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.

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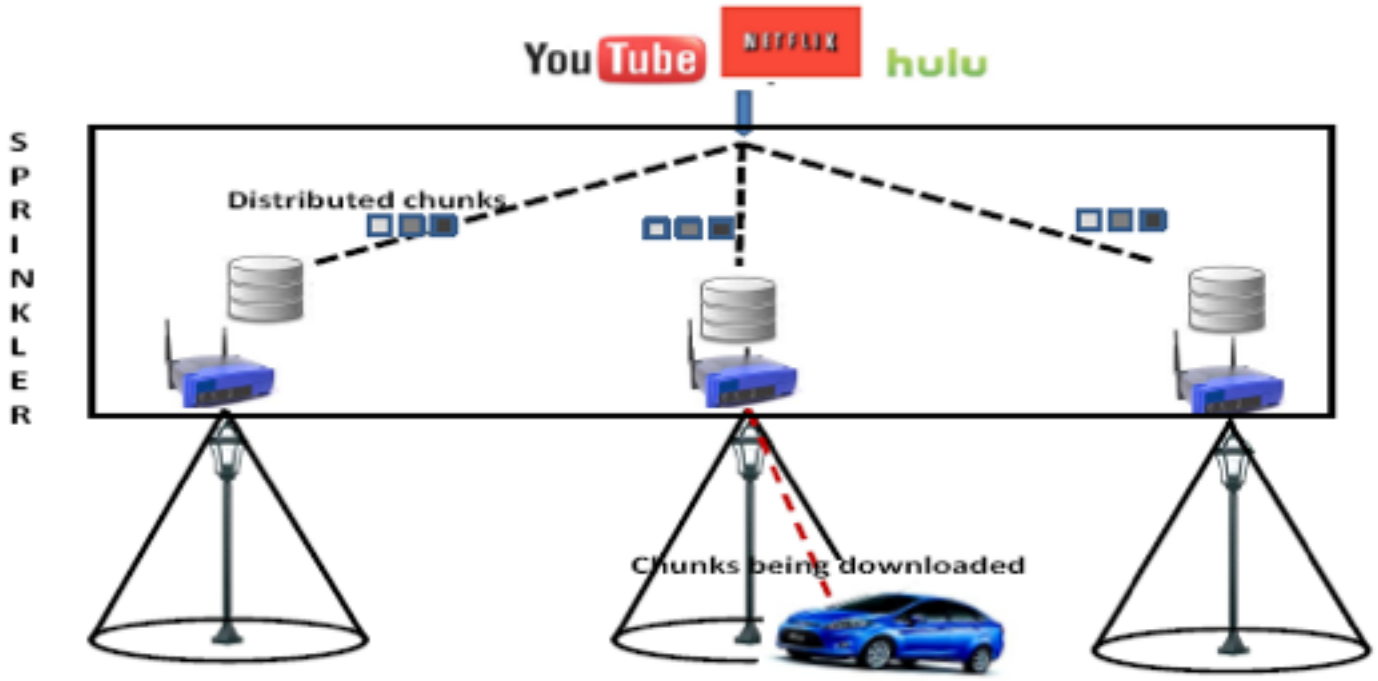
- Scientific community are exploiting different opportunities to accommodate this high demand.
- Offloading cellular traffic to Wi-Fi enhances the efficiency of cellular network significantly.
- For video traffic, lots of compression schemes have been proposed

Problem Definition

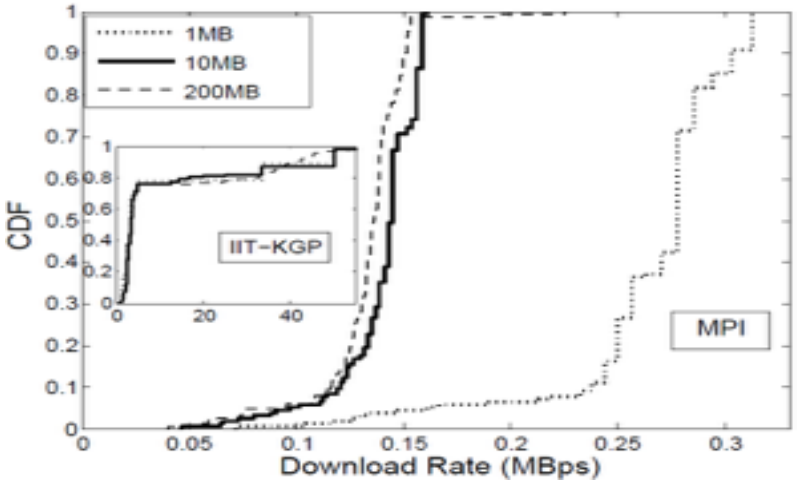
Opportunity

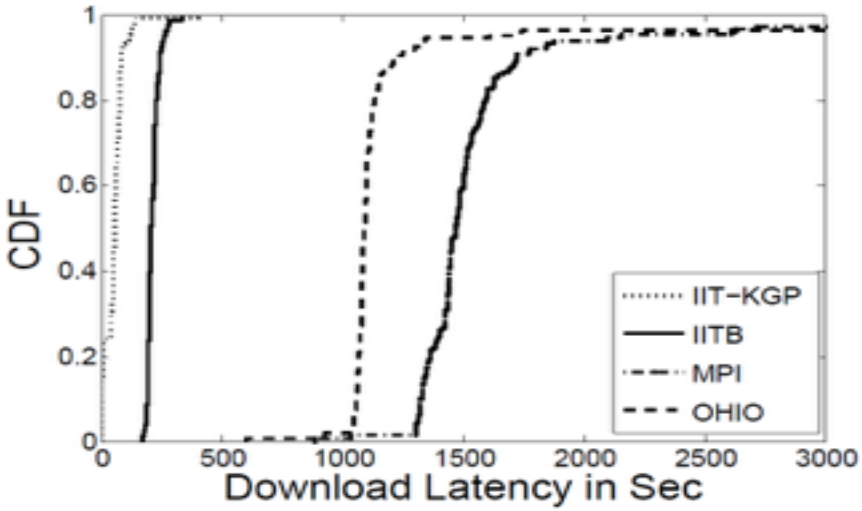
- Many cities across world are being Wi-Fi enabled
- Memory chip can be easily hooked with Wi-Fi AP can serve as local server.

System Architecture



Motivation


1MB
10MB
200MB
IIT-KGP
MPI
CDF
Download Rate (MBps)


IIT-KGP
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OHIO
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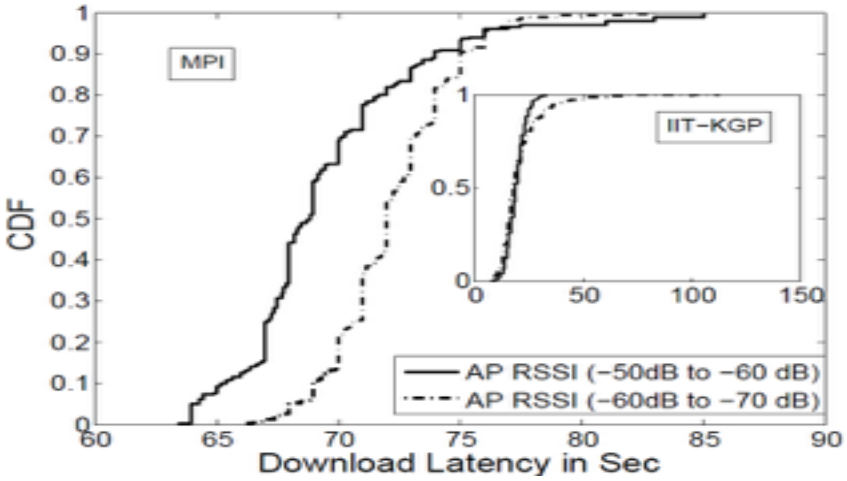
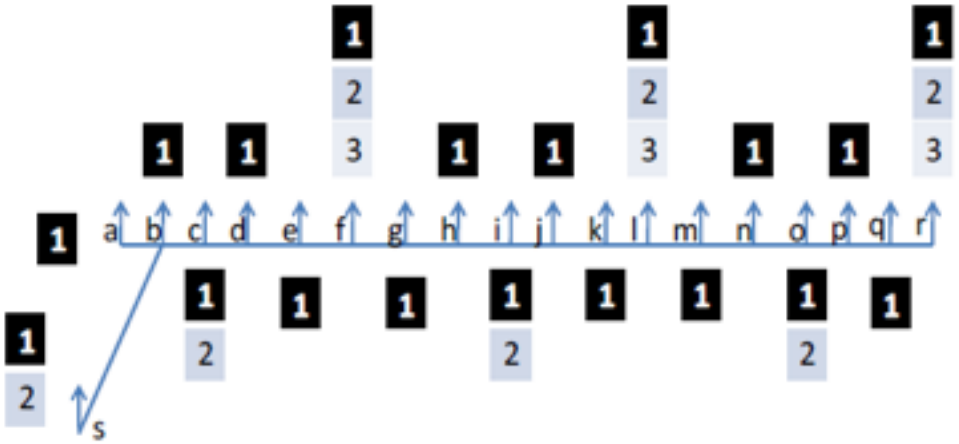
Download Latency in Sec


MPI
IIT-KGP
AP RSSI (−50dB to −60 dB)
AP RSSI (−60dB to −70 dB)
CDF
Download Latency in Sec

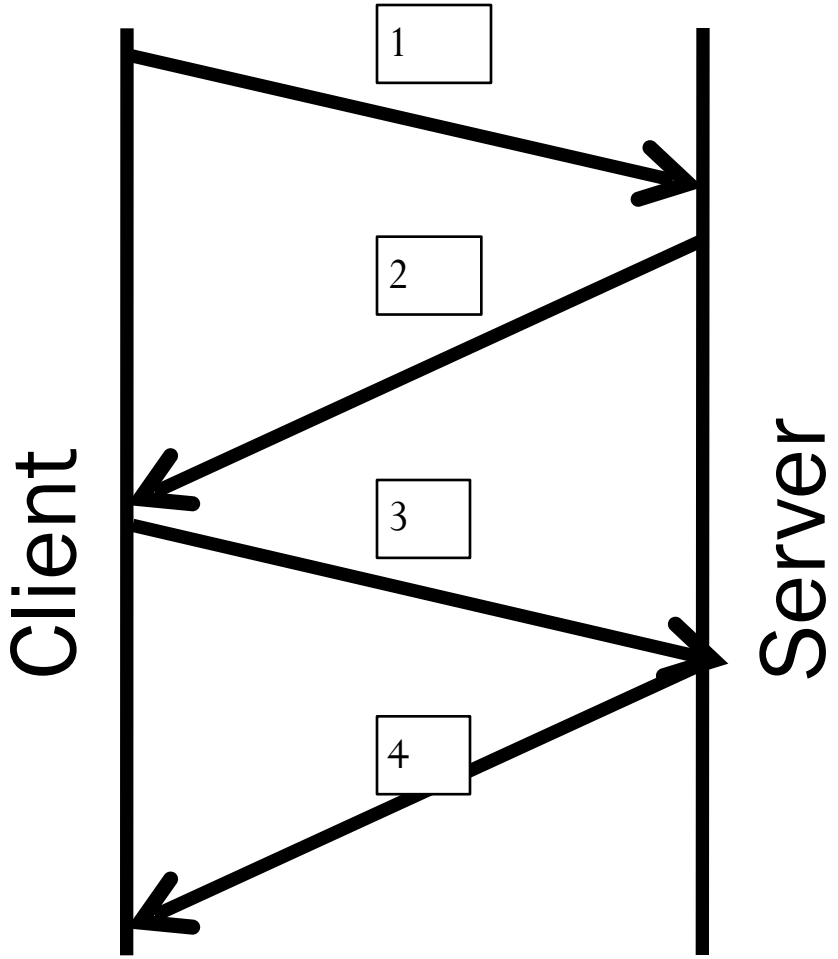
Chunk Distribution Strategy



Optimization Problem

- First chunk is placed at every AP.
- Every shortest path of length (p-1) x 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 serve

3 Actual Chunk request

4 Serving actual chunk

Evaluation Metrics

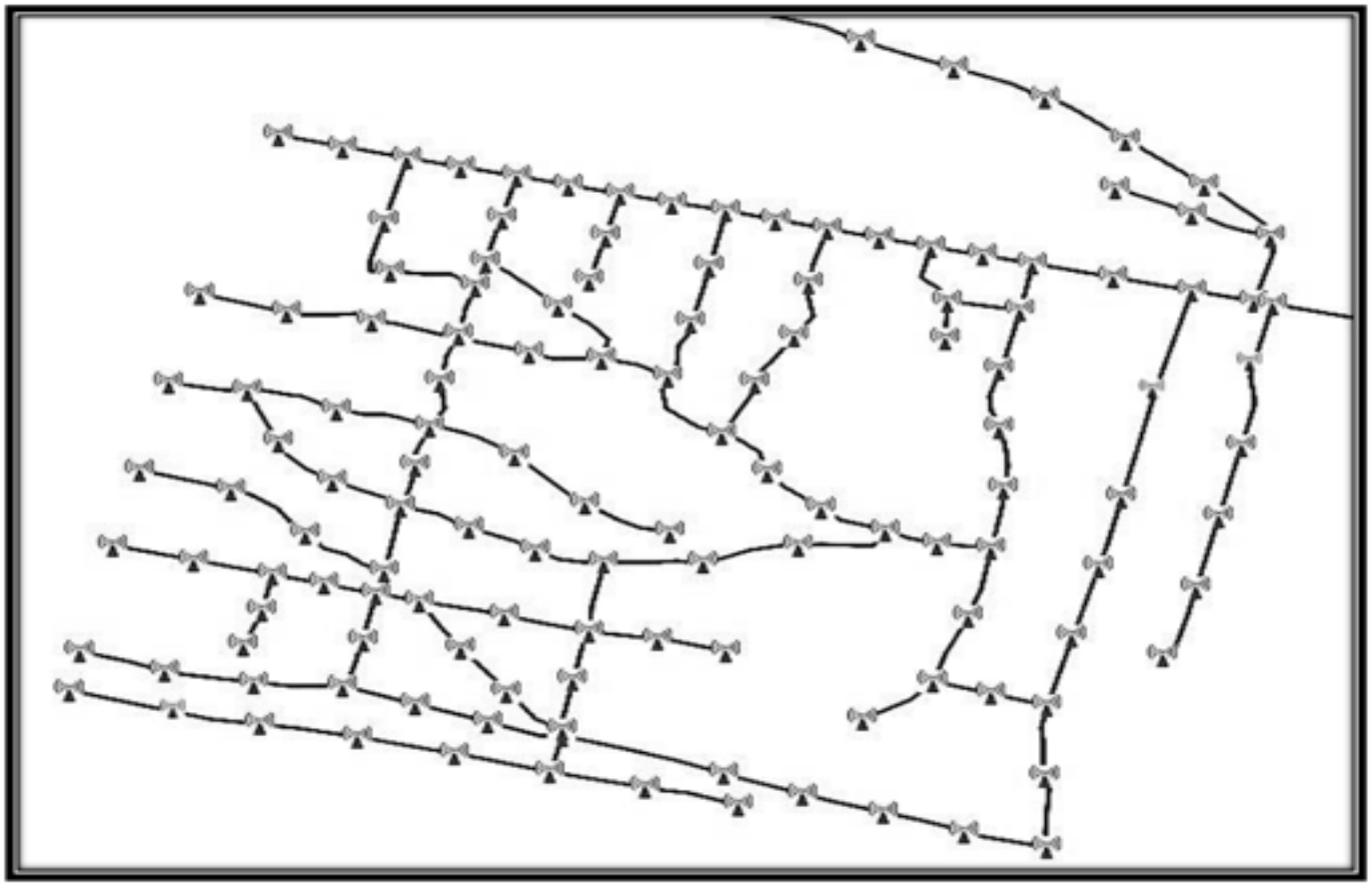
- Metrics of Interest :
  - Fraction of data offload (FDO) measuring the percentage of the video packets during the vehicle's journey downloaded over WiFi.
  - Cost efficiency will capture FDO gained per AP. Like with X number of APs, FDO of a scheme is Y then cost efficiency of that scheme is Y/X.
  - 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

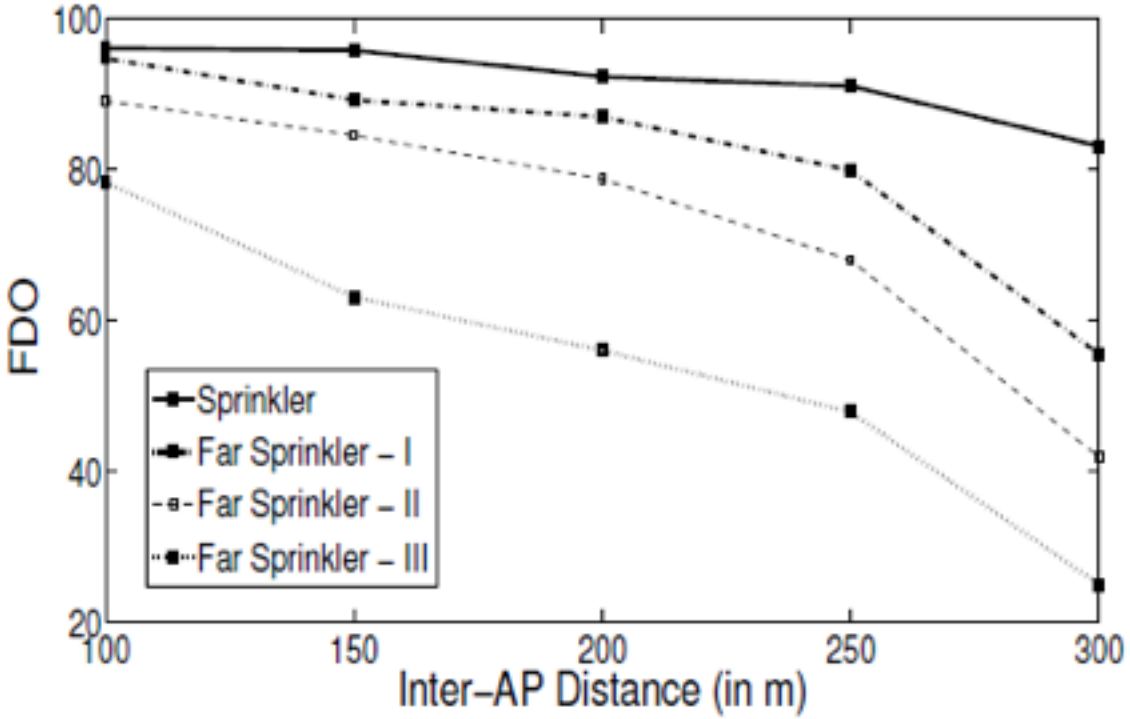
- Mobility Model : Shortest path map based mobility model, with and without pause time.
- Data rates : 9Mbps/ 18Mbps/ 24Mbps
- Speed : 20km/hour – 60km/hour
- Traffic : 1-20 cars per path

Road Map on which experiment was done



Mysore Road Map (APs are placed at every 100m)

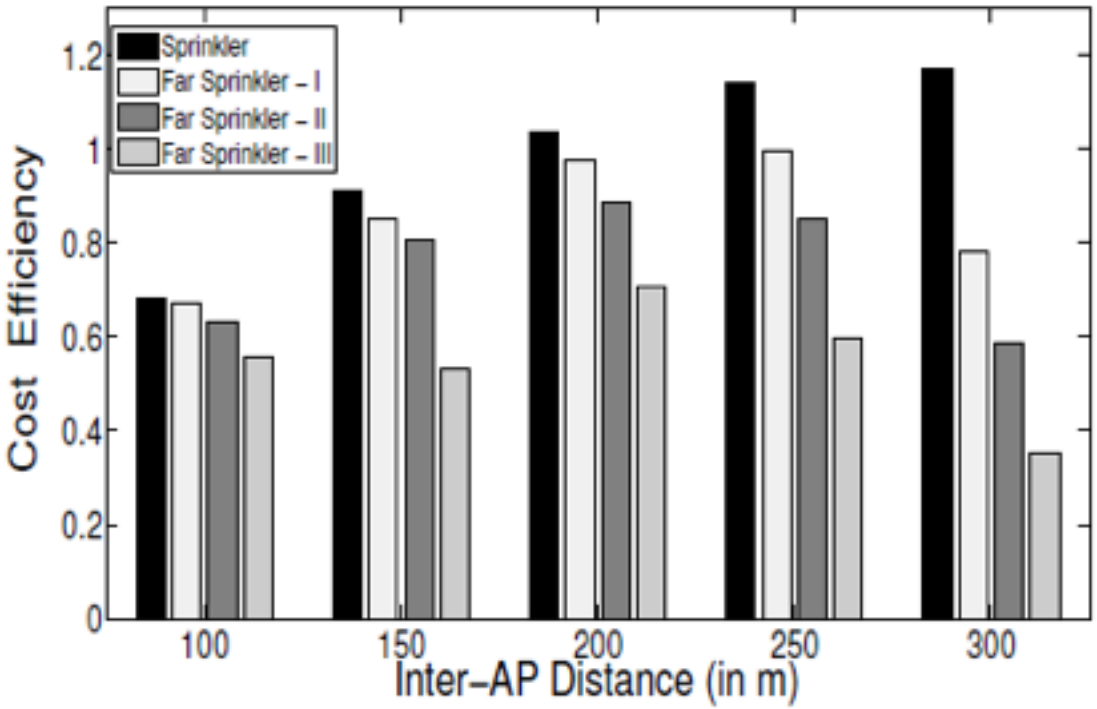
What is the effect of AP-density on Sprinkler?



- **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

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

Cont..



- With blanket AP coverage all schemes performs equally
- As inter-AP distance increases cost efficiency of Sprinkler increases

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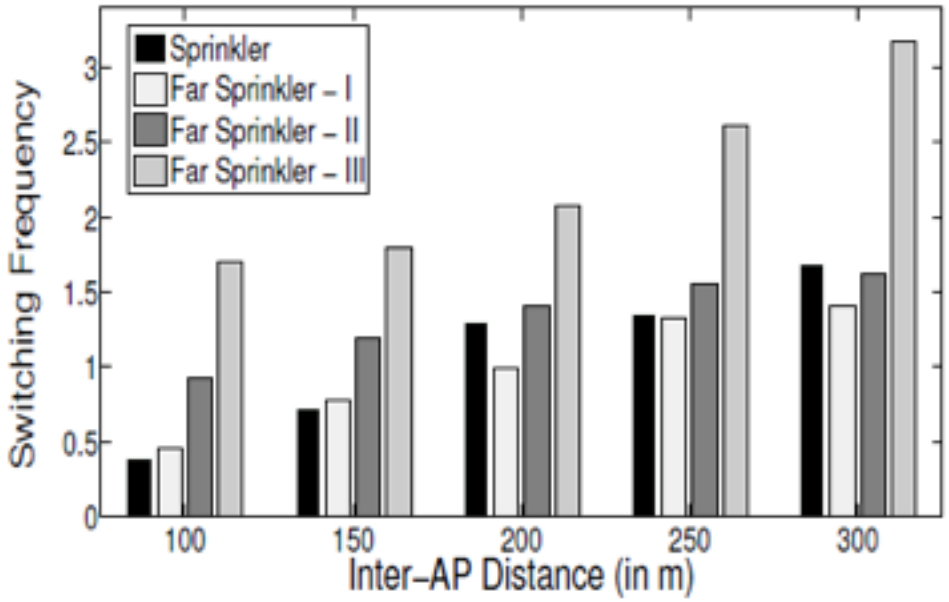
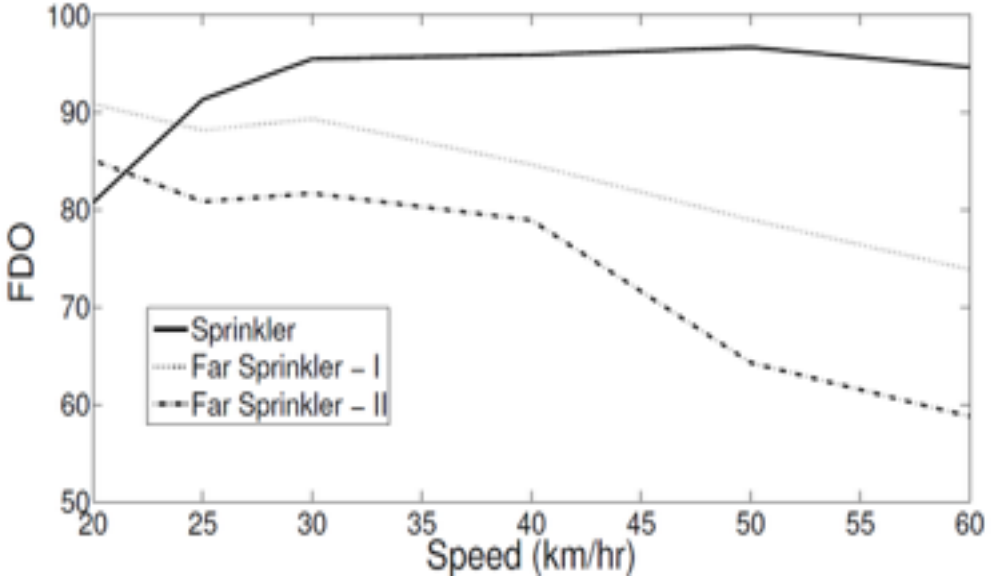


- With inter-AP distance switching frequency of all schemes increases
- Degradation of Far-Sprinkler-III scheme is significant compared to other schemes

What is the effect of speed on Sprinkler?

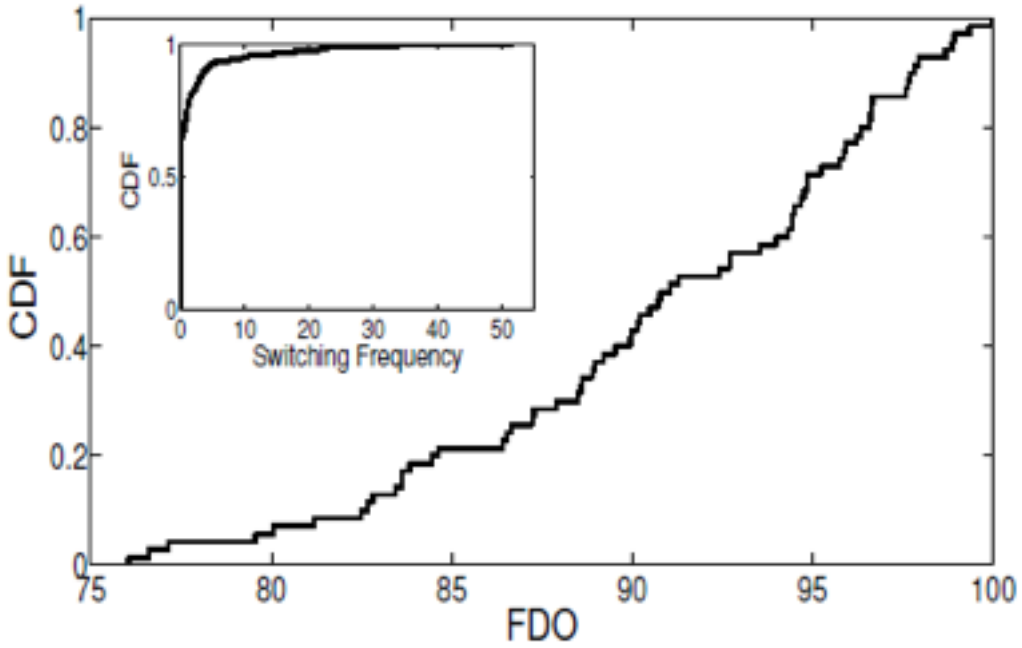


Experimental Parameters

Inter-AP distance = 100m

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

Cont..



Experimental Parameters

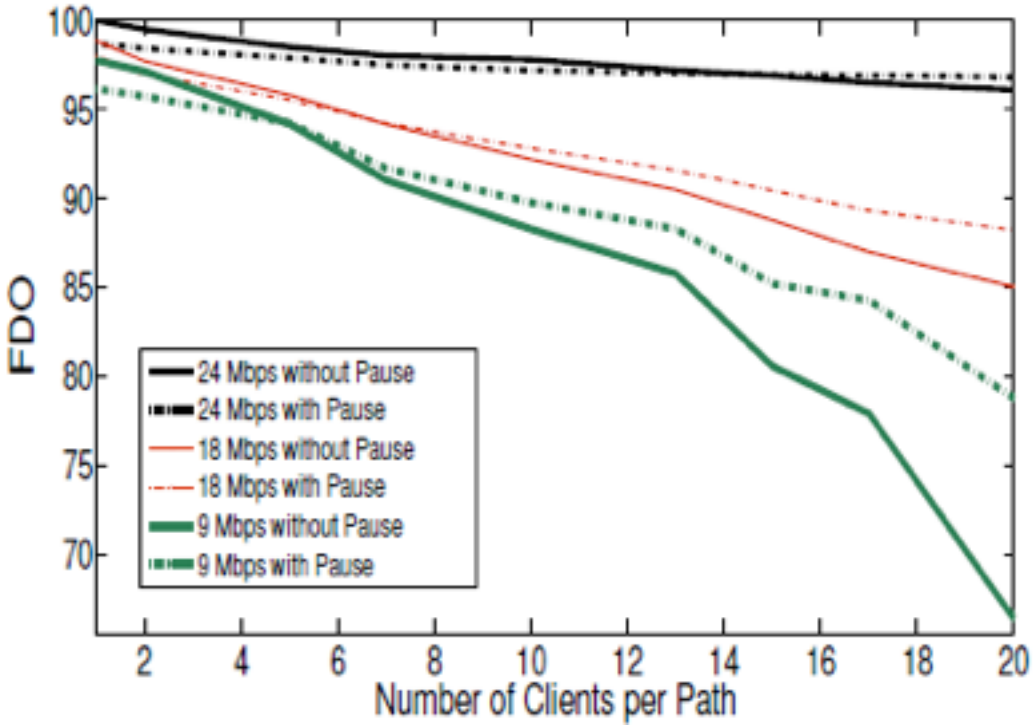
•Inter-AP distance = 100m

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

•Every experiment is done with 7 clients and total 70 runs taken

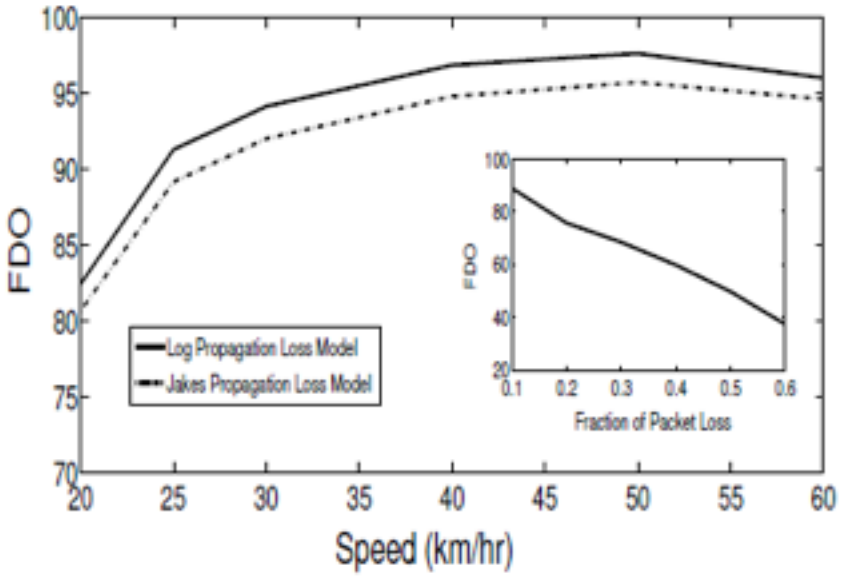
- FDO of clients in between 76 to 100
- 60% clients do not switch to other network in their entire journey
- 10% clients switch 20-30 times a minute to other network.

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

1. P. Deshpande, X. Hou, and S. R. Das, “Performance Comparison of 3G and Metro-Scale WiFi for Vehicular Network Access,” in IMC, pp. 301–307, 2010.
2. S. Dimatteo, P. Hui, B. Han, and V. O. Li, “Cellular Traffic Offloading through WiFi Networks,” in 2011 IEEE 8th International Conference on Mobile Ad-Hoc and Sensor Systems (MASS), vol. 0, (Los Alamitos, CA, USA), pp. 192–201, IEEE, Oct. 2011.
3. J. Eriksson, H. Balakrishnan, and S. Madden, “Cabernet:Vehicular Content Delivery Using WiFi,” in Proceedings of the 14th ACM international conference on Mobile computing and networking, MobiCom, (New York, NY, USA), pp. 199–210, ACM, 2008.

Thank You!!!