DISTRIBUTED RESOURCE ALLOCATION IN BLOCKCHAIN-BASED VIDEO STREAMING SYSTEMS WITH MOBILE EDGE COMPUTING

Presented by:

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Abstract

- **AIM**: Building decentralized P2P networks with flexible monetization mechanisms for Streaming Services.
- **Challenge**: Computationally intensive and time-consuming *Video Transcoding*. Size of block in BC affect performance significantly.
- **Paper Objective**: BC-Based Framework with *Adaptive Size of Blocks* for video streaming using MEC.
- Approaches
  - Design *Incentive Mechanisms* (Content creators, Transcoders and Consumers)
  - *Offloading Modes* and Block Size *Adaptation* Scheme
  - *Optimization Problem* defined for issues of *resource allocation*, *Scheduling of offloading*, and *adaptive block size*
  - *Multipliers-based* algorithm used to solve the problem
  - Simulations show proposed scheme is effective.

Presentation Outline

- Introduction
- Related Works
  - Traditional Video Streaming
  - Blockchain With MEC
- System Architecture
- Related Models
- Offloading Framework and Incentive Mechanism
  - Offloading Framework
  - Incentive Mechanism
- Optimization problem formulation and Solution
- Simulation Results and Discussions
- Conclusion.

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Introduction

- Demand for online video streaming services grows rapidly. *Netflix* and *YouTube* are very popular platforms.
- Disadvantages of traditional streaming platforms
  - Content Creators: *Low Profits*
  - Consumers: *High charges* and *low privacy*
  - Advertisers: *Less-than-ideal* advertising effects
- *Blockchain* is employed addresses the pitfalls. Adopted by Theta, Livepeer, Flixxo, VirtuTV, etc.
  - Through *smart contracts* in a decentralized *P2P* basis; all participants can support each other.
- Challenge for blockchain is *Video Transcoding* because of *larger block sizes* of video blocks in blockchain.
  - Results in *higher delays* and degrades *performance* of BC
- An adaptive block size solution required to improve BC's performance.

Introduction Cont'd…

- Mobile Edge Computing (MEC) prevail to offload computation-intensive transcoding tasks to network servers achieves good performance in accelerating streaming services.

BUT

- Previous MEC-based solutions have been applied to traditional video streaming and *NO INCENTIVE* for MEC nodes for assisting in transcoding.
- Blockchain is suitably qualified to address the MEC-enabled video streaming with added *Incentive Mechanisms*
- Therefore the paper designs *incentive mechanisms* facilitate collaboration among the different participants involved, *block size adaptation scheme* is presented, Introduces an addition *offloading mode* to avoid the overload of MEC nodes, and formulate the *resources allocation, scheduling offloading,* and *adaptive block size* as an optimization problem; offers a solution and perform simulations

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Related Works

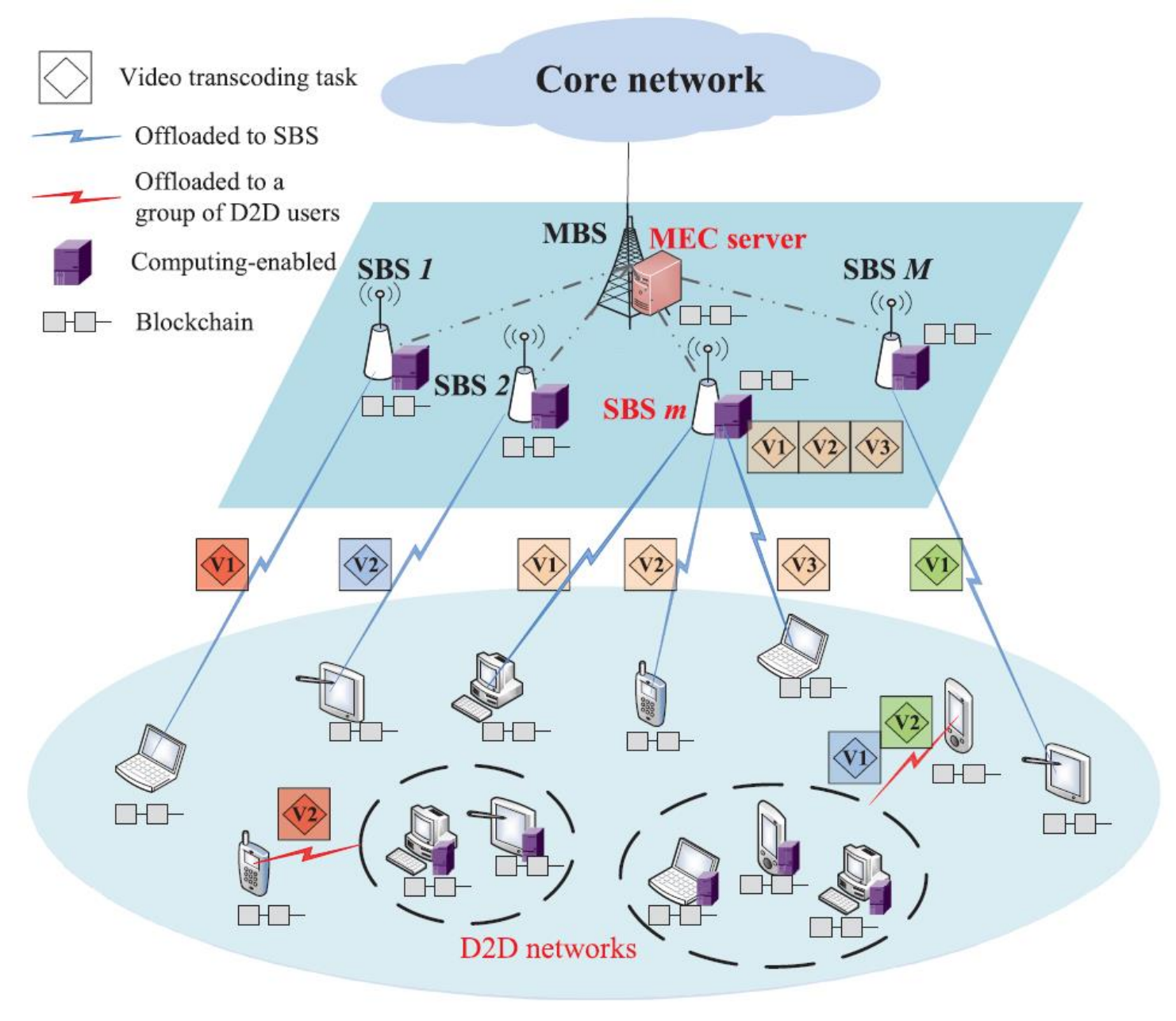
1) Traditional Video Streaming

- Transcoding is required to cater for heterogenous nature of mobile devices, networks and user preferences. And it is *intensive* and *time consuming*
- Using MEC advances; numerous people have explore solutions to overcome these challenges which are mainly based on offloading transcoding tasks from the devices to the edge servers
- The Incentive for MEC nodes is the common shortfall in all the works in this area.

2) Blockchain With Mobile Edge Computing

- Many works in this area drives towards deployment of MEC in facilitating blockchain applications in mobile networks.
- Deployment of MEC in blockchain-based video streaming *NOT WELL INVESTIGATED*.

System Architecture



Various Related Models

1) *Video Transcoding Model*

- A video Segment is the smallest unit of video streams.
- The model requires that as soon as transactions are mined on blockchain, next blockhash selects transcoders from nodes necessary to complete the task.

2) *Computation Offloading Model*

- *Mode 0*:Offloaded to a Nearby SBS.
- *Mode 1*:Offloaded to a Group of D2D Nodes.

3) *Network Model*

- This describes the channels to be used in radio communication the nodes and BSs or other nodes for uplink of transcoding jobs and for downlink of transcoded video segments.

Offloading Framework

1) *Offloaded to a Nearby SBS*

- Performance metrics are specified as *Output Size*, *Delay*, and *Energy Consumption.*
- Delay metric is further broken down into *Queueing delay*, *Transcoding delay*, and *delay for sending back the transcoded video segment*.

2) *Offloaded to a Group of D2D Nodes*

- Same performance metrics are applicable
- For delay metrics in this case; queueing is left out because of limited computational capacity of each node in the D2D network.

Incentive Mechanism

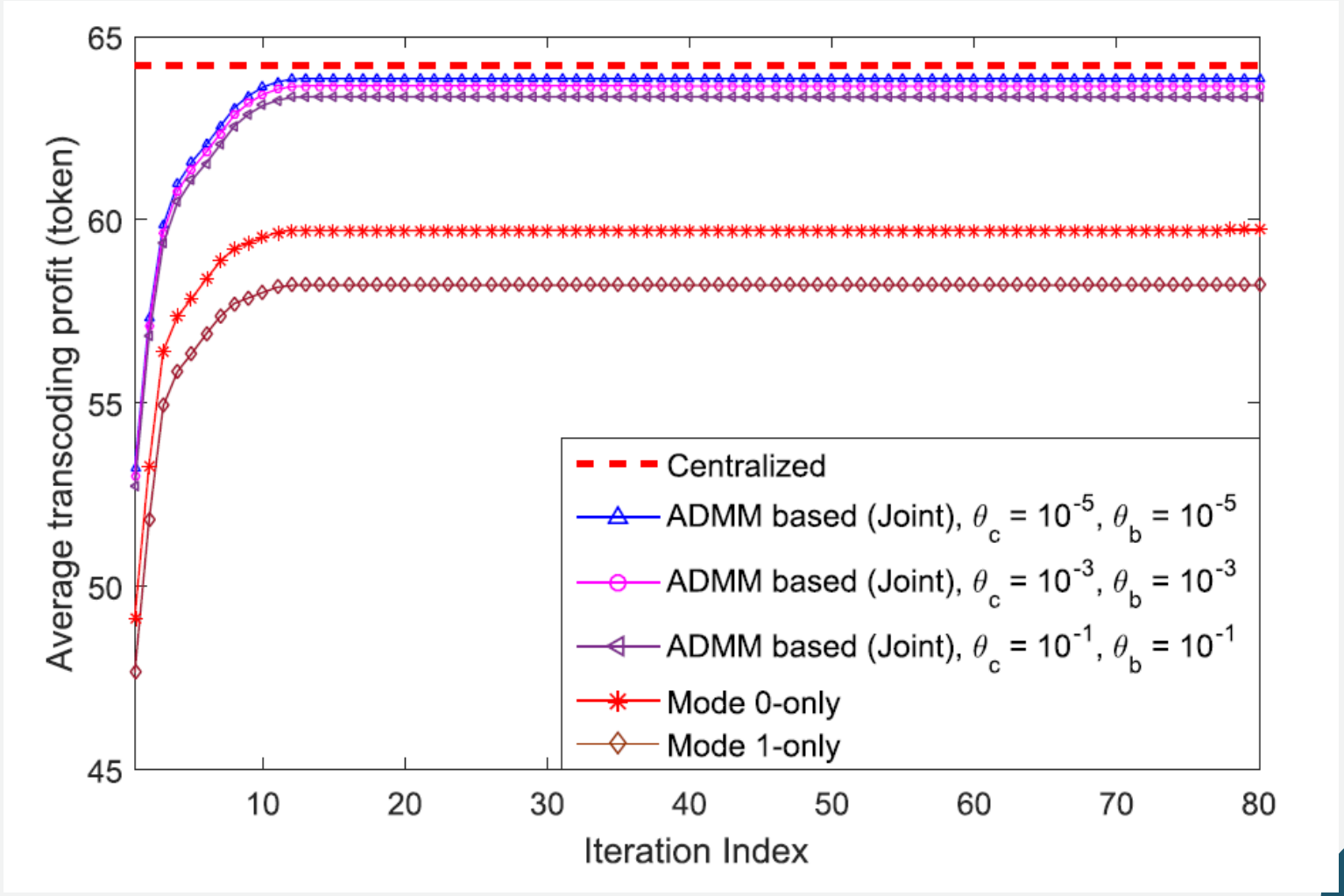
- May be reluctant to become transcoders because it's computational intensive and time consuming.
- Incentive is introduce to encourage the nodes to complete transcoding jobs correctly and on time.
- Comes in the form of virtual currency circulated in the form of *token* that circulate in the blockchain-based video streaming.
  - *The Revenue of Transcoding Service*: received by finishing the transcoding job successfully.
  - *The Cost of Transcoding Service*: Transcoders need to pay for energy cost involved in accomplishing the transcoding.

Problem Formulation and Solution

- To encourage more users to become transcoders; an optimization problem is formulated for maximization of average transcoding service reward by combining issues of *adaptive block size*, *scheduling of offloading*, *computational resource allocation*, and *spectrum allocation*.
- The solution to the formulated problem is achieved by employing a low-complexity alternating direction method of the *multipliers-based algorithm*.

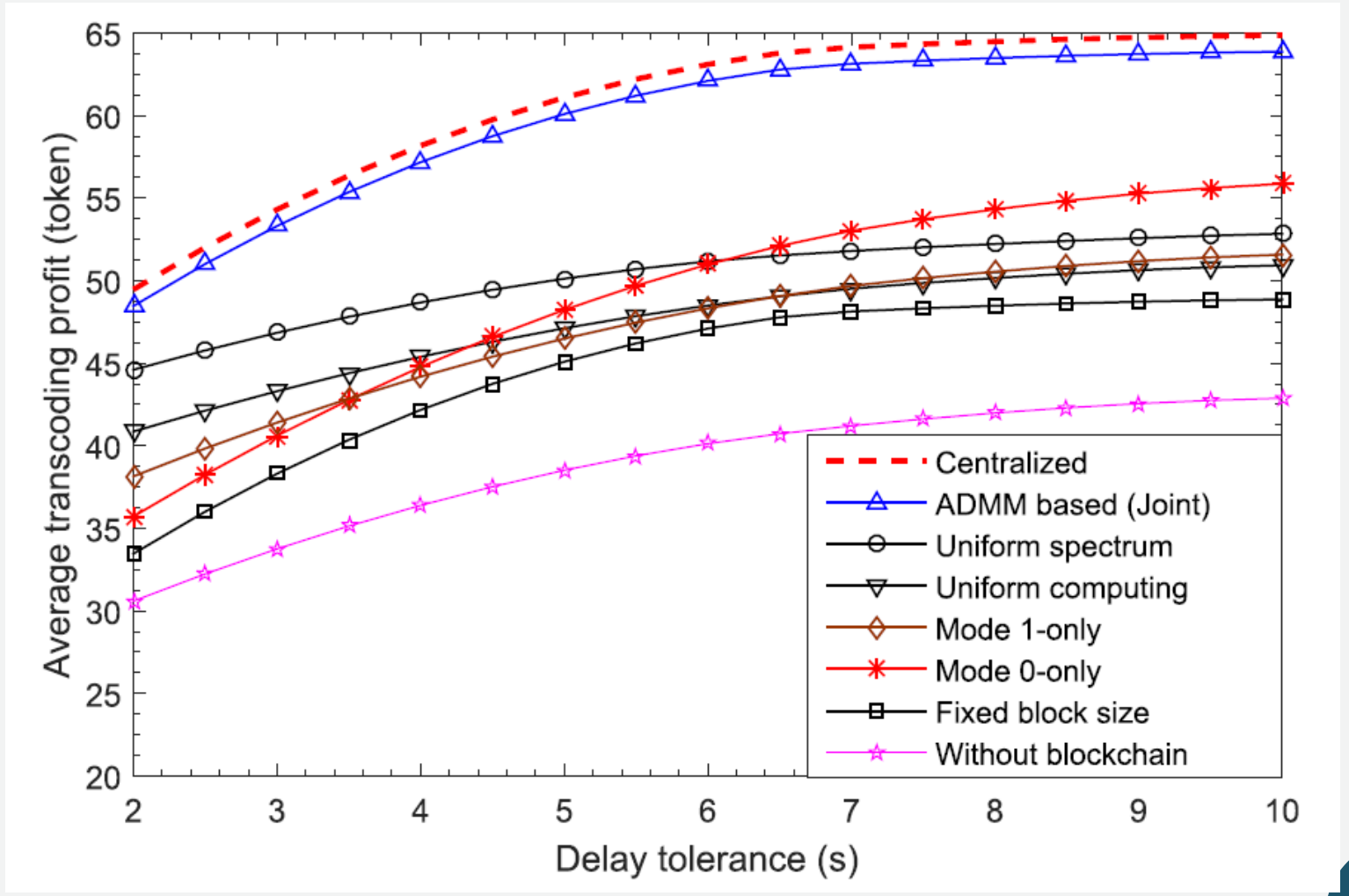
Simulation Results

Iteration Index Vs Average Transcoding Profit



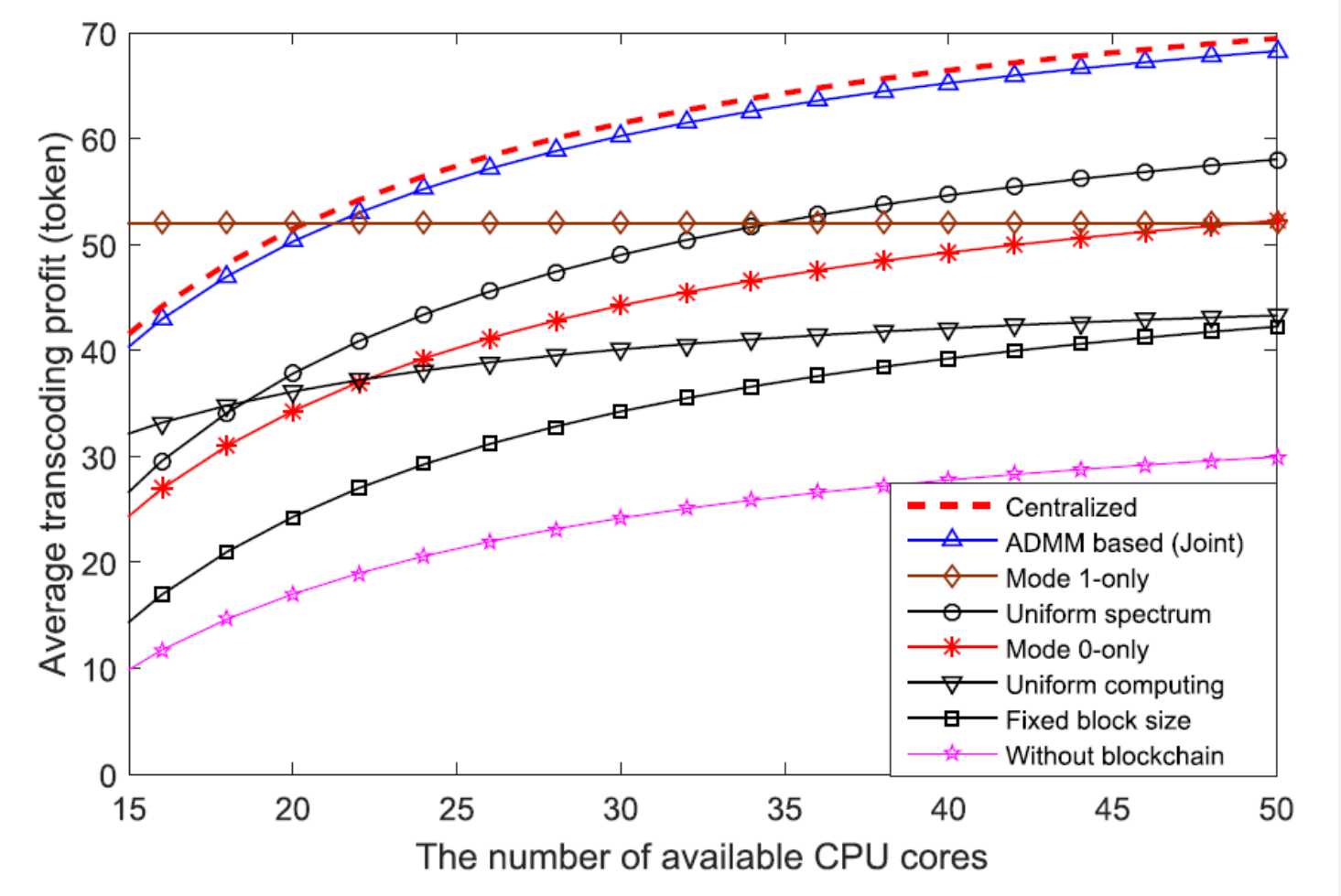
Simulation Results

Delay Tolerance Vs Average Transcoding Profit



Simulation Results

CPU Cores Vs Average Transcoding Profit



Conclusions

- The formulated optimization problem maximizes the average transcoding profit for transcoders.
- The simulation results verifies the model to be effective for the adaptive block size scheme which indicates that the model outperforms other baseline schemes.

Remarks

- Extension of the model to apply in next generation cellular networks applications.
  - E.g. 360° videos in VR and AR to enhance performance and minimize latency.

- The proposed incentive mechanisms can also be used to reward participants in other decentralized systems.
  - E.g. Blockchain for IoT to attract more peers to join as miners and offer increased storage to serve the growing needs and increasing number of participating devices.