

# **OPAL: Oppportunistic Alignment of Advertisement Delivery with Cellular Base station Overloads**

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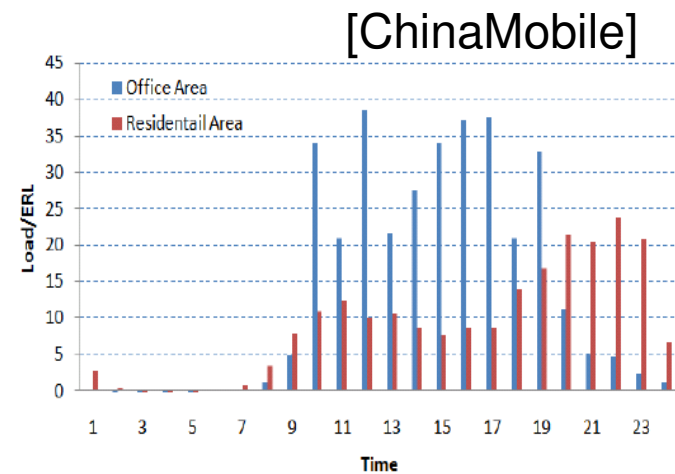
# Motivation: 3 Observations

## 1. Mobile video traffic increasing significantly

- 66% Mobile content will be video by 2015 [Cisco]

## 2. Base station Overloads a growing concern

- Users QoE suffers, especially for video
- Not always overloaded: so worst-case provisioning expensive



## 3. Operator-enabled Mobile Advertising attractive revenue generator

- Users get interrupted every so often

OPAL aligns overloads with advertisements to minimize user interruption

# What this paper “is”, and “is not”

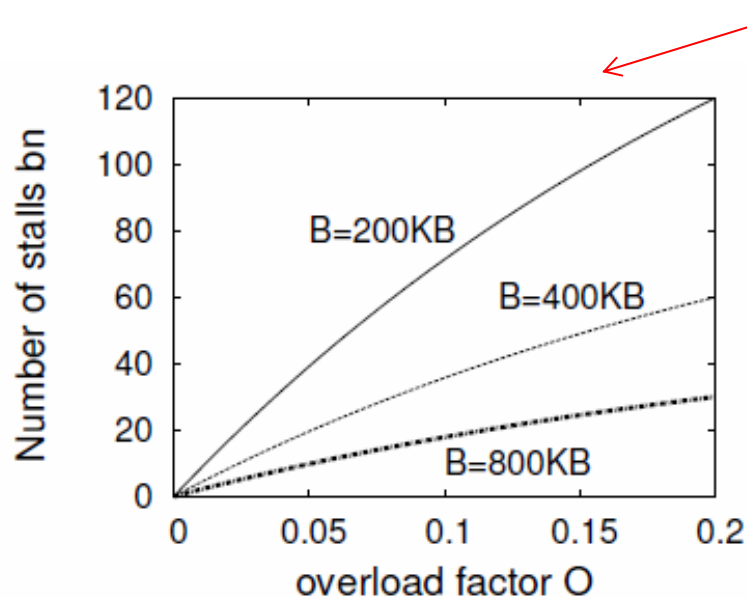
- This paper is not about advertising!
- Instead, it is the following:
  - Operator-enabled advertising will happen anyway
  - Basestation overloads are also happening anyway
  - How can we align them to improve the overall user perception of the cellular network?

# Outline

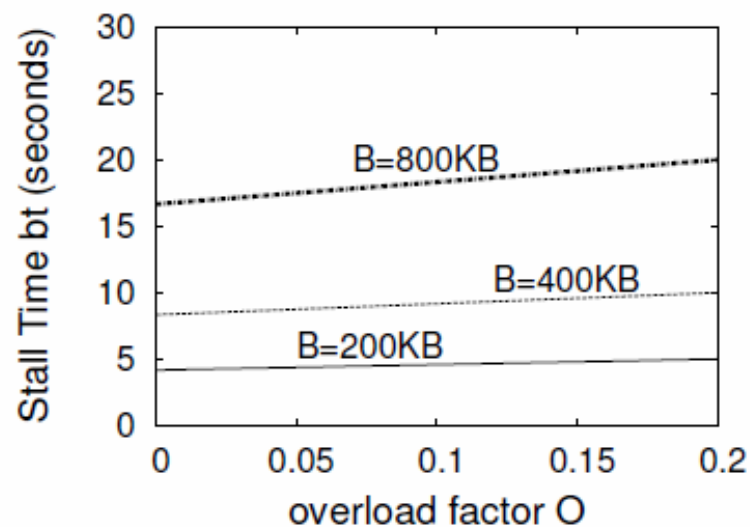
- Merits
  - Why align advertisement delivery with base station overloads?
- Opal Design Overview
  - How to do Overload Management to make it suit ad delivery?
  - How to do ad delivery?
- Evaluation
  - Prototype on a WiMAX testbed
  - Simulation with larger scale scenarios
- Conclusion
  - Future work

# Impact of Base station Overload

- Base station overloads lead to reduced bandwidth per user
  - HTTP videos → number of stalls and time of stalls are important metrics [sigcomm11]
    - Tradeoff with client buffer size
    - More dramatic increase in num.stalls than stall time



(a) Number of stalls



(b) Stall time per instance

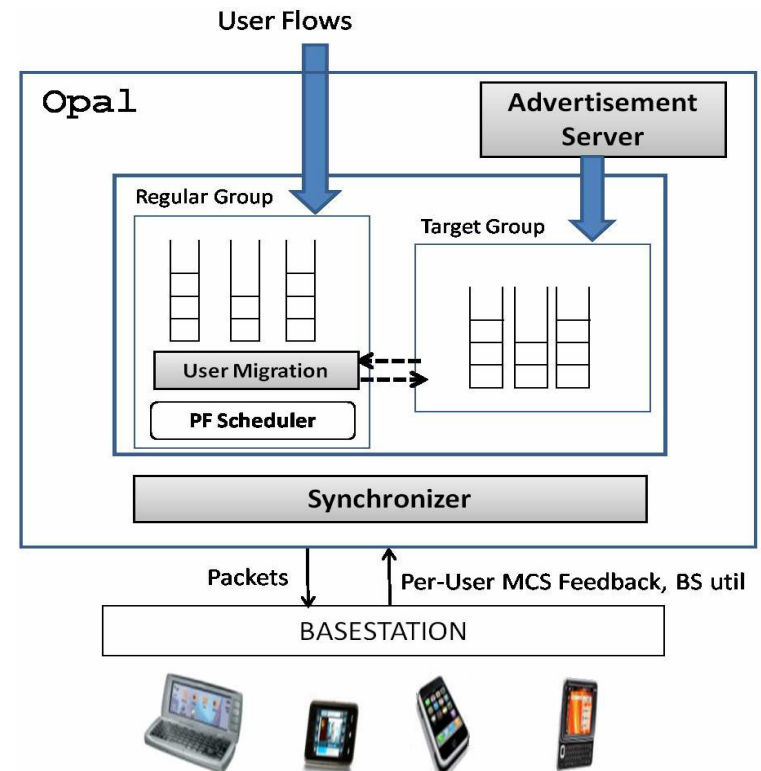
# Can we do something using Ads?

- Advertisement delivery is in control of MNO
  - Choice of advertisements (banners to videos)
  - Rate of advertisements
- So, instead of letting every user suffer
  - show an advertisement of lower rate to some users
- Benefits both users and MNOs
  - Users: Notion of continuity of service, reduced pricing (ad-funded network service)
  - MNOs: Mask off the effect of overload, users happier than perceiving bad availability

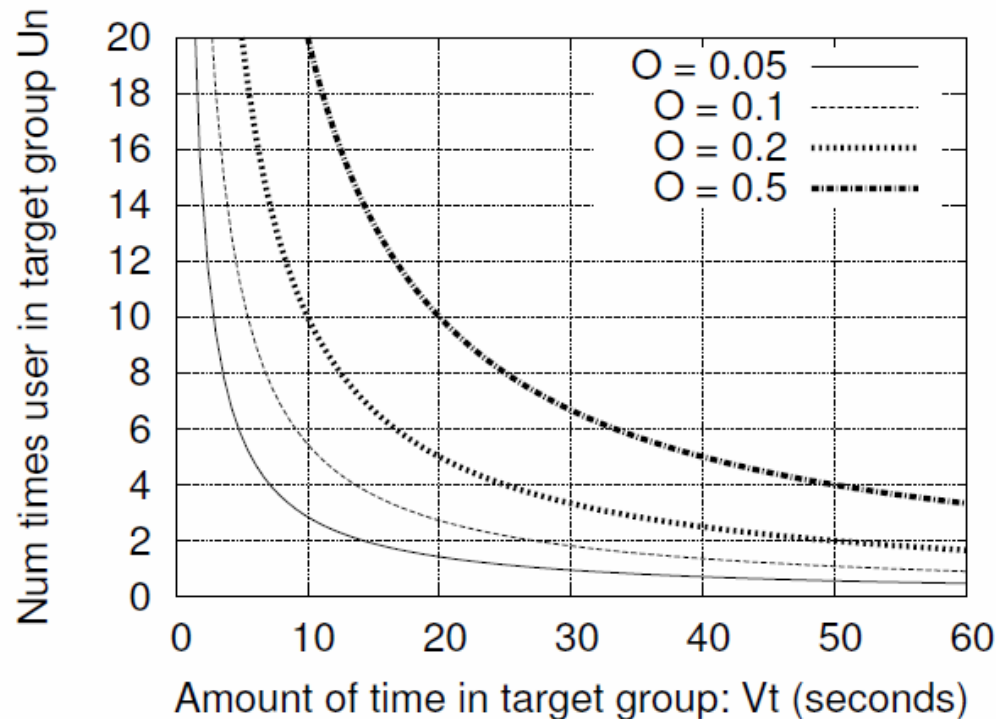
# Opal Design

- When to migrate?
  - Uses Svc rate and queue buildup
  - Challenge: BS capacity unknown
  - Solution: Synchronizer
- Which users to migrate?
  - Uses a long term fairness metric
- When to bring the users back?

## Gateway-level solution



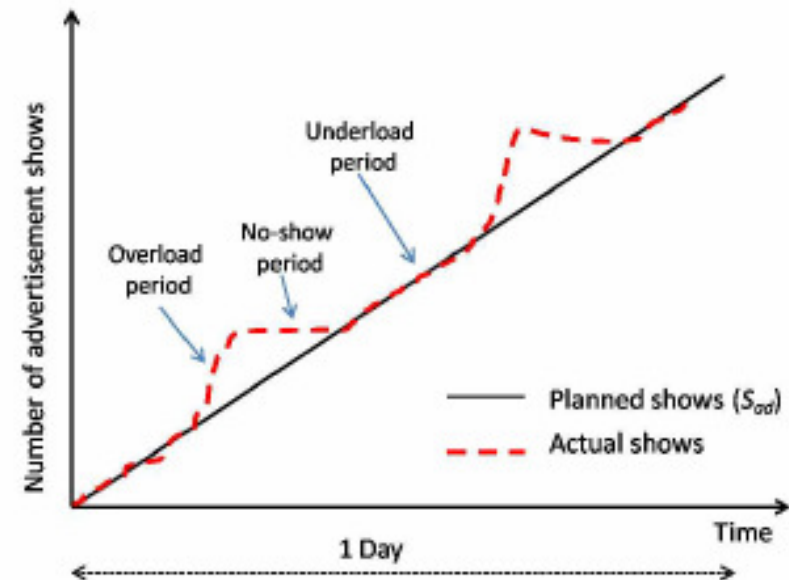
# Tunable Unavailability Framework



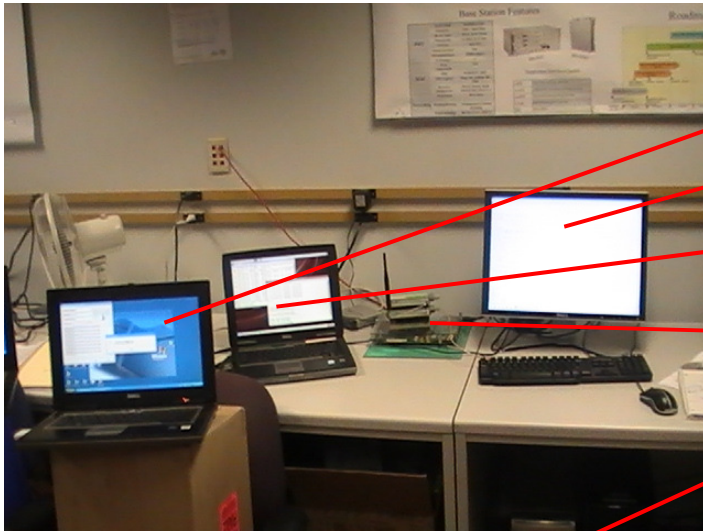
- $V_t$  configurable by the network operators
  - Controllable  $\rightarrow$  predictable ad delivery
- Mobile Marketing Association suggests 15 to 30 seconds
  - [www.mmaglobal.com](http://www.mmaglobal.com)
  - ~700 member companies

# Advertisement Delivery

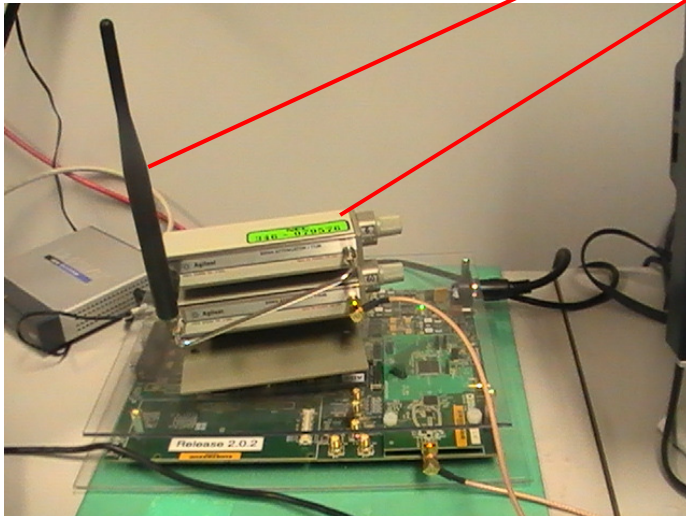
1. Show ads more aggressively during overloads
  2. Balance the total shows over a longer time period
  3. Current design: No state maintenance
    - The design changes slightly for targeted advertising
- Main challenge: Smooth inter-mixing of content and advertisements
    - Either intermediate proxy or
    - a notion of an ad channel that client side applications understand
      - Need standardization!



# Prototype on a WiMAX Platform



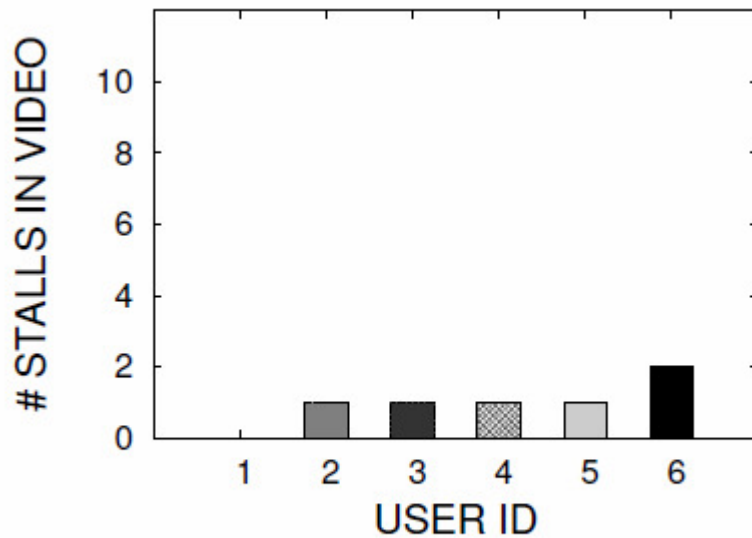
- Clients
- ASN Gateway
- CSN Gateway
- Basestation
- Antenna
- Attenuator



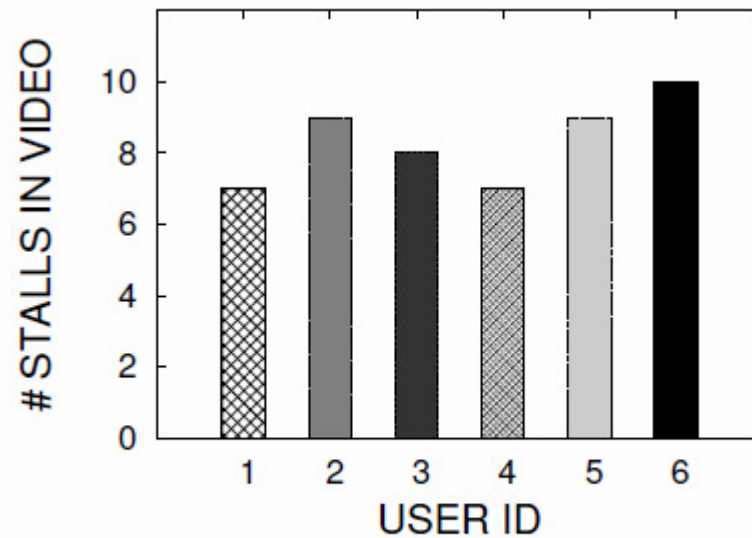
- Opal on ASN gateway
- Ad server attached to ASN gateway
- Client modified to play ad during buffer under-run
- Feedback from BS every 100ms

# Expt 1: QoE Improvement

Prototype setup: YouTube videos are streamed to six clients.



**OPAL**



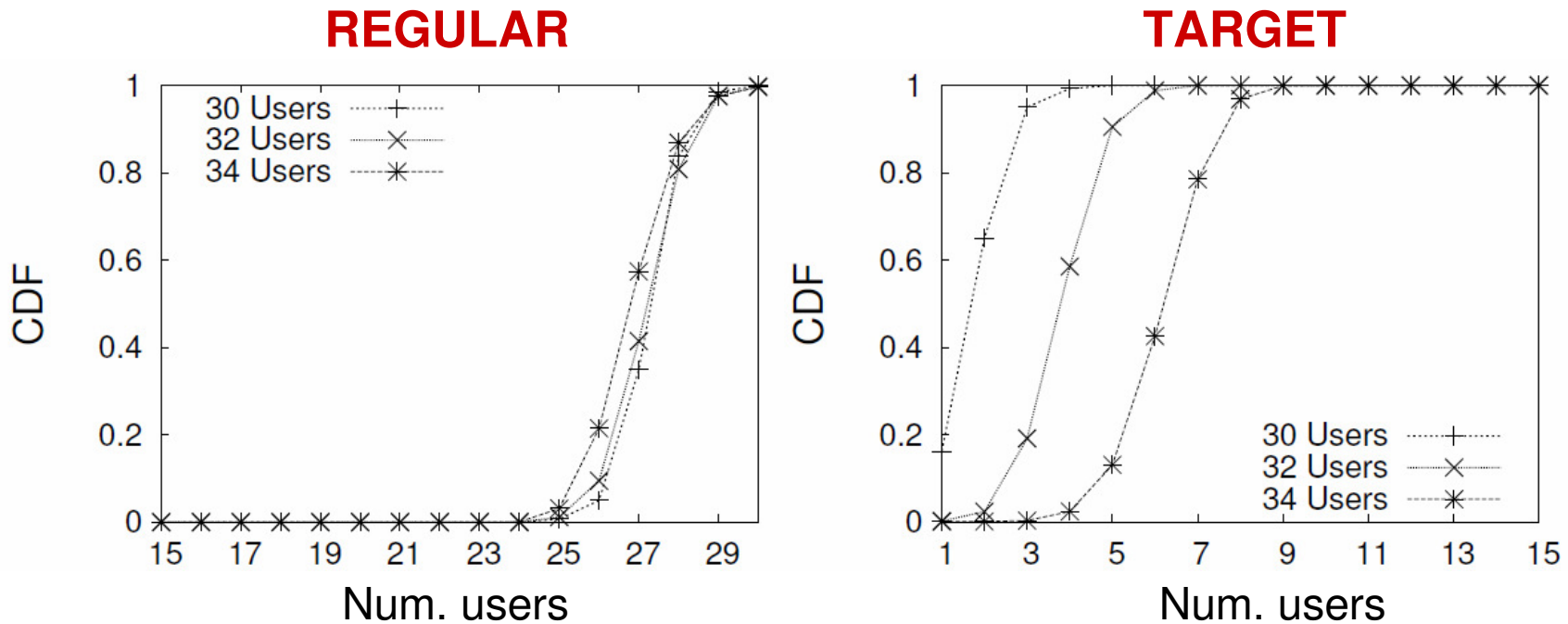
**NO-OPAL**

1. Serving Ads to a few users ensures maximum users see good quality.
2. OPAL efficiently uses advertisements to hide service disruption.

## Expt 2: Simulation Study

Set-up: In-house System-level OFDMA simulator with representative traffic models and channel models.

Videos are streamed to 30,32 and 34 users



OPAL finds the appropriate no. of users in the regular slice

# Conclusion

- OPAL: Align advertisement delivery with cellular basestation overloads
  - Improves overall user perception of network availability
- Operator Enabled Advertising: Lot of Scope for Future Work
  - Incorporate different classes of users
  - Targeted and location-based advertising
  - Multicast for advertisements, or local playout on user devices
  - Quantify user perception of overloads and Advertisement delivery
  - ...

Backup

# Network Operators' Challenge

China Mobile [http://labs.chinamobile.com/article\\_download.php?id=63069](http://labs.chinamobile.com/article_download.php?id=63069)

Telefonica: <http://research.microsoft.com/en-us/events/cnb2010/pablorodriguez.pdf>

Sprint: <http://www.slideshare.net/trxrse/traffic-revenues-decoupling-3584286>

→ Increasing Cost to support ever growing traffic

- Traffic increasing by 90% every year
- Network throughput increasing by 55%

→ Reducing Revenue per byte due to data traffic

