Image Processing and Visual Communications

Scalable Visual Communications

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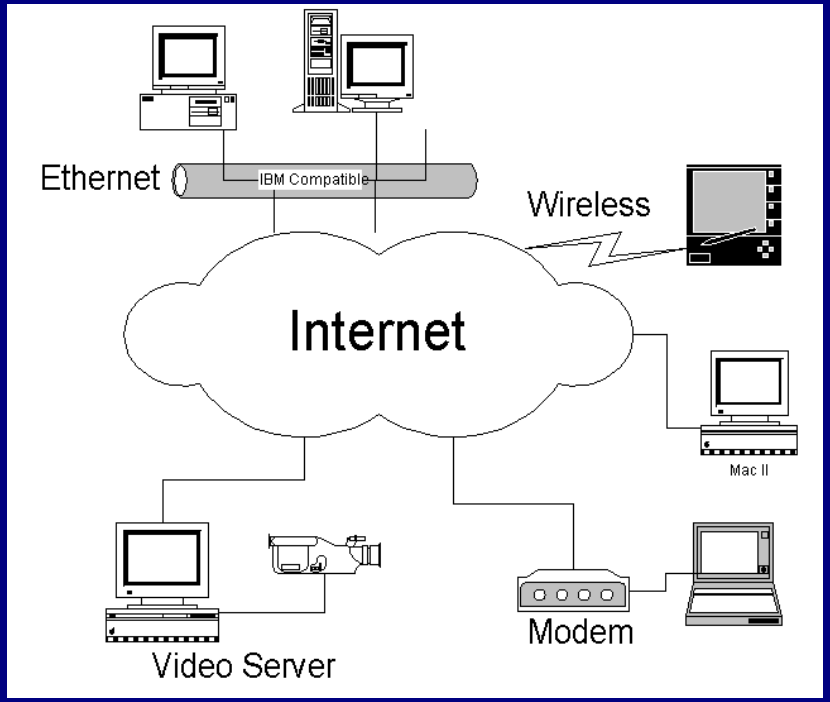
Motivation

- **Challenges of Network Visual Communications**
  - Heterogeneous structure
  - Time-varying network conditions
  - Multi-user
  - Interactive

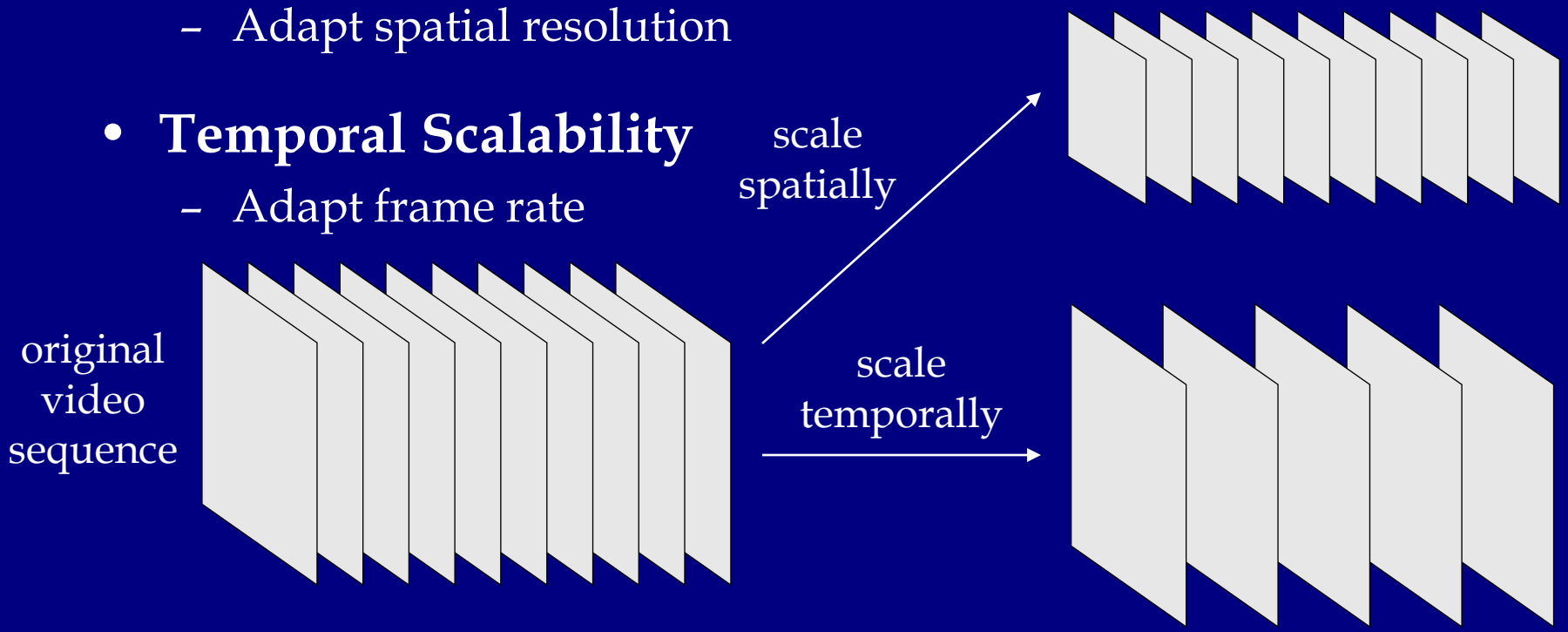
- **Direct Solutions**
  - Repeated encoding
  - Transcoding

- **Limitations**
  - Poor flexibility
  - Poor robustness



Types of Scalability

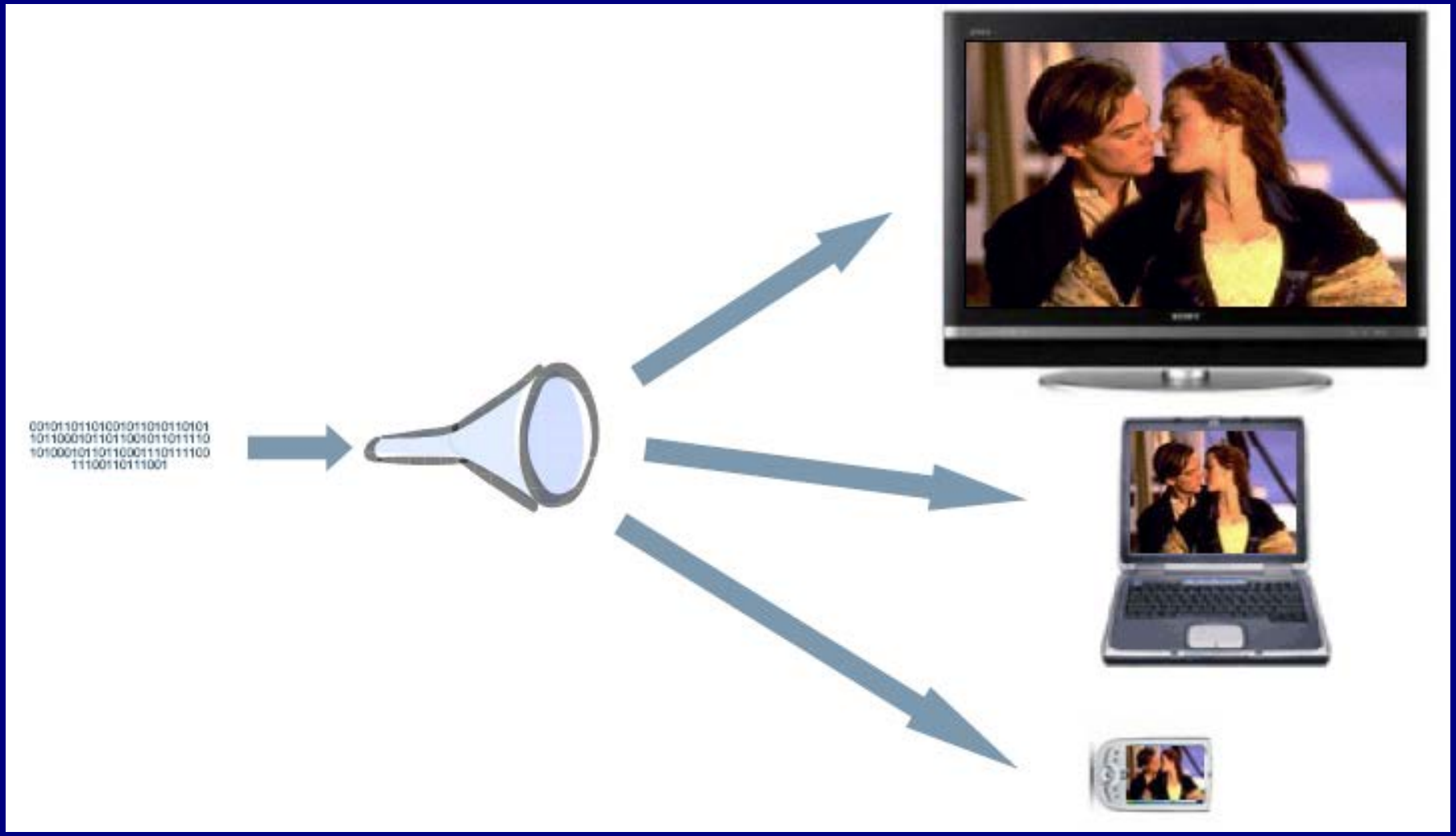
- **Spatial Scalability**
  - Adapt spatial resolution
- **Temporal Scalability**
  - Adapt frame rate



- **Quality/Rate Scalability (SNR Scalability)**
  - Layered coding
  - Continuously rate-scalable coding

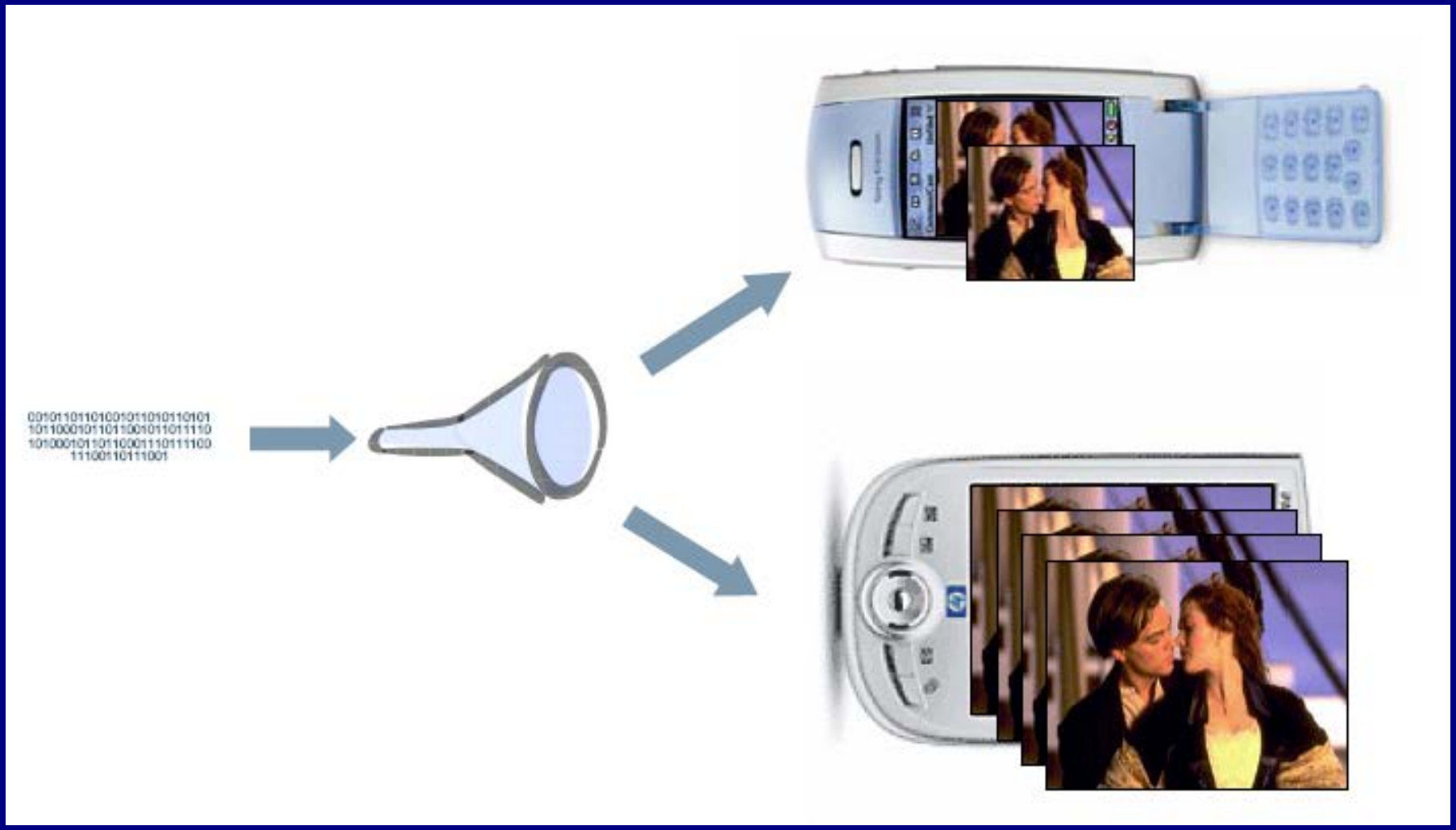
by tradition but
inappropriate terminology

Spatial Scalability



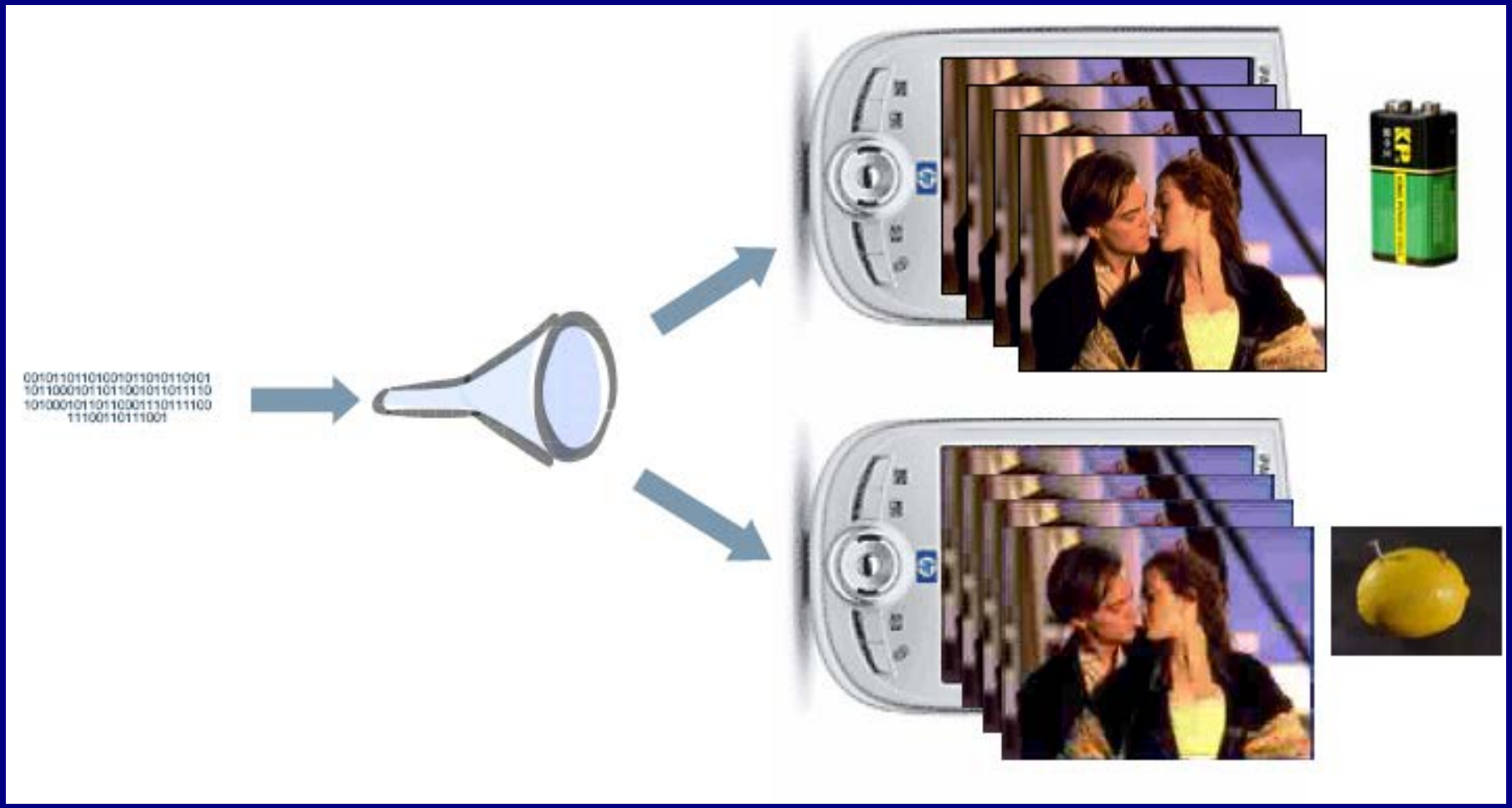
Courtesy: Rahul Panchal

Temporal Scalability



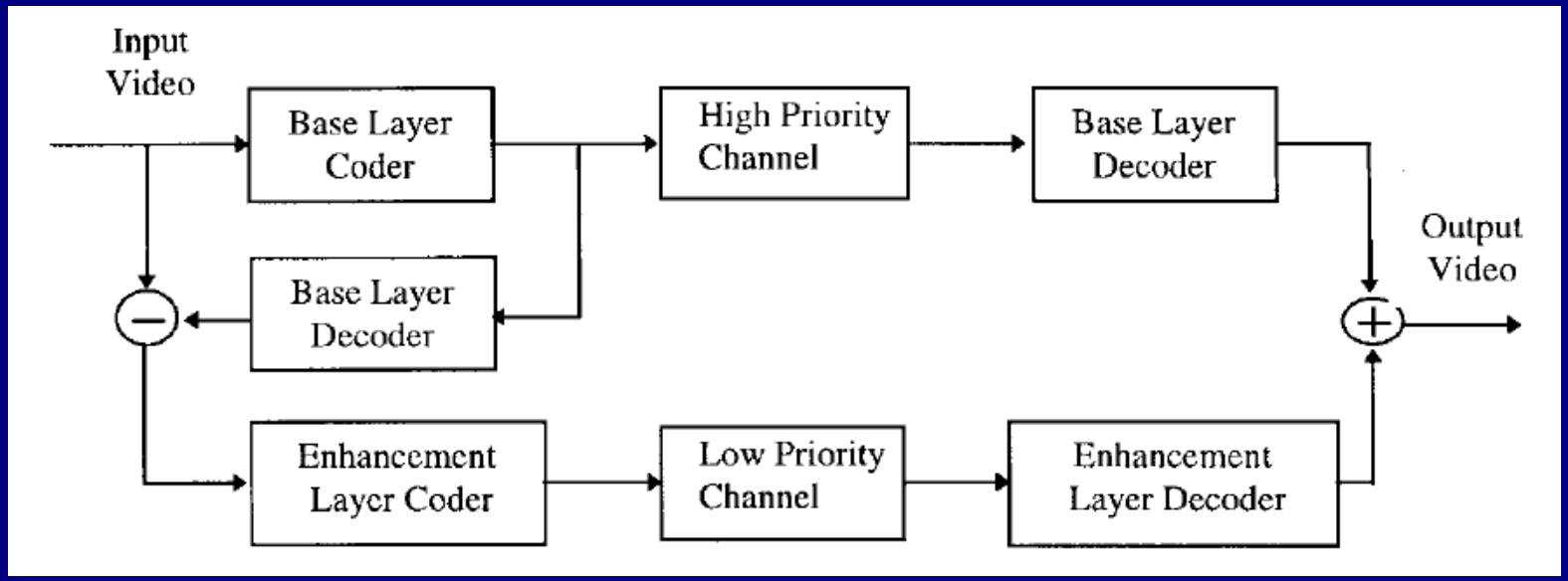
Courtesy: Rahul Panchal

Quality/Rate Scalability



Courtesy: Rahul Panchal

Layered Video Coding

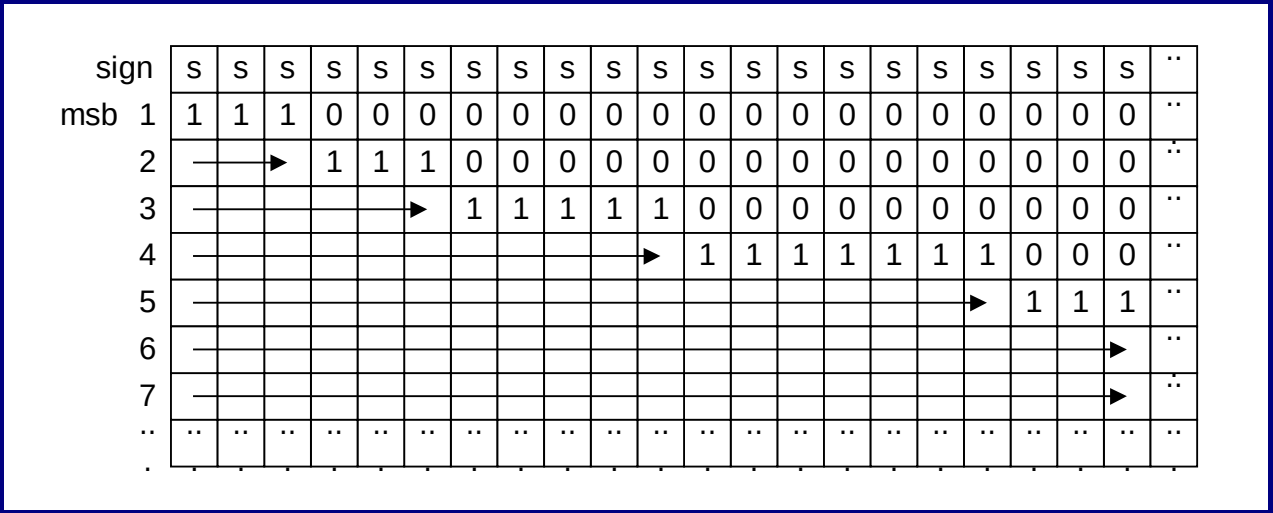


[Wang & Zhu, *Proceedings of the IEEE*, '98]

- **Key Observation**
  - Bits in compressed video streams have highly variable importance
- **Deployment**
  - Send through separate channels of different reliability
  - Send through the same channel but with unequal error protection
  - Included in many video coding standards (MPEG & H.26X)

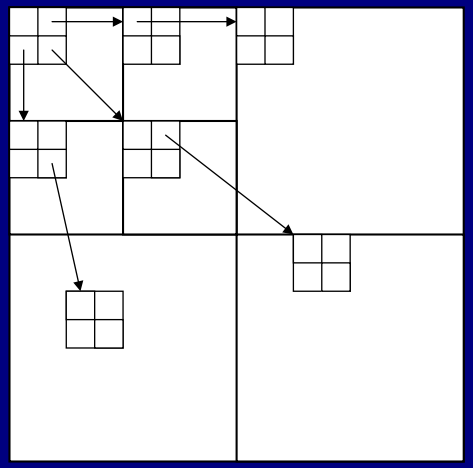
Continuously Rate-Scalable Image Coding

- **Bitplane Coding**



Bitplane representation of wavelet coefficients

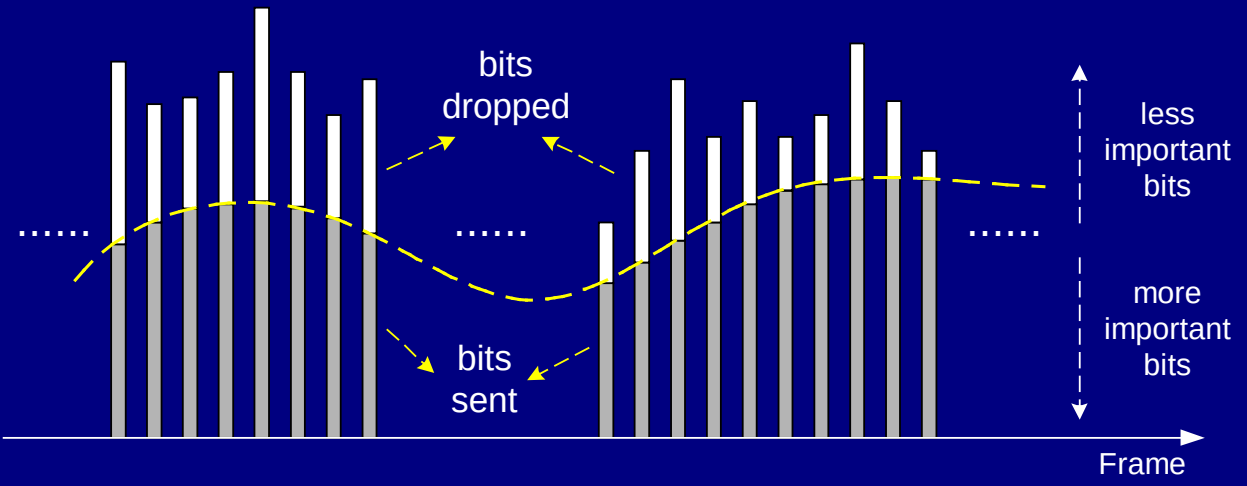
- **Existing Algorithms**
  - Embedded Zerotree Wavelet (EZW)
  - Set Partitioning In Hierarchical Trees (SPIHT)
  - JPEG2000



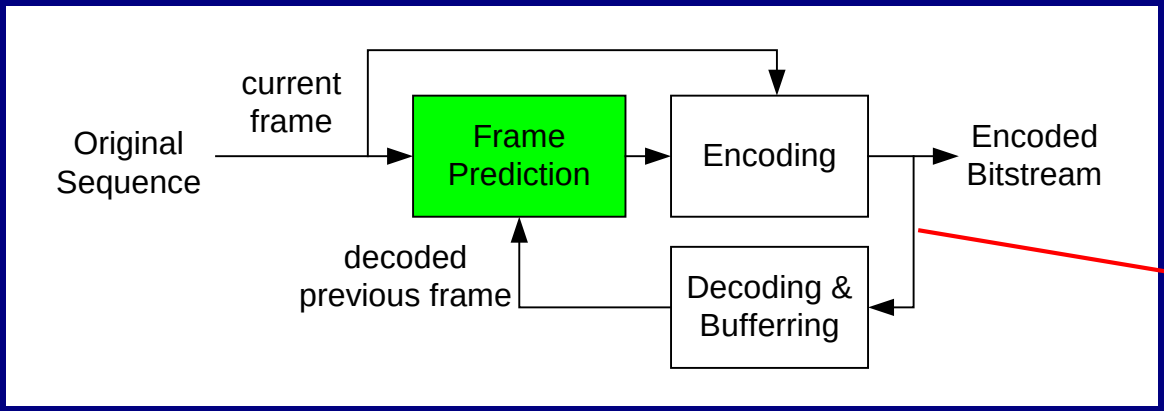
coefficient tree structure

Continuously Rate-Scalable Video Coding

- **Ideal Implementation**



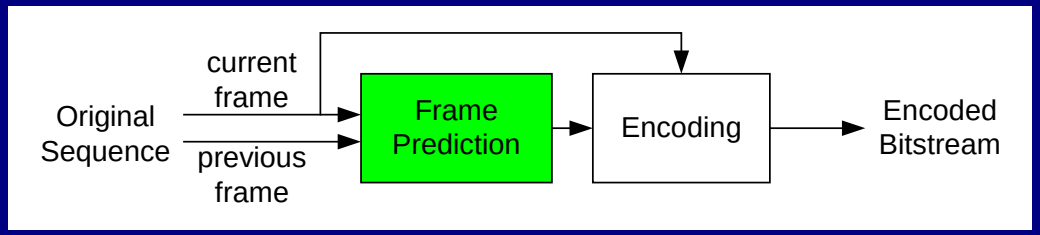
- **Frame Prediction Problem**



but the decoding bit rate is unknown?!

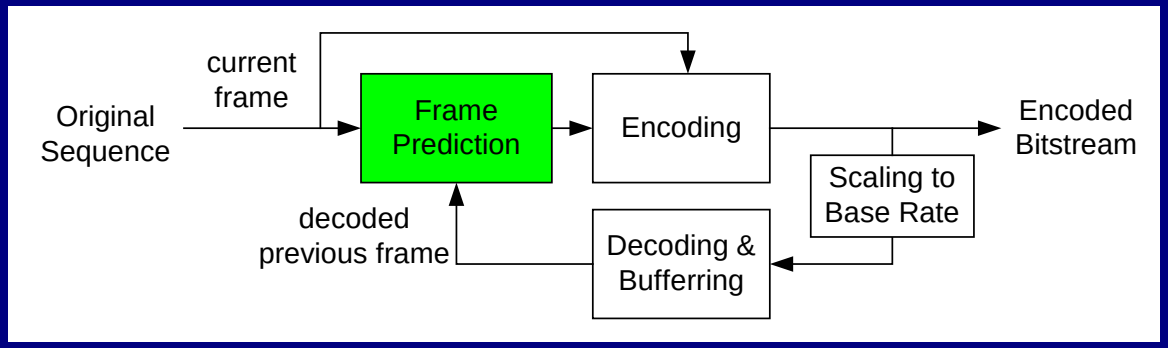
Continuously Rate-Scalable Video Coding

Solution 1



prediction from original previous frame

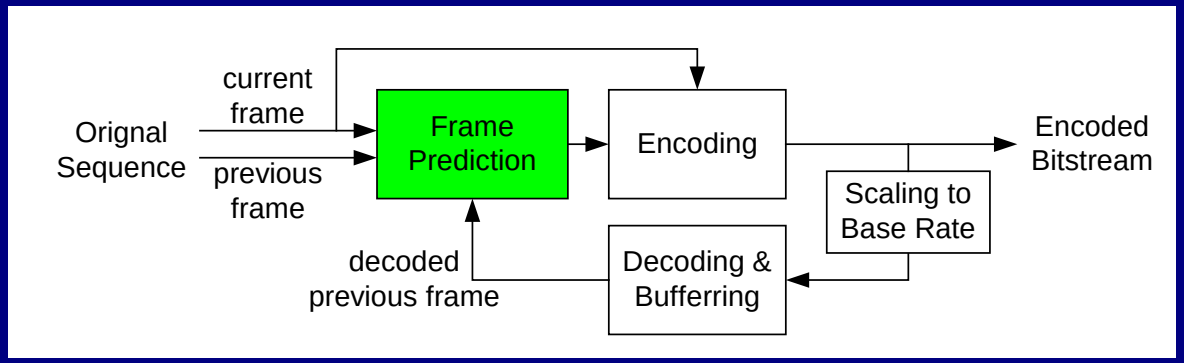
Solution 2



prediction from base-rate decoded previous frame

[Shen & Delp ‘99]

Solution 3



prediction from both original and base-rate decoded previous frame

[Wang *et al.* ‘03]