Augmenting Mobile 3G Using WiFi

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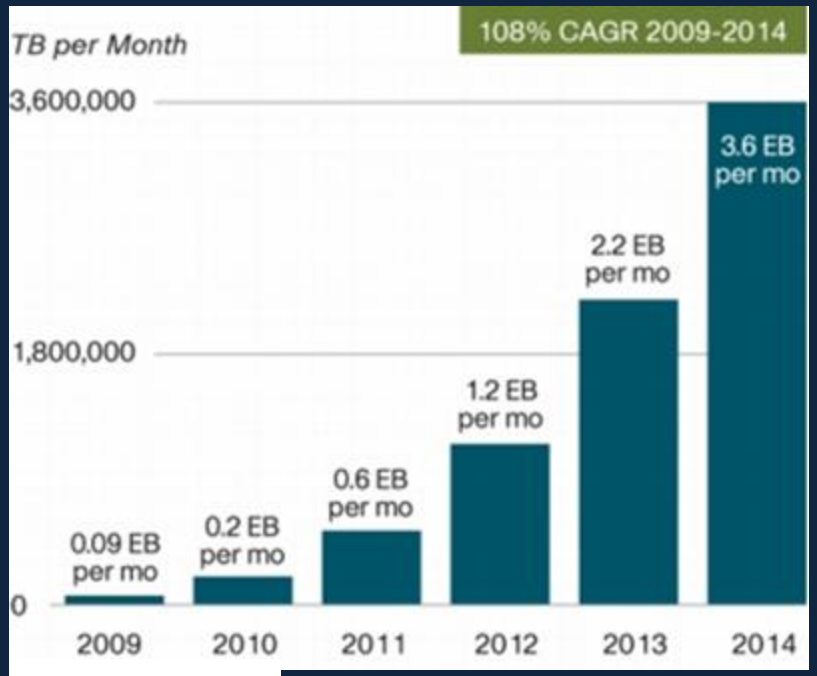
Mobile data is growing exponentially



CISCO VNI 2010

http://www.readwriteweb.com

Mobile Web's Explosive Growth

Written by Sarah Perez / October 29, 2009 7:15 AM / 10 Comments

admob

Mobile ad firm AdMob has re
industry has seen in their lat
this morning. Believe it or no

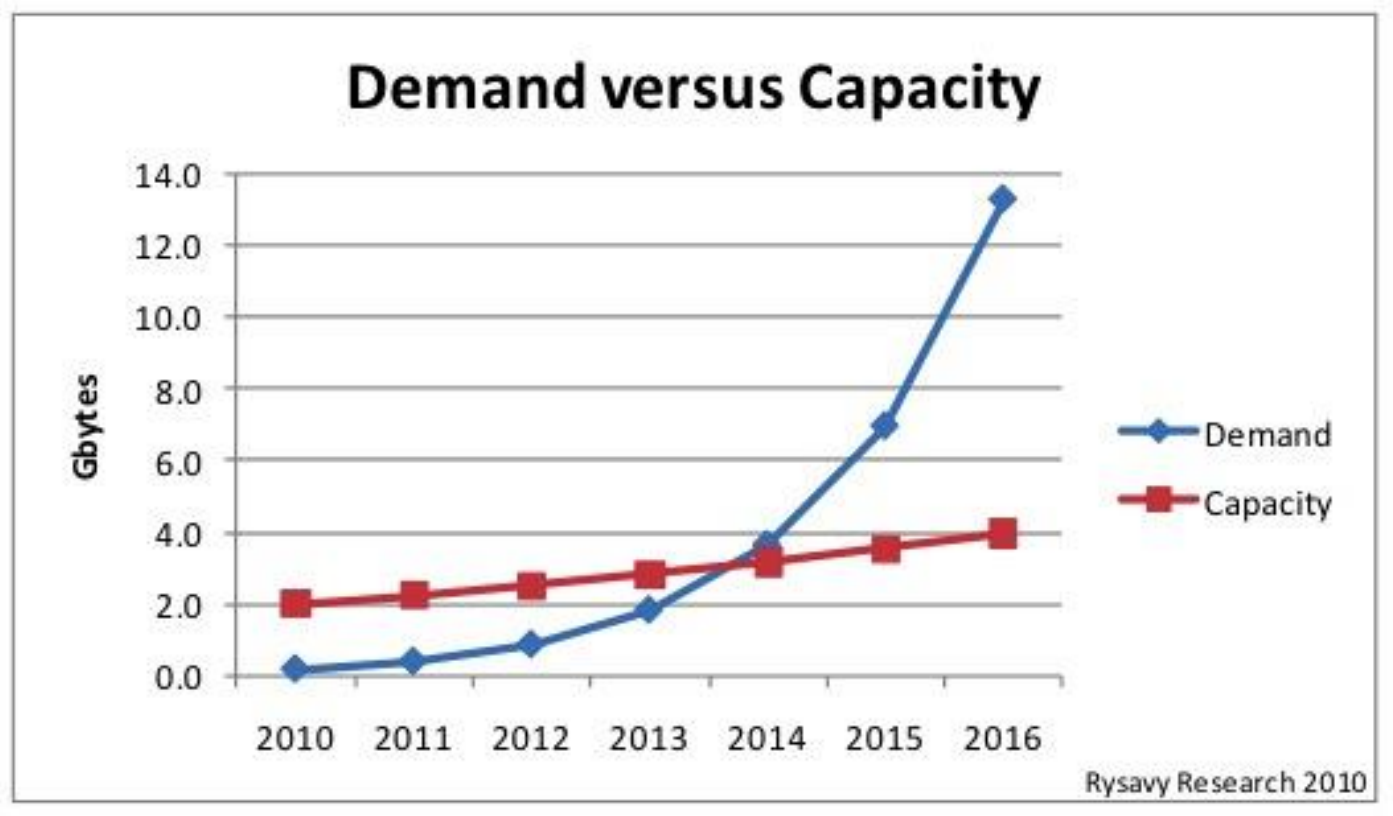
http://www.totaltele.com

Mobile data traffic growth 10 times faster than fixed over next five years – Nokia Siemens

By Nick Wood , Total Telecom, in Paris
Monday 07 September 2009

Network providers need to establish closer relationship with end -users to enable operators to optimise customer experience.

Demand projected to outstrip capacity



Is more spectrum the answer?

Current allocation	409.5 MHz
Available but unallocated	50 MHz
Projected demand by 2016	800-1000 MHz

"In light of the limited natural resource of spectrum, we have to look at the ways of conserving spectrum" -- Mark Siegel (AT&T)

Getting What You Pay For on the Mobile Internet

By KEVIN J. O'BRIEN
Published: April 18, 2010

BERLIN — When TeliaSonera, the Nordic telecommunications operator, switched on the world's fastest wireless network last December, customers quickly ratcheted up their consumption of mobile data tenfold.

RECOMM
TWITTE
E-MAIL

http://www.nyt.com

The BET of spectrum scarcity

Behavioral

December 10, 2009 http://blogs.chron.com/

AT&T wants to 'educate' you about data usage

Any time a business announces that it needs to "educate" its customers about their behavior, you'd best check your wallet, because someone's going to be reaching for it.

Economic

Metered Mobile Data Is Coming and Here's How

Contributor Stacey Higginbotham | Monday, December 28, http://pro.gigaom.com/

Technical

- Increase efficiency
- Reduce usage

Shannon's specter

By Kevin Fitchard http://connectedplanetonline.com

Augmenting Mobile 3G using WiFi

Offload data to WiFi when possible

We look at vehicular mobility

Our work

First joint study of 3G and WiFi connectivity

- Can WiFi usefully augment 3G capacity?
- Conducted across three cities

Wiffler: A system to offload data to WiFi

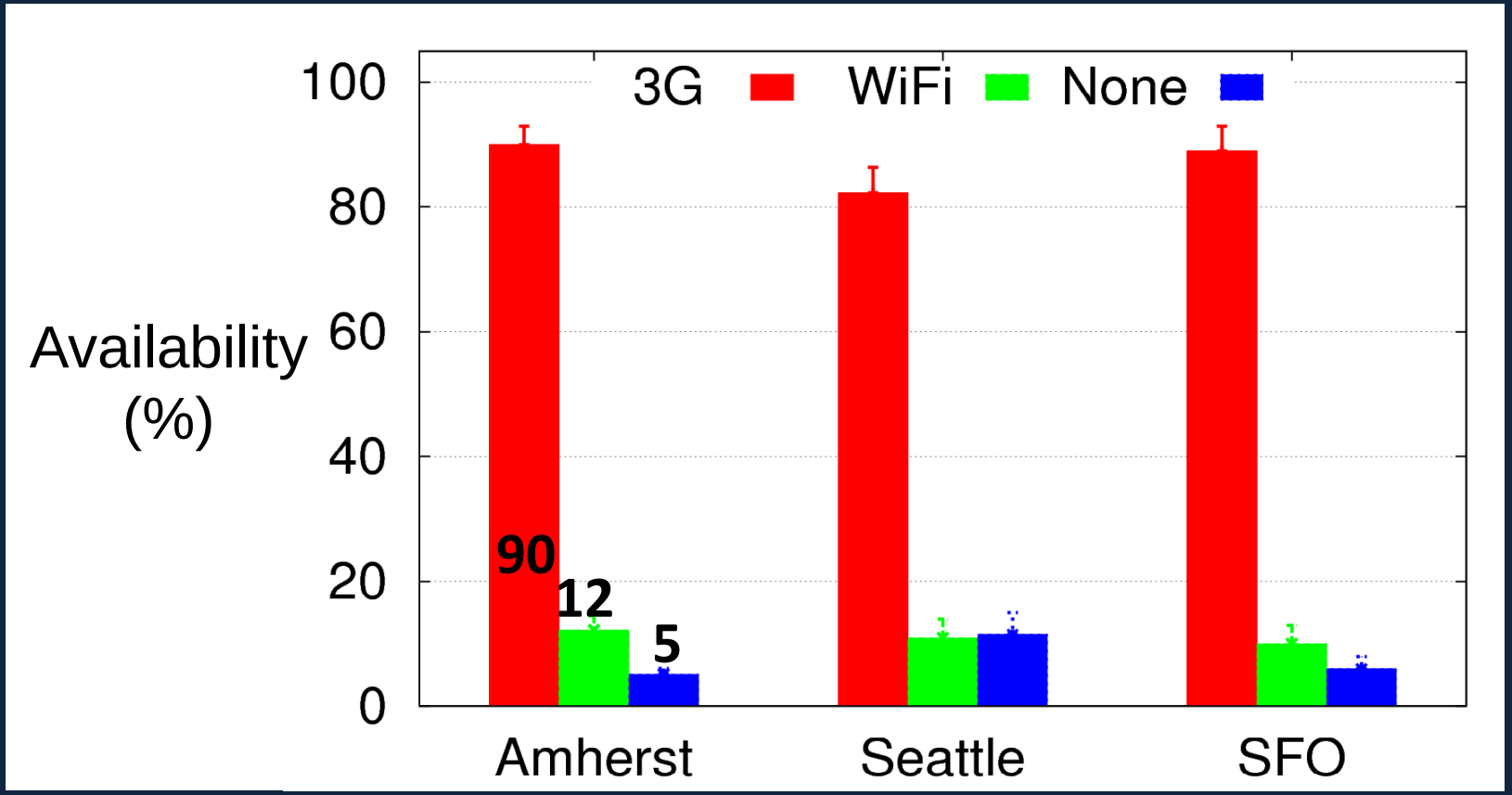
- Increase offloaded data but respect app constraints
- Deployed on 20 vehicles

Measurement study

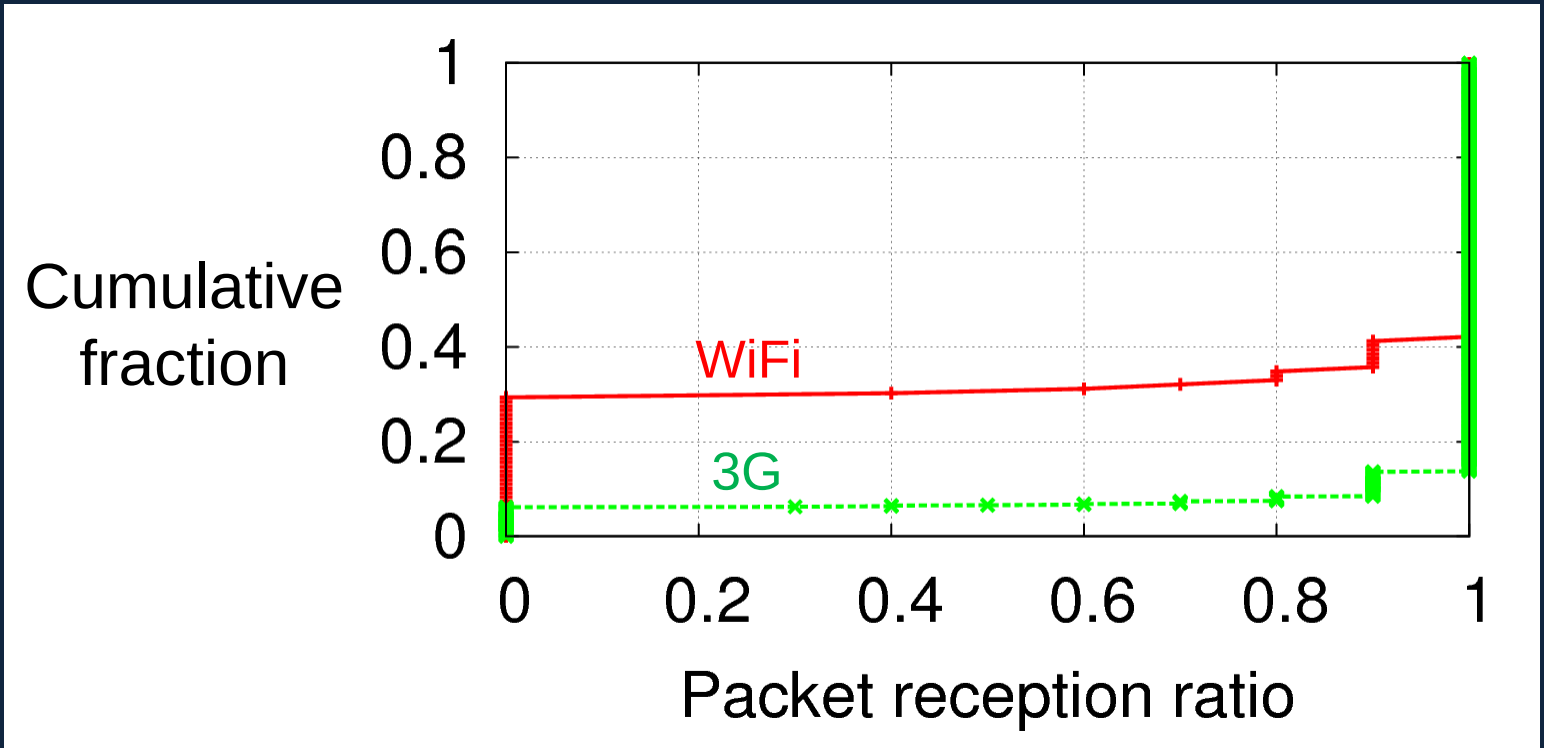
Vehicular nodes with 3G and WiFi (802.11b) radios

- Amherst: 20 buses
- Seattle: 1 car
- SFO: 1 car

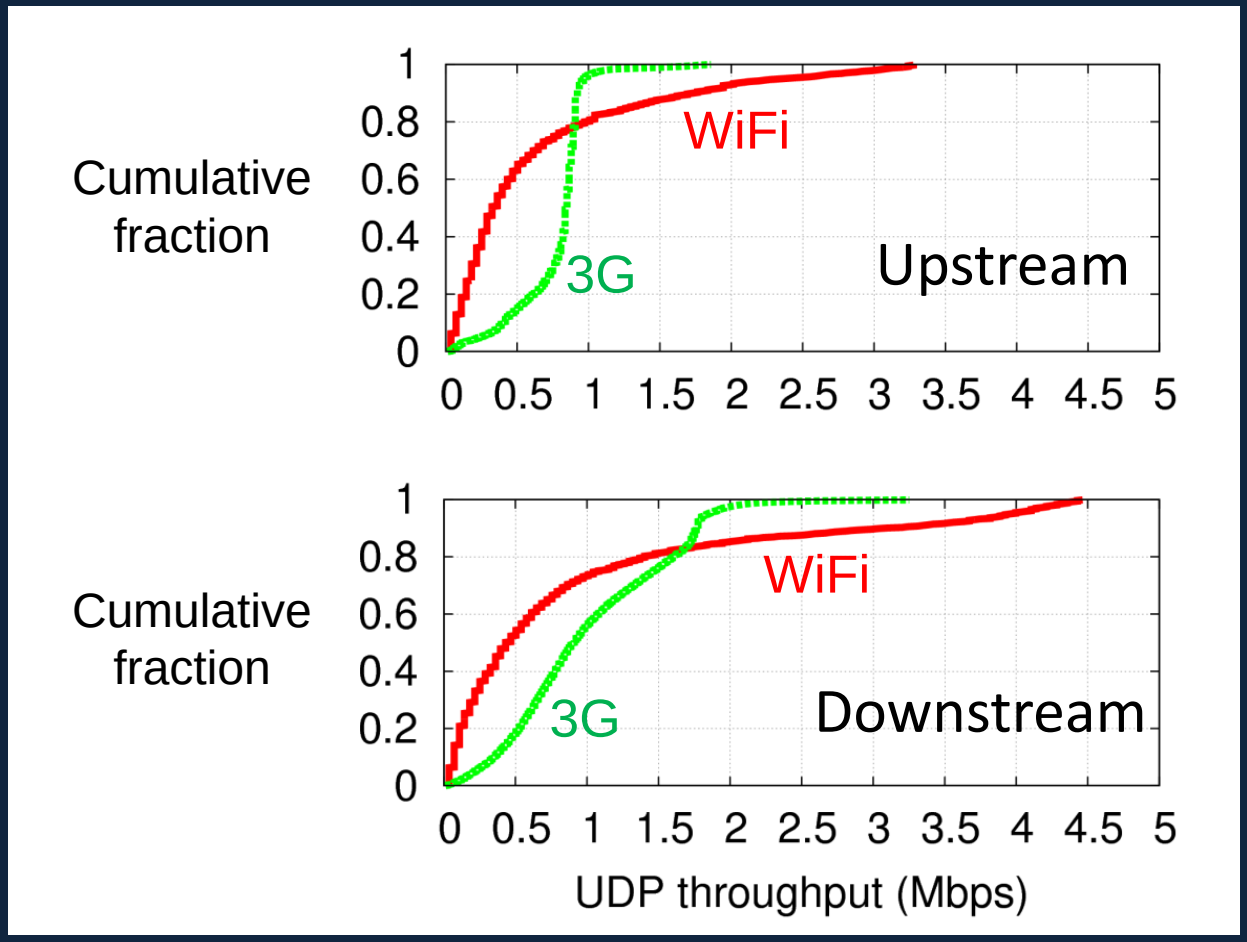
WiFi availability is low



WiFi loss rate is higher



WiFi (802.11b) throughput is lower



Implications for offloading data to WiFi

Straightforward design: use WiFi when available

- Offloads only 10% of the data
- Hurts application performance

Key techniques in Wiffler

Prediction-based offloading

- Exploit the delay tolerance of apps to increase data offloaded to WiFi

Fast switching

- Combat poor WiFi connectivity

Prediction-based offloading

Delay data transfers only if that reduces 3G usage

Transfer requirements: S bytes by D seconds

- W = Predicted WiFi capacity over future D seconds
- Send data on 3G only when ($W < S \cdot c$)
- Send data on WiFi whenever available

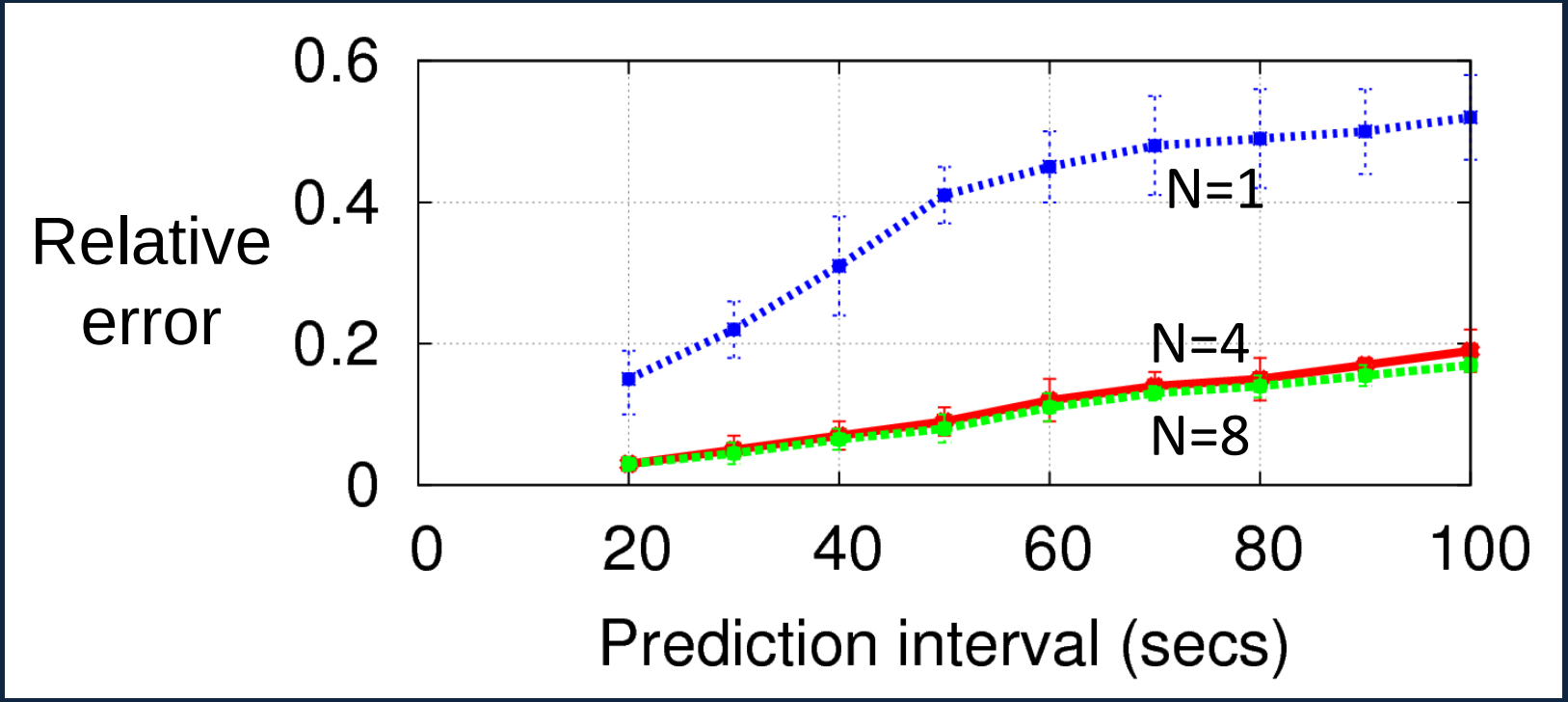
Predicting WiFi capacity

Based on (# of APs) x (capacity per AP)

Observation: future AP encounters depend on recent past

Predict # of APs based on the last N encounters

Error in predicting # of APs



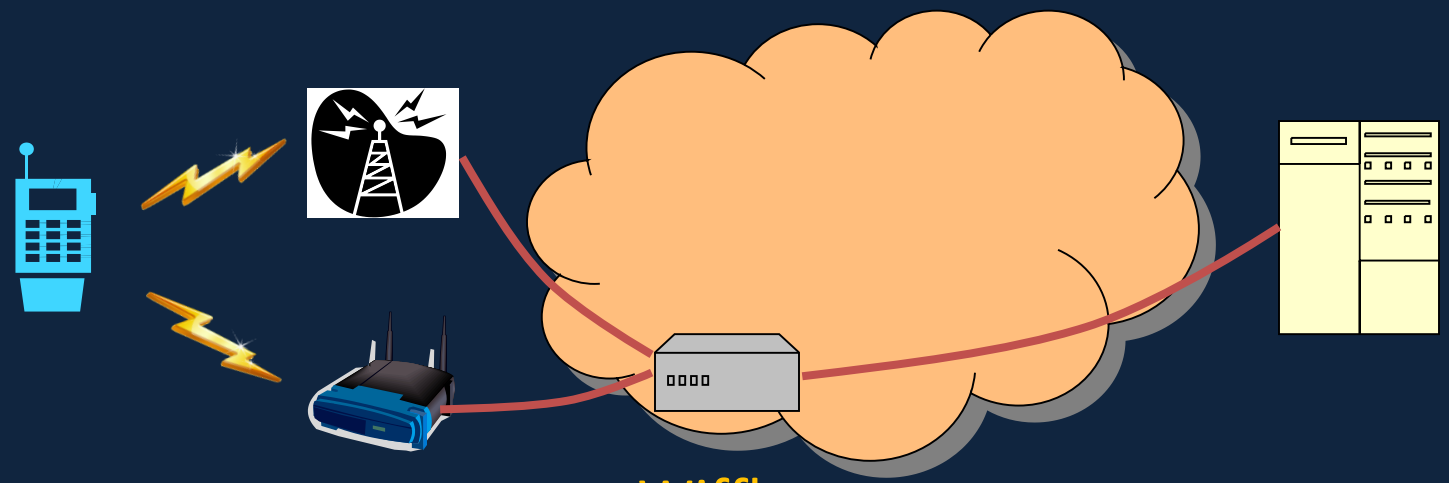
Fast switching

Poor WiFi connectivity will hurt demanding apps such as VoIP and video streaming

Send the packet on 3G if WiFi does not succeed within a threshold

- Link-layer retransmissions take time
- Losses are bursty

Implementation of Wiffler



Evaluation

Deployment on 20 vehicular nodes

Trace-driven simulations

Deployment results

	Data offloaded to WiFi
Prediction-based offloading	30%
WiFi when available	10%

Transfer size: 5MB; Delay tolerance: 60 secs;
Inter-transfer gap: random with mean 100 secs

	Time w/ good voice quality
Fast switching	68%
WiFi when available	42%

VoIP-like traffic: 20-byte packet every 20 ms

Trace-driven evaluation

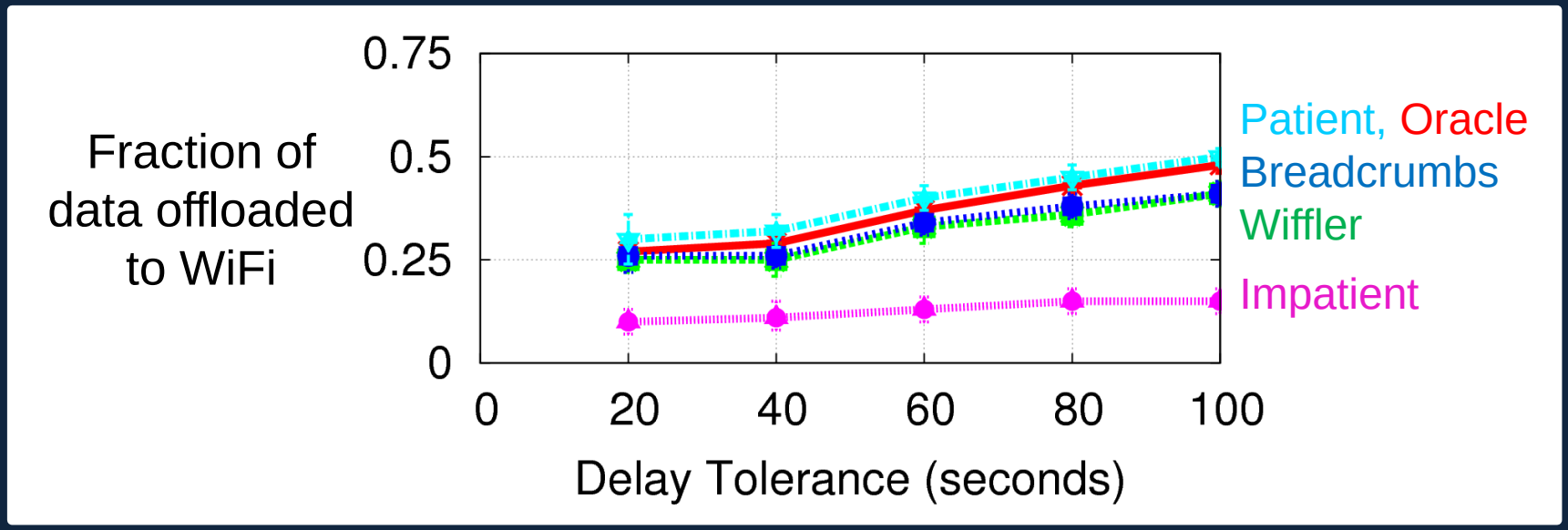
Yields results comparable to deployment

Vary workload, AP density, delay tolerance, switching threshold

Alternative strategies

- Impatient: use WiFi when available
- Patient: waits until the delay threshold
- Breadcrumbs: mobility prediction + location history
- Oracle: perfect future knowledge

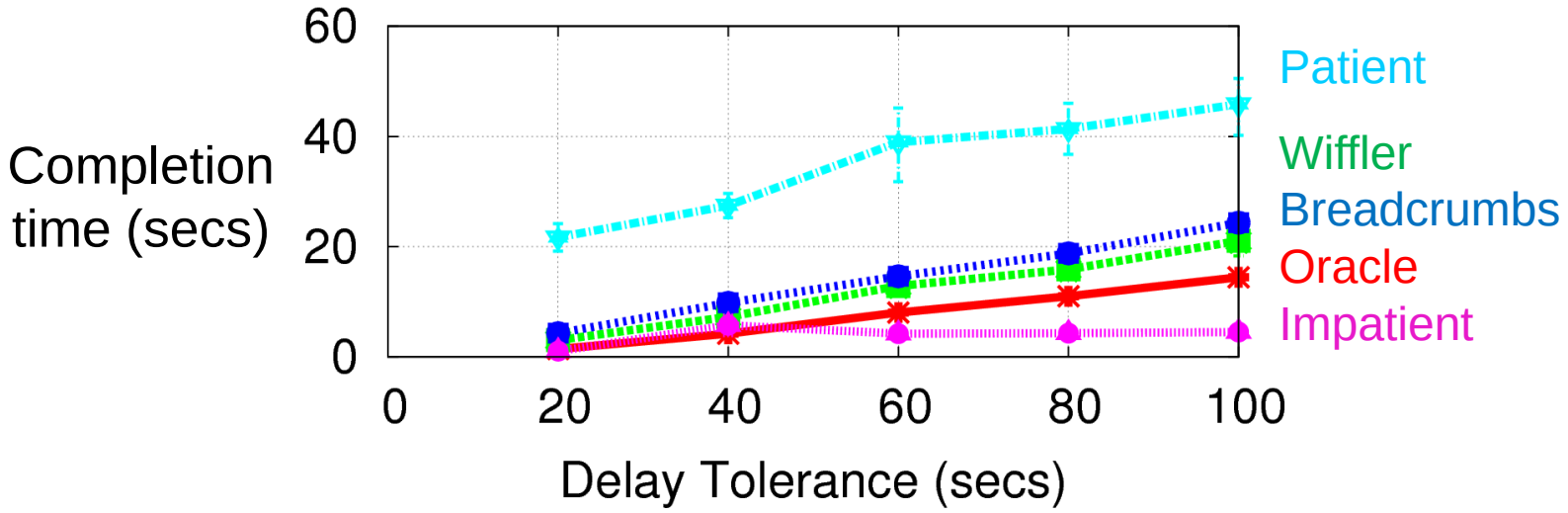
Wiffler increases data offloaded to WiFi



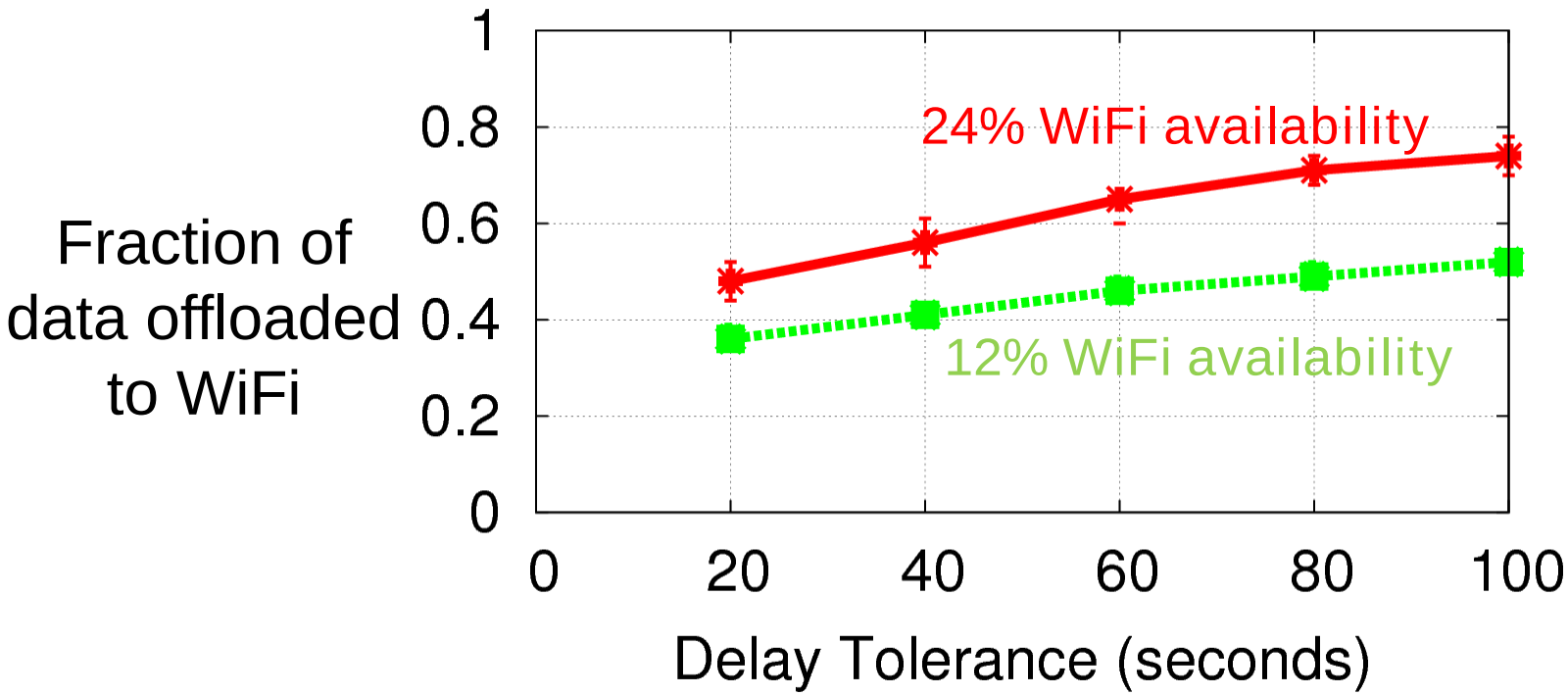
Performance of Wiffler is comparable to optimal

More complicated predictions do not help

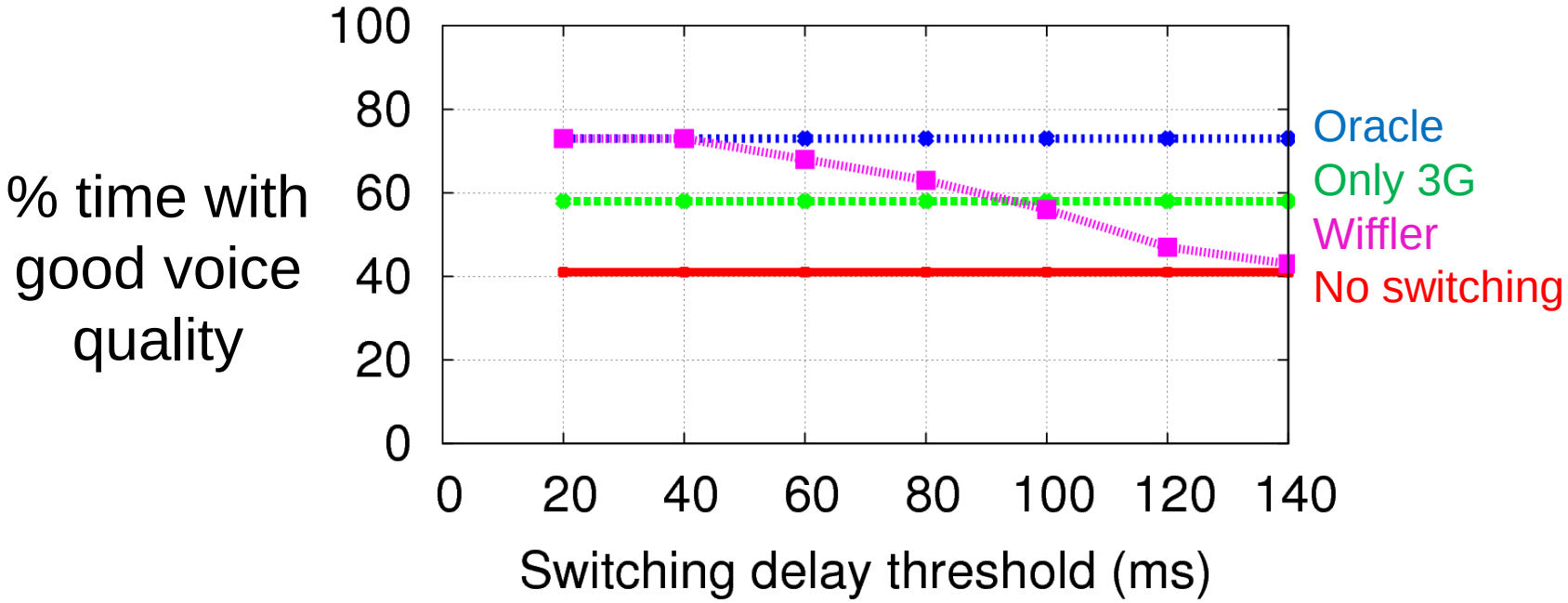
Prediction reduces completion time



More offloading in urban centers



Fast switching improves performance of demanding applications



Possible extensions

Reduce energy cost of searching for usable WiFi

Predict what a user will access and prefetch

Recommend content to users based on what is cached (courtesy Romit Roy)

Conclusions

- Offloading to WiFi can augment mobile data transfer capacity and reduce pressure on cellular spectrum
  - But must overcome the low WiFi availability and performance
- Prediction-based offloading and fast switching can tackle these challenges
  - Offloads a third of the data if 1-min delays are tolerable