



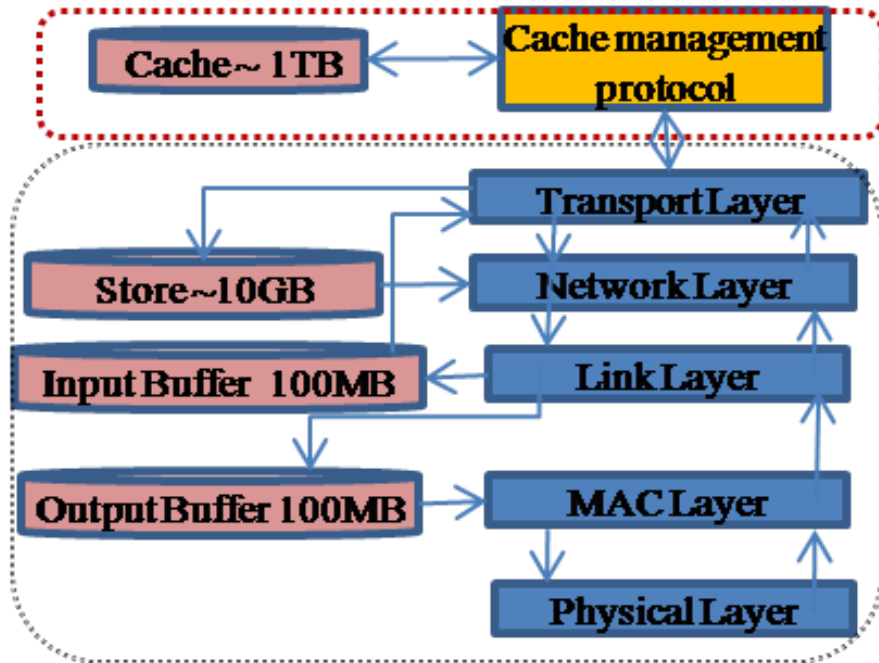
Personal Content Caching for Mobiles

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Caching/Storage Router

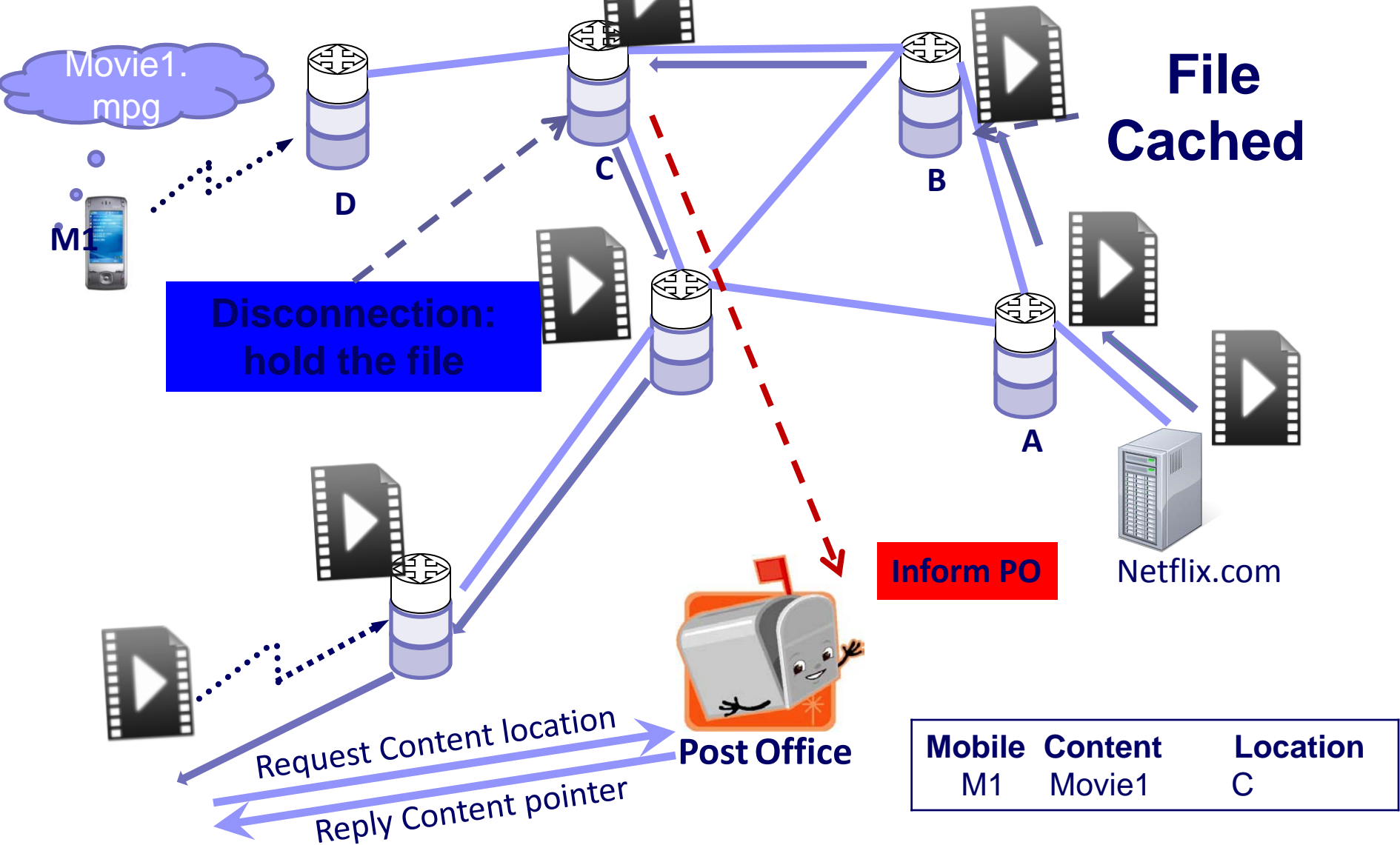


- In-network storage
- Temporary storage of content due to disconnection, poor link quality, congestion etc
- Buffering for hop-by-hop transit

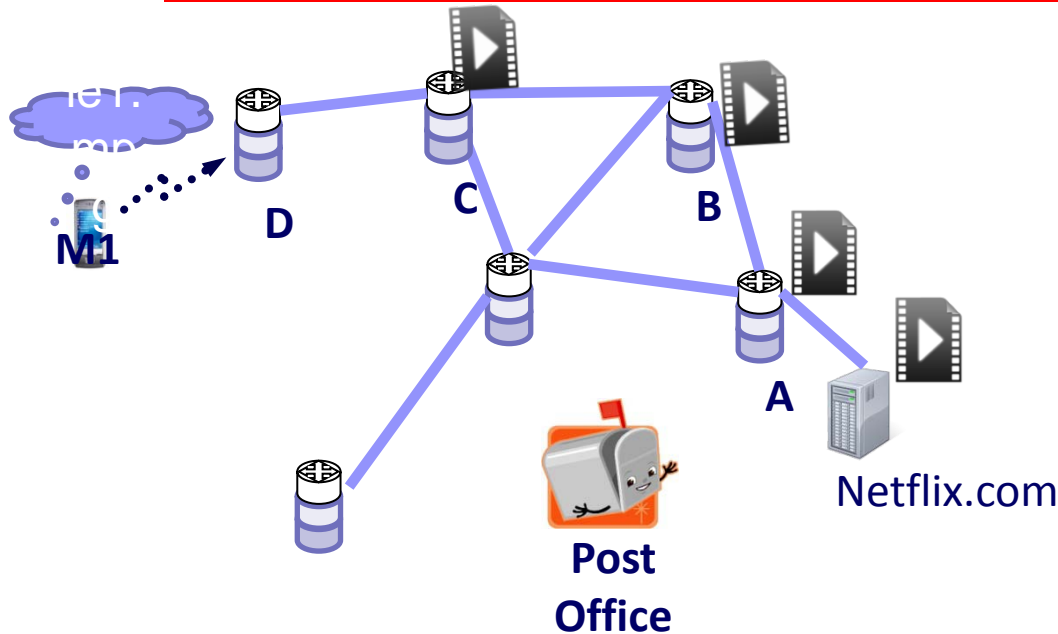
• Personal content

• Intermittently connected mobile users

Disconnected Operation: Post Office



Cache Space is a Network Resource



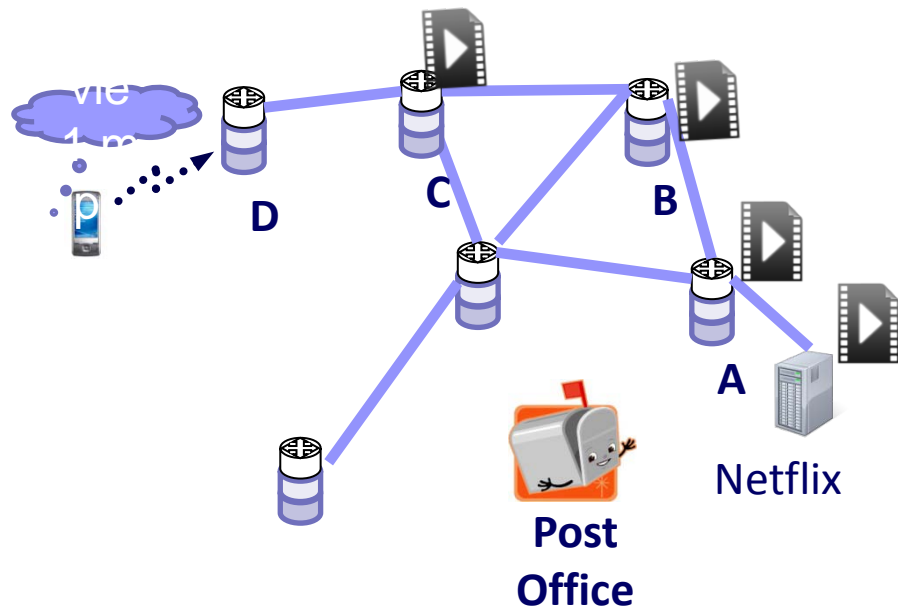
■ In an ideal network:

- Unlimited cache storage
- Files cached everywhere
- On reconnection:
 - file delivered from best cache
 - Max delivery probability
 - Min network load

■ In practice:

- Finite capacity caches
- Personal content is hard to track
- Cache space easily wasted

System Model



- **Mobile users connect via access networks**
 - request personal content stored in the network.
- **Before content delivery ...**
 - mobile moves and disconnects
 - and later reconnects at a new location

- What happens to content in transit?
- Which routers should cache the file?
- How should old content be discarded?

Personal Caching Issues

■ Caches need to be selective

- File still in cache when mobile reconnects?
 - ELT = Expected LifeTime of a file in a cache
 - M = average mobile “away time”
 - Cache useless if $ELT \ll M$

■ Cache rules need to be local

- Global network state is too complex
 - Where is this file already cached?
 - Where are all the other files cached?
 - What are the mobility characteristics of this user?

Personal Caching Approach

- Least Recently Used (LRU) cache deletion
- Identify cache storage rules so LRU works

Cache Storage Policies?

- Cache everything
 - at every intermediate router
- Last node caching
 - at last router when mobile disconnects
- Random caching
- Cache Pricing

Random Caching

- Node i caches a file with probability c_i

■ Cache Probability Optimization

- Node i cache capacity = N_i files
- File arrival rate λ_i
- Little's Law:

$$ELT_i = N_i / (c_i \lambda_i)$$

- Maximize c_i such that $ELT \geq M$
 - M = Mobile away time

Cache Pricing

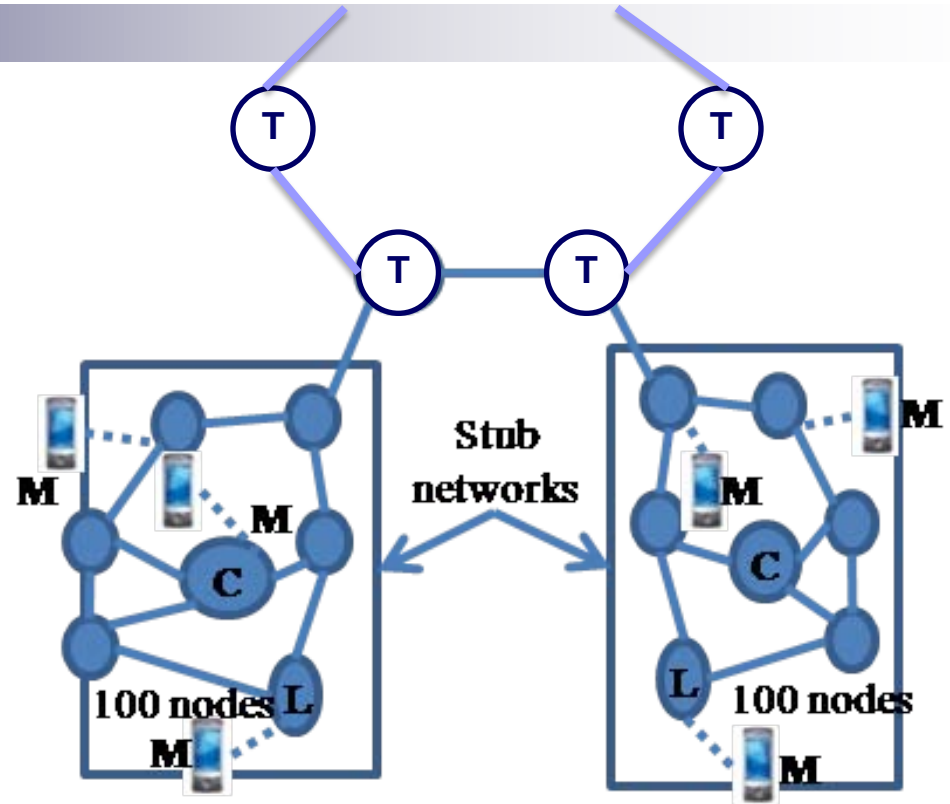
- User j specifies acceptable price q_j for caching
 - Acceptable prices are random over users
- Router i sets a caching cost p_i
- User j file cached at router i if $p_i \leq q_j$
- Router i sets min p_i such that $ELT \geq M$.

Cache Pricing Enables User Selectivity

- Short stay-time users:
 - often fail to retrieve their files
 - will get bigger benefit from nearby caches
 - will have high willingness to pay for cache

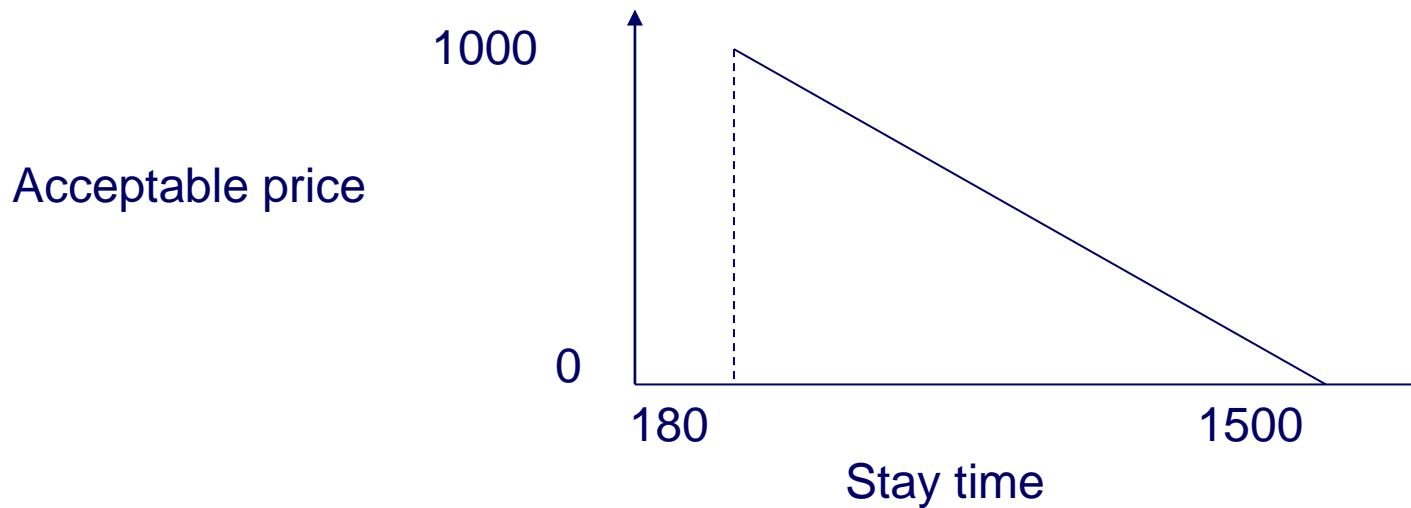
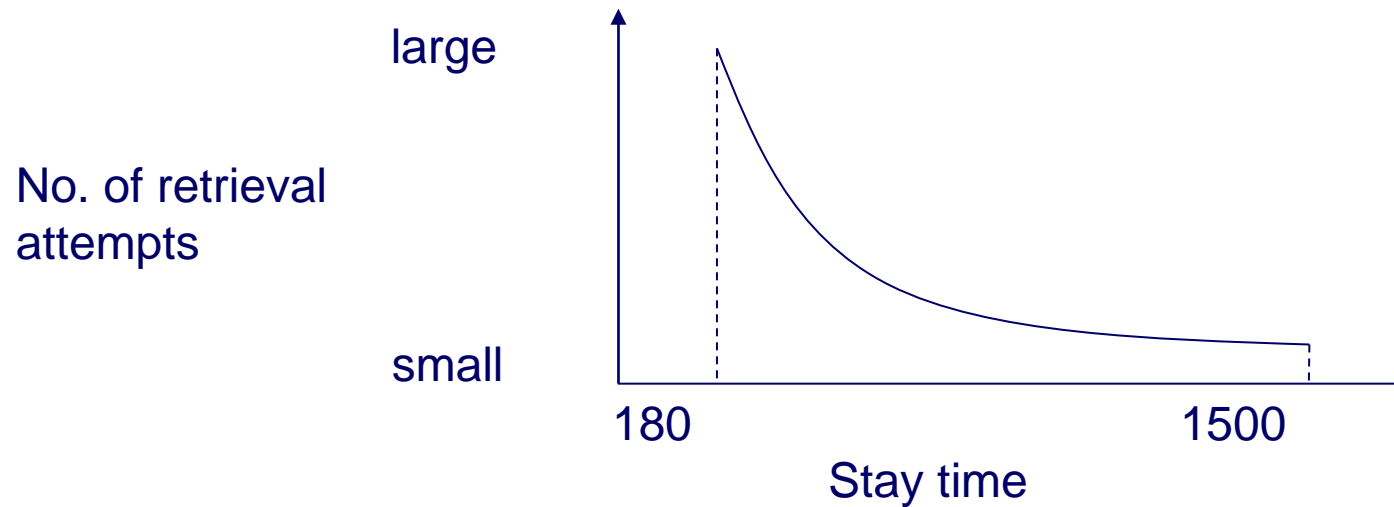
Simulation Setup

- 8 stub networks
- ring transit network

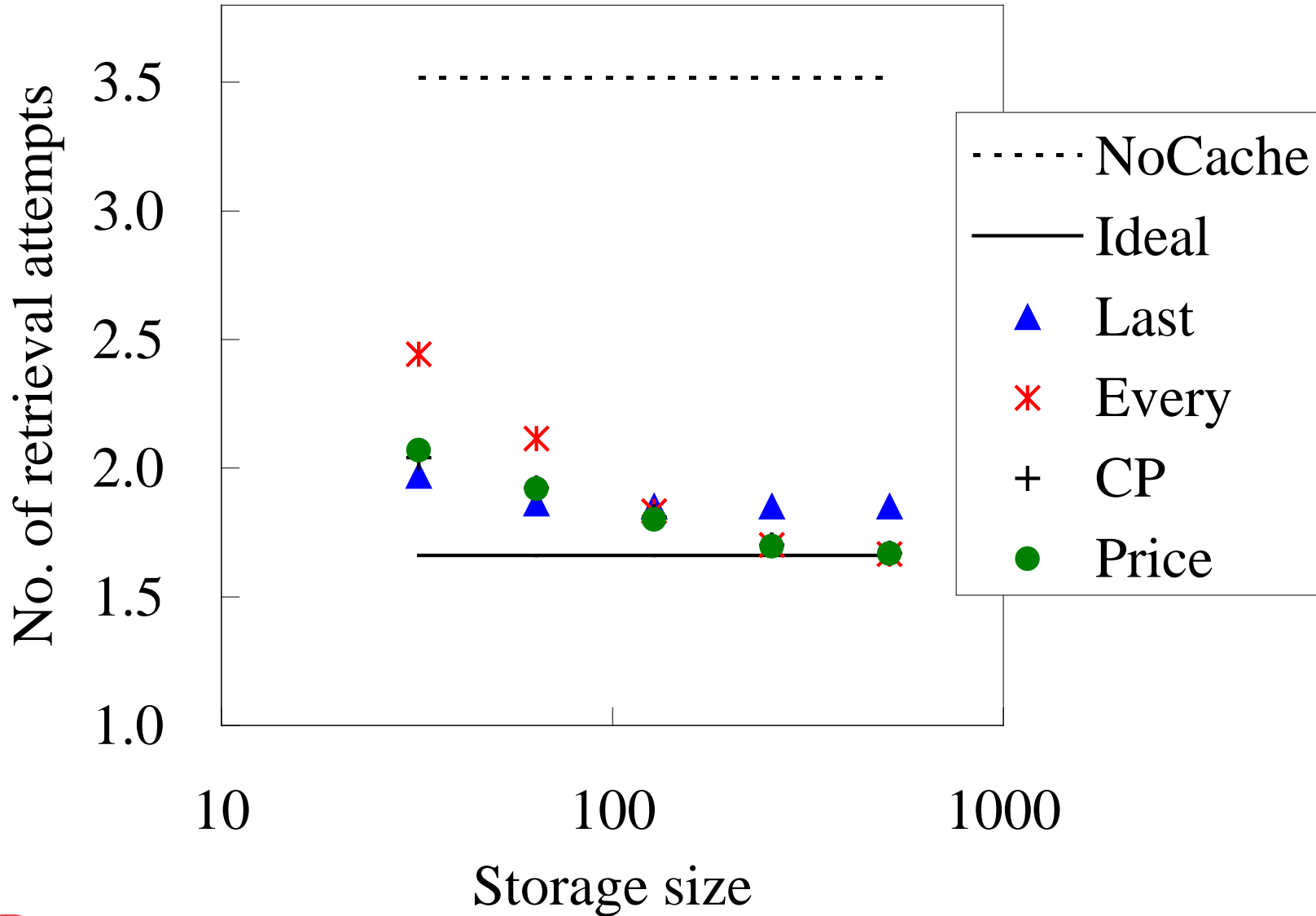


- Stub link: 100Mbps, transit link: 1Gbps
- File size: 1GB, Storage size: 32-512GB
- Stay time: uniform (180-1500 sec)
- Away time: exponential (mean=6000 sec)
- Probability of movement to other stubs: 0.8

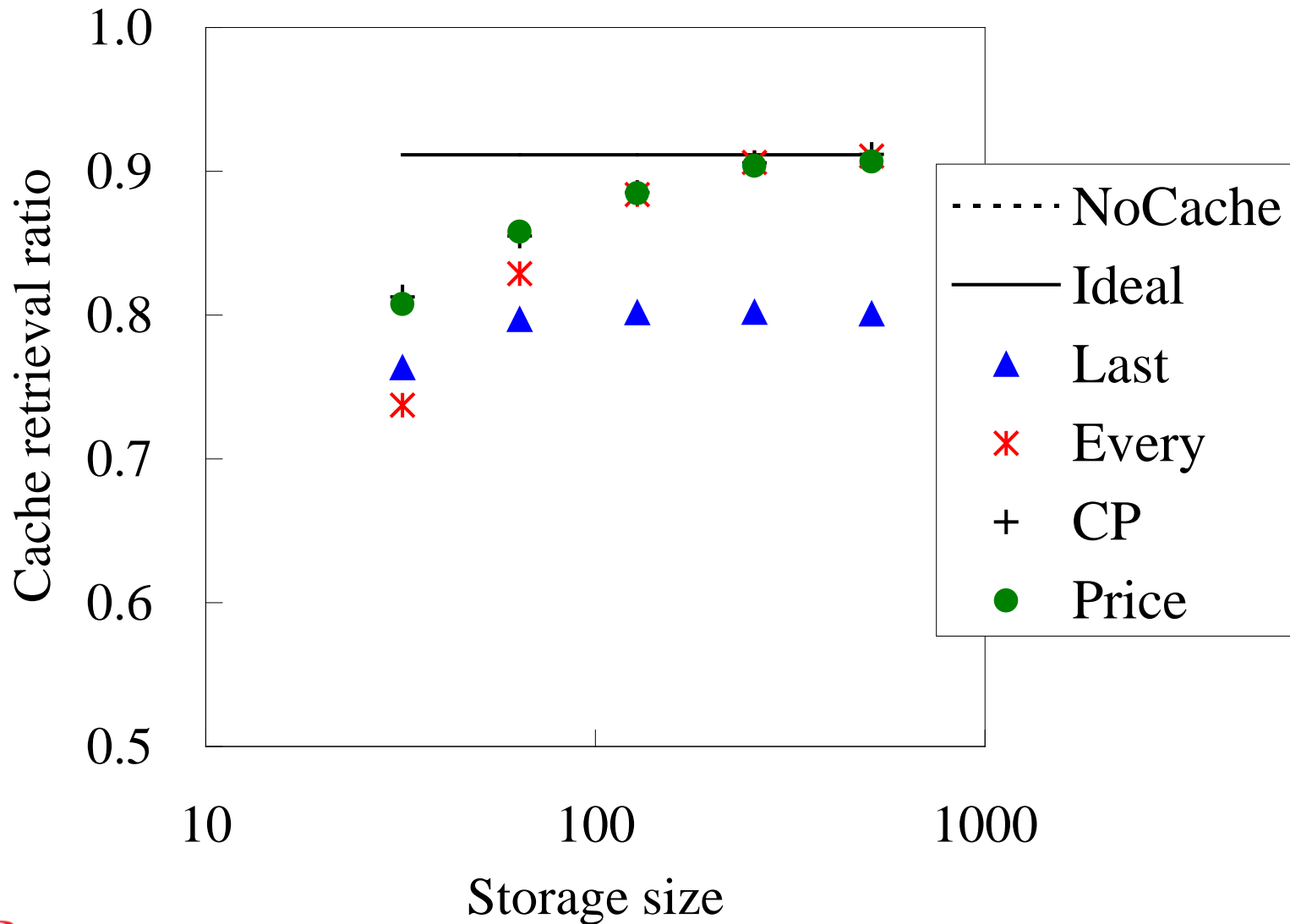
Cache Pricing: Short-Stay users pay more



Retrieval attempts



Cache retrieval ratio



Discussion

- ❑ Your mileage may vary
 - ❑ Results depend on network topology, user mobility,
- ❑ Users' Cache pricing policies needs more study
- ❑ User/Router Cache price interaction/equilibrium
- ❑ Cache pricing + last-router caching?
- ❑ Local neighborhood cache coordination?
 - ❑ File-embedded caching instructions

SIMULATION RESULTS

Dots represent adjusted pricing, lines represented uniform pricing

