Layered Video Communication in ICN Enabled Cellular Network with D2D Communication

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Outline

- Introduction
- Background
- System Architecture
- Communication Scenario
- Problem Formulation
- Resource Allocation
- Performance Evaluation
- Conclusion

Introduction

- Wireless part of the network is always considered as the bottle neck
- Demand of the bandwidth thirsty applications is increasing more rapidly than the growth of the wireless network capacity
- Modern UEs encouraging us to use it for sophisticated applications i.e., D2D communication
  - Larger memory
  - Equipped with ability of powerful processing
- ICN/CCN, a future Internet architecture, enables all the networking devices to play more important role

Introduction Cont'd …

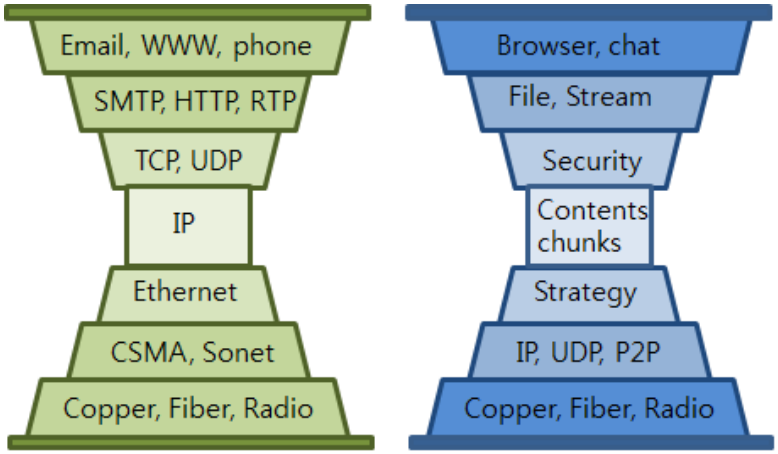
- In this paper, we propose to provide the requested video to users from other users cache, using D2D link
- Our objective is to reduce the download delay for the users' requested video
- We formulate the problem as a matching game in which the resources are assigned to the users in the uplink period

Background: Content Centric Networking (CCN)

- CCN is a new internet structure that changes current IP structure as:

  "What" instead of "where"

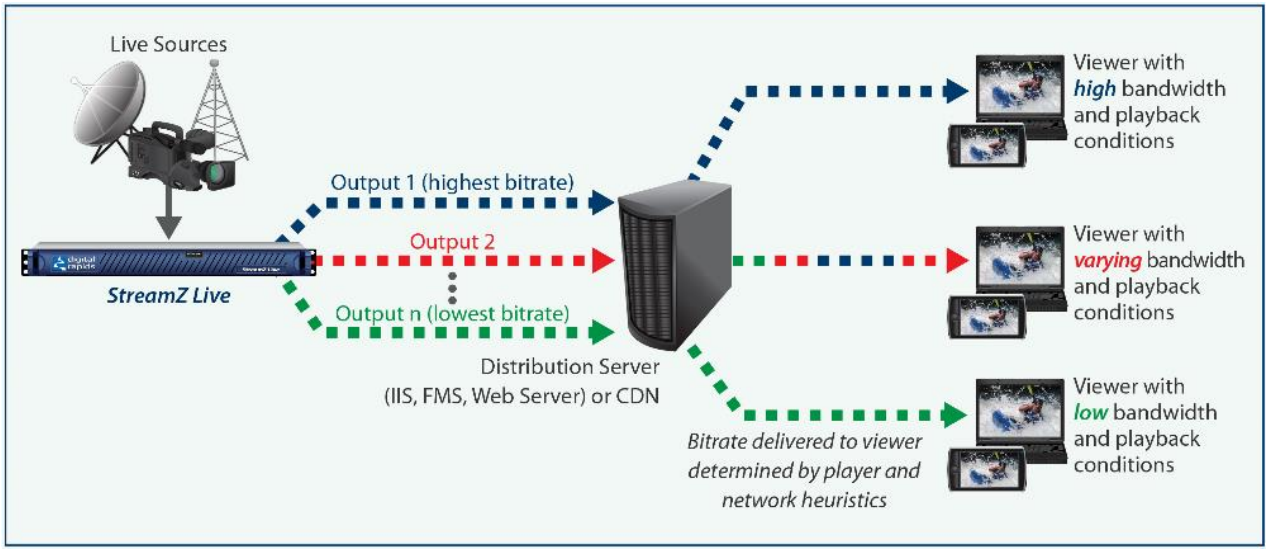
- Users send interest packet and CCN nodes sends back data chunk either from its local content store or request it from content provider
- CCN nodes store a copy of the data chunk that passes through
- Cache is one of the most important resource of a

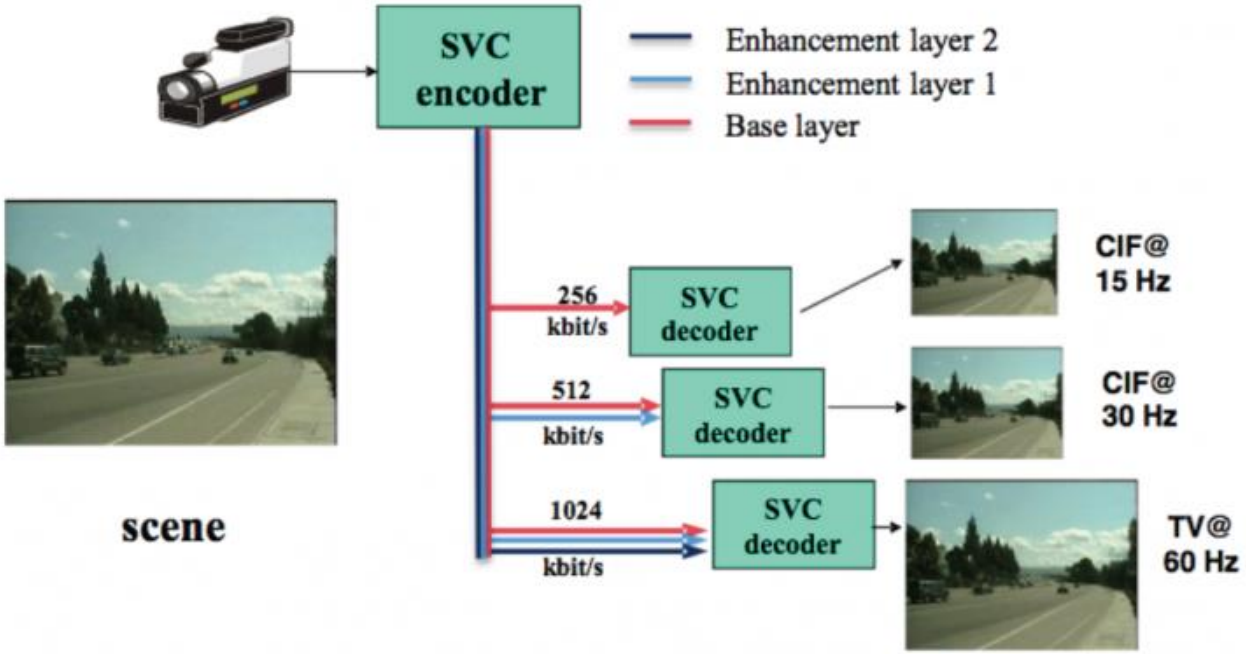


Legacy Internet architecture

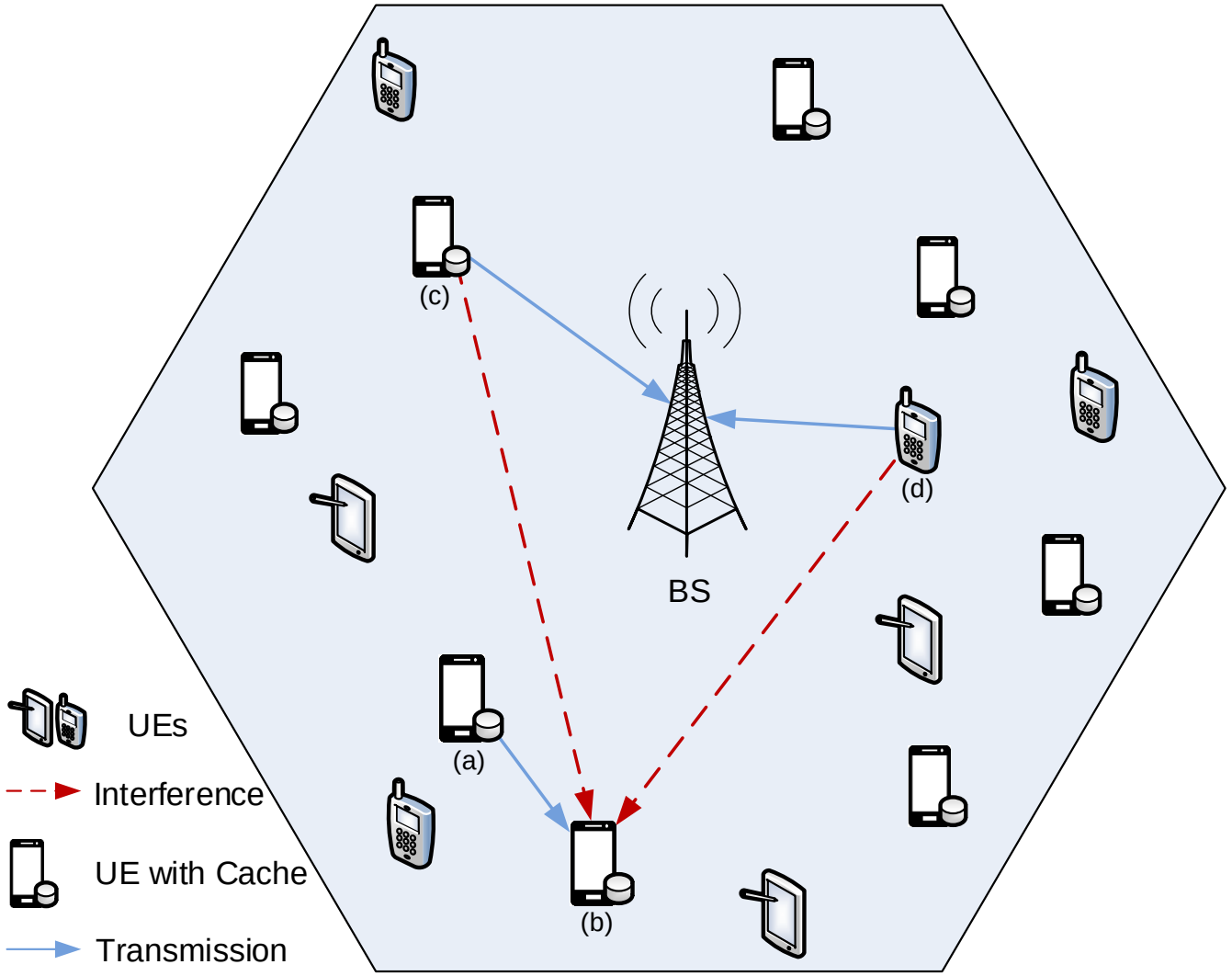
FI & CCN architecture

Background: Scalability in Video Streaming

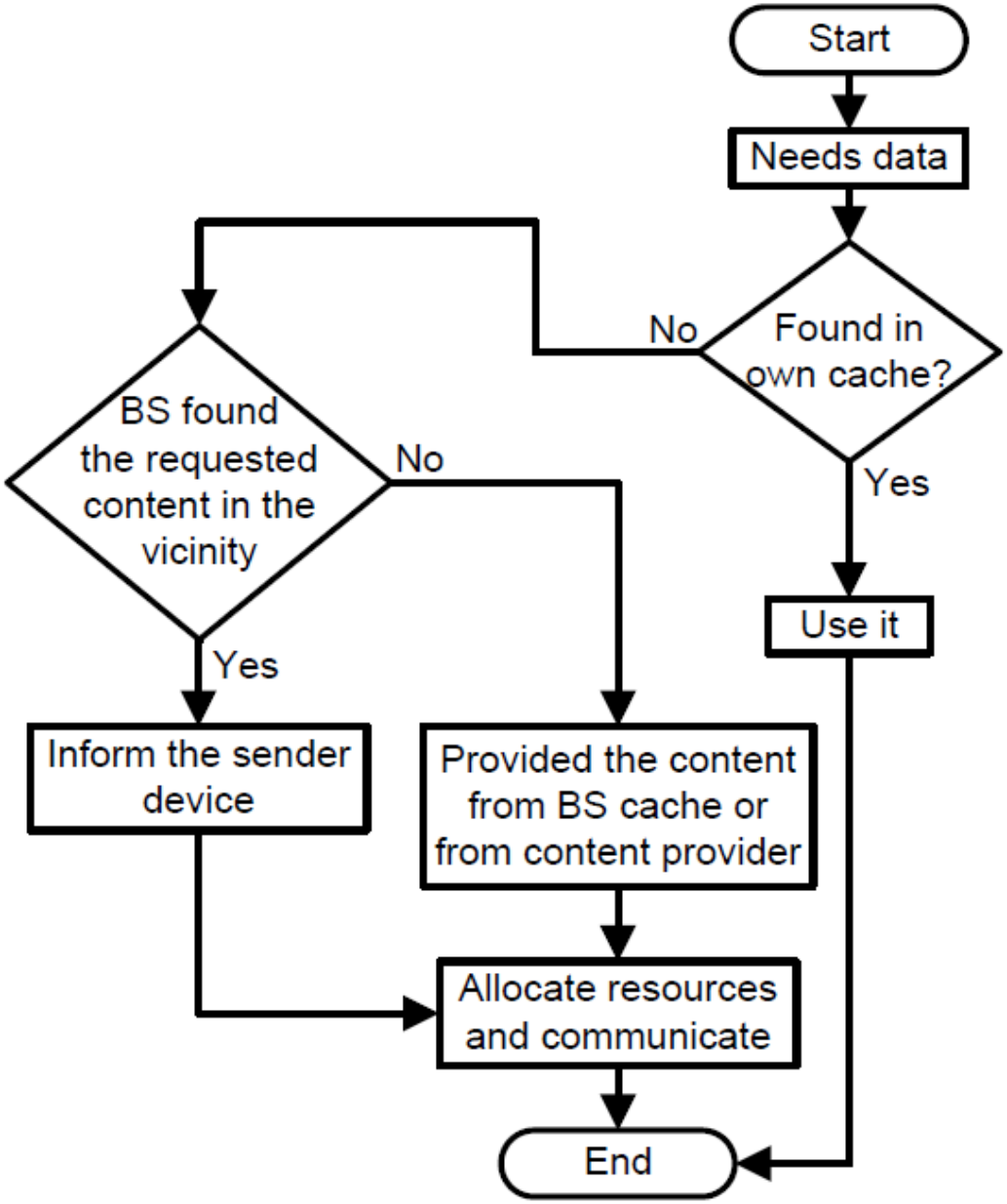




System Architecture



Communication Scenario



Problem Formulation

- For RB allocation we use binary variable x_{mn}^{k}:

$$x_{mn}^{k} = \begin{cases} 1, & \text{If D2D pair in group } g \text{ is assigned RB } k \\ 0, & \text{otherwise.} \end{cases}$$

- D2D transmission rate of a UE

$$R_{nm}^{k}(\mathbf{X},\mathbf{P}) = W^{k} \log \left(1 + \frac{h_{nm}^{k} P_{nm}^{k}}{\sum\limits_{\substack{n' \neq n, \\ m' \neq m}} x_{n'm'}^{k} h_{n'm}^{k} P_{n'm'}^{k} + \sigma^{2}} \right)$$

Problem Formulation Cont'd …

- Total transmission rate

$$R_n(\mathbf{X},\mathbf{P}) = \sum_{m,k} W^k x_{nm}^k R_{nm}^k(\mathbf{X},\mathbf{P})$$

- Delay Analysis

$$D_n(\mathbf{X},\mathbf{P}) = \frac{b_{i,l}^m}{2R_n(m,k)\left(R_n(m,k) - b_{i,l}^m\right)}$$

Problem Formulation Cont'd …

OPT-1 :

$$\text{minimize}_x \quad \sum_{n \in \mathcal{N}} D_n,$$

subject to:

$$R_m(\mathbf{X}, \mathbf{P}) \geq R_{m,\min},$$

$$P_{nm}^k \in P_n = \{0,\ P_{n,\max}\};\ \forall m, n, k,$$

$$x_{nm}^k = \{0, 1\},\quad \forall m, n, k,$$

$$\sum_{k \in \mathcal{K}} x_{mn}^k \leq 1,\ \forall m, n,$$

$$x_{mn} = \{0, 1\},\quad \forall m, n,$$

$$\sum_{n \in \mathcal{N}} x_{mn} \leq 1,\quad \forall m,$$

$$\sum_{m \in \mathcal{M}} x_{mn} \leq 1,\quad \forall n.$$

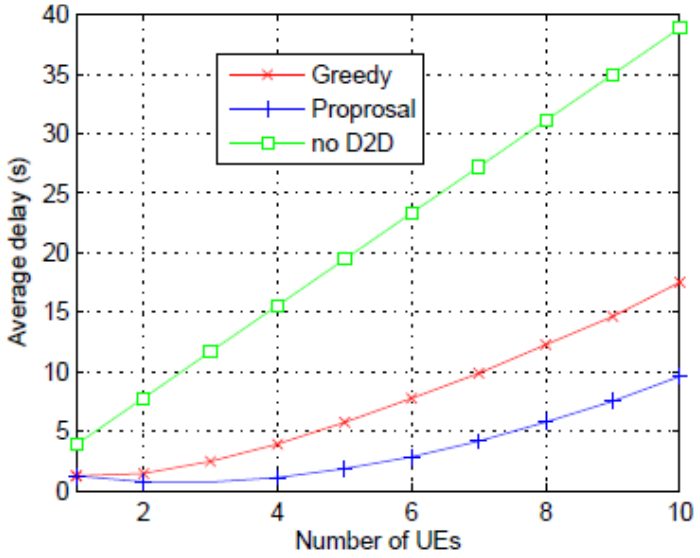
Resource Allocation Algorithm

Algorithm 1 Resource Allocation to cellular and D2D users

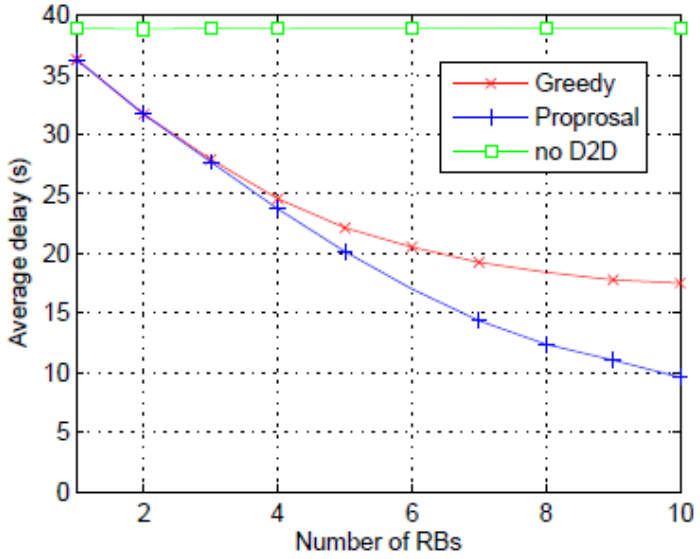
1: **Initialize:** N_x^{req}, $N_x^{accepted}$, $N_x^{rejected}$
2: **Stage I:** *Discovery and utility computation*
3: UE sends request to BS to get content.
4: BS searches the requested content in VC and find M
5: BS broadcasts its sub-channels and M to requesting UEs
6: Requesting UEs compute its utility values and build based on (3)
7: **Stage II:** *Matching operation to find stable matching*
8: Each UE n sends a request for network resource x (m, k) to BS, $x = \arg\min(D_n(x))$
9: *Base station do:*
10: Updates set of requested UEs N_x^{req}
11: Computes utility values and build $\succ_x$ based on (6).
12: Update accepted list following (6):
13: **if** n satisfy (6) **then**
14: $N_x^{accepted} \leftarrow = \arg\min(D_n(x))$ using the Hungarian matching algorithm
15: **else**
16: $N_x^{accepted} \leftarrow n$
17: **end if**
18: BS informs $N_x^{rejected}$. This $N_x^{rejected}$ will be considered in the next uplink transmission period.
19: Go back to step 2
20: Outputs: α^* and Stable matching μ^* [6]

Performance Evaluation

- Download delay for different number of UEs

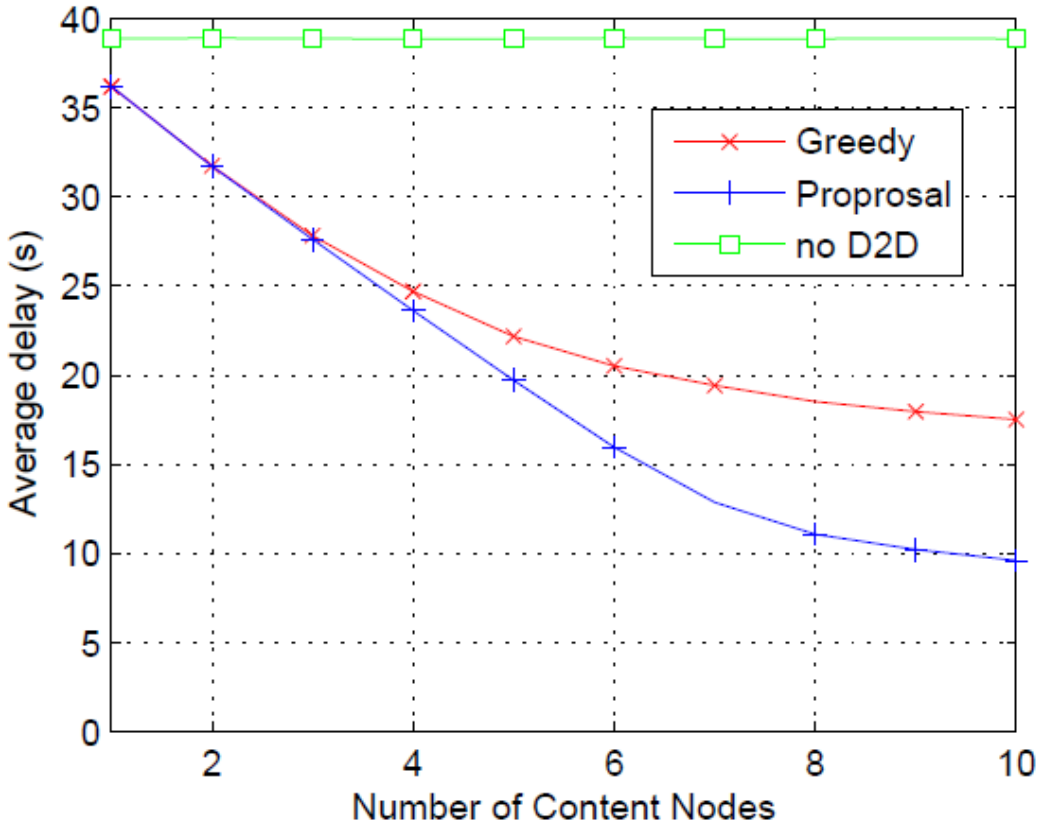


- Download delay for different number of RBs



Performance Evaluation Cont'd …

- Download delay for different number of content nodes



Conclusions

- In this paper, we present resource allocation to the CU and D2D pair in the uplink transmission period
- UEs with memory can provide other users requested content, via D2D link
- We proposed matching game based approach to solve the resource allocation problem
- Objective of the resource allocation is to reduce the download delay of the requesting UEs

Thank You !!!