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Dynamic Route Node Based Timely Content Delivery in DTN

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Abstract: Wireless Sensor Networks have the potential of being composed by an extremely large number of nodes offering multiple services. Such networks have the ability of executing multiple tasks concurrently by allocating simply a fraction of their resources. Many applications, such as product promotion advertisement and traffic congestion notification, benefit from content exchange in Delay Tolerant Networks (DTNs). An important requirement of such applications is timely delivery. Though, the intermittent connectivity of DTNs may significantly delay content exchange and cannot guarantee timely delivery. While the content demanded by a large number of subscribers could follow the same forwarding channel as the content by one subscriber, leading to traffic congestion and packet drop. For that, we develop a solution framework, namely Ameba, for timely delivery. In that also problem will occur like, node problem and path problem. To address this issue, in this paper, we develop a Dynamic Route allocation for delivery of content towards the needed nodes in a timely manner.

Key words: Delay Tolerant Networks · Dynamic Routing · Opportunistic Communication · Experiments

INTRODUCTION

Modern technological advances are enabling the deployment of wireless sensor networks for many different applications. Such applications are also diverse in scope and purpose, ranging from object tracking, structural health monitoring, habitat monitoring and monitoring of the environment and its resources. In the future, with such sensors attached to cars, electronic devices and human bodies [1], we will live immersed in an all pervading sensor sphere that is collected by the internetworking of various sensor network applications. In Delay Tolerant Networks (DTNs), whenever mobile devices encounter each other, they exchange content via short-range communications (e.g., Bluetooth [2] or WiFi). Many applications and services, such as advertisement and traffic congestion notification, benefit from the opportunistic content exchange. An important requirement associated with exchanged content is freshness. That is, besides effectively delivering the content to appropriate users, we further expect the content to be delivered in a timely fashion [3].

In this paper, we study the problem of maximizing the number of users who can receive content promptly. The topic-based model makes to offer personalized content subscription. This model is widely used in many applications (e.g., RSS feeds, online games) to decouple content producers and consumers. The consumers, namely subscribers, declare their interests by specifying topics inside subscription conditions (called filters). An advertisement (which precisely means a content item in this paper) is associated with a topic. An advertisement *matches* a filter (or a filter matches an advertisement), if and only if the advertisement and filter contain the same topic [2].

The state-of-the-art systems leveraged mobility patterns or social properties of mobile devices to optimize content delivery. However, such works do not capture the patterns of delivered content for the content delivery. Without such optimization, the content demanded by a large number of subscribers could follow the same forwarding path as the case with only one subscriber. This obviously leads to traffic congestion and packet drop on the forwarding path. Moreover, many real

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applications show that the number of subscribers frequently exhibits the well-known Zipf distribution [4]. This further aggravates the above-mentioned issue.

To solve the above maximization problem, in this paper, we propose a solution framework, namely *Ameba*, by considering two subproblems and designing the associated techniques. First, *Ameba* considers a simple case by assuming that each node in a DTN has an equal probability to forward a given advertisement towards needed subscribers (i.e., ignoring the constraint of mobility pattern and limited capacity). In this way, *Ameba* develops a strategy to assign an optimal hop count for published content [5]. To solve this subproblem, *Ameba* leverages the distribution of content and assigns a larger hop encounter for the highly popular content demanded by more subscribers. In this way, more nodes act as intermediate carriers of the popular content and subscribers have more chance to receive the advertisement in a timely manner.

Next, *Ameba* solves the general maximization problem, where node capacity is heterogeneous and mobility pattern is further considered. To this end, *Ameba* develops a metric, namely the forwarding utility, to identify (i) which nodes are interested in the advertisement and (ii) how fast the encountered node can forward the advertisement towards subscribers. Based on the developed utility, *Ameba* selects the best carriers to forward the advertisement and adaptively creates the copies of an advertisement for timely delivery [6].

As a summary, we make the following contributions.

- We develop a forwarding strategy to design an optimal hop count for each content. The content with such a hop count is expected to reach the needed nodes.
- By the developed utilities to capture the interests, mobility patterns and resource capacity of mobile devices, we design an adaptive algorithm to select the best carriers for timely delivery.
- By analyzing the locations of mobile devices, we extend the utility function to optimize the selection of the best carrier and further improve the forwarding algorithm.

Problem Statement: Many applications are available such as promotion product advertisement and traffic congestion notification, benefit from an opportunistic content exchange in Delay Tolerant Networks (DTNs) in this system. Time delivery is an important requirement of the mentioned applications. Moreover, the intermittent connectivity of DTNs significantly a delay content exchange and cannot guarantee timely delivery. The state-of-the-arts capture mobility patterns or social properties of mobile devices. Such solutions do not capture patterns of delivered content in order to optimize content delivery. Without such optimization, the content demanded by a large number of subscribers could follow the same forwarding path as the content by only one subscriber, leading to traffic congestion and packet drop. And also address the challenge of the delivered the packet.

Delay Content Exchange: Delay content exchange problem implicitly defines two constraints. (i) The exchange of advertisements among mobile devices incurs resource consumption (e.g., energy). Due to the limited capacity (e.g., battery power), each node allows only a fixed number of exchanges with other nodes. Moreover, mobile nodes typically follow some movement pattern. A given period P consequently indicates that N mobile devices experience a certain number of encounters and an associated number of advertisement exchanges (because an exchange occurs if and only if two nodes encounter each other). (ii) A matching advertisement means that a subscriber defines a filter having the same topics as the advertisement. Thus, an advertisement matches a subscriber node if and only if the defined filter shares the same topic as the advertisement. The second constraint is related to the business requirement of the DTN. With such constraints, the objective is to maximize the number of subscribers receiving matching advertisements. In this method, problem will occur, while moving of data from one node to another node there may a possible of node problem at that time delay will occur.

Traffic Congestion: The general idea of our optimization is as follows. When the period P is given, the mobile nodes in a DTN experience the total number X of opportunistic encounters. Therefore, we treat the number X as a constraint in this section to maximize the number of subscribers receiving advertisements of interest. To this end, we first define the event that two nodes encounter as an encounter event, no matter what the mobility pattern and social properties of mobile devices. For example, given three nodes nj, nj¡¬ and nj", the node nj first encounters nj¡¬ after 1 day and then encounters nj" after only 1 minute. Based on the encounter events, we derive a function $f(\bullet)$ between the number of encounters to relay an advertisement and the number of nodes successfully receiving the advertisements of internet. Next, considering the overall advertisements, we develop a strategy to assign an optimal number of encounters for each advertisement, such that we maximize the total number of nodes which can successfully receive matching advertisements. Essentially, this section exploits the properties of advertisements (i.e., the demanding and supplying rates) and do not consider the mobility pattern and capacity limit of DTN devices. We will utilize such a constraint and pattern to develop the node utilities for timely delivery.

Dynamic Routing: Dynamic routing, describes the capability of a system, through which routes are characterized by their destination, to alter the path that the route takes through the system in response to a change in conditions. The adaptation is intended to allow as many routes as possible to remain valid (that is, have destinations that can be reached) in response to the change. People using a transport system can display dynamic routing. For example, if a local railway station is closed, people can alight from a train at a different station and use another method, such as a bus, to reach their destination.

Routing [7] cost is a critical factor for all organizations. Dynamic routing helps organizations by providing a least-expensive routing technology. This automates table changes and provides the best paths for data transmission. The operations of dynamic routing protocol is as follows:

- On router interface, the router delivers and receives the routing messages.
- The routing messages and information are shared with other routers, using the same routing protocol.
- The routing information is swapped by router to discover data about remote networks.
- Whenever a router finds a change in topology, the routing protocol advertises this topology change to other routers.

On large networks, dynamic routing is easy to configure and is more intuitive at selecting the best route, detecting route changes and discovering remote networks. Dynamic routing consumes more bandwidth because routers share updates, than in static routing; the routers' CPUs and RAM may also face additional loads as a result of routing protocols. Finally, dynamic routing is less secure than static routing, the distributed forwarding scheme leverages the optimal routing [8] hop count and node utilities to deliver content towards the needed nodes in a timely manner. Illustrative results verify that Ameba achieves comparable delivery ratio as Epidemic but with much lower overhead.

Ameba will generate the copies based on the requirement of the request from the subscriber. It will find the appropriate shortest path to send the advertisement in a timely manner. The state-of-the-art systems leveraged mobility patterns or social properties of mobile devices to optimize content delivery. However, such works do not capture the patterns of delivered content for the content delivery. Without such optimization, the content demanded by a large number of subscribers could follow the same forwarding path as the case with only one subscriber.

Provide multi copy to parallel accessing node same file has been duplicated for parallel downloading by multiple node concurrently. Message transferred to a DTN note classified as persistent, which has large amounts of non-volatile storage. It can hold the message until the next communication opportunity.

Architecture Diagram: Many applications, such as product promotion advertisement and traffic congestion notification, benefit from opportunistic content exchange in Delay Tolerant Networks (DTNs). The important requirement of such applications is timely delivery. However, the intermittent connectivity of DTNs may significantly delay content exchange and cannot guarantee timely delivery. To address the challenge, it shows a solution framework, namely Ameba, for timely delivery.

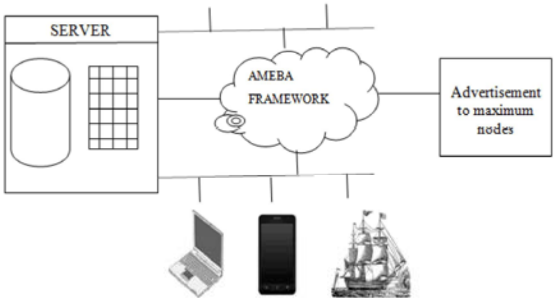

Fig. 1: Architecture Diagram

An important requirement associated with exchanged content is freshness. That is, besides successfully delivering the content to appropriate users, for further expect the content to be delivered in a timely fashion.

Data Flow Diagram: Ameba will generate the copies based on the requirement of the request from the subscriber. It will find the appropriate shortest path to send the advertisement in a timely manner [9]. The state-of-the-art systems leveraged mobility patterns or social properties of mobile devices to optimize content delivery. However, such works do not capture the patterns of delivered content for the content delivery. Without such optimization, the content demanded by a large number of subscribers could follow the same forwarding path as the case with only one subscriber.

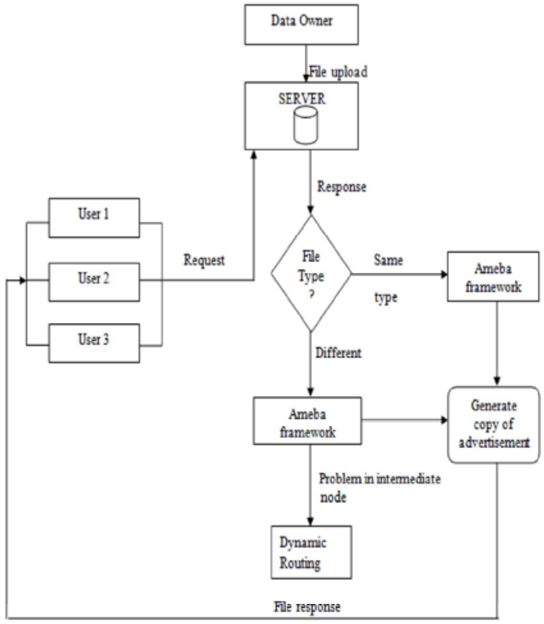

Fig. 2: Data Flow Diagram

In this, when the user can subscribe the content to the server, it will send the data at that particular time the another user can subscribe the same content at the time ameba framework will starts to process it will take the copy of that content and send to the subscriber at the particular time without any loss. Both user can download their advertisement at a same time. This process should be used for more than two users, they can also download their advertisement at a particular time. To avoid the delay in downloading the content ameba concept is used in this delay tolerant networks.

Enhanced Ameba: It is useful in the areas where wireless networks do not cover, wireless access is blocked, or cellular networks are congested. Opportunistic communication thus helps to expand the network coverage, without building dedicated network infrastructures. Server can store all the required information whatever the owner can upload data in it and it will deliver the data based on the user access.

Algorithm : Enhanced Ameba

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input : Node nj, carrying di, is opportunistically encountering node nk
nj (resp. nk ) updates Uj (resp. Uk ) by exchanging utilities with nk (resp. nj);
if nk is interested in di, or Vk > ë during peak time then
    di is forwarded to nk ;
if the element utility uki is larger than the element utility uji then
    nk keeps a copy of di;
    if uki>µ ji
    then nj removes di ;
else nk does not keep a copy of di;
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An important requirement of such applications is timely delivery. However, the intermittent connectivity of DTNs may significantly delay content exchange and cannot guarantee timely delivery. The state-of-the-arts capture the mobility patterns or social properties of mobile devices. However, there is little optimization in terms of the delivered content [10]. Without such optimization, the content demanded by a large number of subscribers could follow the same forwarding path as the content by only one subscribe. Server can use the database to store the information about the owner those can upload the information and the time also. Applications [11] must be careful not to accept timely responses. In fact, the request/response time may often exceed the longevity of the server and client processes.

Ameba in Dynamic Route: The state-of-the-art systems leveraged mobility patterns or social properties of mobile devices to optimize content delivery. However, such works do not capture the patterns of delivered content for the content delivery. While the user can access some data at the time of downloading another user can access the same data means, that intermediate node can analyze that request, if the data that is downloading and the request data is same. It will send the copy of content to the requested another user.

Algorithm : Ameba in Dynamic Route:

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input : Node nj, carrying di, is opportunistically encountering node nk
nj (resp. nk ) updates Uj (resp. Uk ) by exchanging utilities with nk (resp. nj);
if nk is interested in di, or Vk > ë during peak time then
    di is forwarded to nk ;
    if nk is in problem di is dynamically forwarded to nk1;
    if the element utility uki is larger than the element utility uji then
        nk keeps a copy of di;
        if uki>µ ji
        then nj removes di ;
    else nk does not keep a copy of di;
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Provide multi copy to parallel [12]accessing node. same file has been duplicated for parallel downloading by multiple node concurrently. Message transferred to a DTN note classified as persistent, which has large amounts of non-volatile storage. Can hold the message until the next communication opportunity Routing in delay-tolerant [13,14] networking concerns itself with the ability to transport, or route, data from a source to a destination, which is a fundamental ability all communication networks must have.

However, when instantaneous end-to-end paths are difficult or impossible to establish, routing protocols must take to a "store and forward" approach, where data is incrementally moved and stored throughout the network in hopes that it will eventually reach its destination. A common technique used to maximize the probability of a message being successfully transferred is to replicate many copies of the message in hopes that one will succeed in reaching its destination.

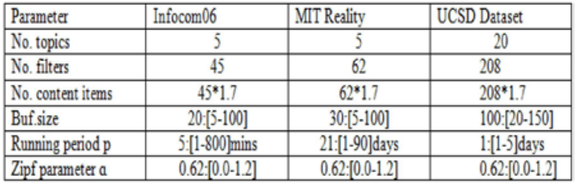
Evaluation

Experimental Setting: We compare Dynamic with the Ameba and Bubble Rap (i.e., the social aware approach). Note that for Bubble Rap, when a content item is needed by multiple subscribers and such subscribers are located at multiple communities, we then have to forward the item to all such communities. In addition, we compare Ameba with the adapted broadcast and unicast schemes with the optimal encounters, both of which are introduced. Next, we use the data sets (i.e., Infocom06 and MIT reality) to run the mobility pattern of DTN nodes. Next, by the Zipf distribution, we generate filters and content items for a set of given topics. In terms of subscribers, we ensure that each node registers a filter and thus the number of subscribers is equal to the node count. Next, we randomly choose publishers among the DTN nodes.

The parameters used in the experiments. Taking the Zipf parameter É as an example, we use 0.95 as the default value and the interval [0:0; 1:2] as the allowable range. For example, with the default É = 0:95, we generate filters and advertisements by the Zipf distribution as the following example results: the number of generated filters over the 1st topic...and the 5th one is respectively 4, 22, 3, 14 and 2 (totally 45 filters equal to the node count) corresponding to the demanding rate p1 = 4=45; :::; p5 = 2=45 and the number of advertisements is respectively 5, 33, 6, 22 and 3 (totally 45*1.7=77 advertisements) corresponding to the supply rate q1 = 5=77; :::; q5 = 3=77.

In addition, we are interested whether or not filter distribution correlates to content popularity. The correlation means that a topic, if highly demanded by subscribers, simultaneously popularly appears in content items. Otherwise, both distributions are anti-correlated. By default, we set up the correlated topics to generate filters and content (with the Zipf distribution).

Table 1: Parameters Used for Experiments



Parameter	Infocom06	MIT Reality	UCSD Dataset
No. topics	5	5	20
No. filters	45	62	208
No. content items	45*1.7	62*1.7	208*1.7
Buf.size	20:[5-100]	30:[5-100]	100:[20-150]
Running period p	5:[1-800]mins	21:[1-90]days	1:[1-5]days
Zipf parameter α	0.62:[0.0-1.2]	0.62:[0.0-1.2]	0.62:[0.0-1.2]

During the experiment, we follow the above parameters to repeat the experiments by 5 times (with random sources and destinations) and measure the average of the following metrics.

- Delivery ratio: the average ratio of the number of successfully delivered destinations to the total number of destinations.
- Average delay: the average delay for all the delivered destinations to receive the data.

Effects of Time Period: First, in Figs. 3 and 4, we study the effect of the allowable time period P over the three traces. In Fig. 3(a), among the schemes, Dynamic achieves comparable delivery ratio as Bubble Rap has a least delivery ratio than Dynamic and Ameba has the lower delivery ratio. Next, a larger P indicates that more nodes have a chance to relay content items towards the needed nodes and thus the delivery ratios of all four schemes increase accordingly. Note that in Fig. 3(a), the delivery ratio of Bubble Rap becomes saturated around 80%, due to the following reason: Given the fixed size of the buffer in each node, the node drops out those overflowed advertisements caused by the flooding messages in Bubble Rap. When we increase the default buffer size to 100, our experiment shows that Bubble Rap can achieve nearly 100% delivery ratio. This result will be consistently verified by Section 4.2. Second, Fig. 3(b) plots the average delay, indicating that Dynamic uses a low delay comparable to Bubble Rap and Ameba to deliver content items towards needed nodes. It is because the developed optimization strategy can optimize the delivery of highly demanded content by using more nodes as carriers and then content items are delivered in a timely manner.

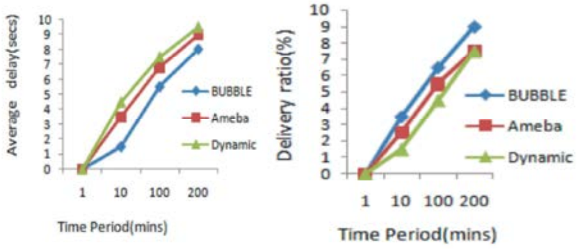


Fig. 3: Time period p: Infocom06 (a) Delivery Ratio (b) Avg. Latency

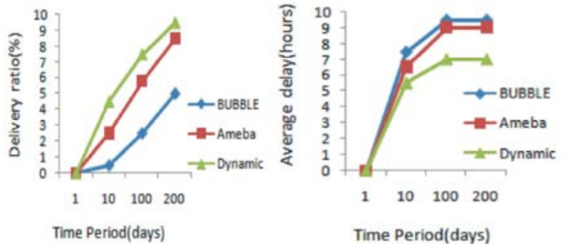


Fig. 4: Time period p: MIT Reality (a) Delivery Ratio (b) Avg. Latency

Only when buffer size (S) is sufficiently large, the number of delivered items becomes large enough to ensure smaller average cost. The trend consistently appears in all traces. Dynamic limits the copies of content and a larger S consistently leads to smaller cost.

Comparison of Schemes: First in Fig 5,6, by combining the benefits of both unicast and broadcast, Dynamic outperforms the two adapted schemes in terms of all used metrics. Second, the anti-correlated topics lead to relatively less delivery ratio and higher average delay, but with larger average cost compared with the results of correlated topics. For example the average cost of Dynamic with anti-correlated topics is increased by 35.66% when compared with the one with correlated topics. Finally, we note that the unicast and broadcast in this figure use less delivery ratio than Ameba and Bubble Rap, respectively. It is because the optimal encounters given by the developed optimization strategy can help the two adapted schemes achieve better delivery of the popular advertisements, which are highly demanded by the majority of mobile devices. Dynamic uses the least cost to achieve the comparable delivery ratio.

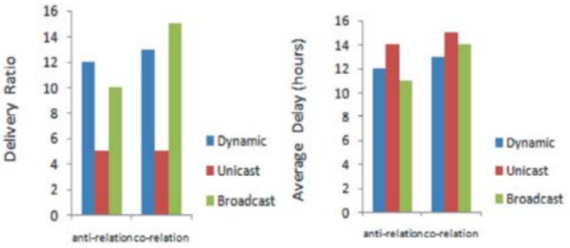


Fig. 5: Comparison: Infocom06 (a) Delivery Ratio (b) Avg. Latency

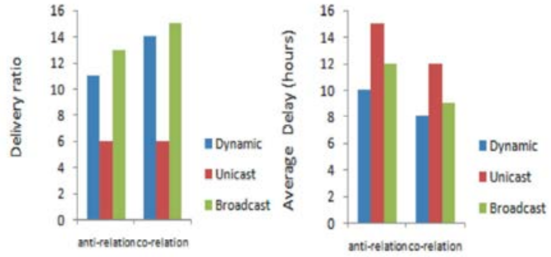


Fig. 6: Comparison: Reality (a) Delivery Ratio (b) Avg. Latency

CONCLUSION

To advertisement content towards needed nodes over a DTN in a timely manner, ameba carefully adjusts the number of encounters and the number of content copies for advertised content, develop forwarding utilities capture interests, mobility patterns, capacity constraint and visit locations of mobile devices with low maintenance cost and design distributed relay algorithms to select the best nodes as the carriers.via extensive experiments, our evaluation demonstrates that the ameba scheme is able to achieve high delivery ratio and significantly low overhead. While downloading the advertisement there may be a possible in occurrence of node failure, path problem or subscriber does not able to access the advertisement at the timely manner, at that time ameba framework will find the path and it will dynamically allocate the another path to send the advertisement for that subscriber. With the help of ameba in Dynamic routing, the maximum number of subscriber can subscribe the required advertisement at a particular time.

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