Efficient Error Estimating Coding: Feasibility and Applications

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Presented by Qingxi Li

Outline

- Motivation
- Application
- Algorithm
- Related Work

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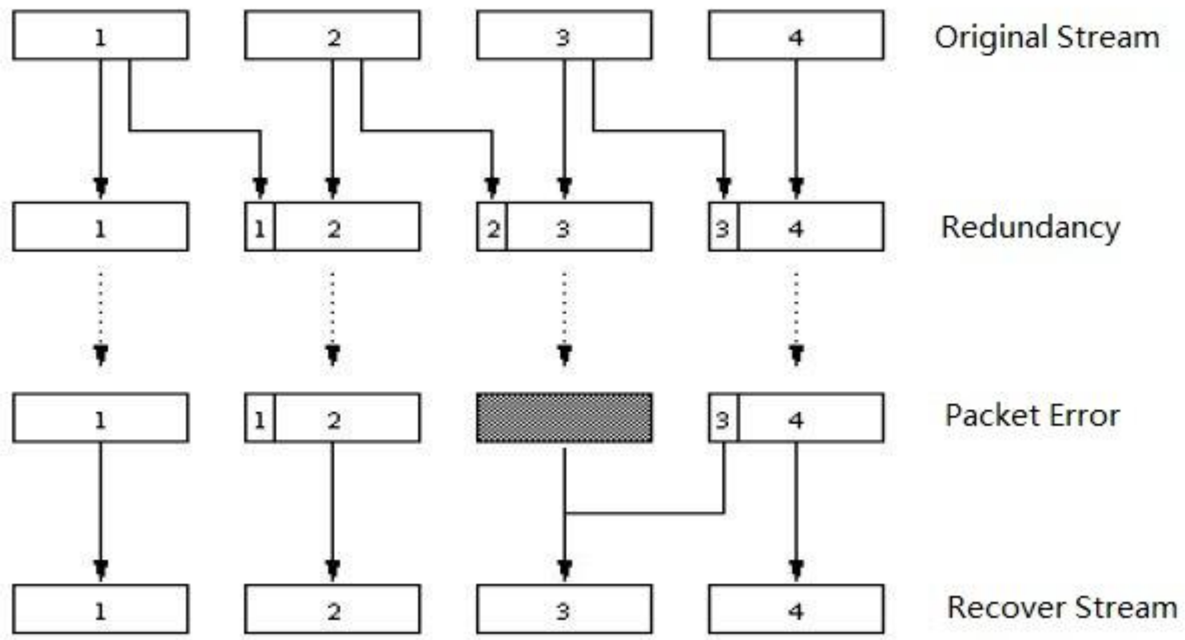
Motivation

- 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 couse, 2008Fall)

Motivation

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- Traditional solution – drop packet
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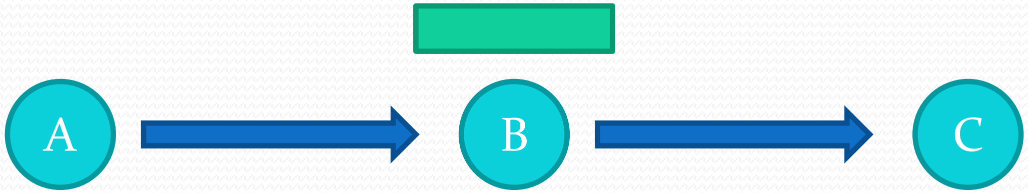
- Some partially correct packets can be used
  - Incremental redundancy from the source to recover the packet
  - Directly use the partial packets, like in video

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



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  - Server side
  - Client side
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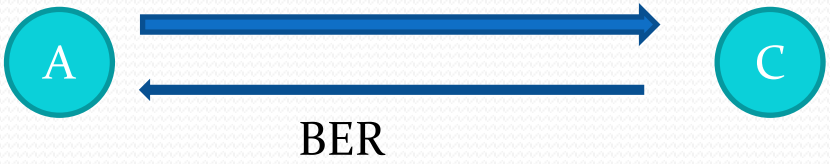
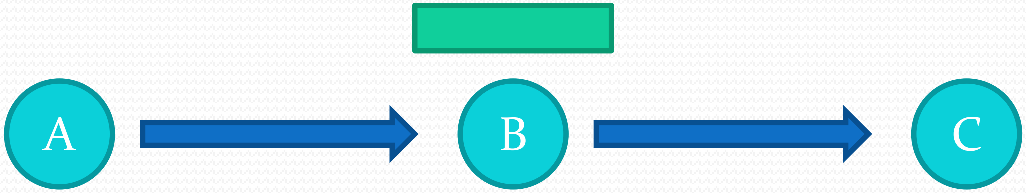
Application

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



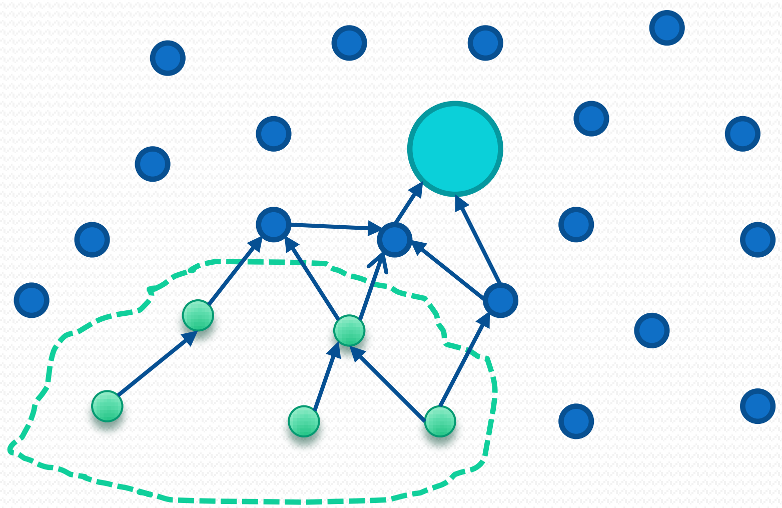
Application

- Client
  - Packet retransmission



Application

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



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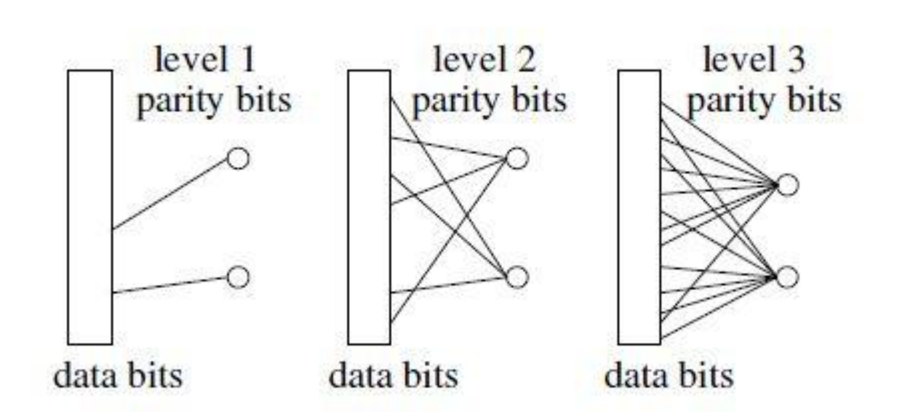
Algorithm

- 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



s=2

Algorithm

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

Algorithm 2 EEC Estimating Procedure.

for $i = 1$ to $i = \lfloor \log_2 n \rfloor$ **do**
    Compute the fraction (q_i) of parity bits at level i that fail parity check;
    if $q_1 \geq c_2$ **then**
        Output $\hat{p} = 1/4$ and exit;
    end if
    if $c_1 < q_i < c_2$ **then**
        Output $\hat{p} = q_i/2^i$ and exit;
    end if
end for
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

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  - 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

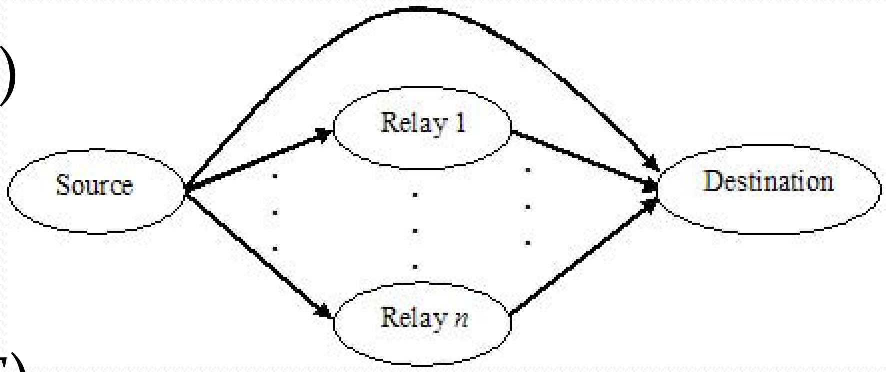
- Successful packet transmission determined by signal-to-interference and noise ratios (SINR)
- SINR determined by
  - received signal strength (RSS)
  - Noise & interference
- Measurement
  - Sender's RSS – RSS indicator
  - Receiver's noise level
  - Receiver's transmission power

Efficient Channel-aware Rate Adaptation in Dynamic Environments

- Estimate path loss
  - Path loss is the energy reduce during transmission
  - path loss = receiver's transmit power – sender's received signal strength
- Predict the path loss in the future
- Estimate SINR at receiver
  - RSS = transmit power – 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 ->1 or 1->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