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DECLINING CELLULAR TRAFFIC BY INCENTIVE FRAMEWORK

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ABSTRACT Cellular networks are currently facing severe traffic overload problems caused by excessive traffic demands. Offloading part of the cellular traffic through other forms of networks, such as Delay Tolerant Networks (DTNs) and Wi-Fi hotspots, is a promising solution. However, since these networks can only provide intermittent connectivity to mobile users, utilizing them for cellular traffic offloading may result in a no negligible delay. As the delay increases, the users' satisfaction decreases. Here we investigate the trade-off between the amount of traffic being offloaded and the users' satisfaction. We provide a novel incentive framework to motivate users to leverage their delay tolerance for cellular traffic offloading. To minimize the incentive cost given an offloading target, users with high delay tolerance and large offloading potential should be prioritized for traffic offloading. To effectively capture the dynamic characteristics of users' delay tolerance, our incentive framework is based on reverse auction to let users proactively express their delay tolerance by submitting bids. We further illustrate how to predict the offloading potential of the users by using stochastic analysis for both DTN and Wi-Fi cases. Extensive trace-driven simulations verify the efficiency of our incentive framework for cellular traffic offloading.

Keywords *–Delay Tolerant Networks (DTNs) and Wi-Fi hotspots*

1. INTRODUCTION

Mobile computing is the discipline for creating an information management platform, which is free from spatial and temporal constraints. The freedom from these constraints allows its users to access and process desired information from anywhere in the space. The state of the user, static or mobile, does not affect the information management capability of the mobile platform. A user can continue to access and manipulate desired data while traveling on plane, in car, on ship, etc. Thus, the discipline creates an illusion that the desired data and sufficient processing power are available on the spot, where as in reality they may be located far away. Otherwise Mobile computing is a generic term used to refer to a variety of devices that allow people to access data and information from where ever they are.

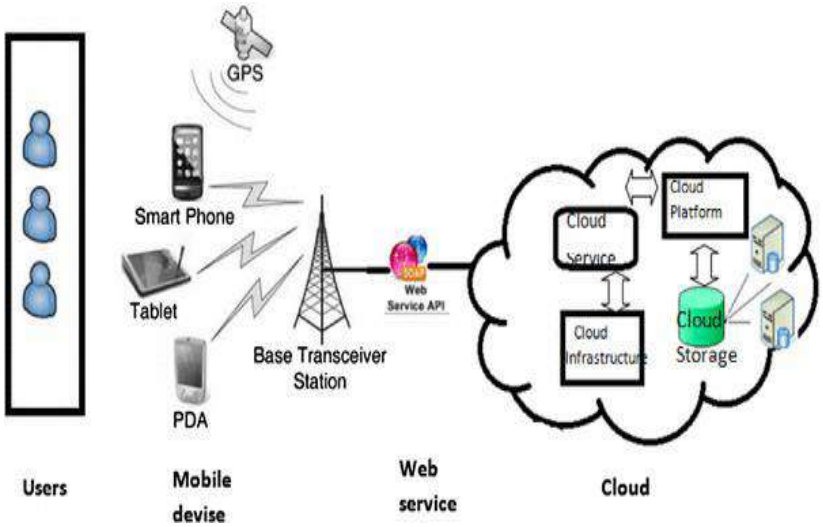

Fig.1: Example figure

The recent popularization of cellular networks (e.g., 4G) provide mobile users with ubiquitous Internet access. However, the explosive growth of user population and their demands for bandwidth-eager multimedia content raise big challenges to the cellular networks. A huge amount of cellular data traffic has been generated by mobile users, which exceeds the capacity of cellular network and hence deteriorates the network quality. To address such challenges, the most straightforward solution is to increase the capacity of cellular networks, which however is expensive and inefficient. Some researchers studied on how to select a small part of key locations to realize capacity upgrade, and shift traffic to them by exploiting user delay tolerance. Remaining the capacity of cellular networks unchanged, offloading part of cellular traffic to other coexisting networks would be another desirable and promising approach to solve the overload problem. Some recent research efforts have been focusing on offloading cellular traffic to other forms of networks, such as DTNs and WiFi hotspots, and they generally focus on maximizing the amount of cellular traffic that can be offloaded. In most cases, due to user mobility, these networks available for cellular traffic offloading only provide intermittent and opportunistic network connectivity to the users, and the traffic offloading hence results in nonnegligible data downloading delay. In general, more offloading opportunities may appear by requesting the mobile users to wait for a longer time before actually downloading the data from the cellular networks, but this will also make the users become more impatient and hence reduce their satisfaction.

2. LITERATURE REVIEW

"Mobile Data Offloading through Opportunistic Communications And Social Participation,"
4G networks are currently overloaded, due to the increasing popularity of various applications for smart phone. Offloading mobile data traffic through opportunistic communications is a promising solution to partially solve this problem, because there is almost no monetary cost for it. We propose to exploit opportunistic communications to facilitate information dissemination in the emerging Mobile Social Networks (MoSoNets) and thus reduce the amount of mobile data traffic. As a case study, we investigate the target-set selection problem for information delivery. In particular, we study how to select the target set with only k users, such that we can minimize the mobile data traffic over cellular networks. We propose three algorithms, called Greedy, Heuristic, and Random, for this problem and evaluate their performance through an extensive trace-driven simulation study. Our simulation results verify the efficiency of these algorithms for both synthetic and real-world mobility traces. For example, the Heuristic algorithm can offload mobile data traffic by up to 73.66 percent for a real-world mobility trace. Moreover, to investigate the feasibility of opportunistic communications for mobile phones, we implement a proof-of-concept prototype, called Opp-off, on Nokia N900 smart phone, which utilizes their Bluetooth interface for device/service discovery and content transfer.

"Energy Efficient Offloading of 4G Networks,"
The increase in data consumed by smart phone is becoming a huge problem for mobile operators. In three years, mobile data traffic in AT&T's network rose 5000%. The US operators invest $50 Billion in the data networks every year and the technology upgrades and innovation still fail to keep up with the demand. In this paper we design two algorithms for delay-tolerant offloading of bulky, socially recommended content from 4G networks. The first one, called "Mix Zones", uses opportunistic, ad hoc transfers between users, and is assisted by predictions made by the network operator. The second one, called "Hot Zones", exploits delay tolerance and tries to download contents when users are close to Wi-Fi access points; it is also assisted by predictions made by the operator. We evaluate both algorithms using a large data set, obtained from a major mobile operator and a realistic application similar to Apple's Ping music social network. The metrics address the amount of offloading, delay and mobile energy efficiency. We find that both solutions succeed in offloading a significant amount of traffic, with a positive impact on user battery lifetime. Surprisingly, we also find that all the benefit obtained from the operator with the Mix Zones algorithm (i.e. with ad hoc exchanges between users) can be achieved with the Hot Zones algorithm and a small investment in Wi-Fi access points. Note that the latter is considerably less complex to deploy than the former.

Modeling Data Dissemination in Opportunistic Networks,"
In opportunistic networks data dissemination is an important, although not widely explored, topic. Since opportunistic networks topologies are very challenged and unstable, data-centric approaches are an interesting direction to pursue. Data should be proactively and cooperatively disseminated from sources towards possibly interested receivers, as sources and receivers might not be aware of each other, and never get in touch directly. In this paper we consider a utility-based cooperative data dissemination system in which the utility of data is defined based on the social relationships between users. Specifically, we study the performance of this system through an analytical model. Our model allows us to completely characterize the data dissemination process, as it describes both its stationary and transient regimes. After validating the model, we study the system's behavior with respect to key parameters such as the definition of the data utility function, the initial data allocation on nodes, the number of users in the system, and the data popularity.

"Socially Aware Routing for Publish Subscribe in Delay-Tolerant Mobile Ad Hoc Networks,"
Applications involving the dissemination of information directly relevant to humans (e.g., service advertising, news spreading, environmental alerts) often rely on publish-subscribe, in which the network delivers a published message only to the nodes whose subscribed interests match it. In principle, publish- subscribe is particularly useful in mobile environments, since it minimizes the coupling among communication parties. However, to the best of our knowledge, none of the (few) works that tackled publish-subscribe in mobile environments has yet addressed intermittently-connected human networks. Socially-related people tend to be co-located quite regularly. This characteristic can be exploited to drive forwarding decisions in the interest-based routing layer supporting the publish-subscribe network, yielding not only improved performance but also the ability to overcome high rates of mobility and long-lasting disconnections. In this paper we propose Social Cast, a routing framework for publish-subscribe that exploits predictions based on metrics of social interaction (e.g., patterns of movements among communities) to identify the best information carriers. We highlight the principles underlying our protocol, illustrate its operation, and evaluate its performance using a mobility model based on a social network validated with real human mobility traces. The evaluation shows that prediction of collocation and node mobility allow for maintaining a very high and steady event delivery with low overhead and latency, despite the variation in density, number of replicas per message or speed.

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3. METHODOLOGY

Existing offloading studies have not considered the satisfaction loss of the users when a longer delay is caused by traffic offloading.

Disadvantages:

- Not considered the satisfaction loss of the users when a longer delay is caused by traffic offloading.
- Only provide intermittent and opportunistic network connectivity to the users.
- Non-negligible data downloading delay.

Here we focus on investigating the trade-off between the amount of traffic being offloaded and the users' satisfaction, and propose a novel incentive framework to motivate users to leverage their delay tolerance for

traffic offloading. Users are provided with incentives; i.e., receiving discount for their service charge if they are willing to wait longer for data downloading. During the delay, part of the cellular data traffic may be opportunistically off-loaded to other networks mentioned above, and the user is assured to receive the remaining part of the data via cellular network when the delay period ends.

Advantages:

- To motivate the mobile users with high delay tolerance and large offloading potential to offload their traffic to other intermittently connected networks such as DTN or Wi-Fi hotspots.
- To capture the dynamic characteristics of users' delay tolerance.
- To predict users' offloading potential based on their mobility patterns and the geographical distribution of Wi-Fi hotspots in the Wi-Fi case.

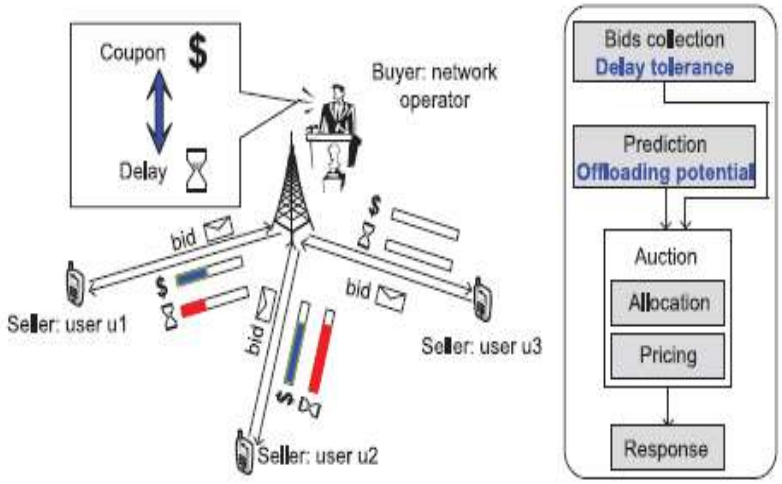

Fig.2: System architecture

MODULES:

1. Network Model.
2. Reverse auction.
3. Prediction of Offloading Potential: The DTN Case
4. Prediction of Offloading Potential: The Wi-Fi Case

MODULE DESCRIPTION:

- **Network Model**

In this module, focusing on offloading cellular traffic to other forms of networks, such as DTNs and Wi-Fi hotspots and they generally focus on maximizing the amount of cellular traffic that can be offloaded.

- **Reverse auction**

In this module, we use a novel incentive framework, Win-Coupon, based on reverse auction, to motivate users to leverage their delay tolerance for cellular traffic offloading; Auction has been widely used in network design. Applying auction in the spectrum leasing is one of the most practical applications. Federal Communications Commission (FCC) has already auctioned the unused spectrum in the past decade, and there are a large amount of works on wireless spectrum auctions. Moreover, auction has also been applied for designing incentive mechanism to motivate selfish nodes to forward data for others. However, none of them has applied auction techniques to cellular traffic offloading.

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- **Prediction of Offloading Potential: The DTN Case**

Mobile users can share data via DTNs by contacting each other. In urban area with higher user density, mobile users have more chances to contact other users who have their requested data.
Large data requests such as video clips tend to drain most of the cellular network resource, and such requests can also tolerate some delay. By offloading them via DTNs, the payload of cellular network can be significantly reduced.

- **Prediction of Offloading Potential: The Wi-Fi Case**

In this module, we model node mobility by a Semi Markov Process, in which arbitrary distributed sojourn times are allowed. To avoid state space explosion, each Markov state represents a geographical area with a fixed size. The process of a user moving from a geographical area to another is modeled as a transition of Markov processes between two states.

5. EXPERIMENTAL RESULTS

Fig.3: Home page

Fig.4: User registration page

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Fig.5: Add product page

Fig.6: Features selection algorithm

Fig.7: Buyer login page

Fig.8: User details page

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Fig.9: Product details page

Fig.10: Product search page

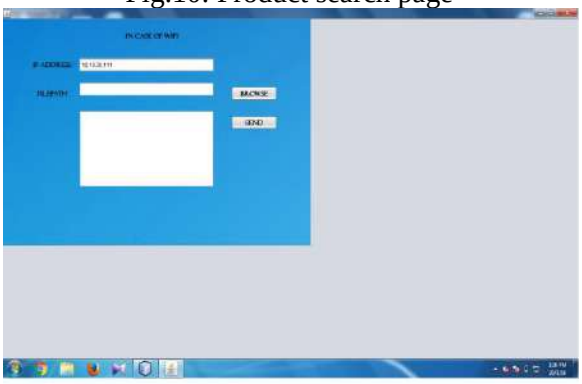

Fig.11: In case of WIFI

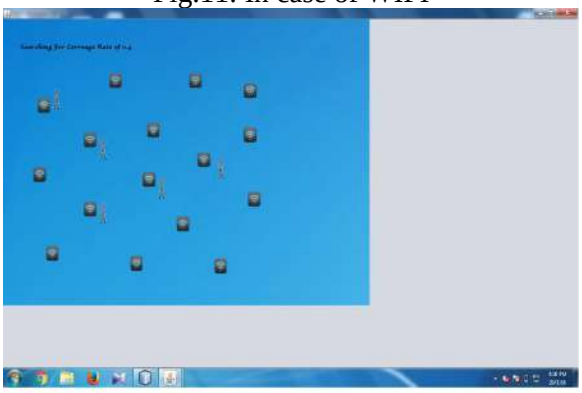

Fig.12: Searching

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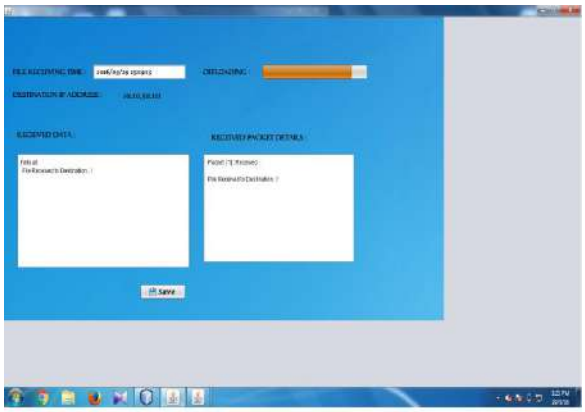

Fig.13: Description

6. CONCLUSION

In the Declining Cellular Traffic by Incentive Framework,a novel incentive framework for cellular traffic offloading was proposed. The basic idea is to motivate the mobile users with high delay tolerance and large offloading potential to offload their traffic to other intermittently connected networks such as DTN or Wi-Fi hotspots. To capture the dynamic characteristics of users' delay tolerance, we design an incentive mechanism based on reverse auction. Our mechanism has been proved to guarantee truthfulness, individual rationality, and low computational complexity. Moreover, we design two accurate models to predict the offloading potential of the users for both DTN and Wi-Fi cases. Extensive trace driven simulations validate the efficiency and practical use of our incentive framework.

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