Resource Allocation in Underprovisioned Multioverlay Live Video Sharing Services

Jiayi Liu[1], Shakeel Ahmad[2], Eliya Buyukkaya[1], Raouf Hamzaoui[2] and Gwendal Simon[1]

[1]Telecom Bretagne

[2]De Montfort University

MMOG player video casting tool

Massively Multiplayer Online Game collaborative tool

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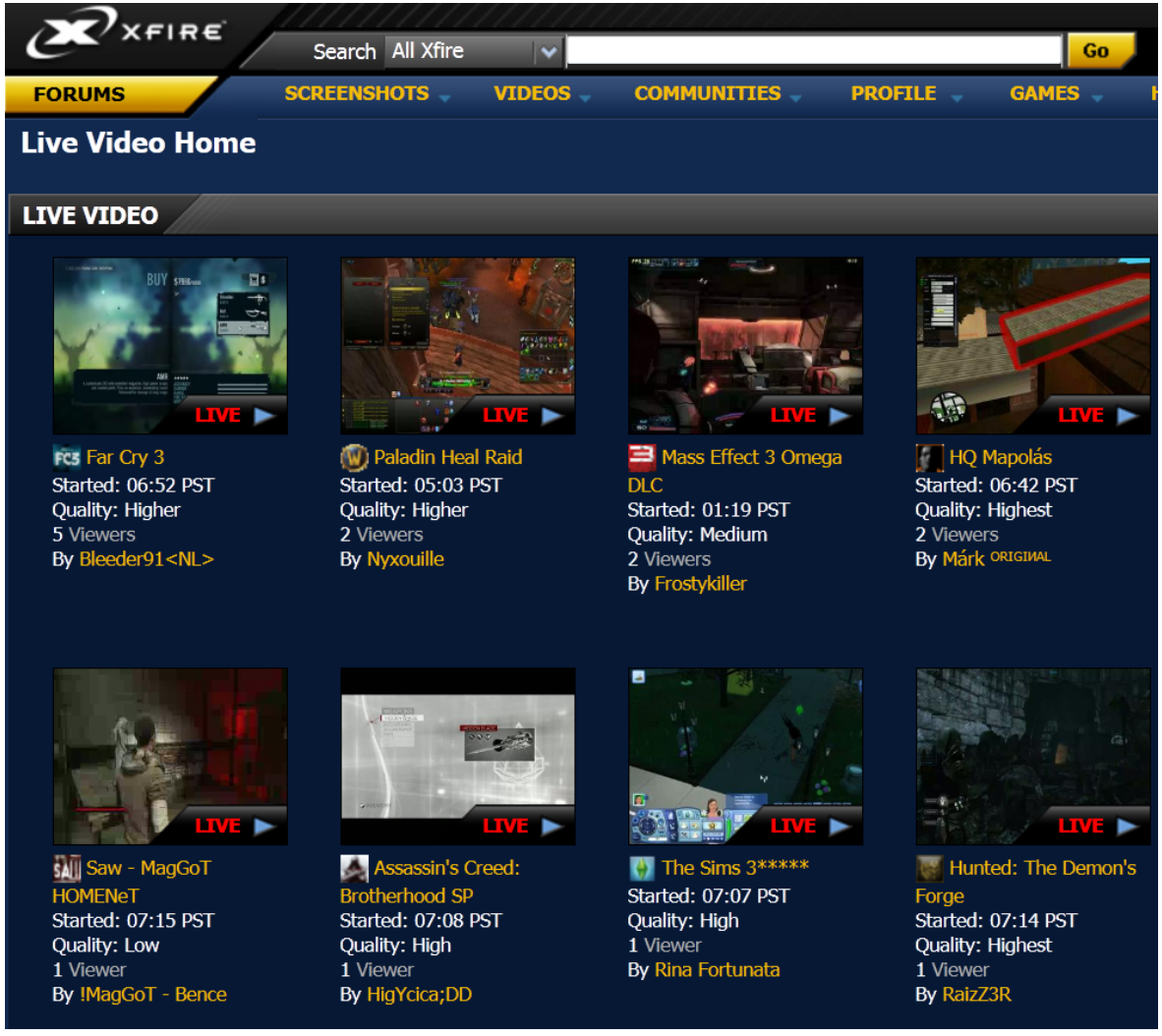
- Players emit user-generated videos
- Developed by the CNG (Community Network Game) project
- Integrated in "The Missing Ink" (www.missing-ink.com)

Xfire : online game player video casting platform



Challenges

- Thousands of simultaneous video sources

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CDN is not cost-effective

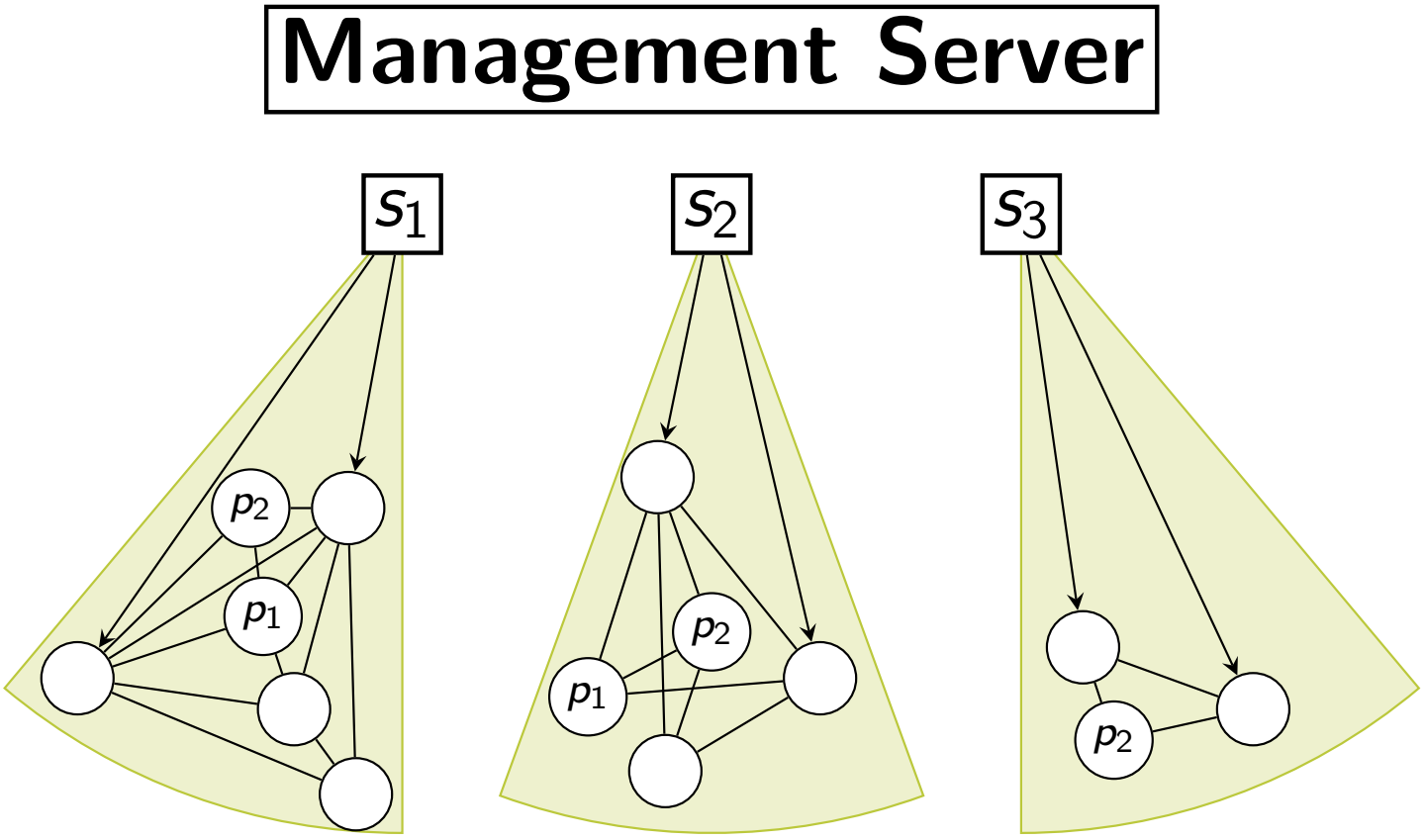
$\rightarrow$ peer-to-peer may be useful

Solution : multioverlay P2P video streaming system

Avancement

1. Multioverlay P2P video streaming system
2. Inter-overlay bandwidth allocation problem
3. Performance evaluation
4. Conclusion

System in a Nutshell



A player can simultaneously watch several videos

System design points

Intra-overlay P2P video streaming :

- Mesh-based : bandwidth fluctuation and peer dynamics

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Intra-overlay P2P video streaming :

- Mesh-based : bandwidth fluctuation and peer dynamics

Inter-overlay bandwidth allocation :

- Peers allocate their uplink bandwidth
- Independent with intra-overlay video streaming

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Bandwidth Allocation Problem

Peers watching several videos should share their uplink

Problem : How to allocate bandwidth to overlays ?

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$overlay_1$ $overlay_2$ $overlay_3$

p_1	p_2	p_3	p_4
uplink : 9	uplink : 5	uplink : 8	uplink : 8

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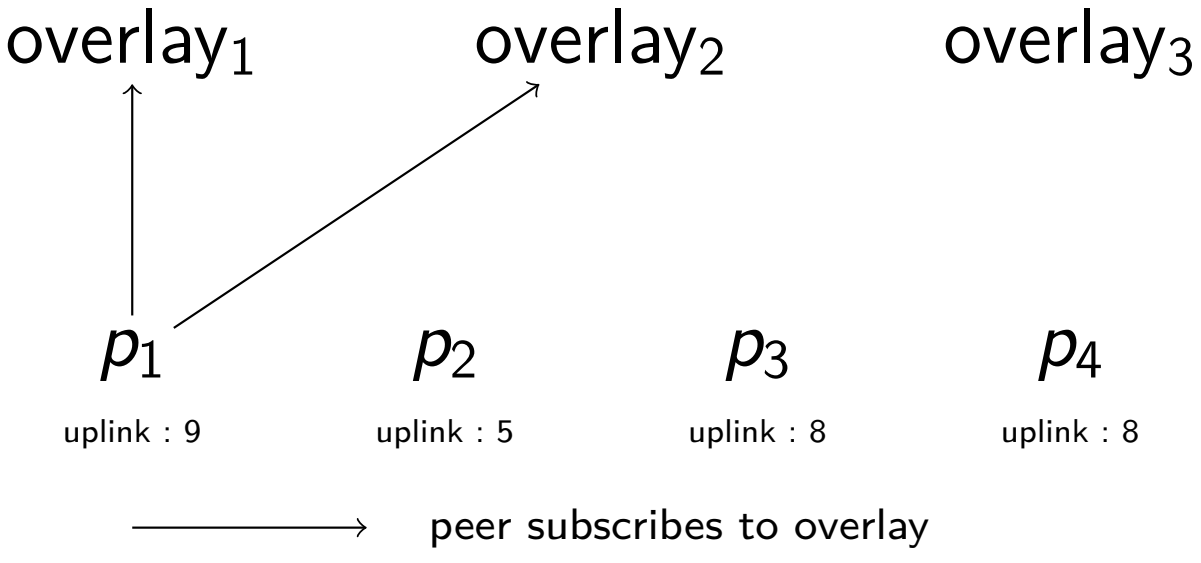

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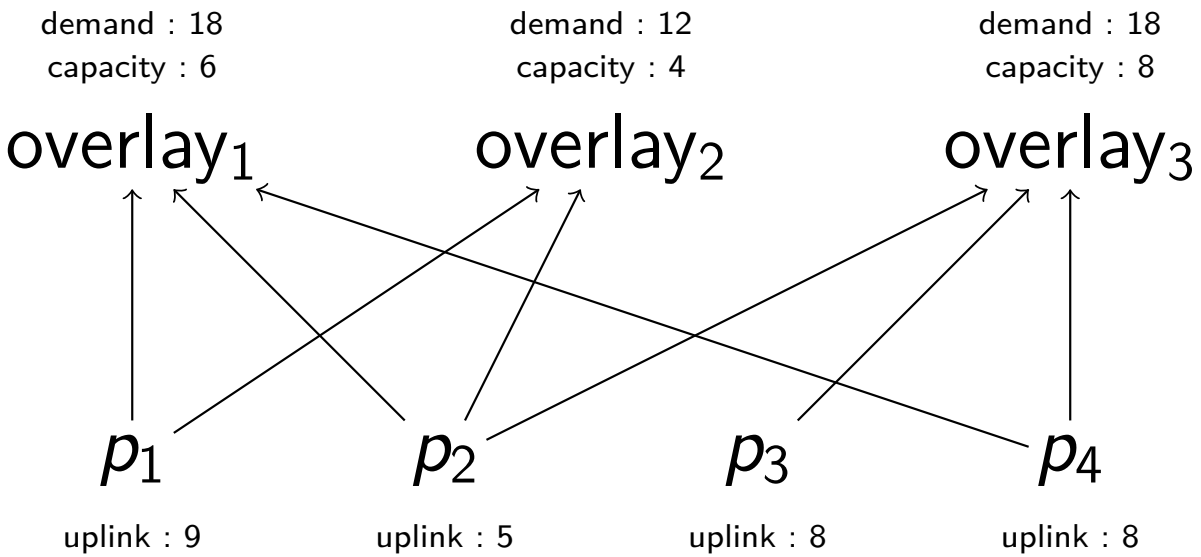

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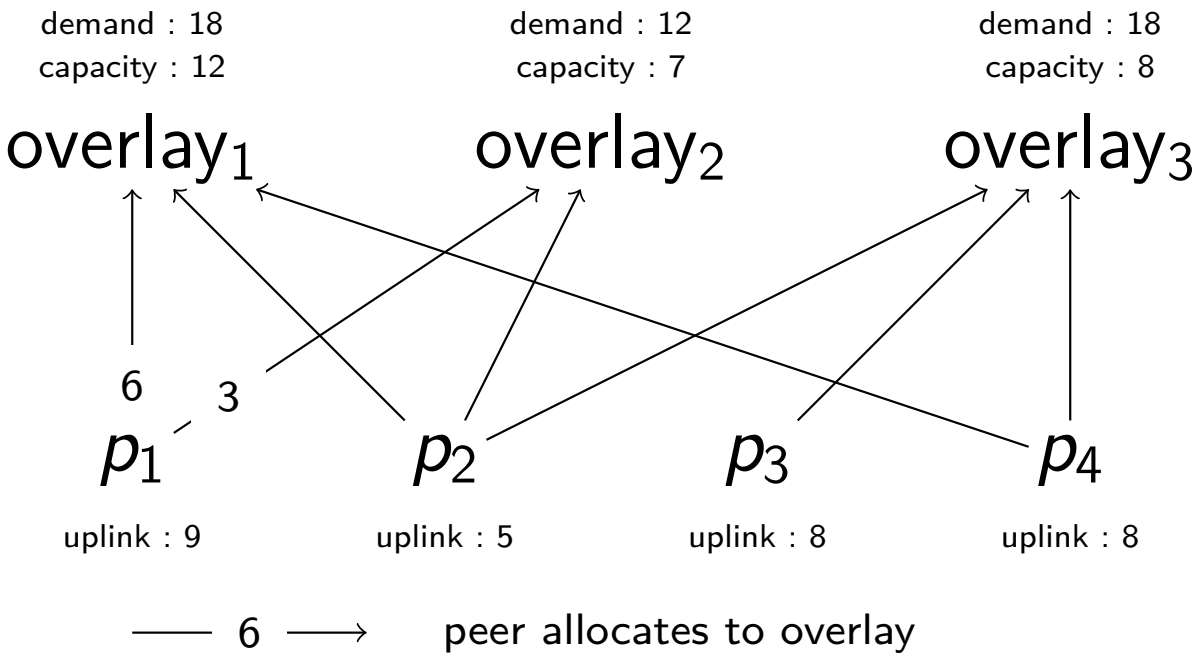

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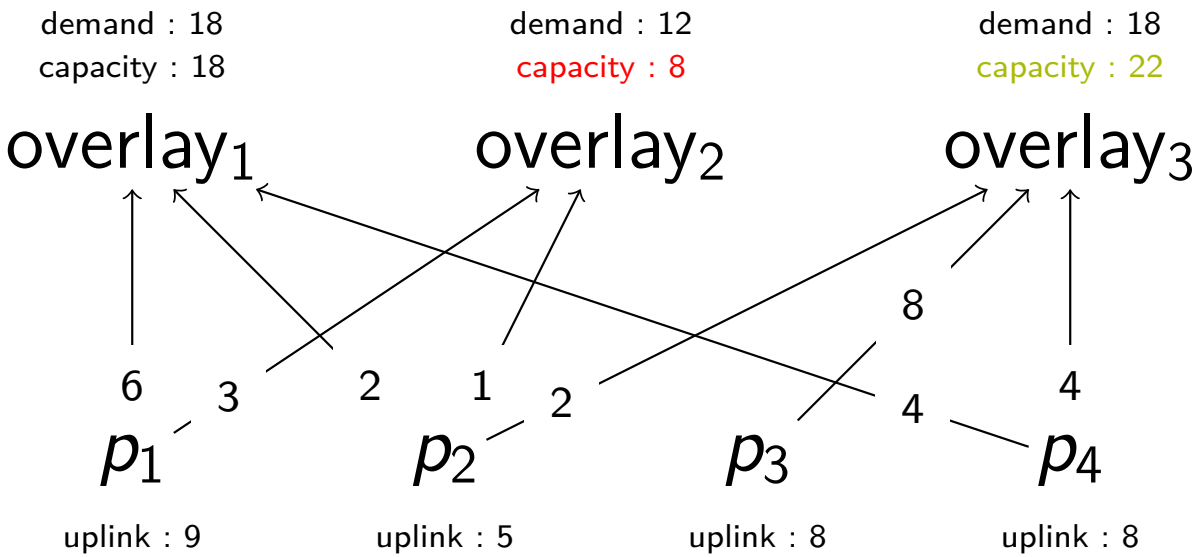

Objective 1 : minimizing the waste of resources

Overlay provisioning :

overlay capacity - overlay demand

- overlay capacity - overlay demand ≥ 0 :
  overprovisioned overlay (G^+)
- overlay capacity - overlay demand < 0 :
  underprovisioned overlay (G^-)

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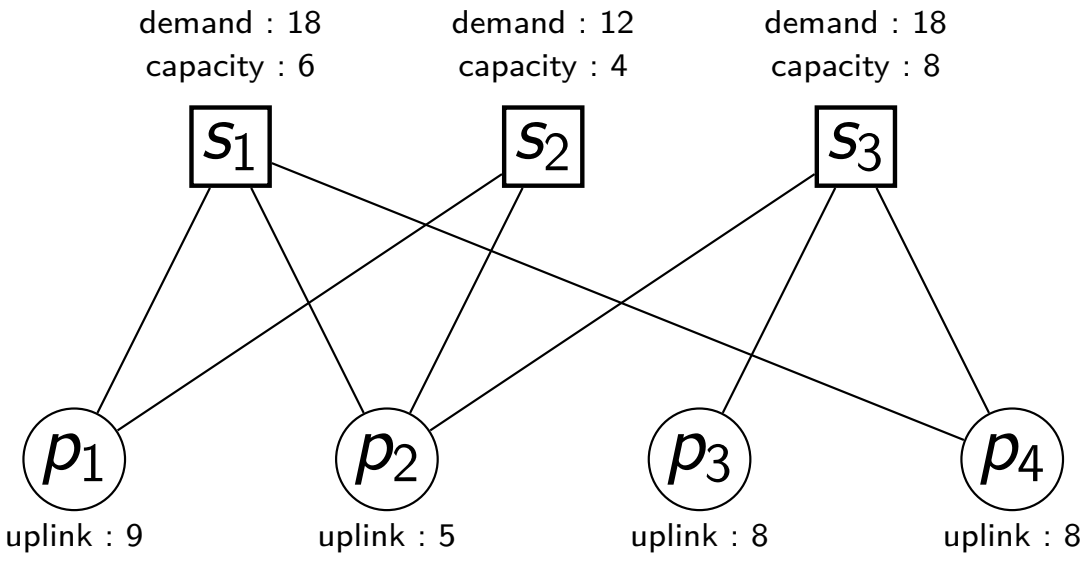
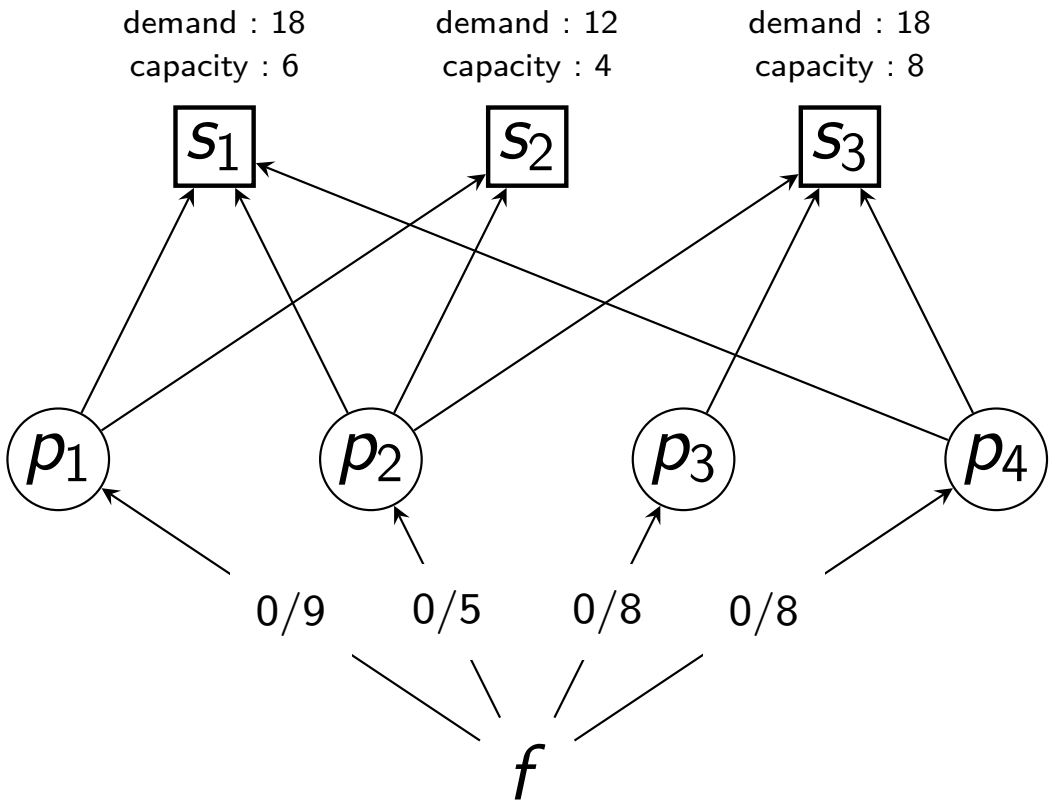
Objective : minimizing total underprovisioning

$$\sum_{overlay \in G^-} |capacity - demand|$$

Our solution : a max-flow



Our solution : a max-flow



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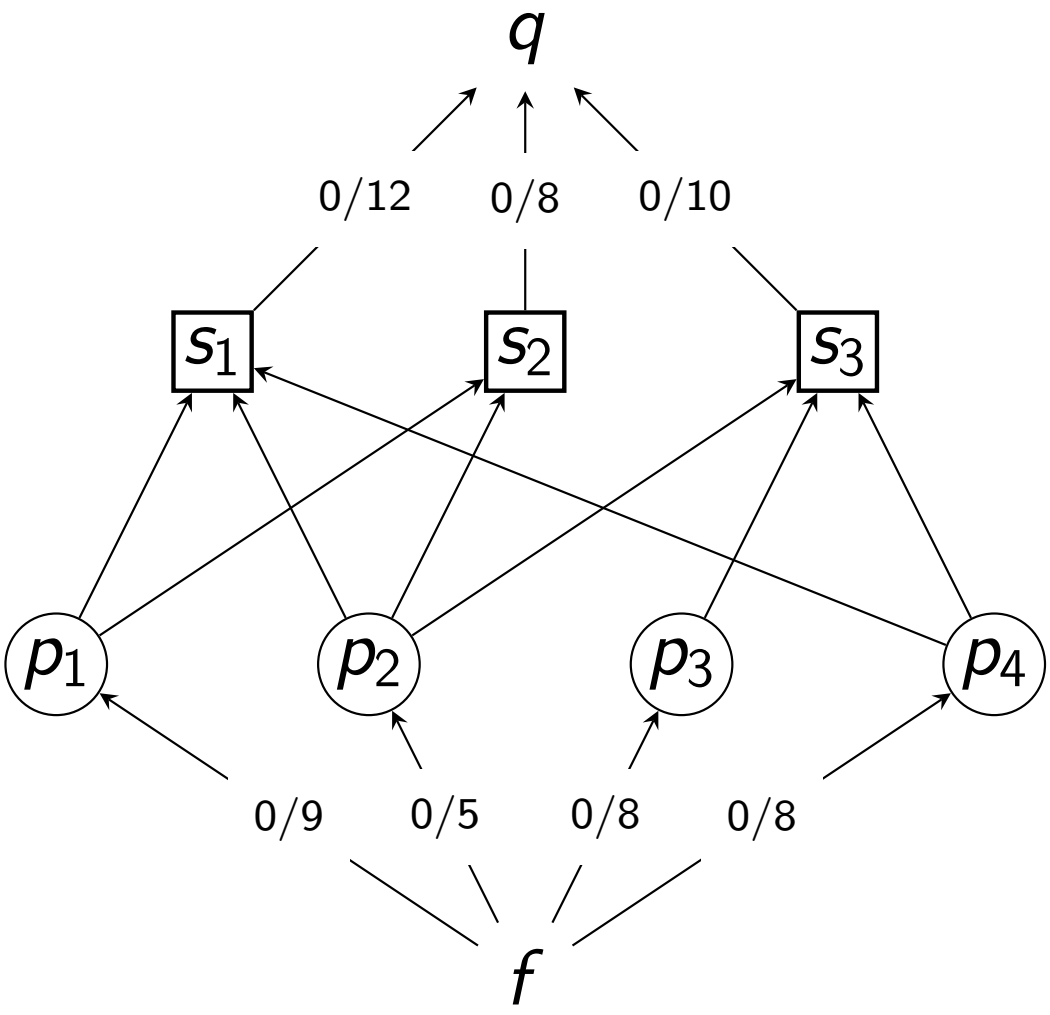

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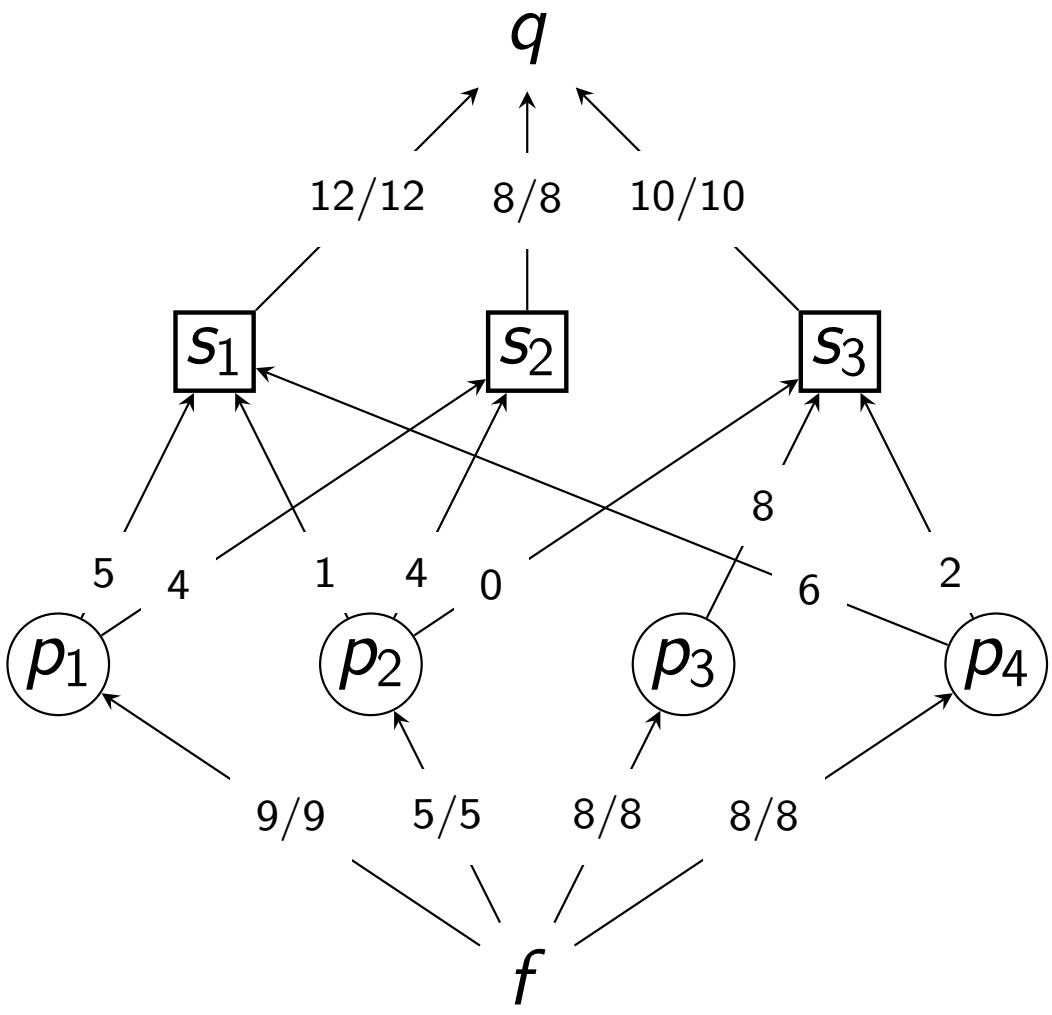

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Underprovisioned system :

$\sum_p$ bandwidth $<$ $\sum_{overlay}$ required bandwidth

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Given objective 1, how to share the resource deficit ?

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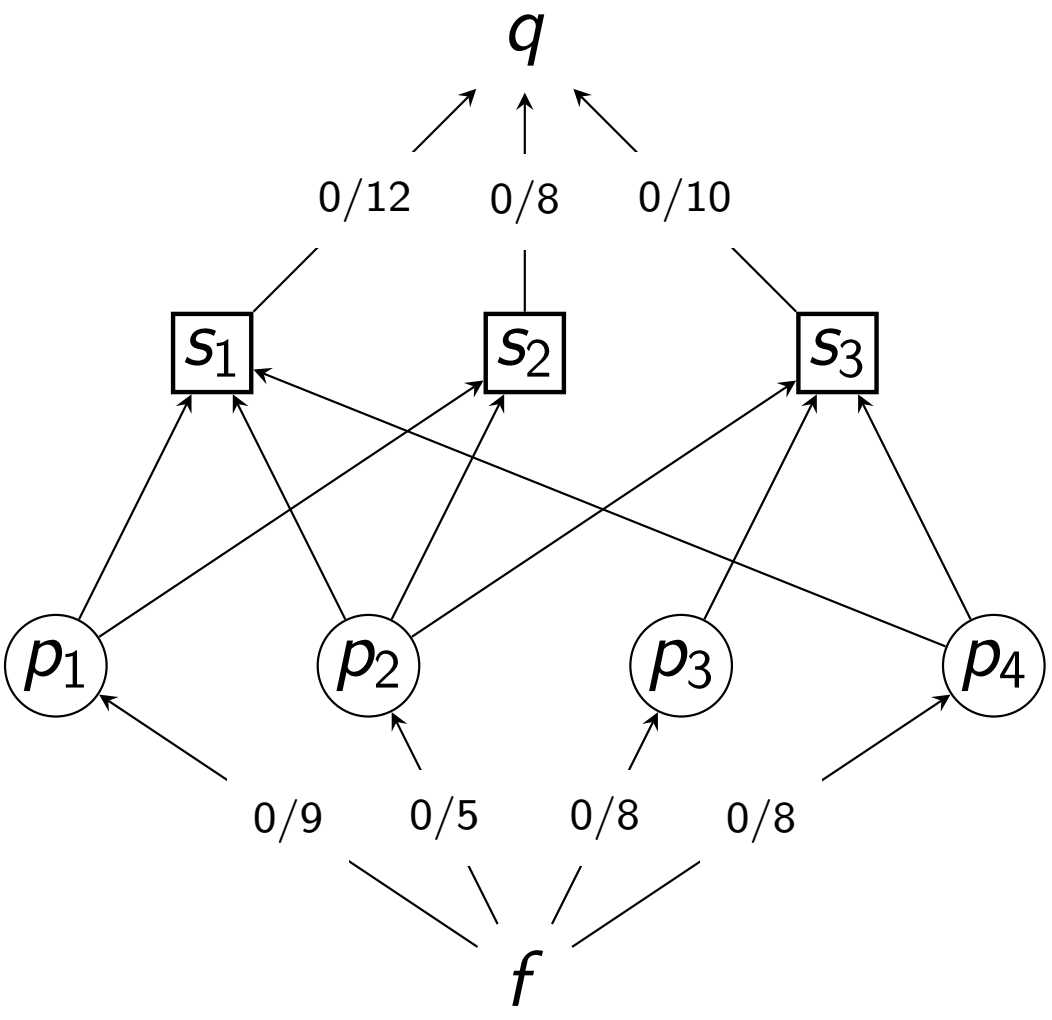
Given objective 1, how to share the resource deficit ?

- **popularity** : the most popular sources first
- **diversity** : the largest number of sources
- **others** : e.g. **payment** : the premium sources first

Our solution : a min-cost max-flow



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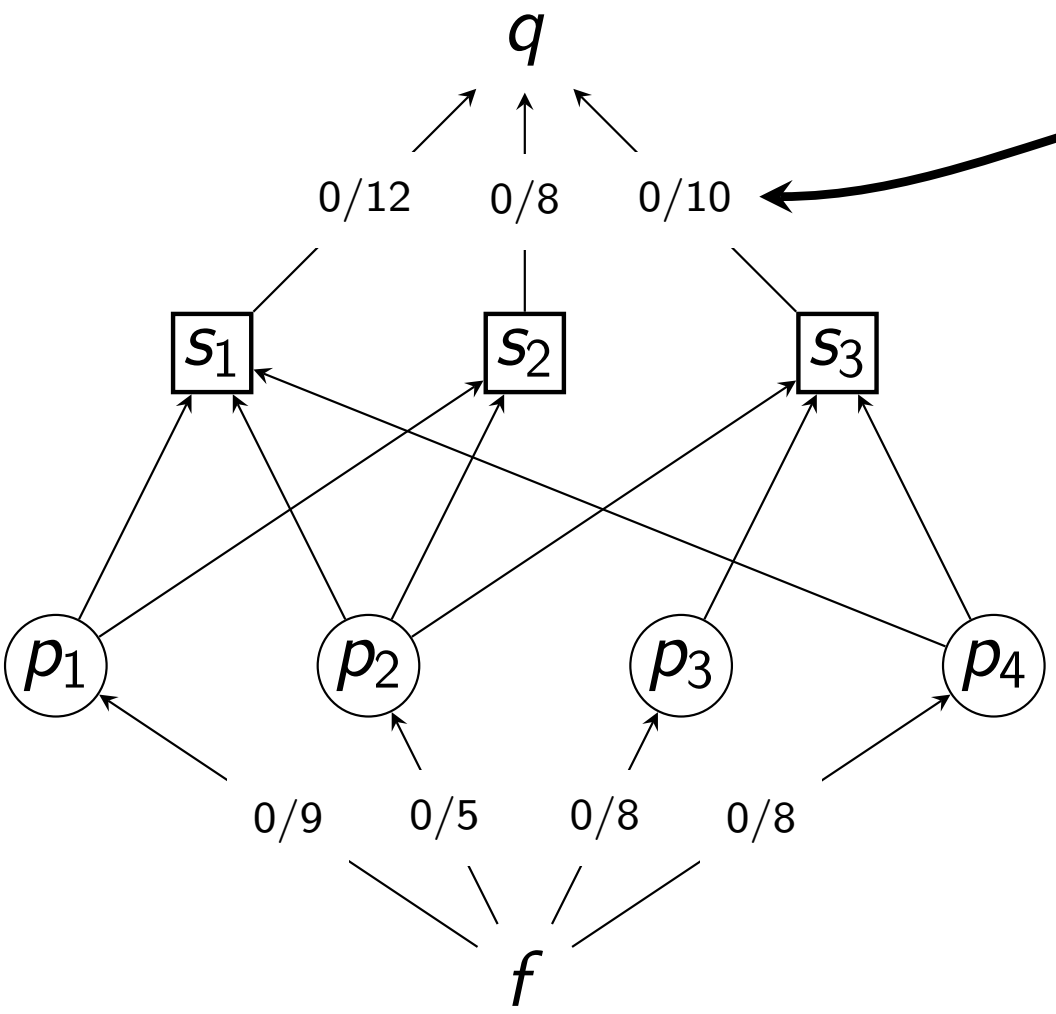

add a *cost* function

popularity : $\frac{1}{n}, \forall s$

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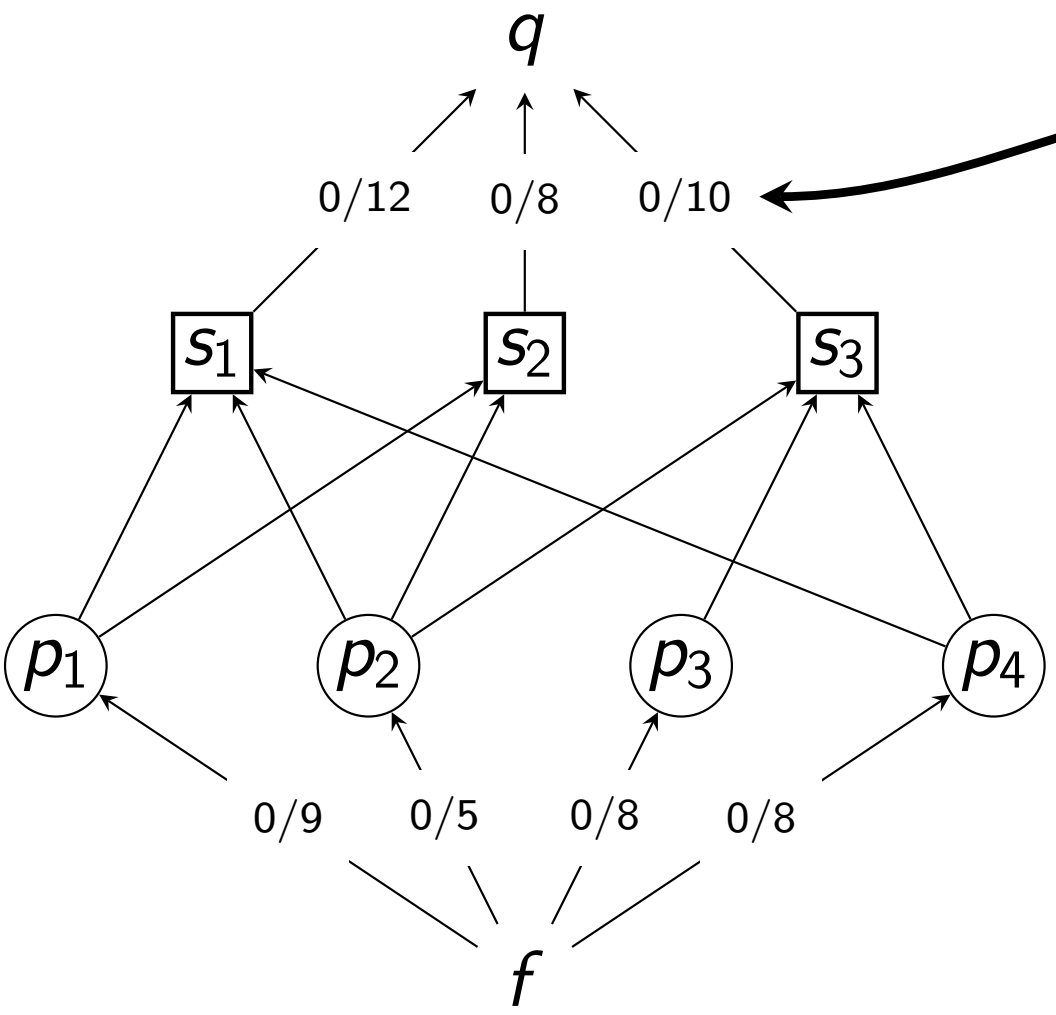

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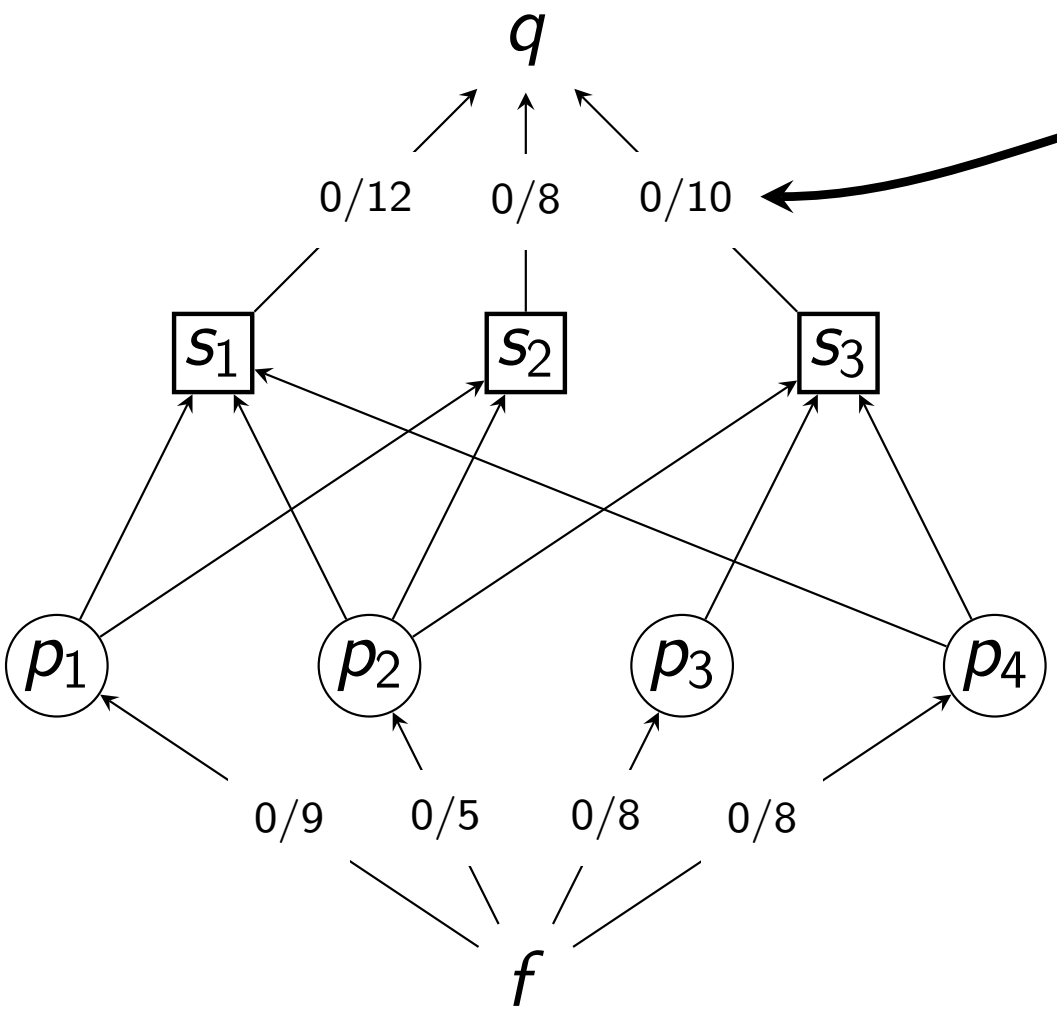

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payment :

$$\begin{cases} 1, \text{if } s \text{ is premium} \\ 2, \text{otherwise} \end{cases}$$

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System practicability

- Peer dynamics
  - Peers periodically report their estimated upload bandwidth
  - Server periodically recomputes, and sends bandwidth allocation
- Light peer server communication overhead
  - **0.8 Mbps** server upload bandwidth : 100,000 peers, 1min period, 3 average watching overlays$\times$2 bytes
  - **0.8 Mbps** server download bandwidth : 100,000 peers, 1min period, 4 bytes bandwidth and 4 bytes peer ID.
- Min-cost-max-flow algorithm computation time

nb. peers	1,000	5,000	10,000	50,000	100,000
time (sec)	0.005	0.086	0.311	7.455	31.887

Simulations : models and settings

Realistic player upload bandwidth :

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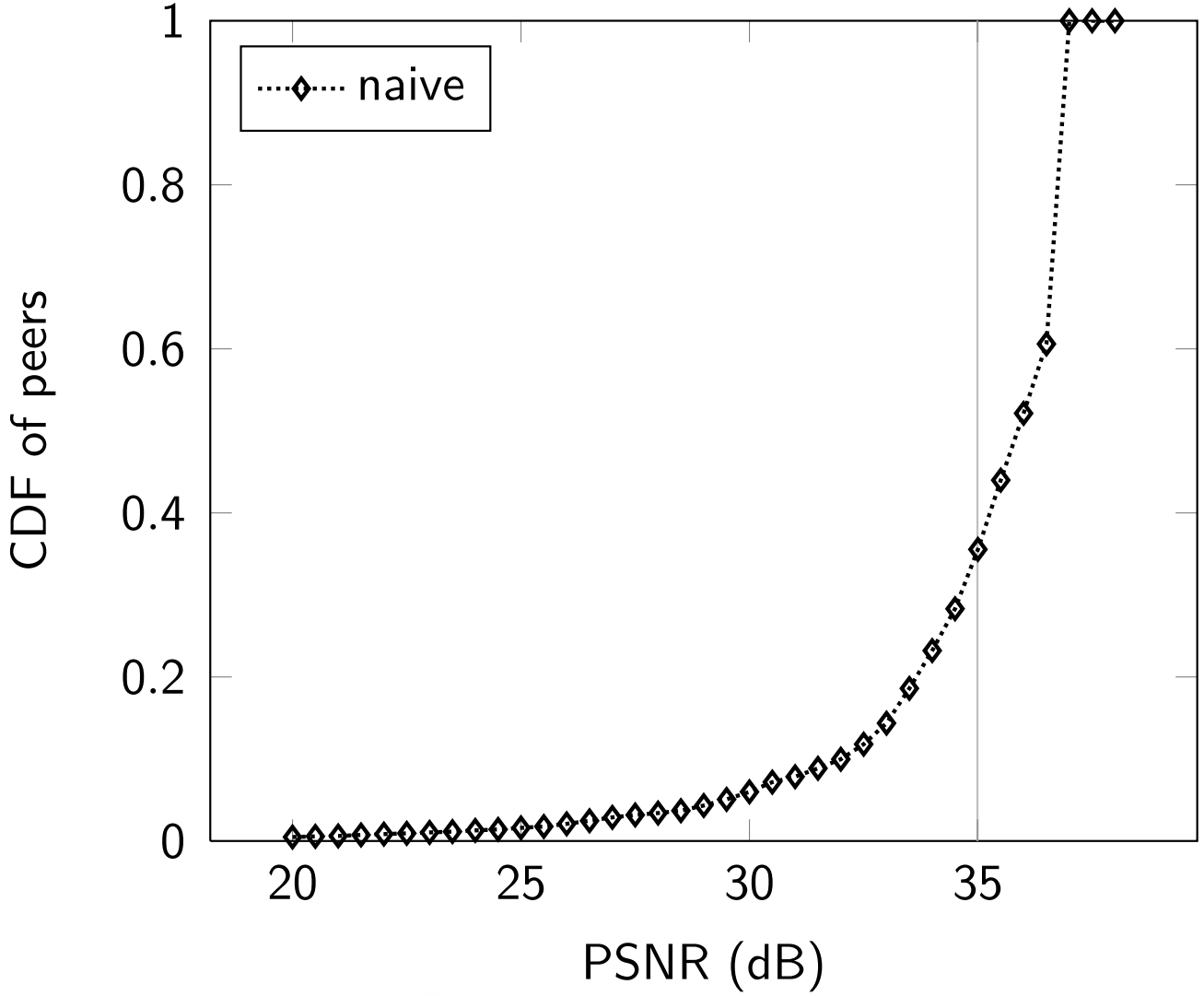
Watchers' behavior leads to a Zipf video popularity :

- most popular : 330 peers ; median popularity : 7 peers

Results - PSNR



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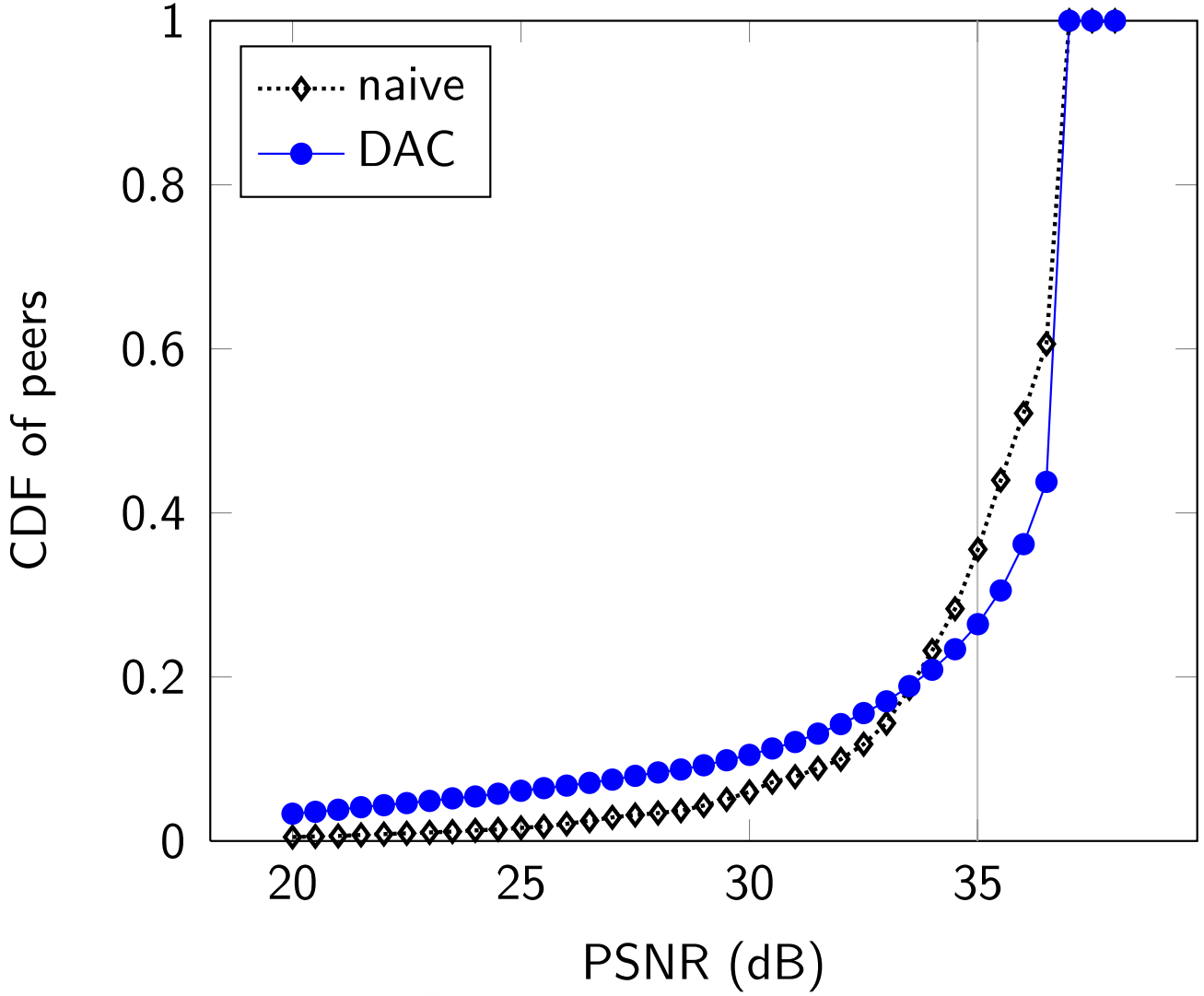

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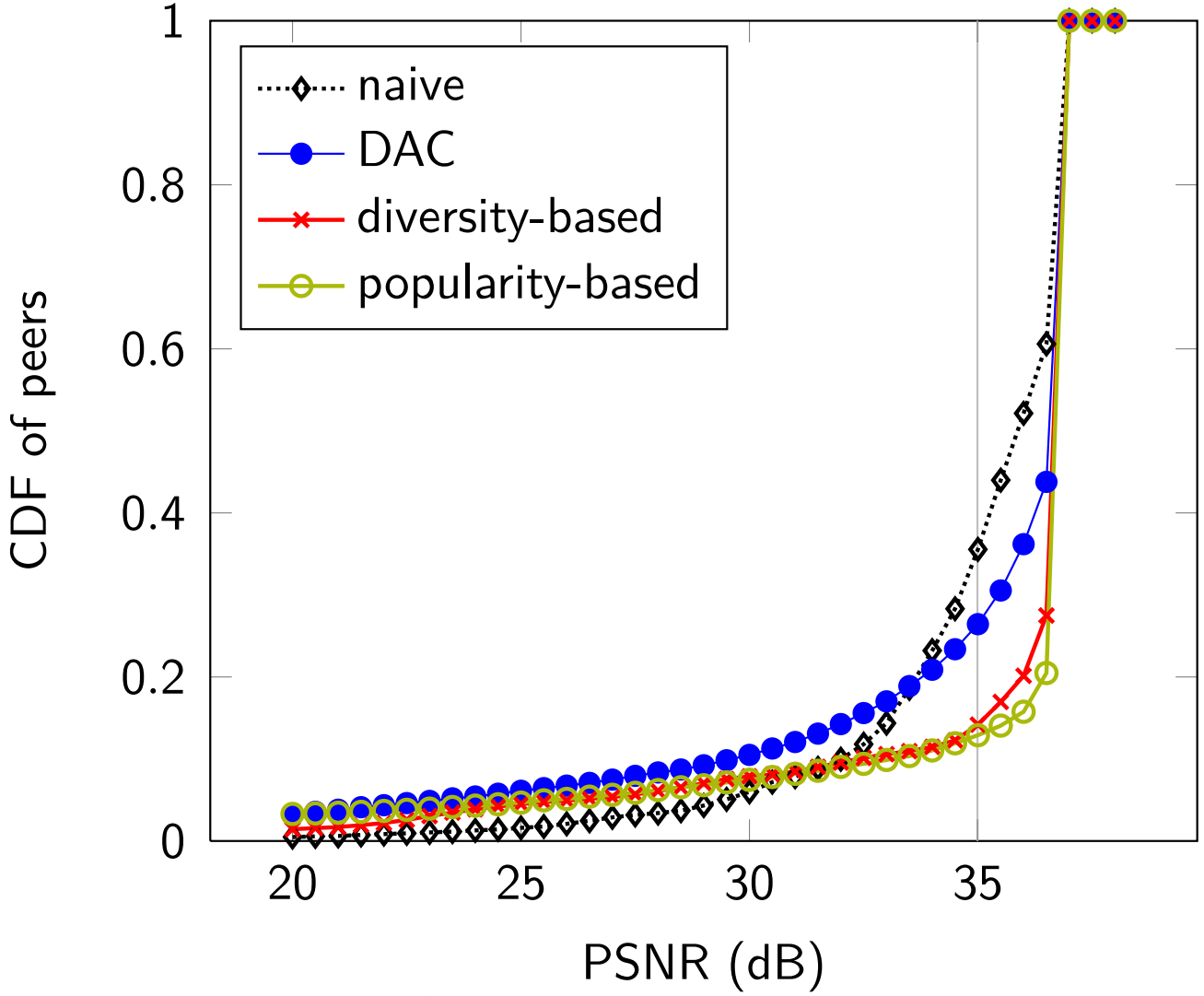

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Conclusion

- A multioverlay P2P live video streaming system
- Inter-overlay bandwidth allocation problem
  - Minimizing global underprovisioning
  - Sharing the resource deficit with different policies

Thanks!