Sprinkler: Distributed Content Storage for Just-in-Time Streaming

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Background

- Mobile data traffic and its demand is increasing in exponential rate.

- Traffic from wireless and mobile devices will exceed traffic from wired devices by 2016

- Significant portion of this traffic is due to video and according to Cisco, two-thirds of the world's mobile data traffic will be video by 2017.
Scientific community are exploiting different opportunities to accommodate this high demand.

Offloading cellular traffic to Wi-Fi enhances the efficiency of cellular network significantly.

For video traffic, lots of compression schemes have been proposed.
Problem Definition
Opportunity

- Many cities across the world are being Wi-Fi enabled.
- Memory chip can be easily hooked with Wi-Fi AP and can serve as a local server.
System Architecture
Motivation
Chunk Distribution Strategy
Optimization Problem

- First chunk is placed at every AP.
- Every shortest path of length \((p-1) \times k\) has at least one copy of chunk 1 to \(p\) (\(k\) is the number of APs, a client crosses within viewing time of one chunk)
- Total storage to host a movie is optimized
Sprinkler Protocol

1. Requests for chunk list of a specific movie
2. List of available chunks with server
3. Actual Chunk request
4. Serving actual chunk
Evaluation Metrics

- **Metrics of Interest:**
  - Fraction of data offload (FDO) measuring the percentage of the video packets during the vehicle’s journey downloaded over WiFi.
  - Cost efficiency will capture FDO gained per AP. Like with X number of APs, FDO of a scheme is Y then cost efficiency of that scheme is Y/X.
  - Switching frequency will reflect the number of times a client switches to other network (like 3G), to continue uninterrupted viewing, per unit time (minute).
Far-Sprinkler is a system where the APs don't locally host video, but pull them from a central server.

- Far-Sprinkler-I: 80% of servers are located nearby client and 20% of servers are located far away from client.
- Far-Sprinkler-II: 70% of servers are located nearby client and 30% of servers are located far away from client.
- Far-Sprinkler-III: 60% of servers are located nearby client and 40% of servers are located far away from client.
Experimental Setup and Parameters

- Mobility Model: Shortest path map based mobility model, with and without pause time.
- Data rates: 9Mbps/ 18Mbps/ 24Mbps
- Speed: 20km/hour – 60km/hour
- Traffic: 1-20 cars per path
Road Map on which experiment was done

Mysore Road Map (APs are placed at every 100m)
What is the effect of AP-density on Sprinkler?

- Offload more than 90% across wide range of speed
- Performance degradation is very graceful of Sprinkler

**Experimental Parameters**
- Chunk size = 3MB
- Total Chunks in system = 30
- Chunks are distributed considering 40km/Hour is ideal speed
- Speed chosen for cars in range of 30km/hour – 50km/hour
- Every AP can store 10 chunks
● With blanket AP coverage all schemes perform equally.
● As inter-AP distance increases cost efficiency of Sprinkler increases.
● With inter-AP distance switching frequency of all schemes increases

● Degradation of Far-Sprinkler-III scheme is significant compared to other schemes
What is the effect of speed on Sprinkler?

- Offload more than 90% across wide range of speed
- Sprinkler maintains its FDO after a moderate speed (30km/hour)
- FDO of Far-Sprinkler reduces with speed

Experimental Parameters

Inter-AP distance = 100m
● FDO of clients in between 76 to 100
● 60% clients do not switch to other network in their entire journey
● 10% clients switch 20-30 times a minute to other network.

Experimental Parameters

• Inter-AP distance = 100m

• Speed chosen for cars randomly in between 20km/hour — 60km/hour

• Every experiment is done with 7 clients and total 70 runs taken
What is the effect of traffic on Sprinkler?

- With traffic load performance degrades
- With data-rate performance enhances
- With traffic and pause time performance enhances, enhancement is
- more significant when data rate is low
Different error model
Conclusion & Future Work

- With the offload potential, Sprinkler provides a less costly video streaming opportunity.
- With this facility, future cities can be envisioned as “a movie theatre in my car.”
- System needs to be evaluated with different mobility model.
References


Thank You!!!