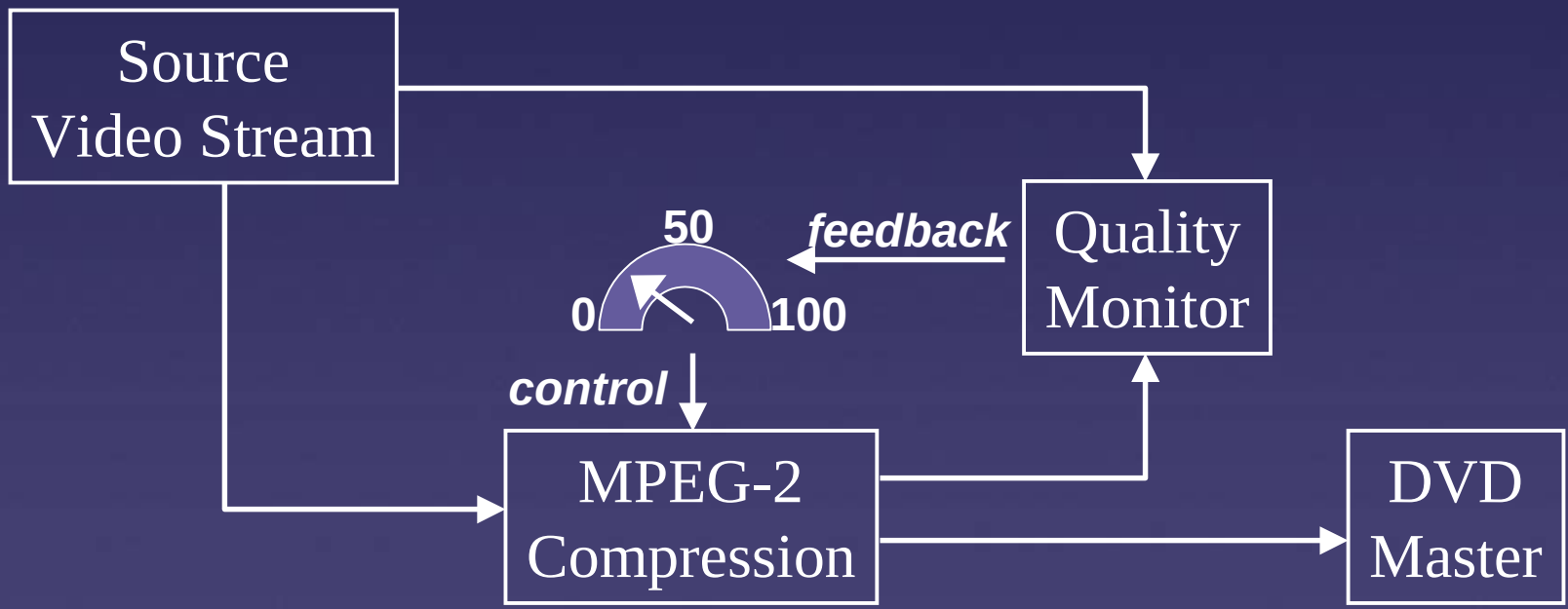
As content changes, compression demands vary, necessitating continuous monitoring

Human monitoring is tedious and unreliable



DVD Processing with Quality Feedback

Accurate monitoring means no human action needed



DVD Processing with Quality Feedback

Feedback loop from monitor to compressor

Ensures minimum bit rate for desired quality

Busy content automatically re-coded with desired algorithm (degraded quality, lengthened pre-roll, increased buffering)

Accurate monitoring means no human action needed

Theories of Quality Measurement

- MSE, PSNR
- Experimental
- MPEG-Specific Measures
- Sarnoff Labs: JNDMetrix
- NASA: DVQ
- Futureware: Visibel-Based Quality Measurement (VBQM)

Current Quality Measures

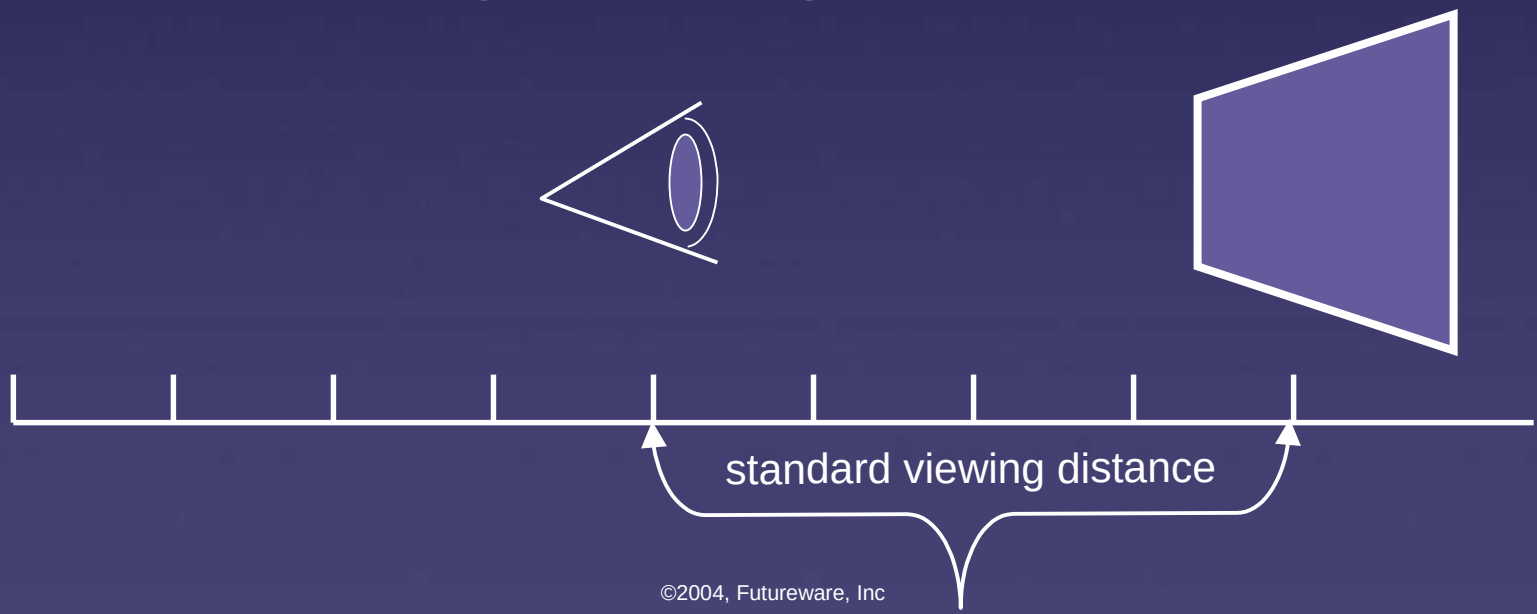
- PSNR - Peak Signal to Noise Ratio
- S/DSCQE - single-/double-stimulus continuous quality evaluation
- PAR – “Picture Appraisal Rating” (Snell & Wilcox)
- QMM – “Quality Measurement Module” (Pixelmetrix)
- PQR – “Picture Quality Rating” (Tektronix)
- Visibel (Futureware)

Visibel™ - Based Quality Measure

- Based on Human Visual System
- Visibel = *subjective* analogue to Decibel
- Measure is independent of compression technique
- After initial calibration with human subjects, completely objective and repeatable

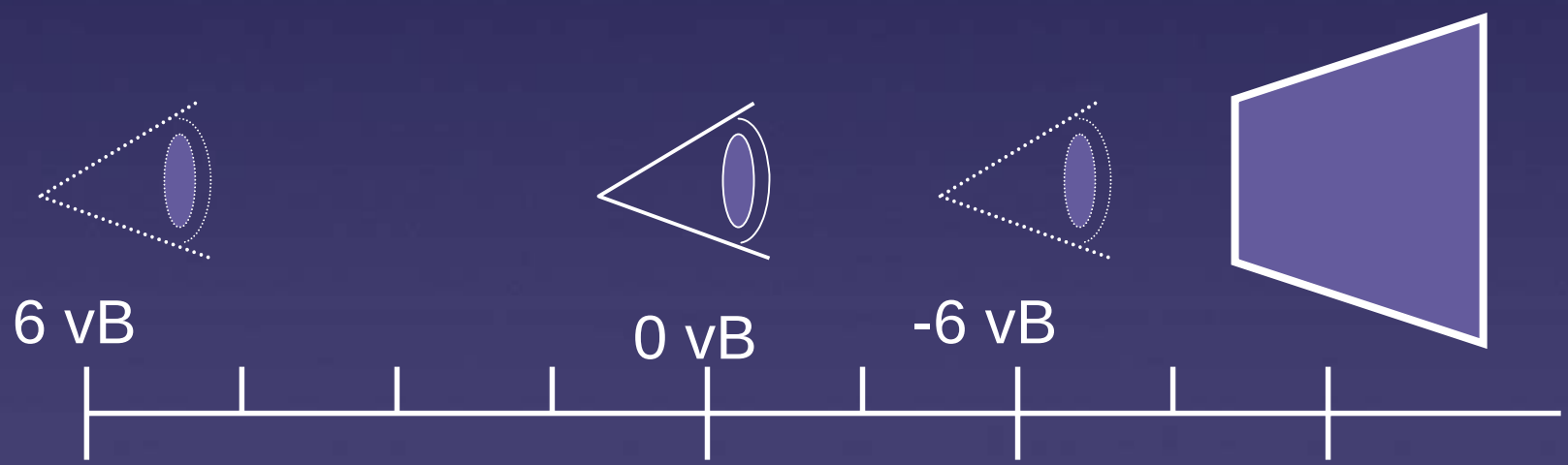
Visibels™ Defined

- Correlates distance to viewing screen vs. appearance of visible defects
- Errors at the limit of human visibility (at standard viewing distance) are defined as 0 vB



Visibels™ Defined

- Error indiscernible at double the standard viewing distance is defined as 6 vB
- Error which would be imperceptible at one-half the distance is defined as -6 vB



Advantages of VBQM

- Independent of compression system
- Can detect *all* visible discrepancies between reference and test signals
- Repeatable and consistent
- Easily understood by engineers
- Allows lowest-bit rate DVD encoding
- Allows accurate remote monitoring (broadcast)

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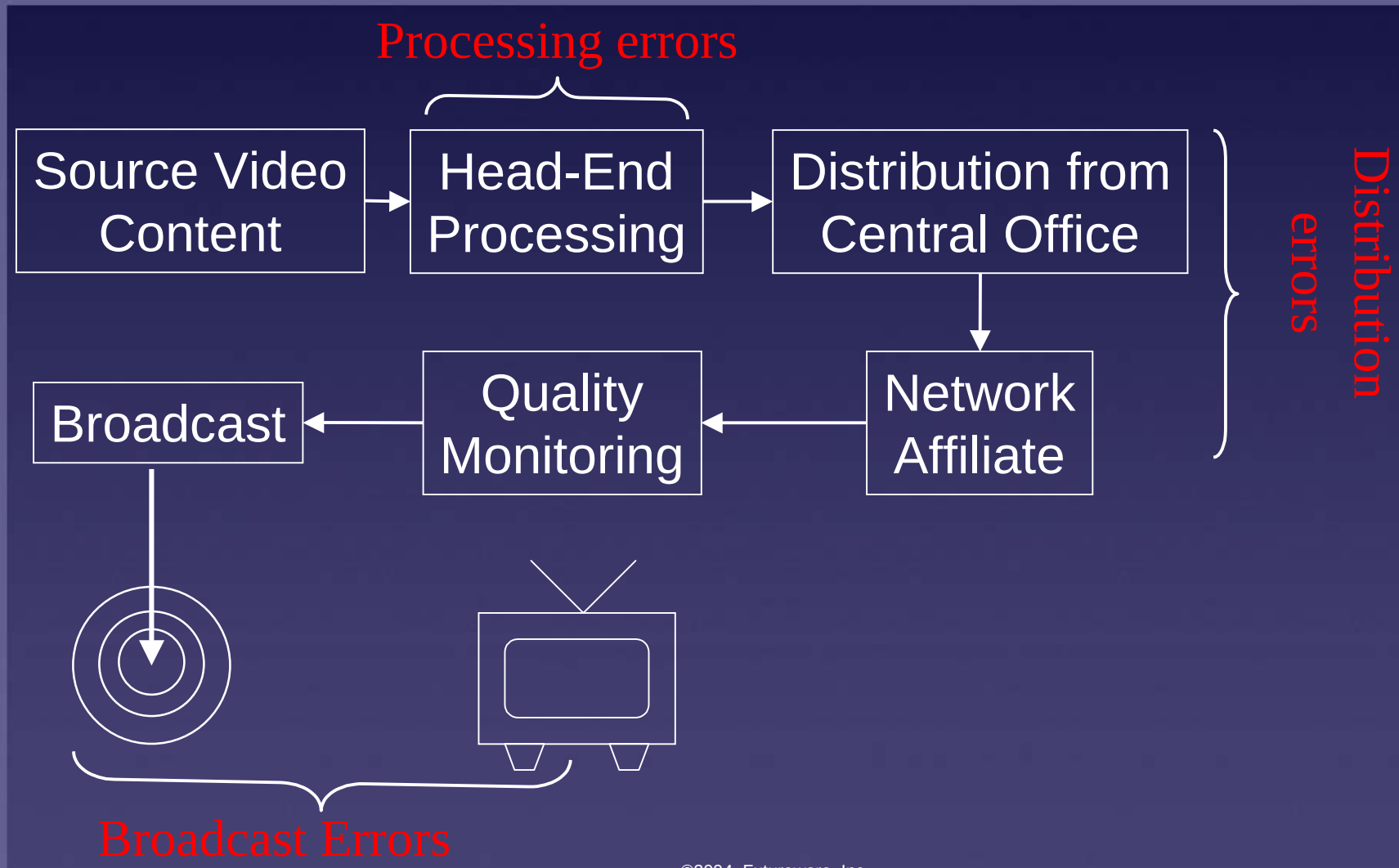
Case Study: Broadcast Quality Monitoring

- New requirements result from move to all-digital processing
- Old monitoring paradigms are inadequate
- More accurate monitoring is now possible, and can easily be delivered where needed

Monitoring Analog Transmission

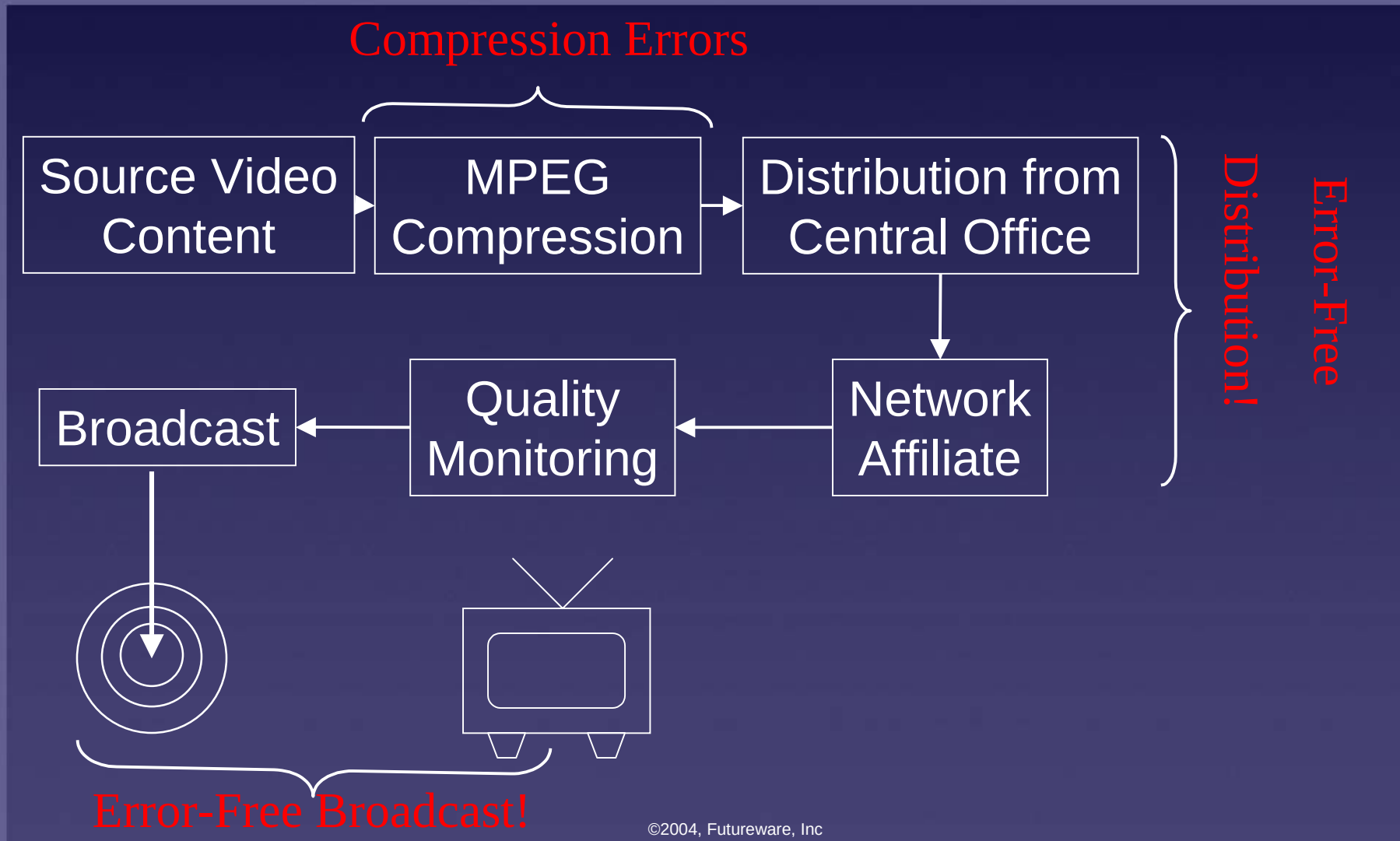


Types of Broadcast Monitoring

Single-ended (No Reference)

- No reference signal needed
- Can only find *expected* artifacts
- No need for synchronization, normalization

Monitoring Digital Transmission

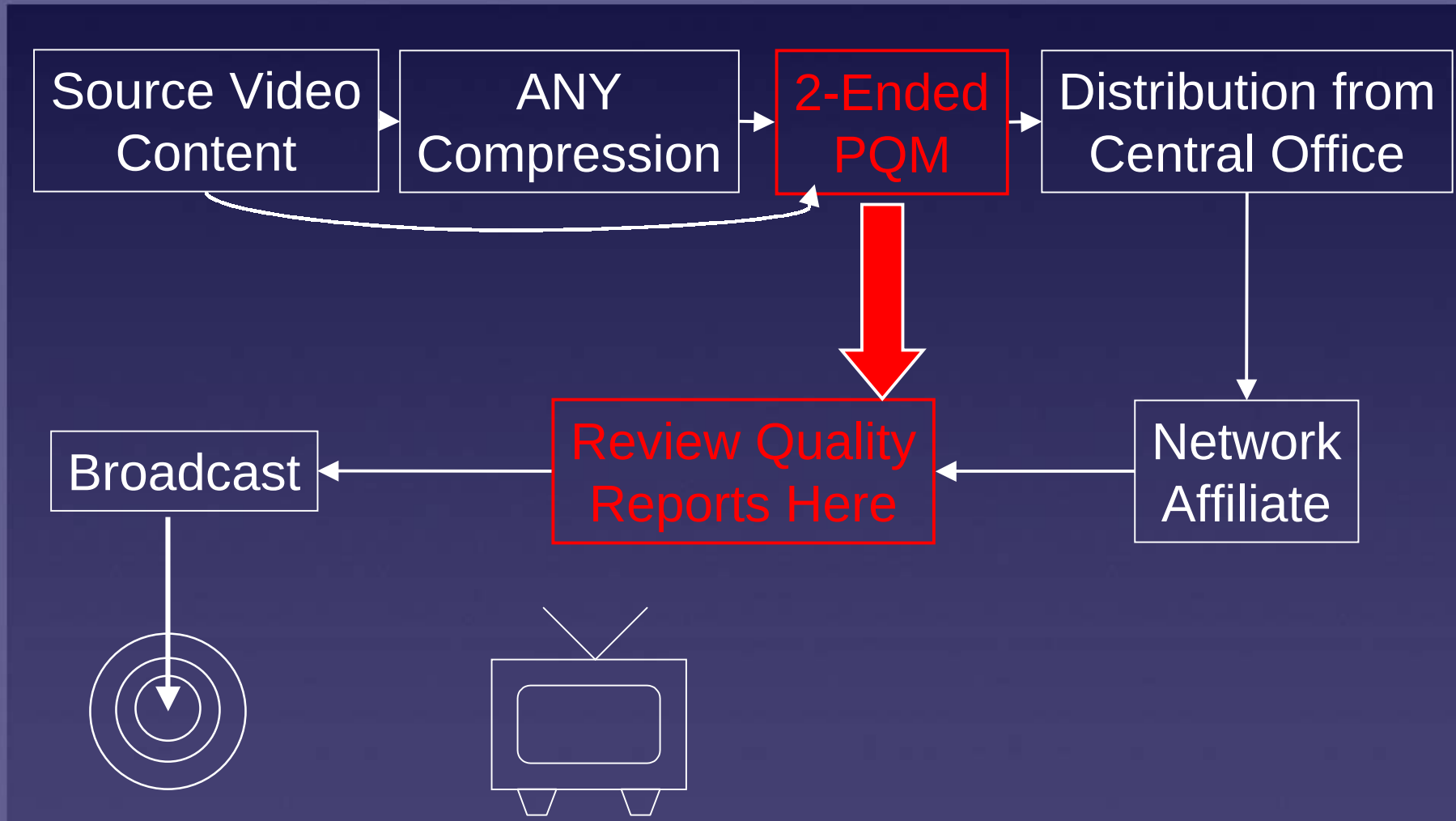


Types of Broadcast Monitoring

"Reduced Reference", "Feature Extraction"

- Can be single- or double-ended
- Extracts *some aspects* of video stream to compare with reference
- May use special MPEG stream information
- Only finds expected artifacts

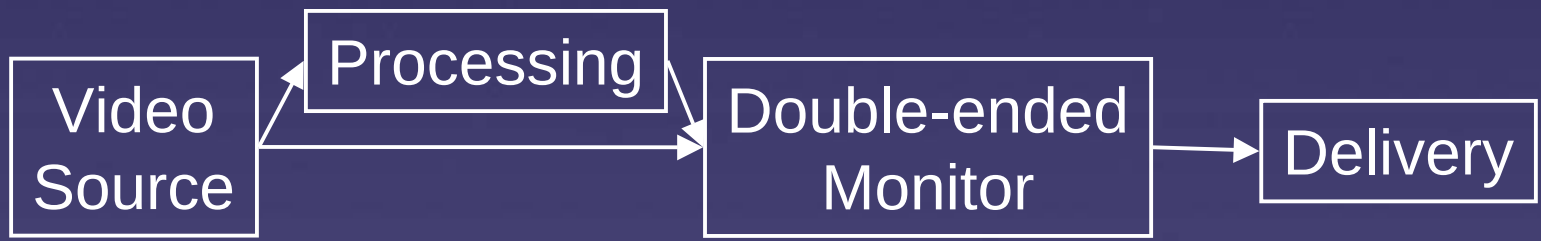
Better Digital Monitoring



Types of Broadcast Monitoring

Double-ended (Full Reference)

- Compares reference signal to test signal
- Synchronization, normalization issues exist
- Can identify *all* errors



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