

# Wavelet Compression of Network Measurements

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# Overview

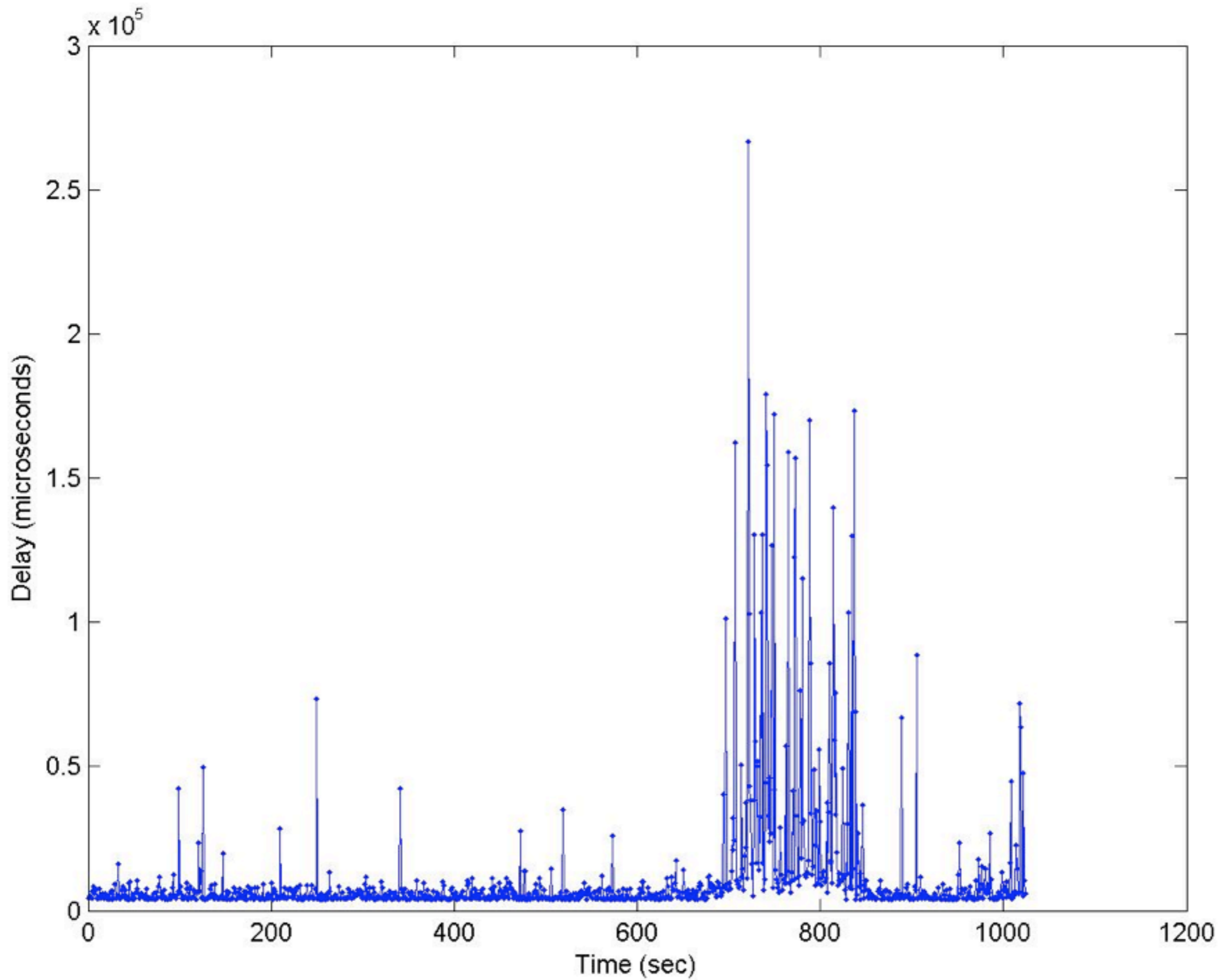
- The problem we try to solve
- How Wavelets have been used
- Reasons for choosing Wavelets
- Achieving compression
- Simulation – Practical Results

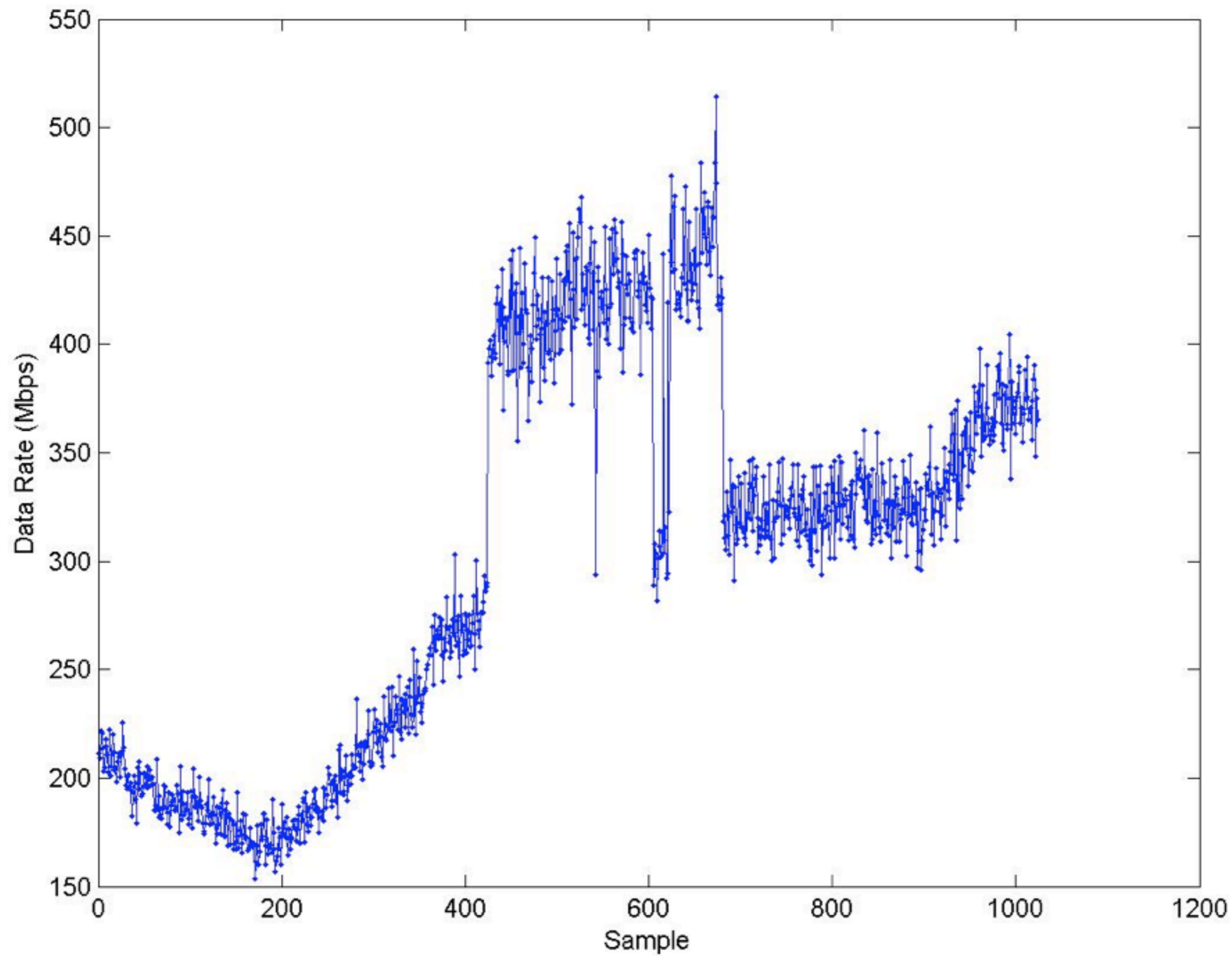
# Aims

- Monitor UKLight
- Archive and store huge amounts of data
- Compress data but ...
- Keep important features of signals

# Benefits

- Useful for researchers, administrators
  - Examine network's behavior
  - Store statistics describing network
  - Look back in history





# Wavelets and Computer Networks

- In general: Detect Network Performance Problems
- WT on traffic rate: Infer RTT
- WT on one-way delay: Detect shared congestion

# Why Wavelets ?

- Varying window: adapts to various time-scales and performs local analysis
- Finite nature: Better analysis non-stationary signals
- Better Signal Energy compaction
- Compression can be varied



# Achieving compression

- Wavelet analysis is not a compression tool
- Transforms data to the Wavelet domain
- WT coefficients (coefs.) more eligible to compression



- Small coefs.:

- Attributed to noise of signal, i.e. detail characteristics of signal.

- Small percentage of signals total energy

- Can be discarded with no significant loss in quality

- Large coefs.:

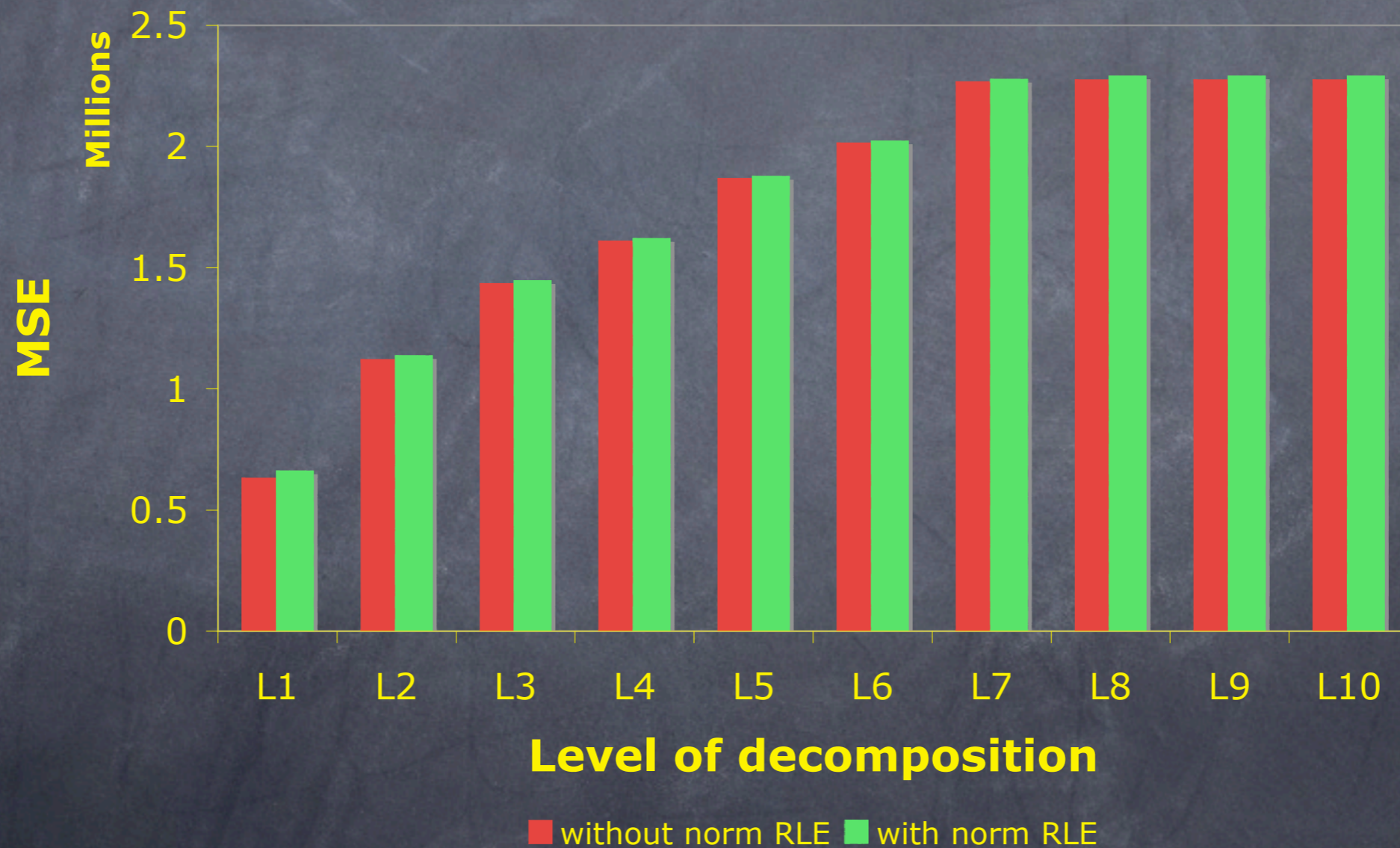
- Represent important characteristics

- Should be kept to preserve quality

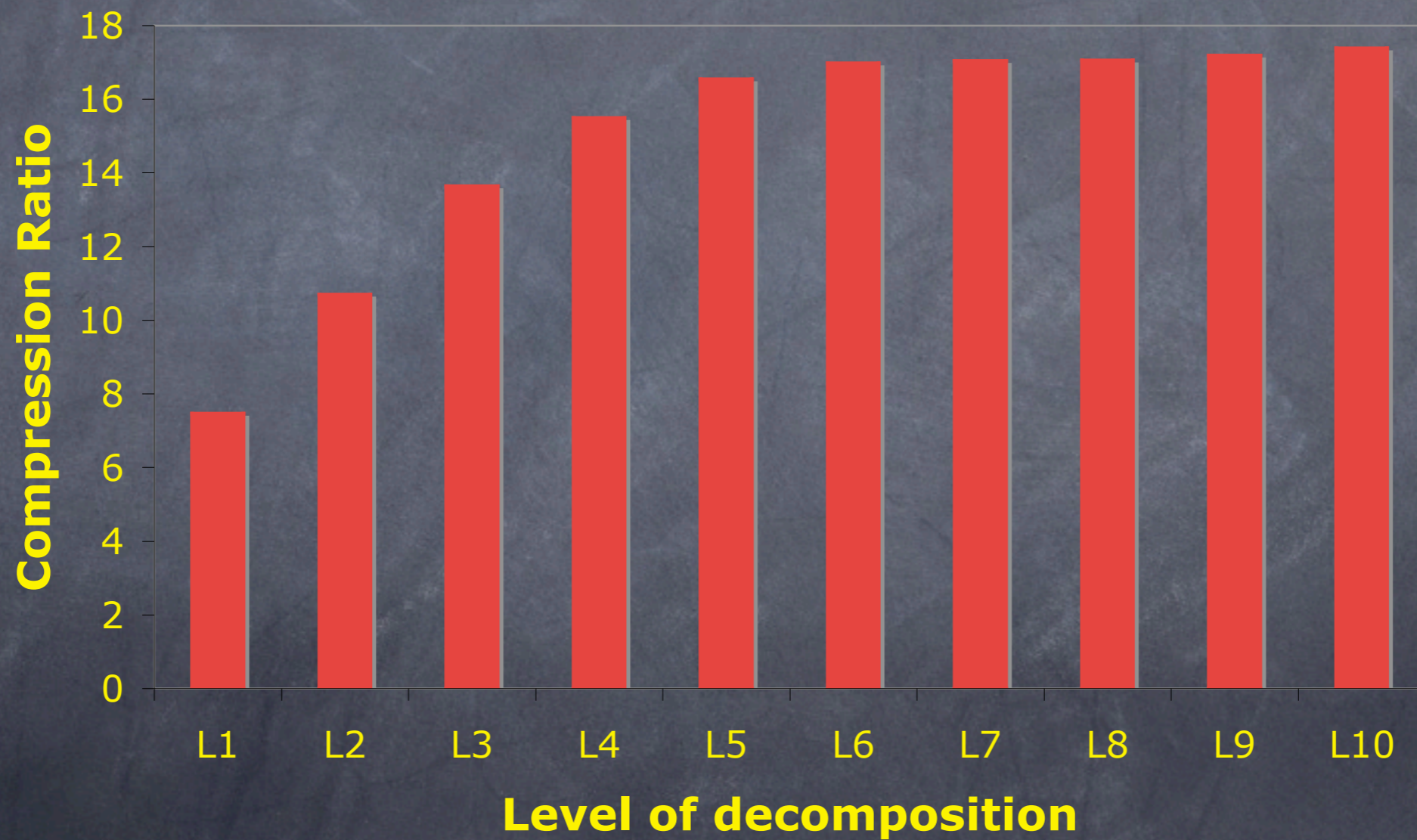
# Threshold selection

- Most research focused on signal de-noising
- Need a Threshold selection depending on the value of coefs.
  - Calculate  $\sigma$ ,  $\mu$  of non-zero coefs.
    - If  $\sigma > \mu$ ,  $T=2\mu$
    - else  $T= \mu-\sigma$

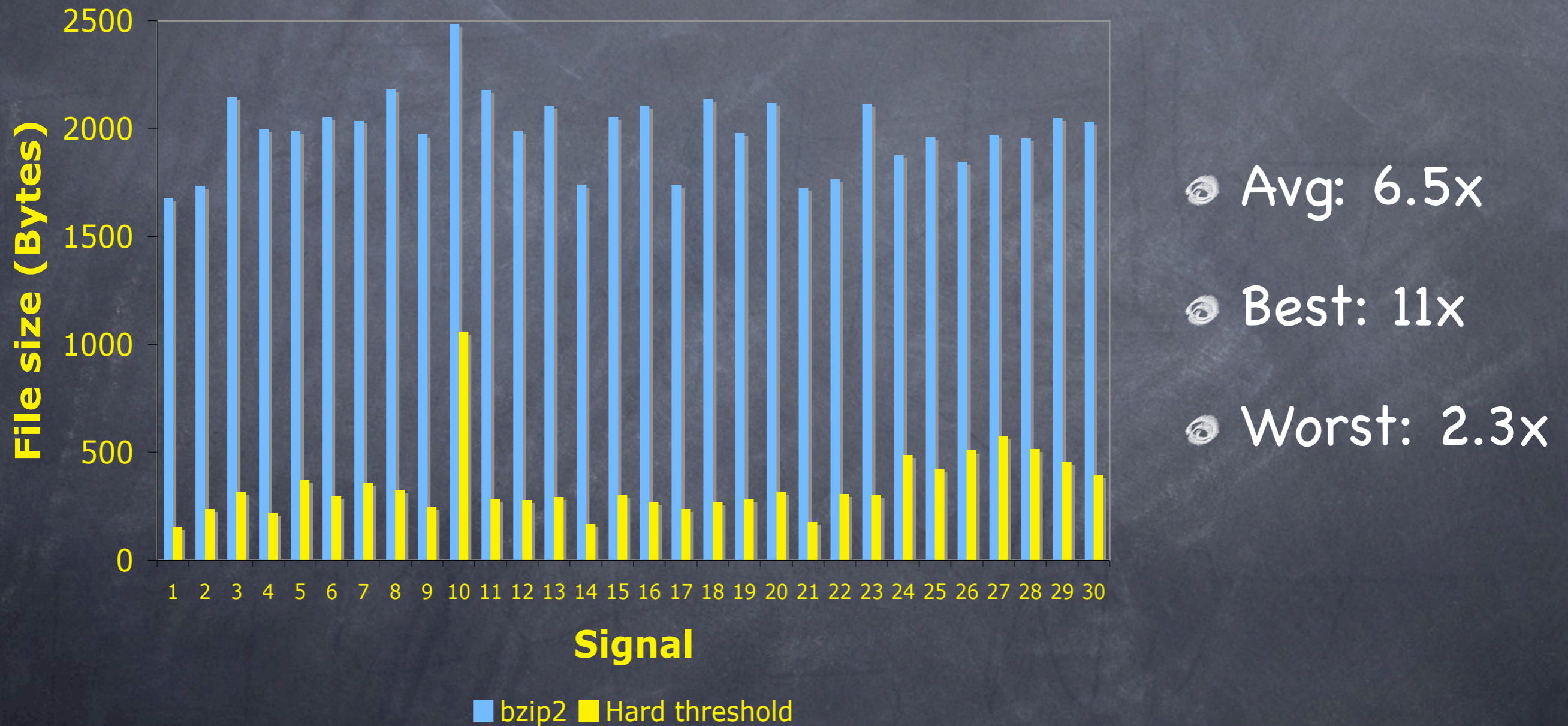
# Delay Reconstruction Results



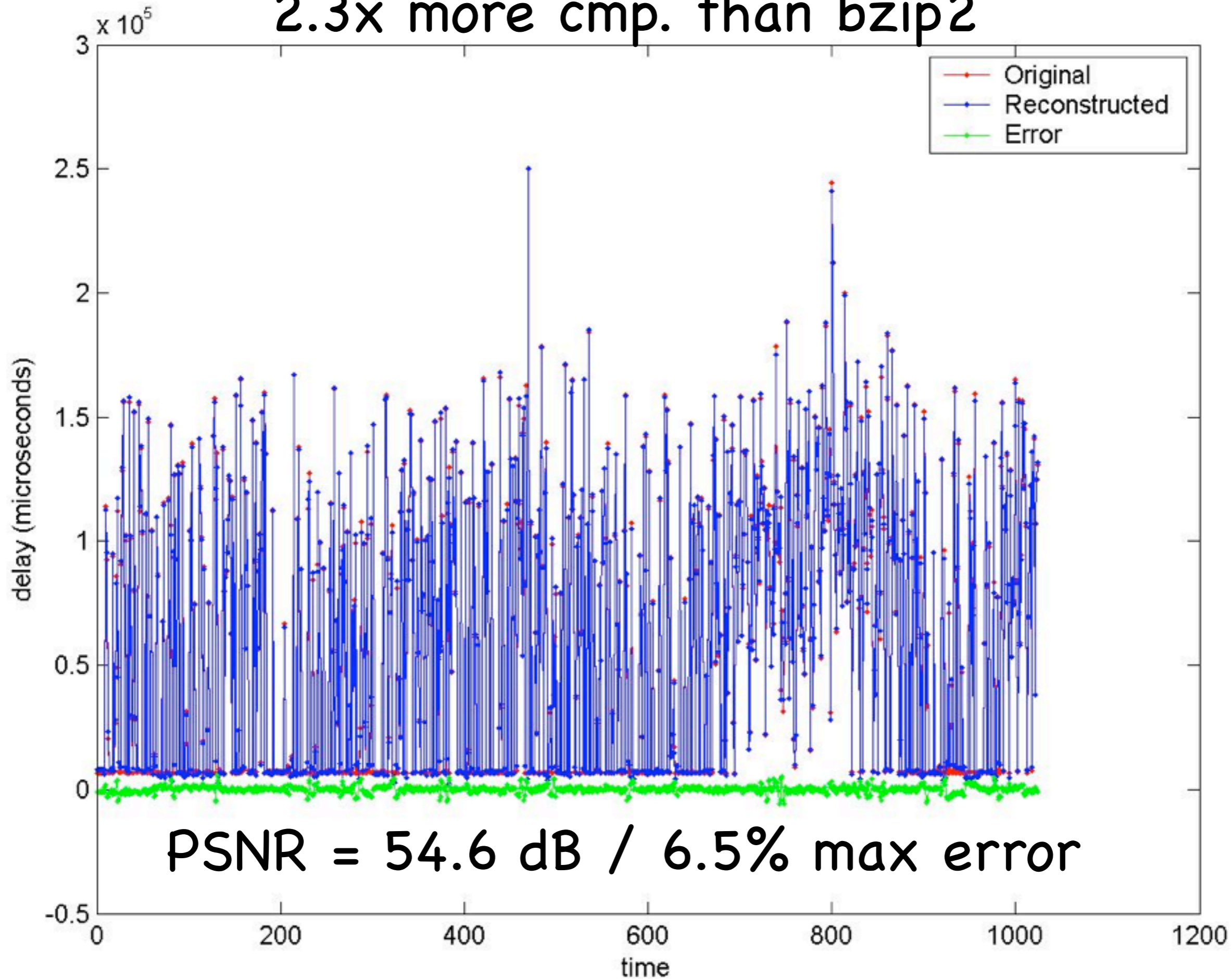
# Delay Reconstruction Results



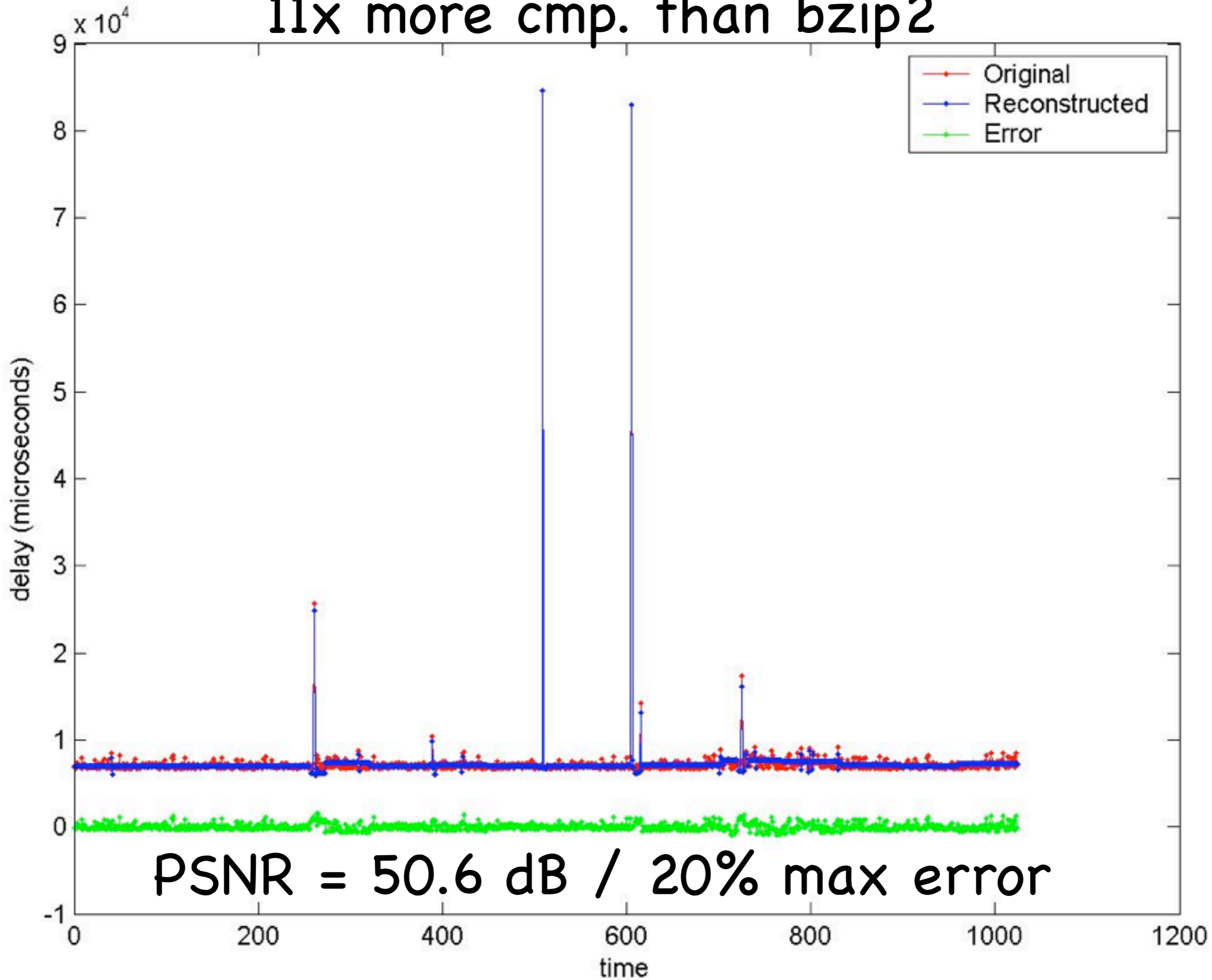
# Delay signals: WT vs bzip2



# 2.3x more cmp. than bzip2

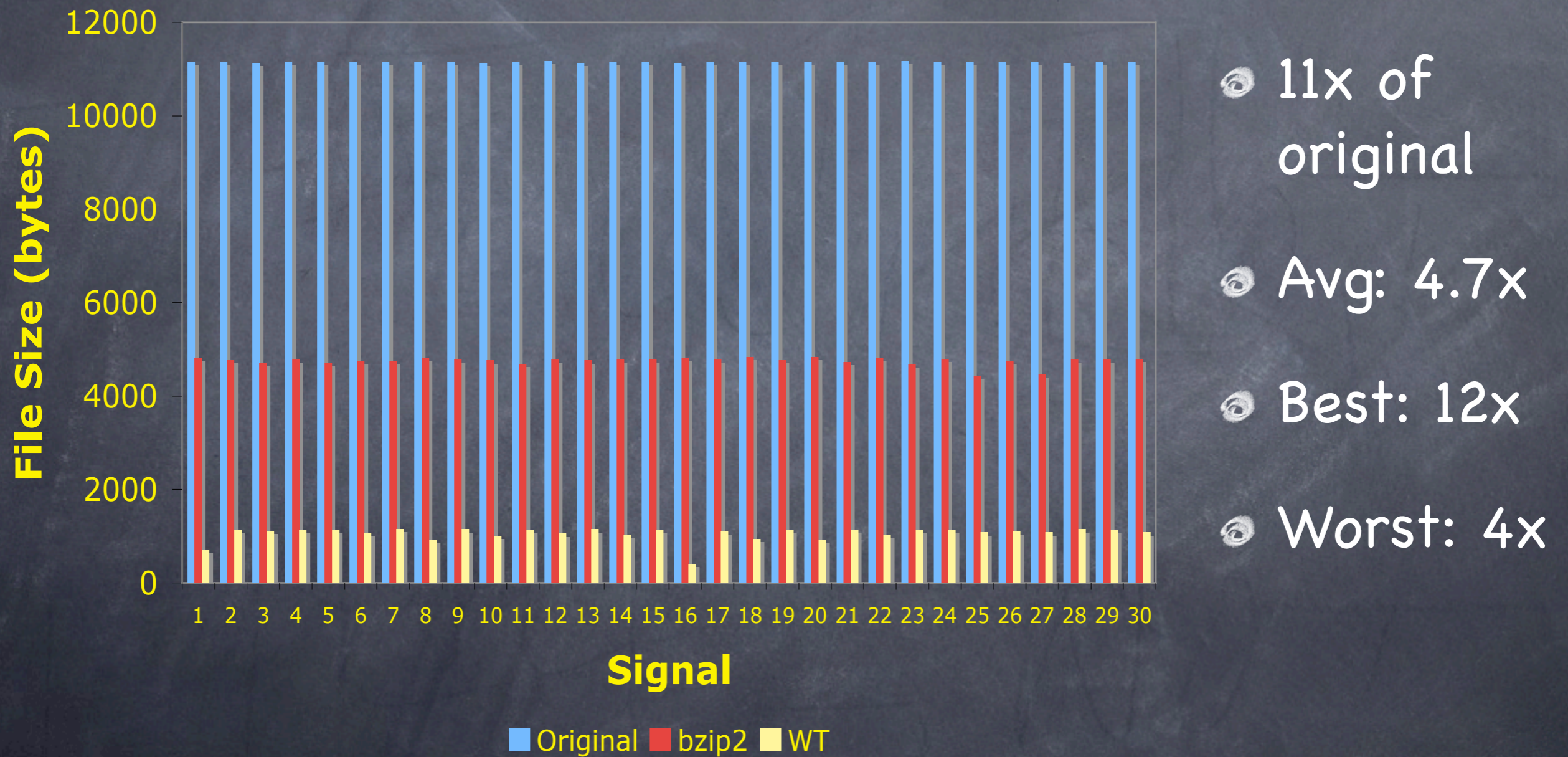


# 11x more cmp. than bzip2

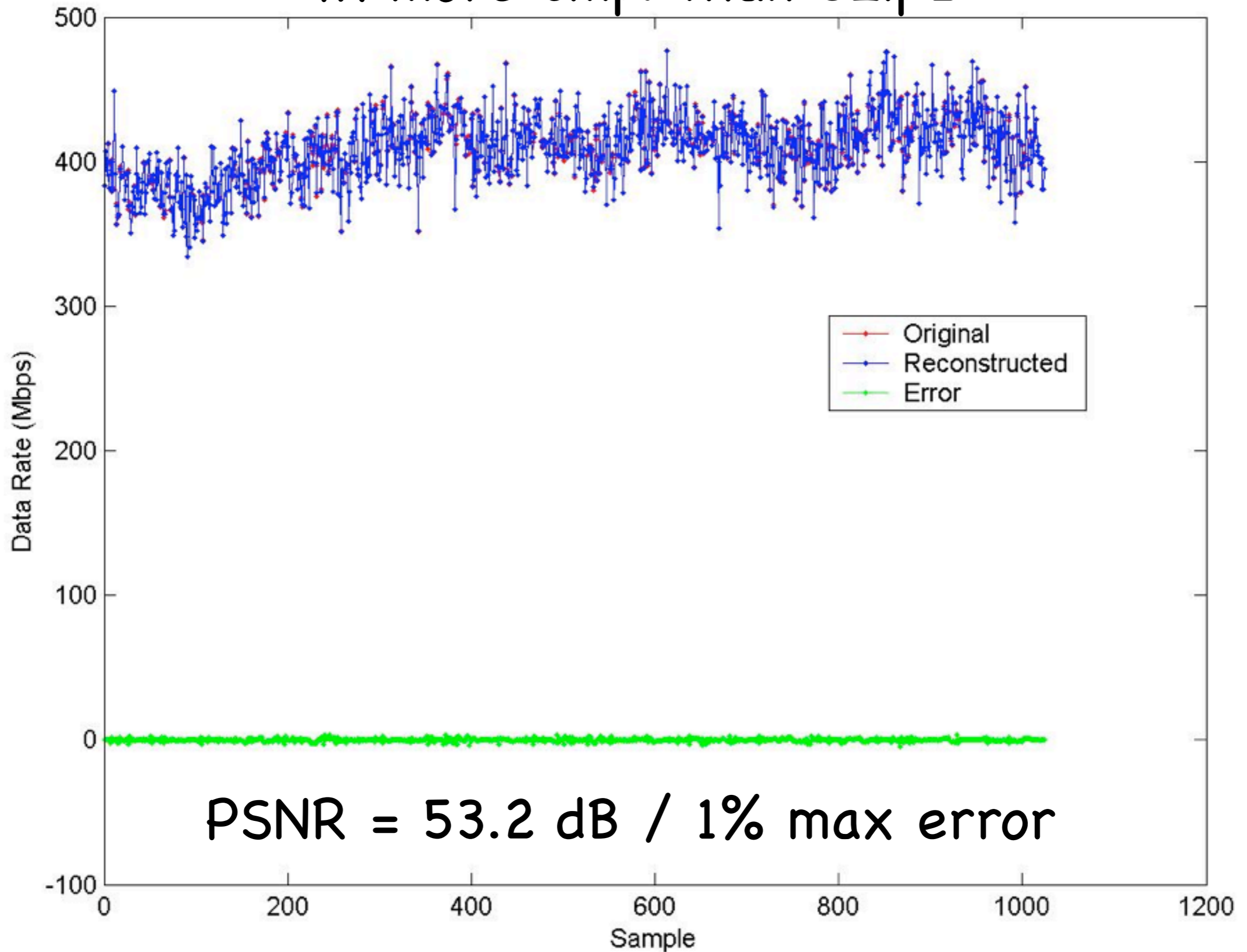




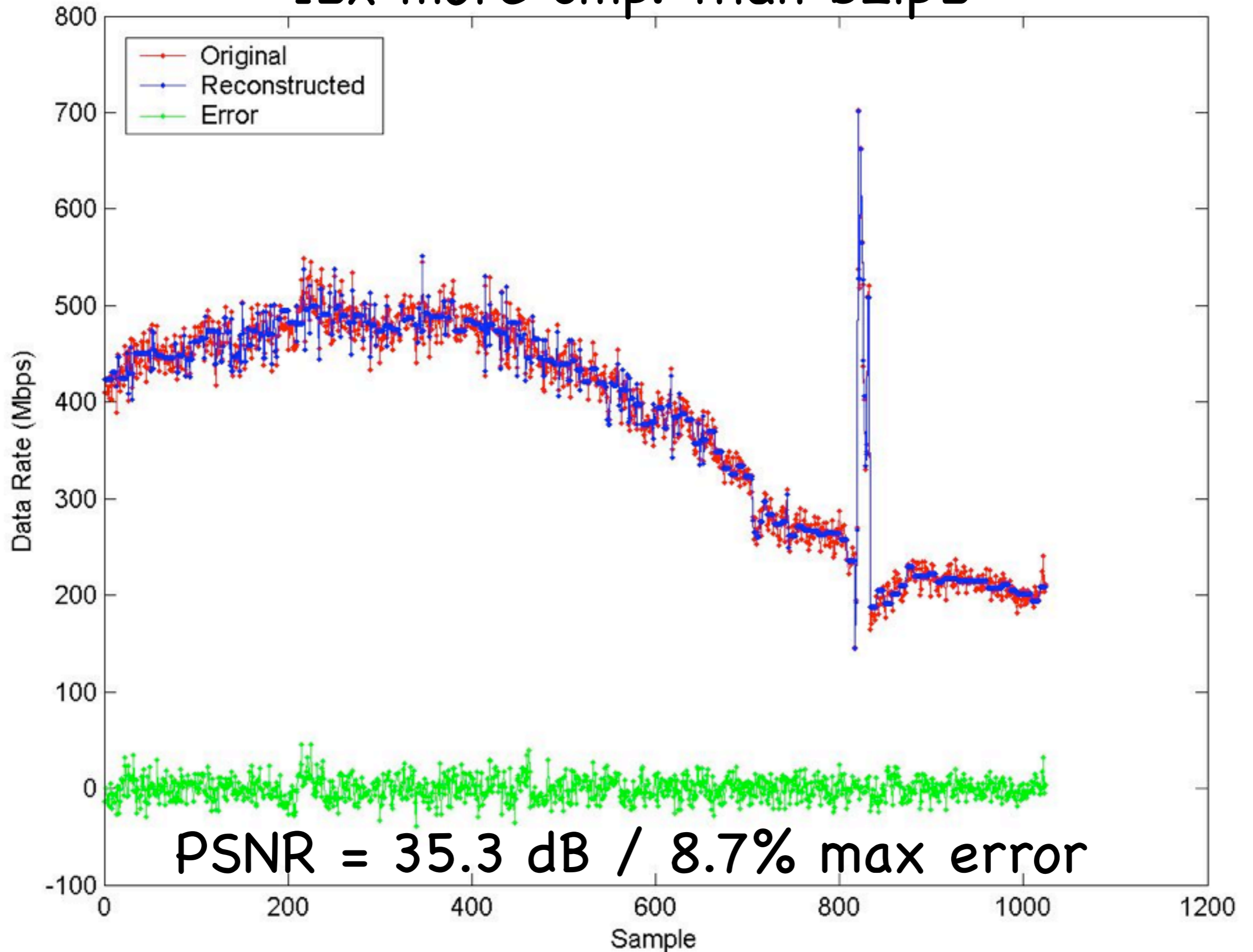
# Data rate: WT vs bzip2



4x more cmp. than bzip2

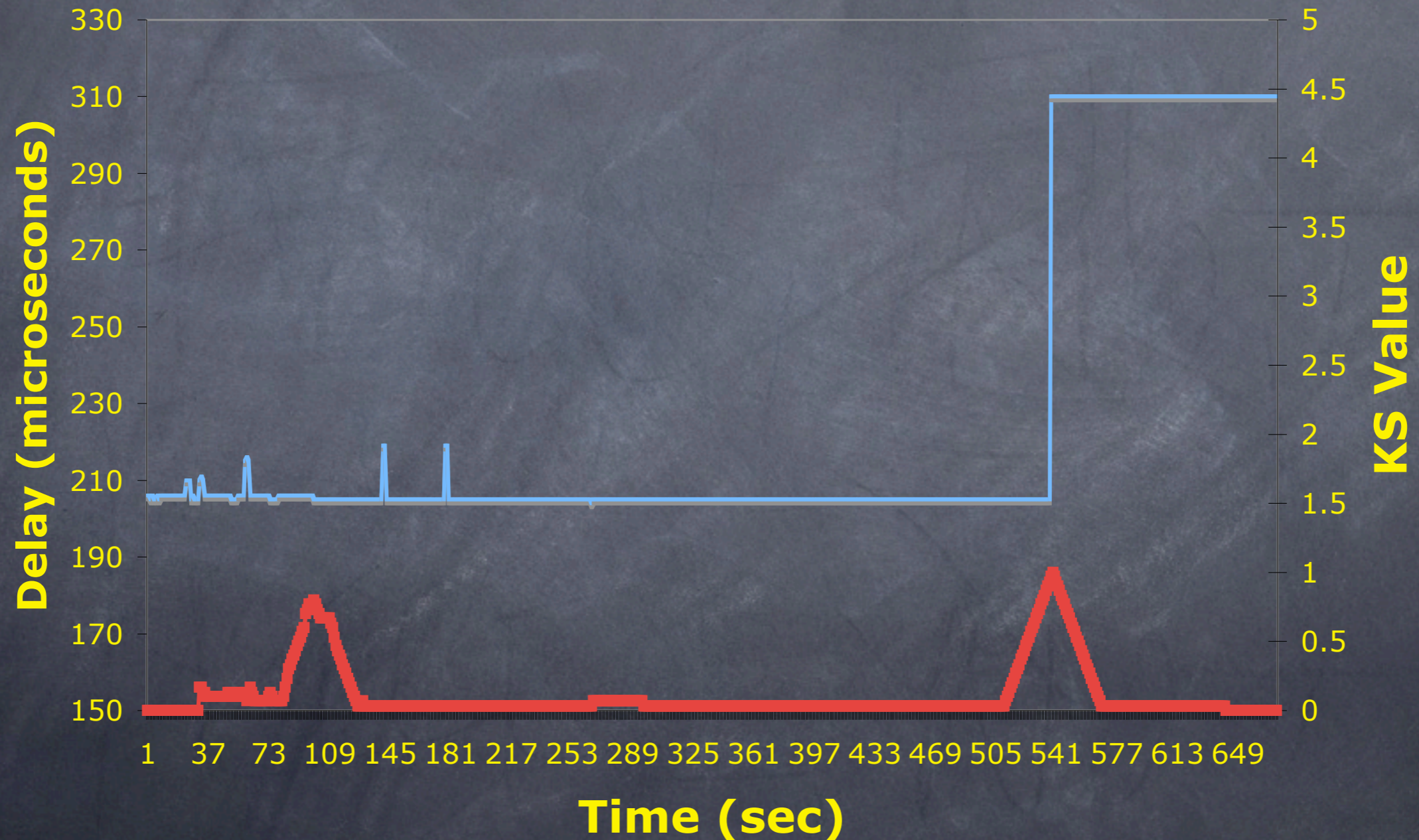


# 12x more cmp. than bzip2



PSNR = 35.3 dB / 8.7% max error

- More control over threshold
- KS test can detect changes in signals

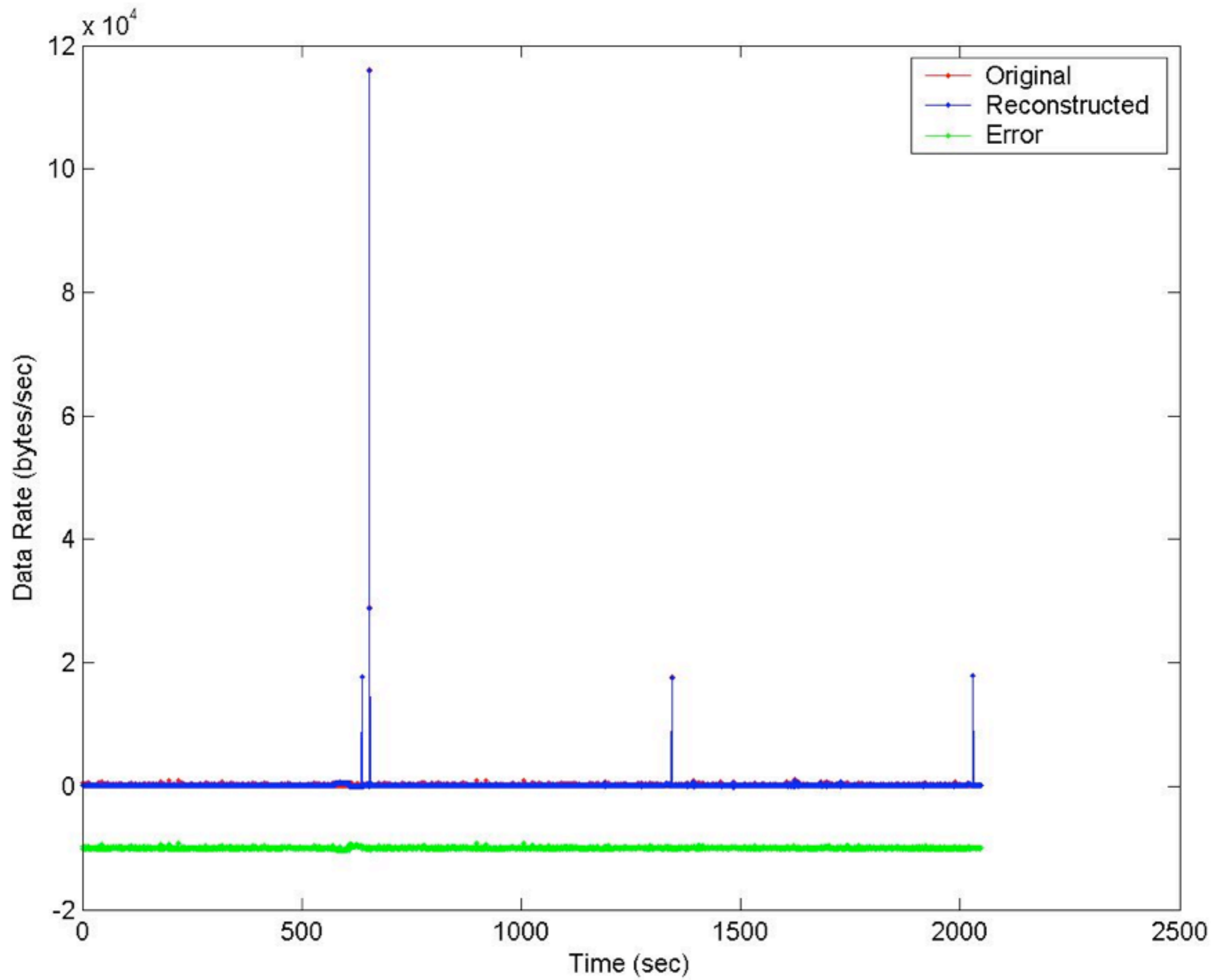


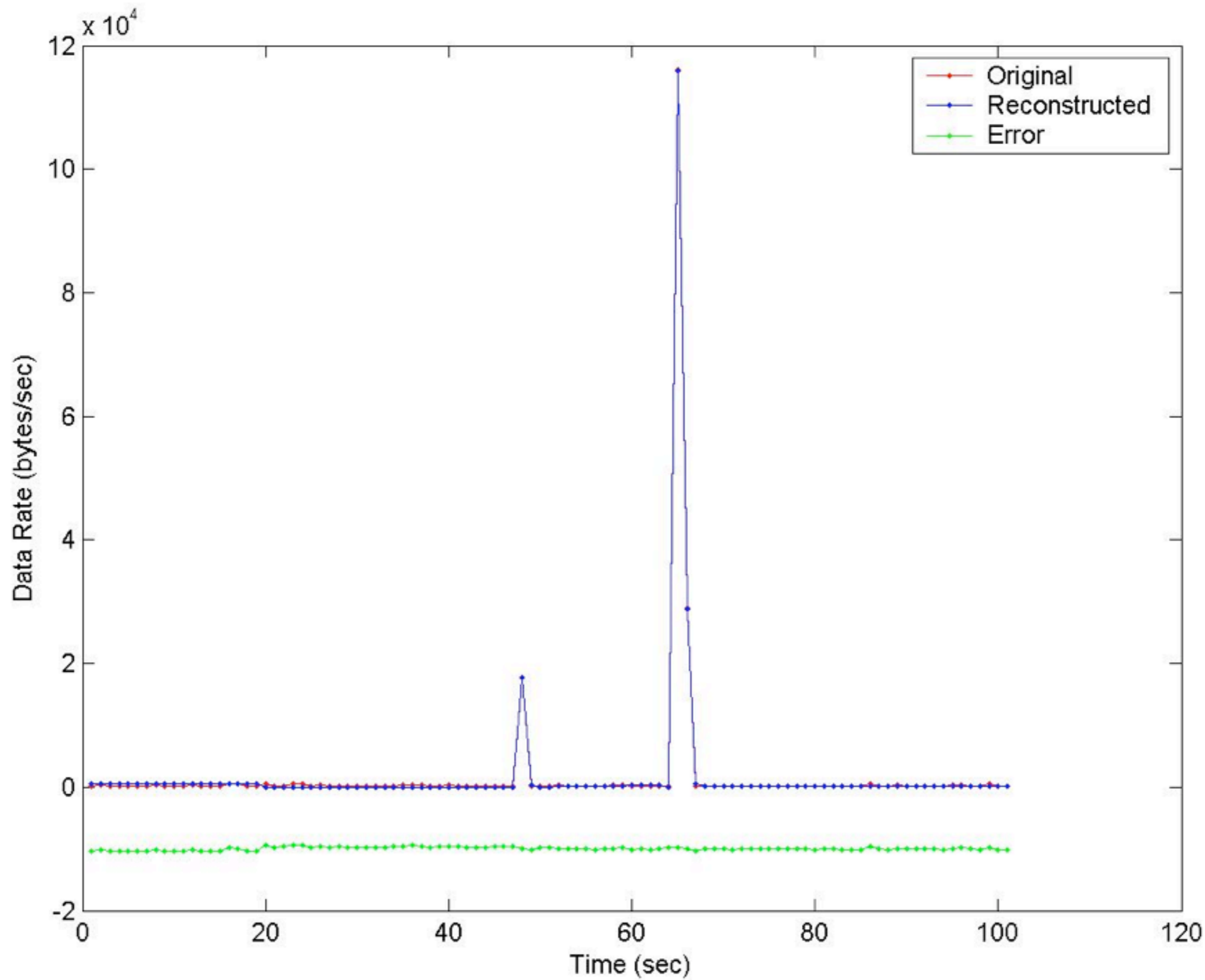
# WT in CoMo

- Full algorithm implemented in CoMo
- CoMo: Passive Monitoring platform
- Monitors network links at high speeds
- Replies to Real Time queries
- Compresses CoMo measurements
- When queried, decompresses data

# Traffic Module Results

- Compared two versions of Traffic module
- Both modules count bytes/sec + timestamp
- Only one had WT compression
- Independent of link's speed
- After 9 days, C.R. = 38.5:1







Thank you

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