Efficient Error Estimating Coding: Feasibility and Applications

Binbin Chen, Ziling Zhou, Yuda Zhao & Haifeng Yu

Presented by Qingxi Li
Outline

- Motivation
- Application
- Algorithm
- Related Work
Outline

- Motivation
- Application
- Algorithm
- Related Work
Motivation

- **Flips:**
  - 0 -> 1 or 1 -> 0

- **Traditional solution – drop packet**
  - The application can or should use completely correct packets
  - Wastes time and bandwidth

- **Partially correct packets can be used**
  - Incremental redundancy from the source to recover the packet
Motivation

By Yunhao Liu (COMP 362 course, 2008 Fall)
Motivation

- Flips:
  - 0 -> 1 or 1 -> 0
- Traditional solution – drop packet
  - The application can or should use completely correct packets
  - Wastes time and bandwidth
- Some partially correct packets can be used
  - Incremental redundancy from the source to recover the packet
  - Directly use the partial packets, like in video
Motivation

- Not all the partially correct packet can be used
  - Determined by Bit Error Rate (BER)
  - Drop if Bit Error Rate (BER) over some threshold
  - Still have bandwidth & time waste
- Goal of this paper: Estimate the bit error rate
Outline

- Motivation
- Application
  - Server side
  - Client side
- Algorithm
- Related Work
Application

- Senders
  - Transmission rate, channel, power ...
  - Trade off
    - High transmission rate => high throughput & high lost/error rate
Application

- Client
  - Packet retransmission
Application

- Client
  - Packet retransmission
  - Packet forwarding priority
    - Emergency response in WSN
Outline

- Motivation
- Application
- Algorithm
- Related Work
Algorithm

- Encoding (client side):
  - $\log_2 n$ levels & $s$ bits.
  - For level $i$, randomly choose $2^i - 1$ bits to calculate parity bit, repeat $s$ times.
    - Parity bit: even parity bit & odd parity bit
Algorithm

- Estimating (server side):
  - Assume EBR is in \([a, b]\) \((a=0, b=\frac{1}{4})\)

```

1: for \(i = 1\) to \(i = \lfloor \log_2 n \rfloor\) do
2:     Compute the fraction \((q_i)\) of parity bits at level \(i\) that fail
     parity check;
3:     if \(q_1 \geq c_2\) then
4:         Output \(\hat{p} = \frac{1}{4}\) and exit;
5:     end if
6:     if \(c_1 < q_i < c_2\) then
7:         Output \(\hat{p} = \frac{q_i}{2^i}\) and exit;
8:     end if
9: end for
10: Output \(\hat{p} = 0\) and exit;
```
Algorithm

- Time complexity
  - \( s \sum 2^i = O(sn) = O(n) \) (both decoding and encoding)

- Increasing packet size
  - \( s \log_2 n = O(\log n) \)
  - For some application only want to know whether EBR exceeds \( a \), we only care about the level \( i \) s.t. \( a \in [2^{-i-1}, 2^{-i}] \)
    - \( 2\% \) of the packet size
Outline

- Motivation
- Application
- Algorithm
- Related Work
  - Efficient Channel-aware Rate Adaptation in Dynamic Environments
  - Simple Adaptive Relaying Protocol for Wireless Relay Networks
Efficient Channel-aware Rate Adaptation in Dynamic Environments

- Optimal transmission rate depends on environment
  - Higher transmission rate increase throughput & reduce the transmission time
  - ...but reduces the range at which the transmission can be successfully decoded
- How to pick the optimal transmission rate
  - Static channel
    - Trail-and-error
  - Dynamic channel (vehicle, mobile)
    - Properties of the channel change quickly
Efficient Channel-aware Rate Adaptation in Dynamic Environments

- Successful packet transmission determined by signal-to-interference and noise ratios (SINR)
- SINR determined by
  - received signal strength (RSS)
  - Noise & interference
- Measurement
  - Sender’s RSS – RSS indicator
  - Receiver’s noise level
  - Receiver’s transmission power
Efficient Channel-aware Rate Adaptation in Dynamic Environments

- Estimate path loss
  - Path loss is the energy reduce during transmission
  - $\text{path loss} = \text{receiver's transmit power} - \text{sender's received signal strength}$
- Predict the path loss in the future
- Estimate SINR at receiver
  - $\text{RSS} = \text{transmit power} - \text{path loss}$
  - Noise level measured by receiver
- For each transmission rate, determine a good possible SINR by history of successful/fail transmission
- Choose the transmission rate based on the SINR
Simple Adaptive Relaying Protocol for Wireless Relay Networks

- Wireless relay networks
  - Reduced signal transmit power
- Relaying protocols
  - Decode And Forward (DAF)
    - Reduce the noise
    - error propagation if error rate is large
  - Amplify And Forward (AAF)
    - Amplify the noise & won’t suffer error propagation
- Relays can correctly decode the signal will use DAF otherwise AAF
Q & A
Motivation

- **Flips:**
  - $0 \rightarrow 1$ or $1 \rightarrow 0$

- **Traditional**
  - The application can or should use completely correct packets
    - Waster time and bandwidth

- **Current situation**
  - Partially correct packets can be used
    - Incremental redundancy from the source to recover the packet
    - Directly use the partial packets, like in video