

ROBUST WIRELESS DELIVERY OF SCALABLE VIDEOS USING INTER-LAYER NETWORK CODING

Pouya Ostovari and Jie Wu

Computer and Information Sciences
Temple University



Center for Networked Computing
<http://www.cnc.temple.edu>



Agenda

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- Introduction
 - ▣ Multi-layer video coding
- Robustness multi-layer video streaming
- Evaluations
- Conclusions

Introduction

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- Advances in technology

- Smartphones and tablets

- Internet is accessible everywhere

- Video streaming is used widely and frequently



- Video streaming is a dominant form of traffic on the Internet

- YouTube and Netflix:

- Produce 20-30% of the web traffic on the Internet



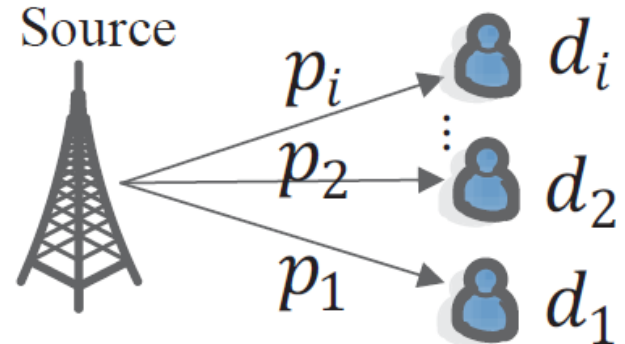
Introduction

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- A challenge in multicasting
 - ▣ Different link conditions
 - ▣ Loss rate, bandwidth

- Scalable video coding
 - ▣ Delivering video stream using different resolutions to satisfy different client needs/constraints

- Multi-Layer Coding
 - ▣ Base layer
 - ▣ Enhancement layers



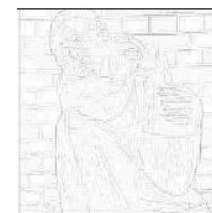
(a) Original



(b) Layer 1



(c) Layer 2



(d) Layer 3



(e) Layers 1 & 2



(f) Layers 2 & 3

Multi-Layer Video Streaming

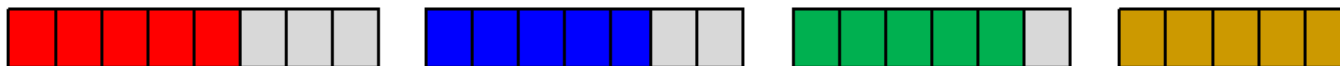
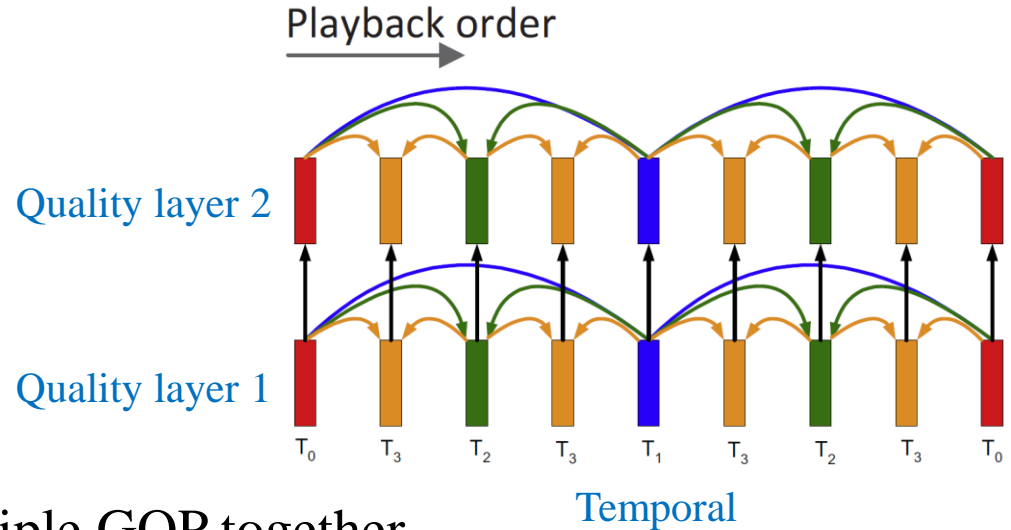
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- H.264/SVC coded

- Temporal layers
- Quality layers
- Spatio layers

- Unequal error protection

- Grouping the packets of multiple GOP together
- Providing different levels of protection for different groups
 - Intra-layer network coding
- Different heuristics are proposed
 - They focus on measuring the effect of each layer on the video quality



Inter-Layer Coding Strategies

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- Random linear network coding (RLNC)

$$\alpha_1 L_1 + \beta_1 L_2 + \gamma_1 L_3$$

$$\alpha_2 L_1 + \beta_2 L_2 + \gamma_2 L_3$$

$$\alpha_3 L_1 + \beta_3 L_2 + \gamma_3 L_3$$

- Triangular coding

- Prefix coding

$$\alpha_1 L_1$$

$$\alpha_2 L_1 + \beta_2 L_2$$

$$\alpha_3 L_1 + \beta_3 L_2 + \gamma_3 L_3$$

- Packets in lower layers are more important
 - Included in more coded layers
 - More chance to be decoded

Advantage of Triangular Coding

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- Coefficients are not shown for simplicity
- 6 transmissions in round-robin pattern
 - ▣ Blue cells are received

No coding

$L1$	$L2$	$L3$	$L1$	$L2$	$L3$
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Unable to decode

Random linear coding

$L1 +$ $L2 + L3$	$L1 +$ $L2 + L3$	$L1 +$ $L2 + L3$	$L1 +$ $L2 + L3$	$L1 +$ $L2 + L3$	$L1 +$ $L2 + L3$
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Unable to decode

Triangular coding

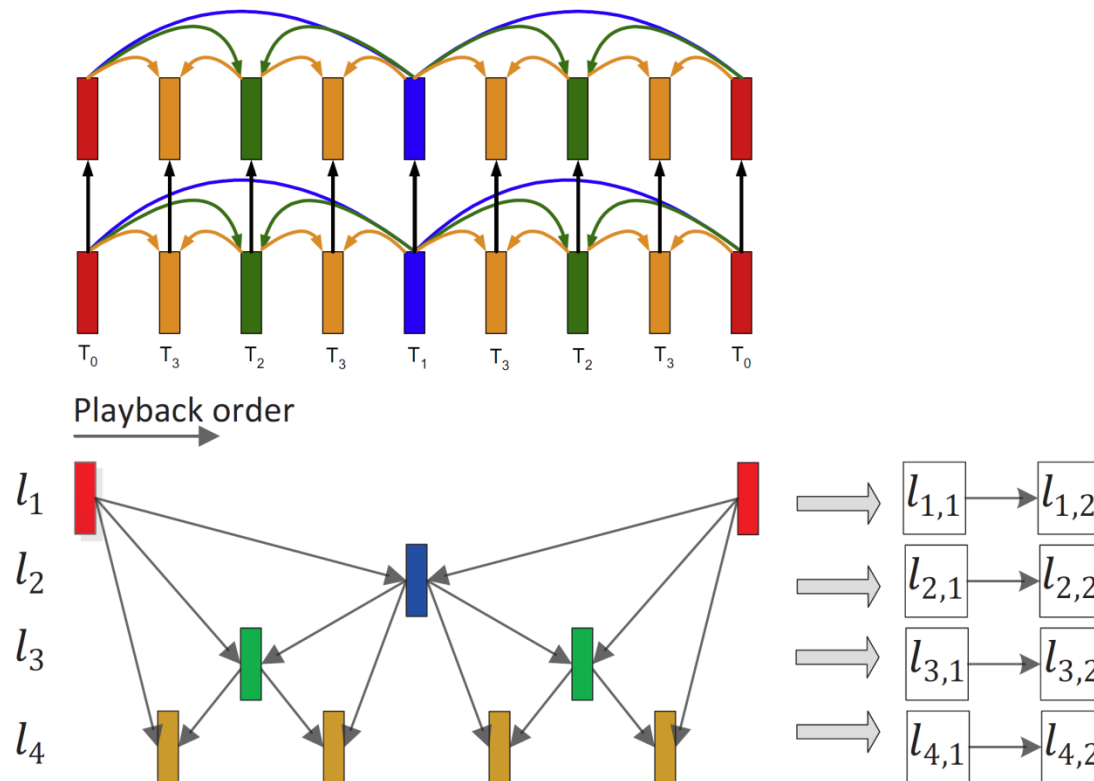
$L1$	$L1 +$ $L2$	$L1 +$ $L2 + L3$	$L1$	$L1 +$ $L2$	$L1 +$ $L2 + L3$
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Decodes 2 layers

Two-Dimensional Inter-Layer NC

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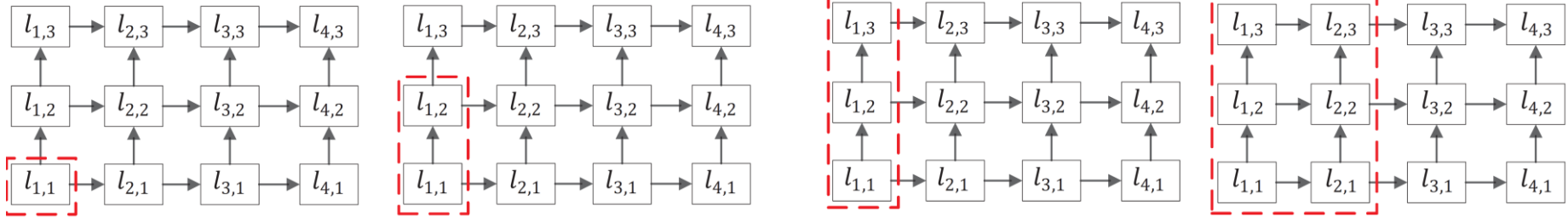
- Performing inter-layer triangular NC on **quality** and **temporal** layers



Two-Dimensional Inter-Layer NC

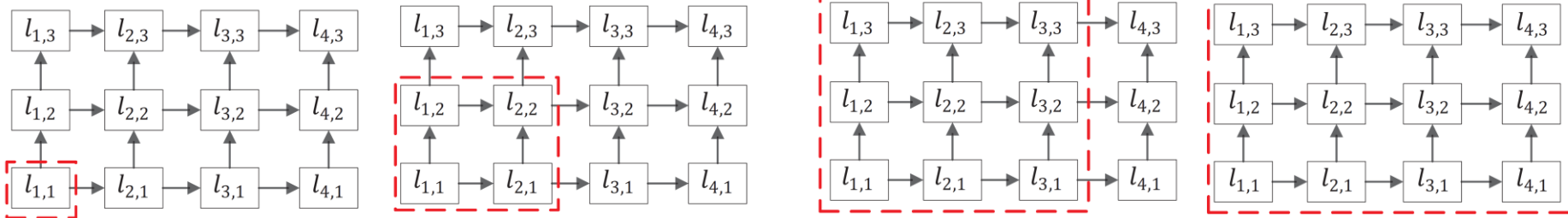
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Vertical triangular NC



Horizontal triangular NC

Diagonal triangular NC



Transmissions Distribution

- Fixed number of transmissions
 1. Reference table creation
 - Considering all the possible distributions
 - Checking the possible outcomes
 - Calculating the layers that can be decoded
 2. Searching in the reference table to find the best transmission distribution

Evaluations- Setting

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- Comparison with Percy method
 - ▣ Is performed among the spatio layers
- Bus video trace
 - ▣ 352×288 pixels, 30 frames
 - ▣ 4 temporal layer
 - ▣ 3 spatio layers

PSNR OF THE DECODED LAYERS

n \ m	1	2	3	4
1	31.24	32.85	34.30	35.62
2	31.72	34.12	36.97	40.6
3	39.51	49.4	67.11	99

Evaluations- Setting

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Original video

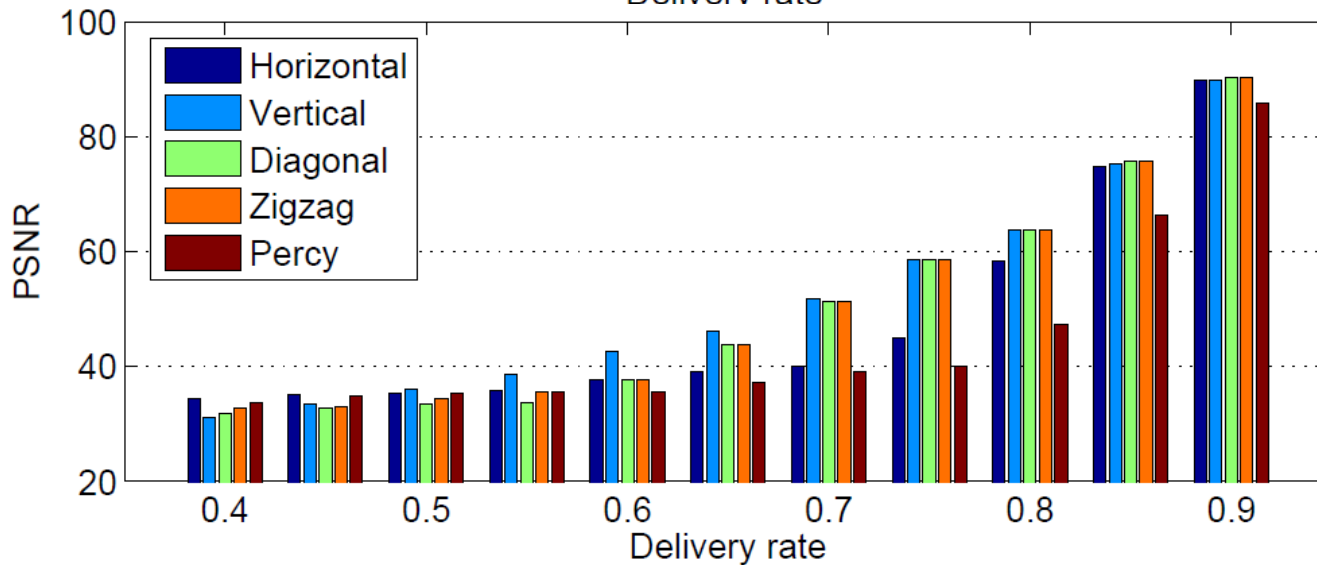
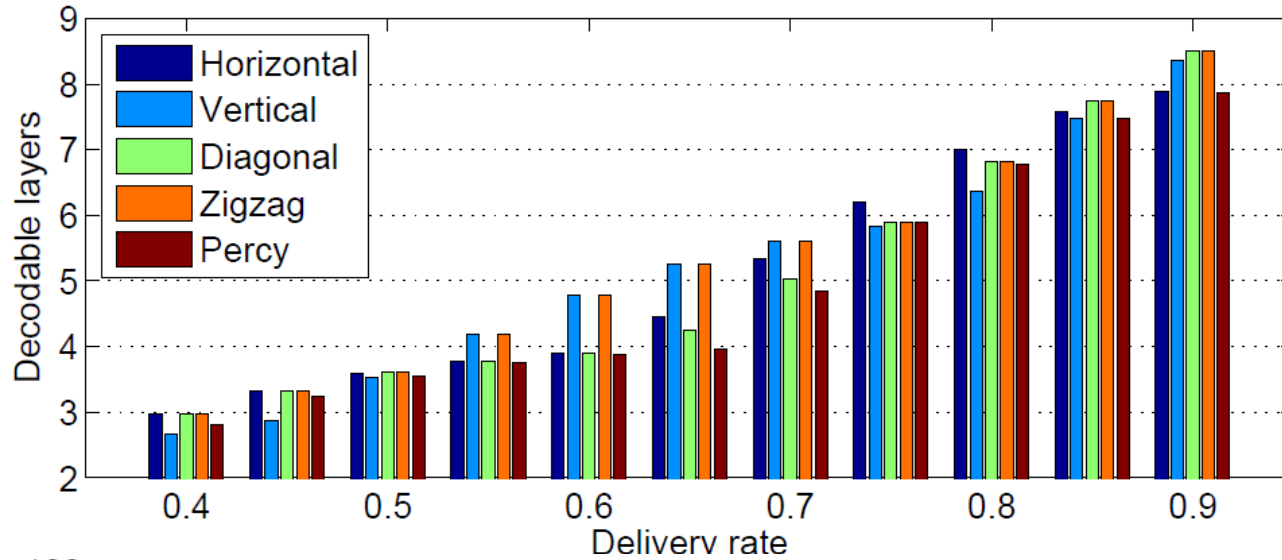


Base spatio layer



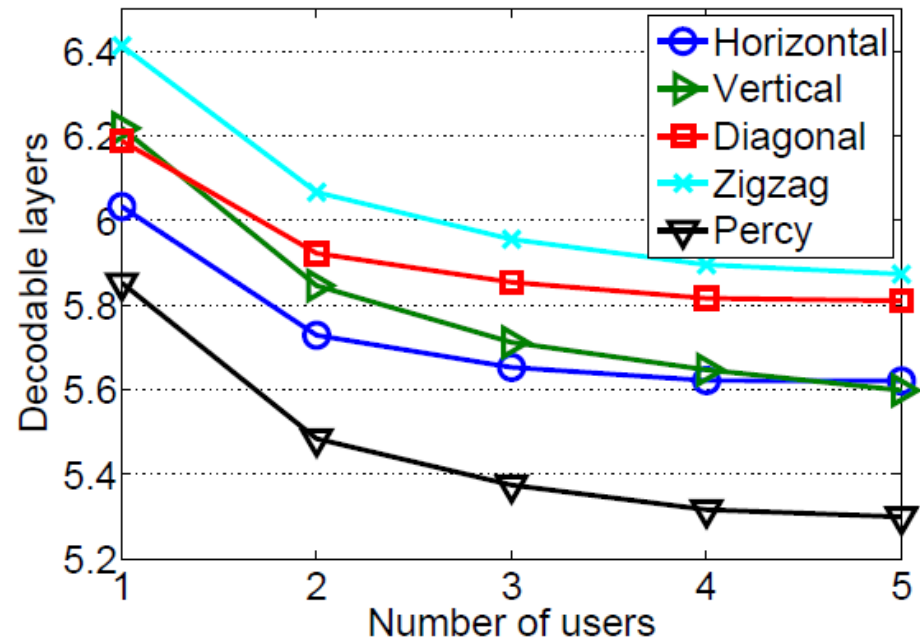
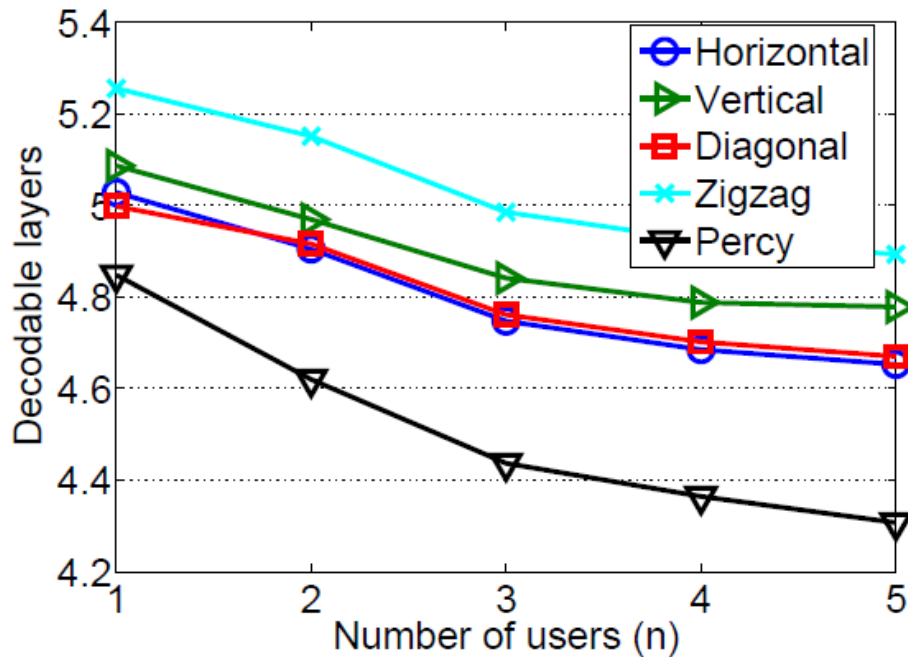
Evaluations

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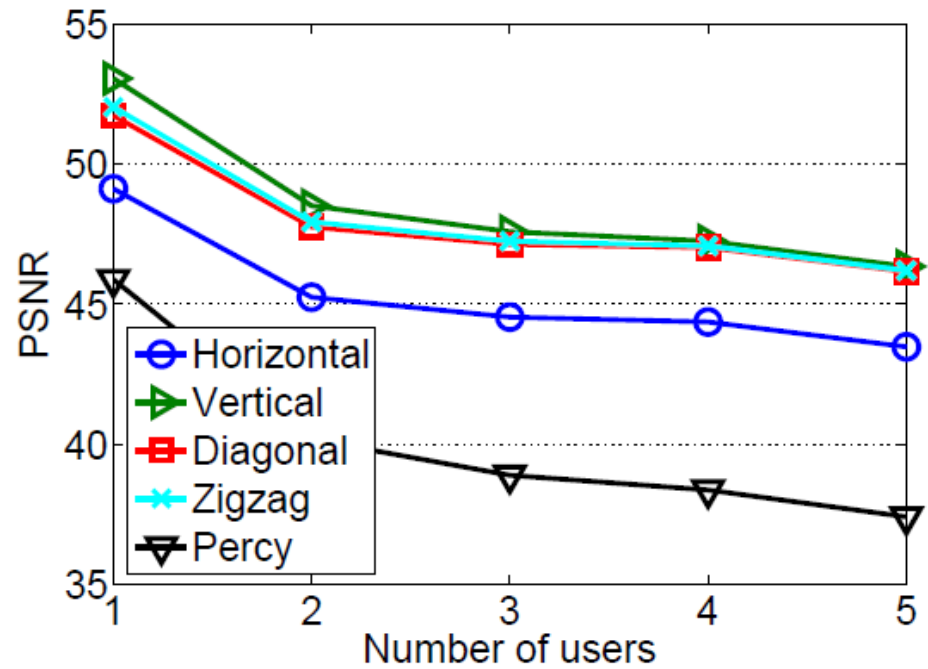
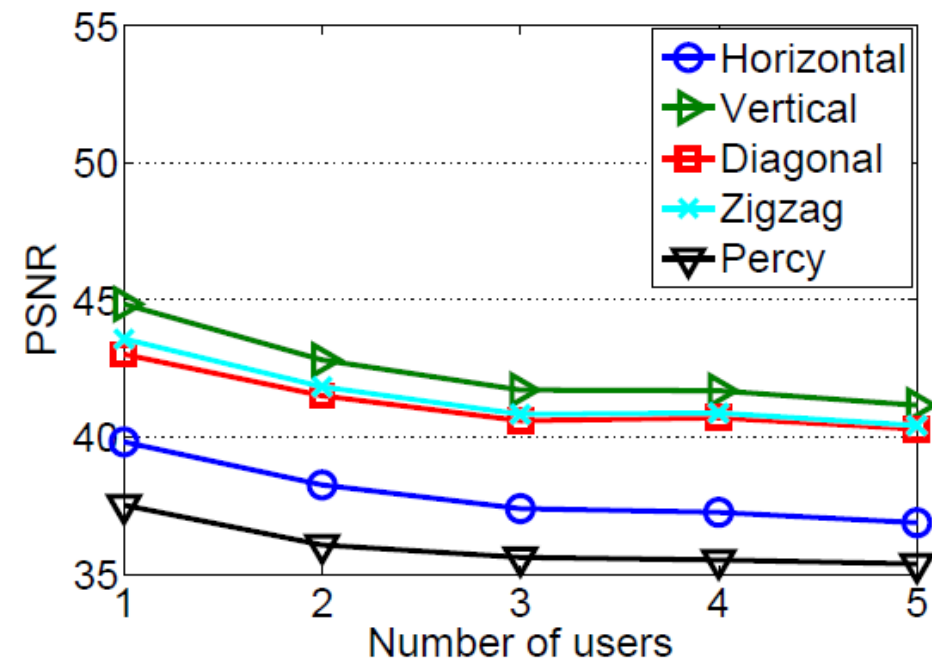
Evaluations

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Evaluations

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Conclusions

- Challenges in multicasting
- Dependency in multi-layer videos
- Unequal error protection
- Two-dimensional triangular network coding
- Trace-driven evaluation

Thank you