Velocity based Dynamic Flow Mobility in Converged LTE/Wi-Fi Networks

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Introduction

- In IP flow mobility (IFOM), a flow (typically identified by the five tuple: protocol, source IP address, destination IP address, source port, destination port) can be seamlessly moved from one interface to the other using IP mobility management solutions.
- Host-based Mobility Management (HMM): MN is aware of the mobility i.e., the MN takes part in the mobility signaling. E.g. Dual Stack Mobile IPv6 (DSMIPv6).
- Network-based Mobility Management (HMM): MN is not aware of the mobility All the signaling and tunneling procedures are taken care by the network entities based on observed Layer 2 (L2) triggers from the MNs. E.g. Proxy Mobile IPv6 (PMIPv6).
- PMIPv6 supports offloading traffic at the granularity of flows instead of moving the entire traffic generated by the MN.
- In our work, we investigated the performance of different available flow offloading schemes in converged LTE/Wi-Fi networks supported by IP flow mobility.
- Proposed an integrated flow offloading approach that considers SNR, Wi-Fi load, user location and user velocity for taking offloading decisions.

An example scenario of road model with Wi-Fi

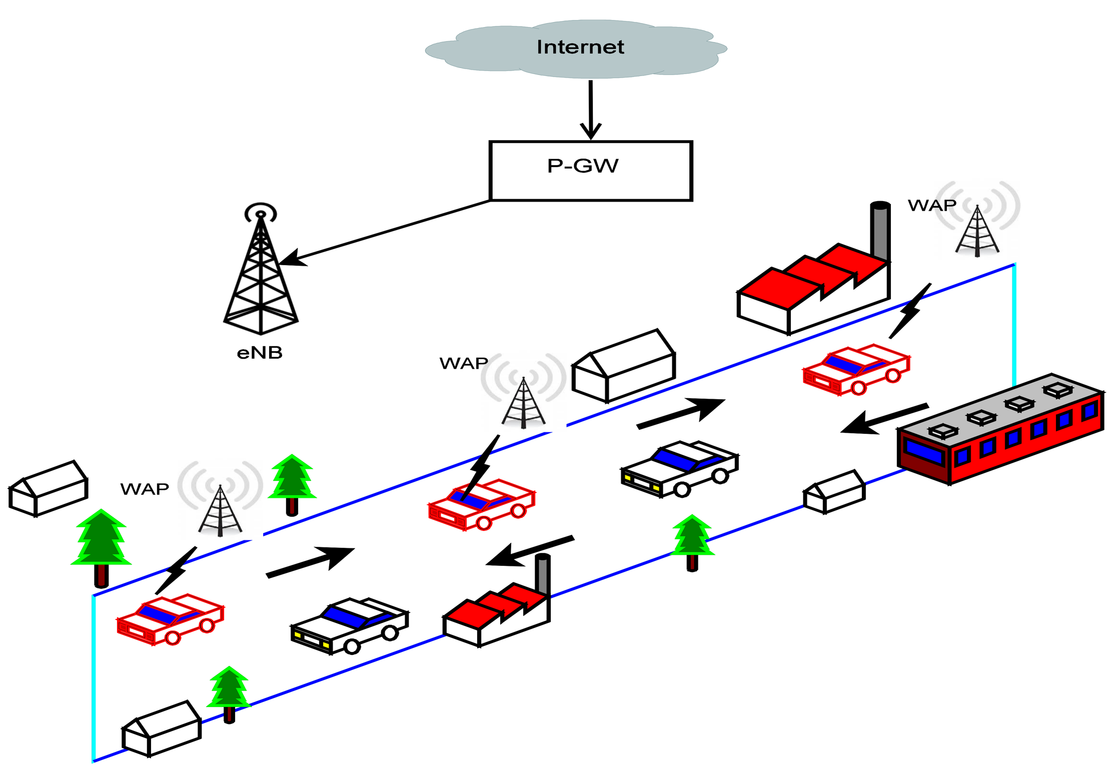


Fig. 1. Experimental Scenario – Road Model with Wi-Fi alongside

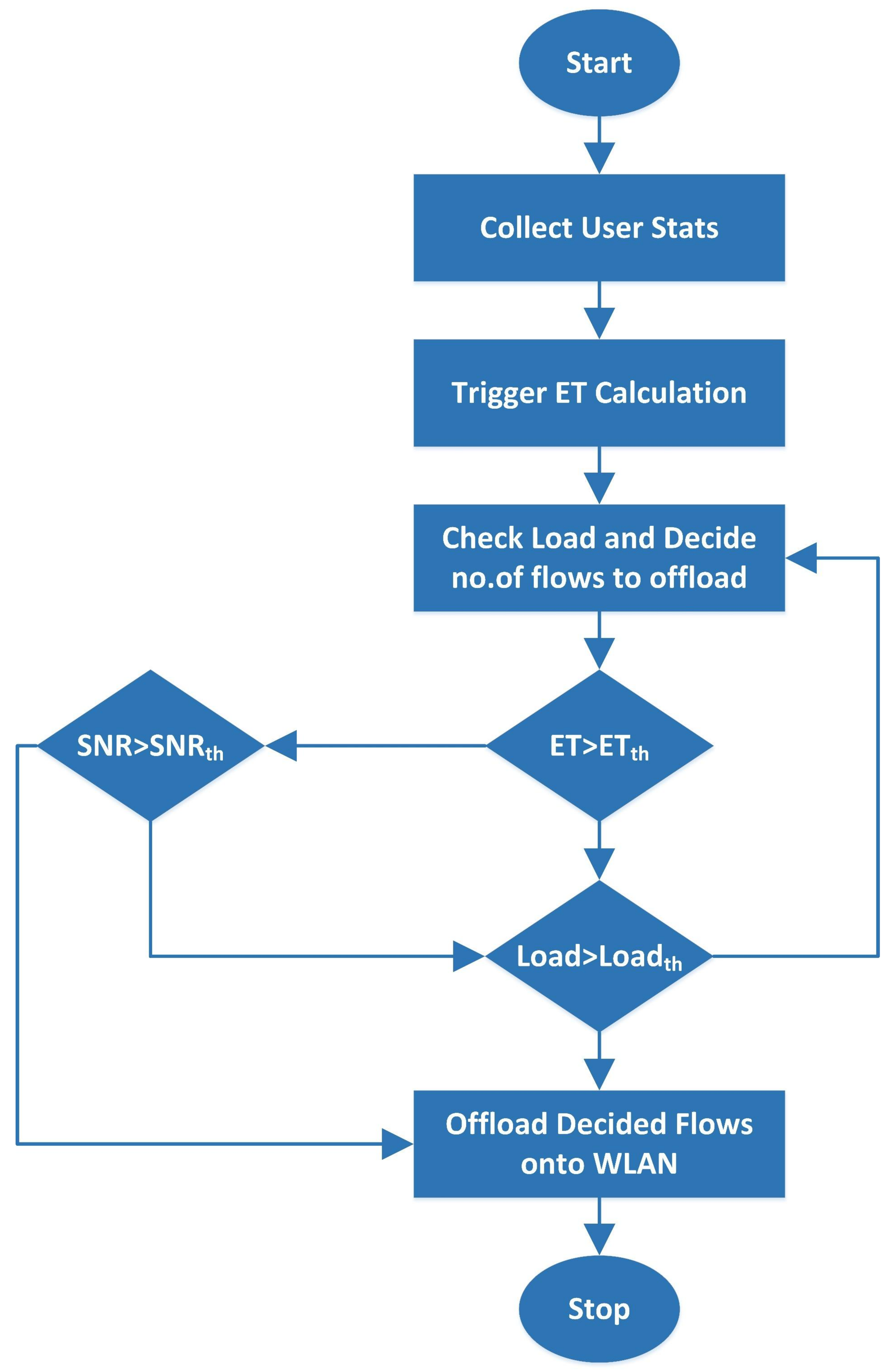
Proposed work

- In this work, we proposed Velocity based Integrated Flow Mobility (VIFM), an integrated flow offloading approach that considers SNR, Wi-Fi load, user location and user velocity for taking offloading decisions.
- Based on user location and direction, we calculate the Expected Time (ET) that user is expected to spend in Wi-Fi coverage area.
- Linear Regression is used to predict the user direction and estimated stay time is obtained based on the user velocity.
- If the expected time to be spent in Wi-Fi area is greater than a predefined threshold for expected time (ET_{th}), then for those users SNR is checked for making a decision. If SNR from the WAP of a chosen user is greater than SNR_{th}, , then offloads NF_{of} flows on to the WAP.
- Number of flows for offloading is given by $NF_{of} = \lambda * N_f$, where N_f is the total number of flows at a MN. $\lambda \in [0\ 1]$, is an exponentially decreasing function.
- If SNR constraint is not met then offloading of these NF_{of} flows will be done only if the load of WAP is less than $Load_{th}$ else offload is not done.
- VIFM processes the users in descending order of their ET_{Wi-Fi}, all the users with higher ET_{Wi-Fi} would try offloading their flows based on above conditions.
- For the users with ET_{Wi-Fi} less than ET_{th}, the load of WAP will be checked. If the load of WAP is lesser than $Load_{th}$, then the WAP is under utilized and could take up additional load by admitting some more flows. Therefore, it offloads users with short stay time for increasing the network utilization.
- Also, we compared the performance of VIFM with various offloading approaches like SNR based Flow Mobility (SFM), SNR-Load based Flow Mobility (SLFM) and Load based Flow Mobility (LFM).

Simulation Setup & Parameters

Parameters	Value
LTE Scheduler	Proportional Fair Scheduler
Number of Resource Block	50
MN Speeds	3km/h, 30km/h, 60km/h
Load Threshold	80%
Simulation duration	100 seconds
Wi−Fi standard	802.11 a
Wi-Fi Rate Control Algorithm	Adaptive Auto Rate Fallback
High User Density	54 per cell
Medium User Density	36 per cell

Velocity based Integrated Flow Mobility (VIFM)



Results & Analysis

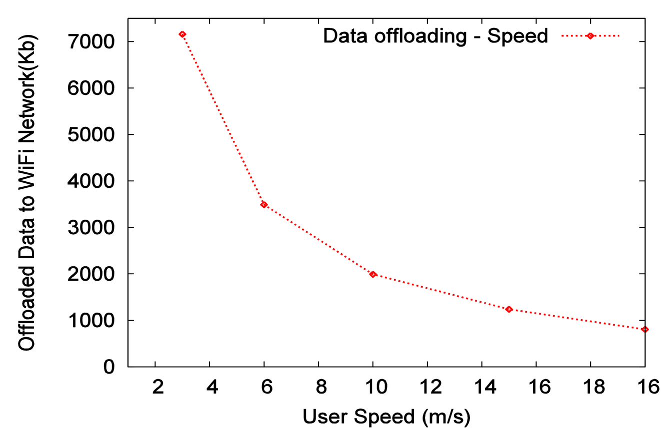


Fig. 2. Data offloaded vs User Speed

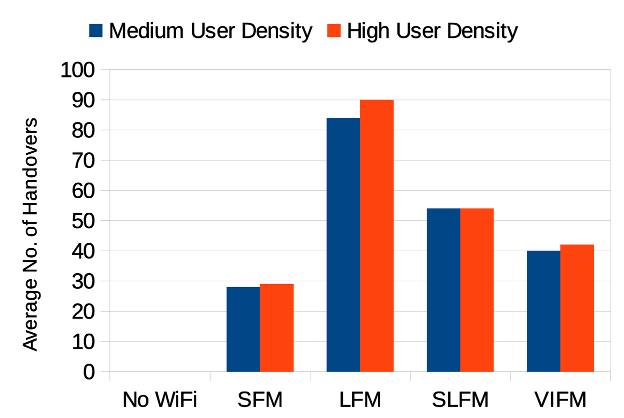


Fig. 4. : : Average no. of Handovers

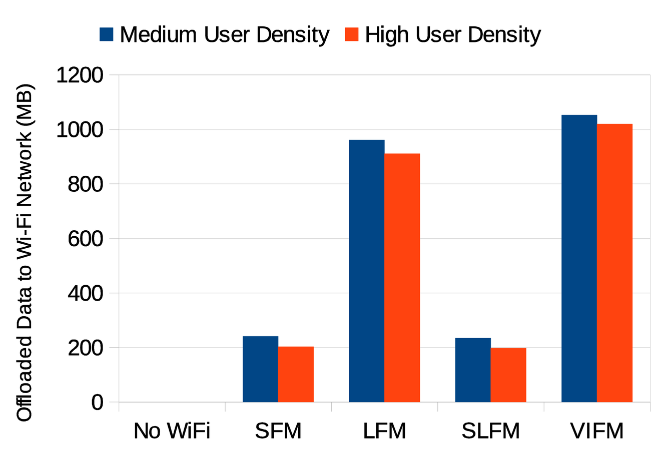


Fig. 4. : Amount of Data Offloaded to Wi-Fi

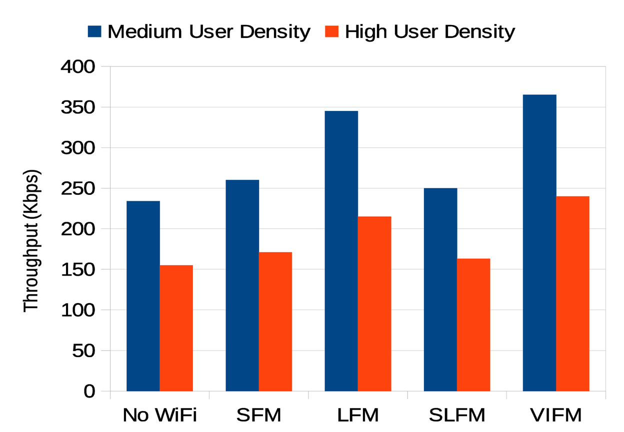


Fig. 5. : Per Flow Throughput

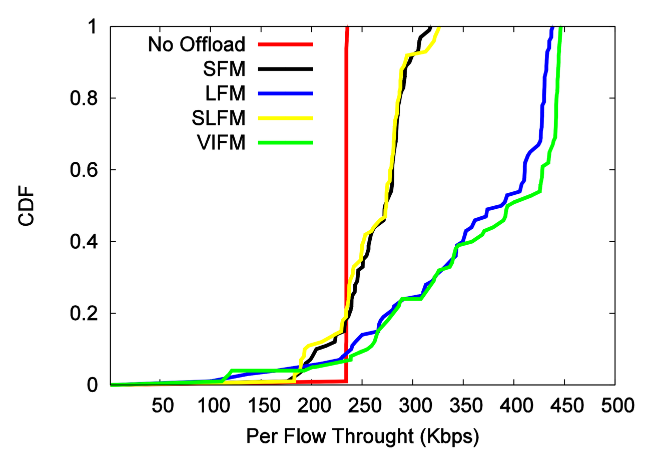


Fig. 6. : CDF of Flow Throughput for Medium User Density

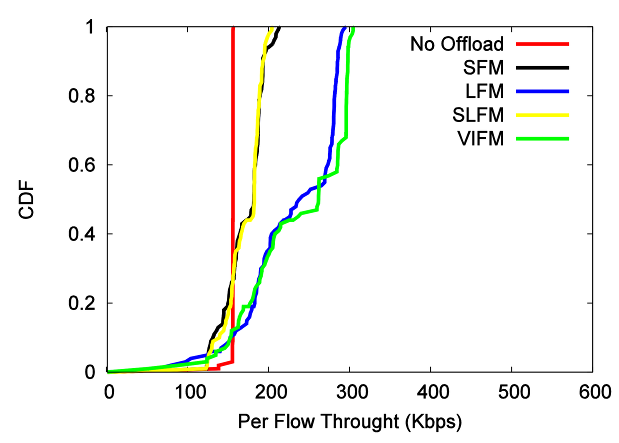


Fig.7. : CDF of Flow Throughput for High User Density

- VIFM has reduced number of handover by 50% and increased the network utilization by 12%.
- VIFM has given best offloading compared to all existing techniques, this improvement is attained through careful attention towards type of flow, user velocity and estimated stay time in Wi-Fi.

Conclusions

- In this work, proposed VIFM scheme which prevents unnecessary offloading of flows to Wi-Fi network in converged LTE/Wi-Fi networks by considering velocity of the users which is used to estimate stay time of users in Wi-Fi coverage area.

Acknowledgement

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