Smart Caching for Supporting Video Streaming in Heterogeneous Wireless Networks

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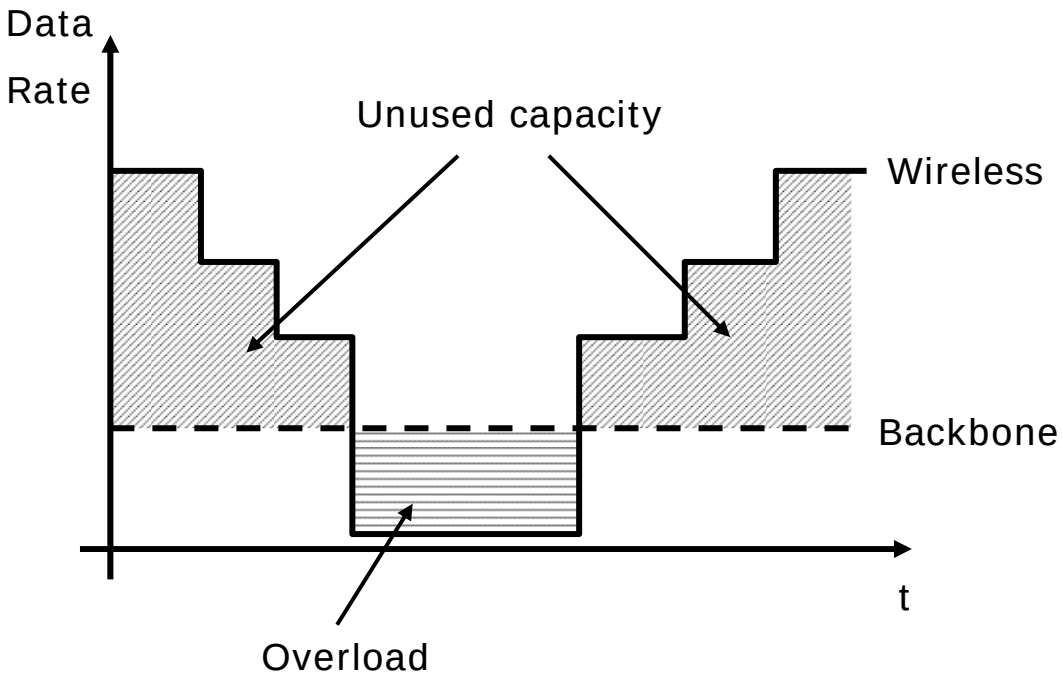
Overview

- Motivation and Introduction
- Smart Caching
- User Scenario
- Queuing Model
- Results
- Conclusion and Outlook

Motivation

- Mobilizing services and applications:
  - Video on Demand
  - Online VCR
  - IPTV
- Broadband wireless coverage vs. heterogeneity
- Discrepancy between capabilities of fixed and wireless networks
- High bandwidth requirements – low delay constraints

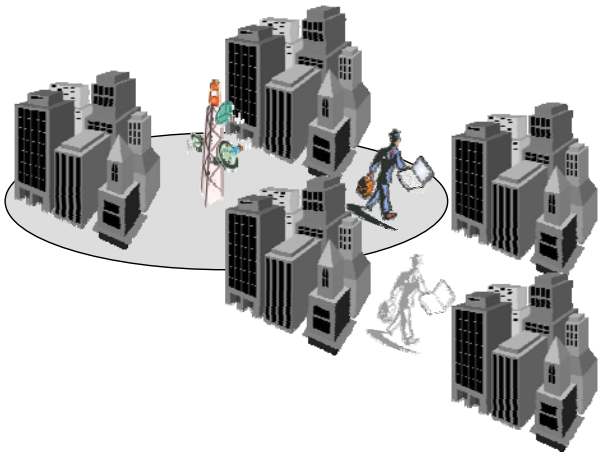


➢ Adapt wireless networks

➢ Decouple wired and wireless networks

Introduction

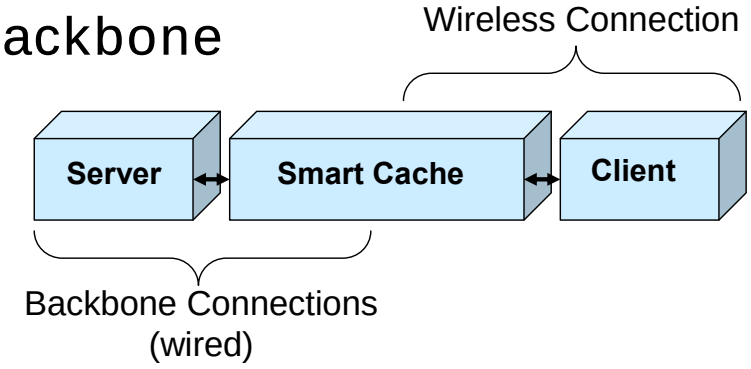
- Video streaming requires high average data rates
  - More than cellular networks can provide
  - Smaller than WLAN peak data rates



- Data rate varies due to
  - Used wireless network
  - Distance to Access Point (AP)
- Life on buffered data in phases of no coverage
- Legacy buffering in end device is not enough
- Maximum network utilization is necessary
  - Be greedy – Use always as much network resources as possible
  - Requires user data provision

Smart Caching

- Buffering at the edge of the core network
- Separation of end-to-end link
  - One hop in the (wired) backbone
  - Second hop (mostly) in the wireless network
- On top of transport layer
  - Packets leave transport layer, buffered and forwarded
- Reuse of data requires clustering of access points
- Protocol overhead kept away from backbone
- Fast reaction on changing link conditions
- Integration of different networks possible

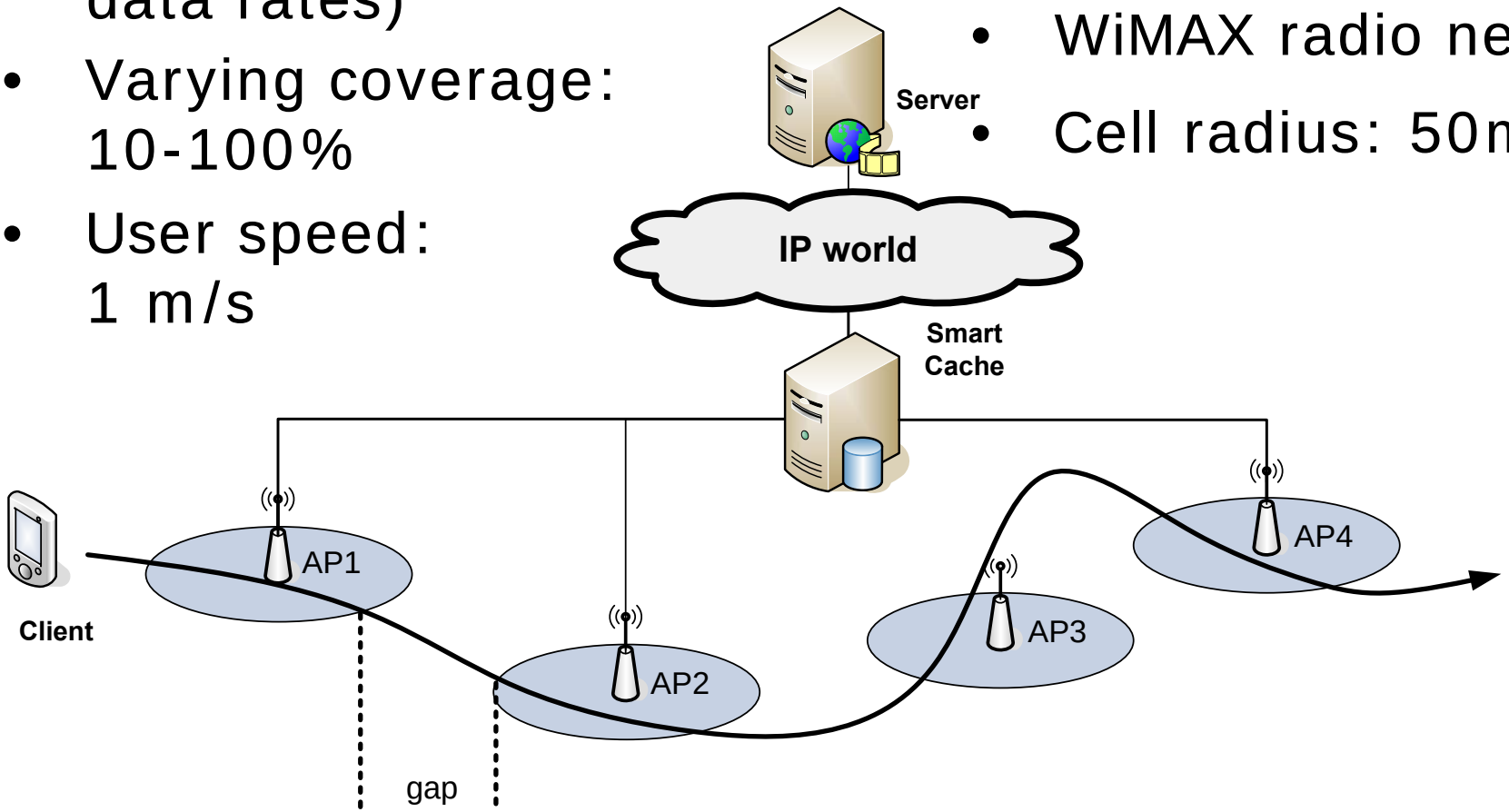


- In case of enough bandwidth no buffering necessary

Application Scenario

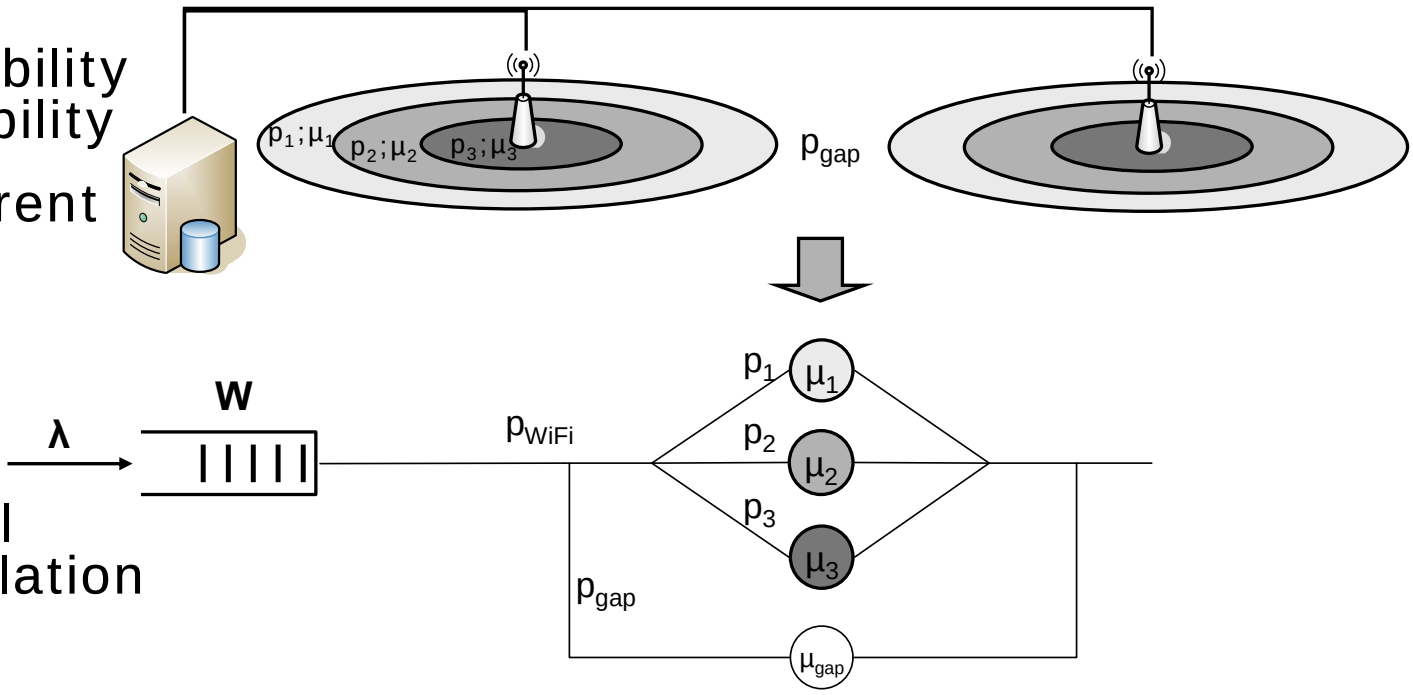
- Applied service:
  Video streaming (varying data rates)
- Varying coverage:
  10-100%
- User speed:
  1 m/s

- Urban environment
- WiMAX radio network
- Cell radius: 50m



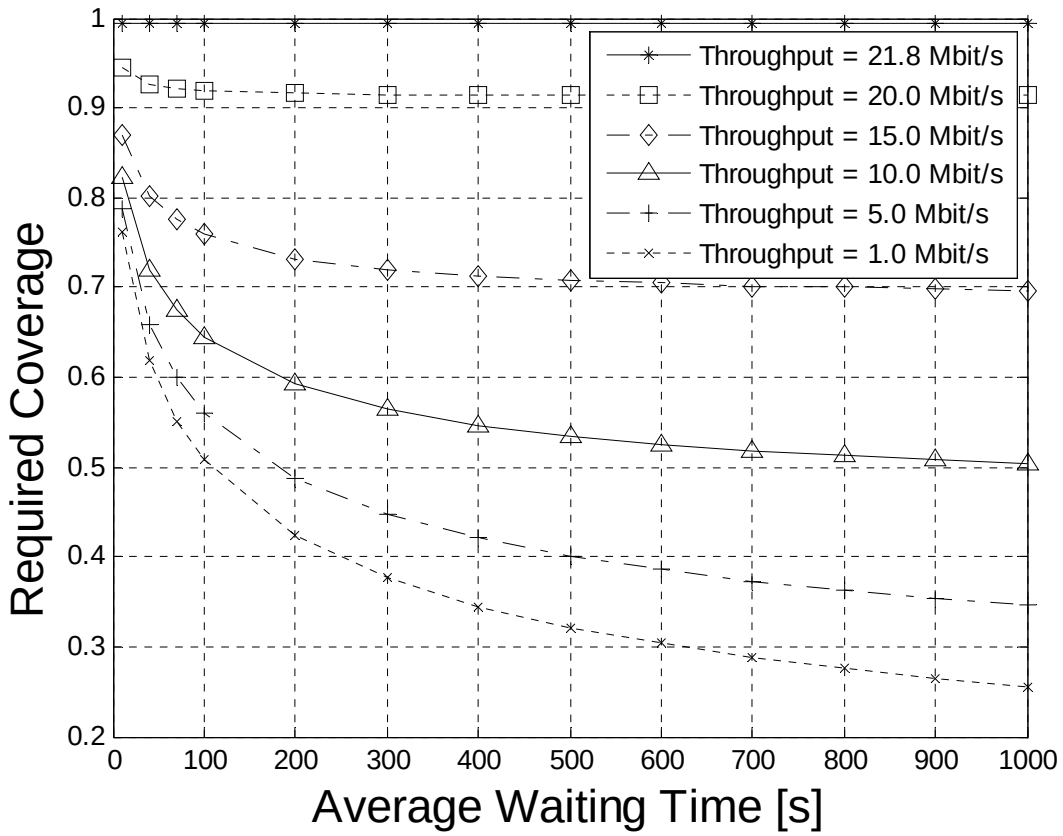
Queuing Model

- Emulation of service interrupt with “gap packets“
- Arrival process: Poisson and batch arrival (more appropriate for MPEG streams)
- Translation of residence probability into path probability
- μ given by different PHY modes of WiMAX
- Packet size: 100 Byte
- Analytical model allows the calculation of Waiting Time distribution



Simulation Results

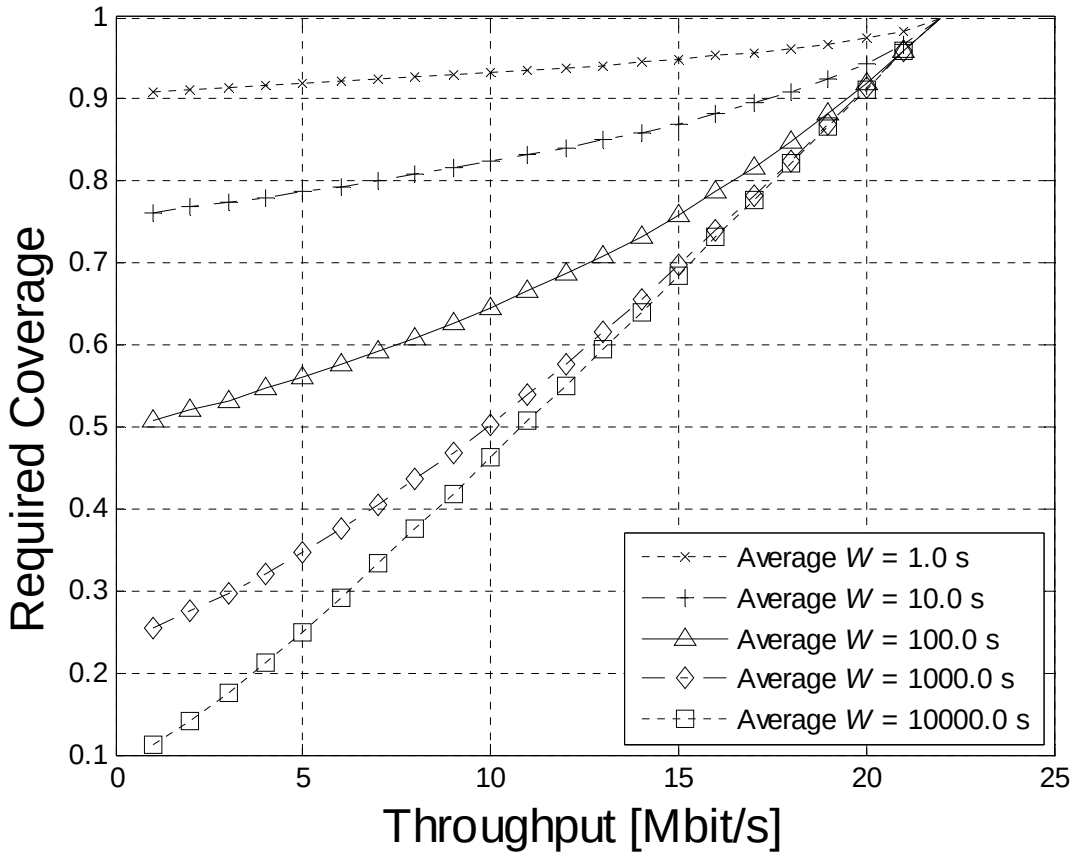
- Average Waiting Time corresponds to the required lead time for video streaming



- Smart caching focuses on delay insensitive traffic
- Less delay tolerant applications require more coverage
- Usual video streaming rates allow small coverage portions
- No loss of data
- The closer the systems comes to the maximum throughput rate the more ineffective Smart Caching gets

Simulation Results

- Waiting Time boundaries imply certain coverage rates
- Strict limits require almost full coverage -> No Smart Caching
- Lowest curve is limit of available throughput

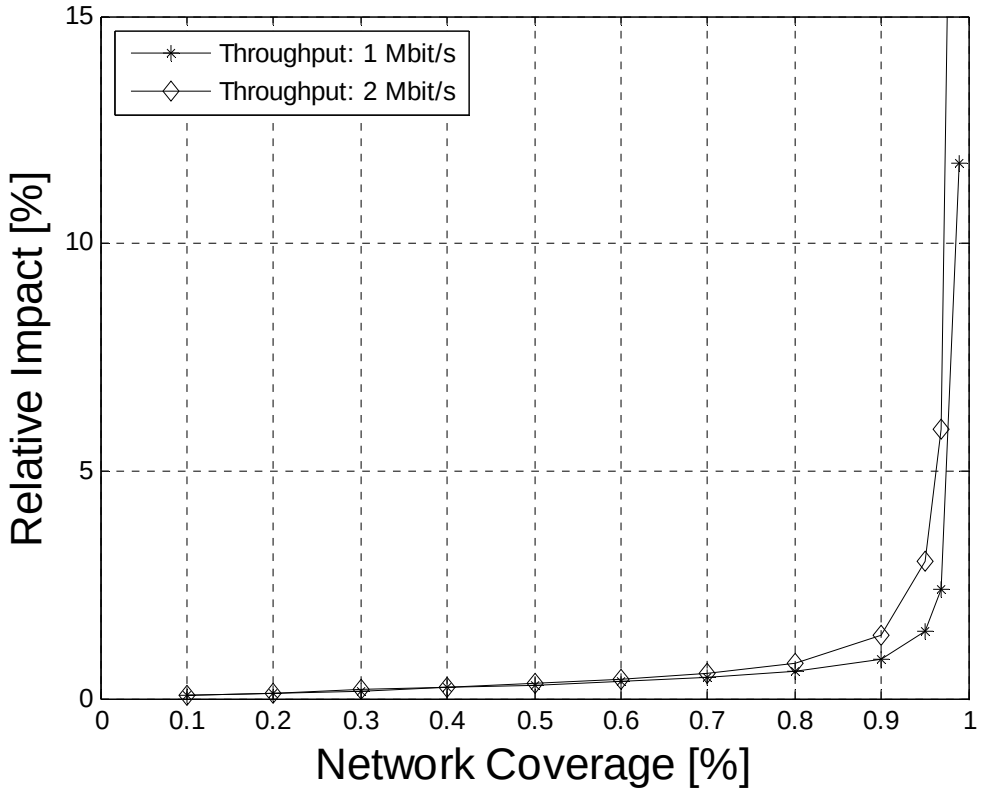


- ~22 Mbit/s is maximum data rate of the scenario

Simulation Results

- Which influence has the traffic modeling? Compare:
  - Poisson stream
  - MPEG stream (batch arrival)
- Change in average waiting time
- Less influence of interarrival time variance
- Effect increase with raising data rate
- For coverage portions of less than 70% Poisson arrival is sufficient

- Smart Caching -> Smoothing of arrival process



Conclusion and Outlook

- Smart Caching improves performance of heterogeneous networks
  - Patchy network coverage
  - Variance in link quality
- It is suitable for video streaming services:
  - Video on Demand (VoD)
  - IPTV
  - E.g.: Bandwidth consuming delay tolerant traffic
- No full network coverage is required

- Future:
  - Restrict transfer of streaming data to high performance areas
  - Scheduling based on delay requirements and available bandwidth

Thank you for your attention !

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Any questions?