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Opportunistic Routing Protocols In Human Working Day Model Delay Tolerant Networks

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Abstract: **Delay-tolerant Networks are used to enable communication in sparse mobile ad-hoc networks and other weak as well as challenged environments where traditional networking fails and new routing and application protocols are required. Experiences with DTN routing and application protocols has shown that their performance is extremely dependent on the mobility and node characteristics. Opportunistic routing protocol drives to improve wireless performance by making a good use of communication opportunities arising by chance. DTN protocols evaluation across many scenarios requires suitable simulation tools. This project presents the opportunistic networking routing simulator specifically designed for evaluating DTN routing and application protocols. Also provides users to create scenarios based on different synthetic movement as well as real-world traces. It offers a framework for implementing routing and application protocols with six well-known routing protocols**

Keywords: Delay Tolerant Network, HDTN, Opportunistic Routing ,WDM

1. Introduction

Conventional MANET routing protocols are built with the supposition that the network is dense enough so that it is fully connected that there always exist a path between each node in the network. These assumptions do not grasp in many MANET applications, where the free movement of nodes and the radio range and quality of the wireless links can lead to partitioning of the network, making these protocols unable to operate completely or with unacceptable performance. Well-organized usage of resources is important in wireless environment with mobile node since they typically have restrictions in bandwidth, available storage memory and a limited energy supply i.e. battery capacity, making resources in short supply. This adds some other problems on top of the ones introduced by partitions. These kind of networks are in which there is will not be a path between the sender and the destination exists are belonging to the general category of delay/ disruption tolerant networks (DTN). New kinds of routing protocols are needed to be able to communicate in such networks.

Opportunistic DTN Routing with Window-aware Adaptive Replication (ORWAR) is a resource efficient delay-tolerant routing protocol projected by Gabriel Sandulescu and Simin Nadjm-Tehrani, for routing messages in Delay-Tolerant Networks. ORWAR is anticipated to be used in failure relief efforts or emergency operations were a DTN could be a fast way to enable rescue workers to be able to communicate. In these sorts of scenarios fast delivery of messages and high success ratio together with competent usage of the network resources are critical to the success of such operations.

To prevail over the problem with intermittent connectivity and partitions in the network, DTN routing protocols utilize the mobility of the nodes and buffering of messages, which makes a node to carry messages and in that way bridge partitions in the network. This form of routing is called store-carry-forward (SCF). When a message is created it gets stored at the source node and the message is sent over this contact when a contact becomes available to a next-hop node. The message will be stored at the new node until the next-hop in the path is found and the destination is found. And it results in a path from the source node to the destination without an assurance for a contemporaneous path.

DTN routing protocols are grouped in to two basic schemes, single copy schemes and multi-copy schemes. The difference between the schemes is the number of replicas of a message that may exist at the same time in the network. Single-copy schemes forwards a single copy of each message and is a resource efficient method, but it success from long delivery delays, since the chance of finding the destination node is low when only one copy exist.

Multi-copy schemes forwards a copy of each message sent and is also called replication. Several copies of the same message stay alive in the network, thus having a higher resource utilization compared to single-copy. It gives a lower delivery delay, due to the higher probability that one of the copies will get to its destination. And due to the higher resource consumption algorithms try to avoid replication when it does not increase the chance of delivery or else limit the number of copies. Direct delivery and epidemic routing are the examples of existing routing protocols are. The simplest single-copy routing scheme is Direct delivery in which a node holds a message until it reaches the destination node of the message, to which it deliver the messages. The simplest multi-copy scheme is the Epidemic routing, in which when a node comes in contact with another node it replicates all its messages to that node making the messages to spread quickly in the network.

The performance of opportunistic networks may vary significantly, depending on the movement of mobile nodes, density of the node population, and how far apart the sender and the receiver are. The delivery latency may vary from a few minutes to hours or days, and a major fraction of the messages may not be delivered. The key factors are the routing and forwarding algorithms used and how well their design suppositions match the actual mobility patterns. No perfect routing scheme has been found so far.

2.PROPOSED WORK

The Proposed system presents the Opportunistic Networking Environment simulator, a Java based tool offering a broad set of DTN protocol simulation capabilities in a single framework, designed based upon our experience from analyzing numerous DTN routing and application protocols. Only the geographic character is unreliable and not enough to route messages efficiently due to the nodes' mobility characteristics. However, given the dynamic nature of DTNs, it should take other characteristics into consideration, as a viable and beneficial option in order to increase efficiency.The contributions is twofold:

- The simulator offers an extensible simulation framework itself supporting mobility and event generation, message exchange, DTN routing and application protocols, a basic notion of energy consumption, visualization and analysis, interfaces for importing and exporting mobility traces, events, and entire messages.
- Using this framework, we implemented an extensive set of ready-to-use modules: six synthetic mobility models that can be parameterized and combined to approximate real-world mobility scenarios, six configurable well-known DTN routing methods, a set of base primitives to design application protocols, a basic battery and energy consumption model, several input/ output filters for interacting with other simulators, and a mechanism for the integration with real-world test beds.

The simulator is designed in a modular fashion, allowing extensions of virtually all functions to be implemented using well-defined interfaces.

There is an agent-based discrete event simulation engine in which at each simulation step the engine updates a number of modules that implement the main simulation functions.
The main purposes of the simulator are the modeling of node movement, routing, message handling and inter-node contacts. Result collection and analysis are done through visualization, reports and post-processing tools. Node movement is applied by movement models like synthetic models or existing movement traces. Connectivity between the nodes is mainly based up on their location, communication range as well as the bit-rate. The routing function can be executed using the routing modules that decide which messages to forward over existing contacts. Finally, the messages themselves are engendered through event generators and the messages are always unicast, having a single source and destination host inside the simulation world. Simulation results are collected primarily through reports generated by report modules during the simulation run. Report modules receive events (e.g., message or connectivity events) from the simulation engine and generate results based on them. The results spawned may be logs of events that are then further coursed by the external post-processing tools, or they may be aggregate statistics analyzed in the simulator. The graphical user interface (GUI) displays a visualization of the simulation state illustrating the positions, active contacts and messages carried by the nodes.

2. RELATED WORKS

Human-associated delay-tolerant networks (HDTNs) are networks where mobile devices are linked with humans and can be viewed from multiple dimensions counting geographic and social aspects. The grouping of these different dimensions enables to understand delay-tolerant networks and thus use this multidimensional information to recover overall network efficiency. Together with the geographic dimension of the network, which is anxious with geographic topology of routing, social dimensions such as social characters can be used to direct the routing message to improve not only the routing efficiency for individual nodes, but also effectiveness for the entire network. Hence propose a multidimensional routing protocol (M-Dimension) for the human associated delay-tolerant networks which utilizes local information derived from multiple dimensions to recognize a mobile node more precisely. The importance of each dimension has been measured by the weight function and it is used to calculate the best route.

Another important work related is the use of Epidemic routing protocols. Mobile ad hoc routing protocols let nodes with wireless adaptors to converse with one another without any pre-existing network infrastructure. Obtainable ad hoc routing protocols, while vigorous to rapidly changing network topology, suppose the presence of a connected path from source to destination. Given power limitations, the arrival of short-range wireless networks, and the wide physical conditions in which ad hoc networks must be organized, in some scenarios it is likely that this supposition is invalid. Hence develop techniques to deliver messages in the case where there is never a connected path from source to destination or when a network partition exists at the time a message is invented. To this end, we introduce Epidemic Routing, where random pair-wise exchanges of messages among mobile hosts ensure eventual message delivery.

On the other hand, Opportunistic networks are one of the most interesting developments of MANETs. In opportunistic networks, mobile nodes are enabled to communicate with each other even if there is not a connected route existing between them. In addition, nodes are not supposed to own or acquire any awareness about the network topology, which (instead) is necessary in traditional MANET routing protocols. Routes are constructed dynamically, while messages are en route between the sender and the destination(s), and any likely node can opportunistically be used as next hop, presented it is likely to bring the message closer to the final destination.

A Delay-Tolerant Network Architecture for Challenged Internets is another related work. The highly winning architecture and protocols of today's Internet may work poorly in environments described by very long delay paths and recurrent network partitions. These problems are worsened by end nodes with limited power or memory resources. Frequently deployed in mobile and severe environments lacking constant connectivity, many such networks have their own specialized protocols, and do not make use of IP. To achieve interoperability between them, propose a network architecture and application interface prepared around optionally-reliable asynchronous message forwarding, with fractional expectations of end-to-end connectivity and node supplies. The architecture operates as an overlay above the transport layers of the networks it interconnects, and gives key services such as in-network data storage and retransmission, authenticated forwarding, interoperable naming and a coarse-grained class of service.

4. IMPLEMENTATION

4.1 Networking

For our simulations, we suppose interpersonal communication between mobile users in a city using modern mobile phones or analogous devices, using Bluetooth at 2 Mbit/s net data rate with 10m radio range. We examined that WLAN radios with 100m radio range have only a minor effect and do not change the elementary interaction characteristics. The mobile devices have up to 100MB of free buffer space for storing and forwarding messages (flash memory may mostly be occupied by music or photos). We have 544 and 1029 mobile nodes (humans, cars and trams) referred to as small and large circumstances, respectively which move in a terrain of 8300X7300 m. The area is either a town square (for simple mobility models) or a part of the Helsinki city area (for map-based movement).

4.1.1 Random Way Point:

As a baseline, we use the Random Waypoint Model with all nodes modeled as pedestrians moving at random speeds of 0.5 1.5 m/s with pause times of 0–120 s (both uniformly distributed) in a town square. With RWP, the space is slightly larger than for the other models because the rectangular shape includes those map sections which are covered by the Baltic Sea.

4.1.2 Helsinki City Scenario:

A simple map-based movement model is the Helsinki City Scenario described: we use six trams following predefined routes; one third is car and two thirds of the left behind nodes are pedestrians. Cars run at 10–50 km/h and trams at 25–36 km/h with pause times of 10–120 s and 10–30 s, respectively. The pedestrians and cars choose random destinations in their contact on the map and move there following the shortest path. As the previous results shows that varying the numbers of trams and cars has some effect but does not change the basic communication characteristics, we attach to a single scenario.

4.1.3 Working day Model:

To approach realistic movement, we use the Working Day Movement model with the settings from for the large and from for the small scenario. The reduced number of nodes is achieved by shrinking all the group sizes proportionally leaving the basic contact characteristics unchanged.

A node replicates a mobile endpoint capable of acting as a store-carry-forward router (e.g., a pedestrian, car or tram with the required hardware). Simulation scenarios are built from groups of nodes in a simulation world. Each group is configured with different capabilities. Each node has a set of basic capabilities that are modeled. These are radio interfaces, movement, persistent storage, energy consumption, application interactions and message routing. Node capabilities like persistent storage that involve only simple modeling are configured through parameterization (e.g., storage capacity and peer scanning interval). More complex capabilities such as movement, routing and network interfaces are configured through specialized modules, which implements a particular behavior for the capability

Modules in each node can access the node's basic simulation parameters and state, including the current movement path, position and current neighbors. This allows implementation of context-specific algorithms like geographic routing. In addition, modules can make any of their parameters available for other modules in the same node through an inter module communication bus. This way a movement module can change its behavior depending on the router module's state or a router module can adjust the radio parameters based on the node interaction times.

The attention of the simulator is on modeling the behavior of store-carry-forward networking, and hence we deliberately refrain from thorough modeling of the lower layer mechanisms such as media access control (MAC) algorithms or retransmissions due to corrupted link layer frames. Instead, the radio link is abstracted to a communication range and bit-rate. The bit-rate is dependent on the interface model and can be time-varying. Furthermore, the context awareness and dynamic link configuration mechanisms can be used to adjust both range and bit rate depending on the distance between peers, the surroundings, and the number of (active) nodes nearby. The node energy consumption model is based on an energy budget approach. Every node is given an energy budget which is used up by energy consuming events such as scanning or transmission and can be filled by charging in certain locations (e.g., at home).

4.2 Node Mobility

Node movement capabilities are executed through mobility models. Mobility models describe the algorithms and rules that create the node movement paths.
Three synthetic movement models are included:
1) Random Movement
2) Map-Constrained Random Movement
3) Human Behavior Based movement.

The simulator includes a framework for creating movement models as well as interfaces for loading external movement data. Implementations of popular Random Walk (RW) and Random Waypoint (RWP) are comprised. While these models are admired due to their simplicity, they have various known failures. It is also promising to completely omit mobility modeling and build topologies based on static nodes. To enhance model real-world mobility, map-based mobility constrains node movement to predefined paths and routes drawn from real map data. Additional realism is added by the Working Day Movement (WDM) model that tries to model typical human movement patterns during working weeks.

A map-based movement model tends the node movement to paths defined in map data. The simulator contains three map-based movement models: 1) Random Map-Based Movement (MBM), 2) Shortest Path Map-Based Movement (SPMBM), and 3) Routed Map-Based Movement (RMBM). Furthermore, the release contains map data of the Helsinki downtown area (roads and pedestrian walkways) that the map-based movement models can use. But, the movement models understand random map data defined in (a subset of) well known Text. Such data can be typically converted from real world map data or created manually using Geographic Information System (GIS) programs.

While high-level movement models such as RWP, MBM, and SPMBM are easy to understand and competent to use in simulations they do not generate inter-contact time and contact time distributions that match real-world traces, particularly when the number of nodes in the simulation is small. In order to boost the reality of (human) node mobility, have developed the Working Day Movement (WDM) model.

The WDM model carries more reality to the node movement by modeling three major motions typically performed by humans during a working week: 1) sleeping at home, 2) doing works at office, and 3) going out in the evening. These three motions are divided into matching sub-models between which the simulated nodes transition depending on the node type and the time of the day. Beyond the motions themselves, the WDM model comprises three different transport models. That is, nodes can move alone or in groups by walking, driving or riding a bus. The capability to move alone or in groups at different speeds increase the heterogeneity of movement, which has a shock on the performance of routing protocols.

Finally, WDM initiates communities and social relationships which are not confined by simpler models such as RWP. The communities are collected from nodes which work in the same office, use time in the same evening activity spots or live together. We have shown that the inter-contact time and contact time distributions generated by the WDM model follow closely the ones found in the traces from real-world measurements.

4.3 Message Routing

The message routing capability is executed similarly to the movement capability: the simulator contains a framework for defining the algorithms and rules, which are used in routing and comes with ready implementations of renowned Delay Tolerant Network routing protocols.
Three six included routing protocols are there,

1) Direct Delivery(DD)
2) First Contact(FC)
3) Spray-And-Wait
4) PROPHET
5) MaxProp
6) Improved Epidemic

This topic covers the most important classes of DTN routing protocols such as single-copy, n-copy and unlimited-copy protocols, and also estimation based protocols. First Contact and Direct Delivery are single copy protocols where only one copy of each message exists in the network. In Direct Delivery, the node transports messages until it meets their final target. In First Contact routing the nodes forwards the messages to the first node they meet, which results in a “random walk” search for the destination.

Spray-and-Wait is an n-copy routing protocol that limits the number of message copies shaped to a configurable maximum and distributes (“sprays”) these copies to its contacts until the number of copies is exhausted. Both variants of Spray-and-Wait suggested by its authors are included: in normal mode, a node gives one copy to a contact; in binary mode half of the copies are forwarded. When only a single copy is left, it is forwarded only to the final receiver.

Three routing protocols perform alternatives of flooding. Epidemic duplicates messages to all encountered peers, at the same time Prophet tries to find which node has the highest “likelihood” of being able to transport a message to the final destination based on node encounter history. Max Prop deluges the messages but explicitly clears them once a copy gets delivered to the target. Also, Max Prop sends messages to other hosts in specific order that takes into account message hop counts and message delivery probabilities founded on previous encounters.

As the implementation of Epidemic router conveys only a single message at a time, the update technique does not do anything if there is a continuing transfer. Also, if the routing module's message buffer is unfilled, or the node does not have any connections to other nodes, nothing needs to be performed. Then, the routing module checks if any of the messages it has is for one of the nodes it is at present connected to, and if so, it starts to transfer such a message and go back from the method. Finally, all other messages are to be had on all connections and a transfer is started if any of the connected nodes recognize any of the messages.

4.4 Reporting and Visualization

Store-carry-forward performance from recording message delivery statistics such as latencies and delivery probabilities and their distributions in various states. Such simulations help to construct accepting of the performance of a complete DTN message delivery service under different routing algorithms, mobility models and node features. Visualize consequences of the simulation in two ways: via an interactive Graphical User Interface (GUI) and by producing images from the information collected during the simulation.

Simulation scenarios are constructed by defining the simulated nodes and their abilities. This includes defining the basic parameters such as storage capacity; transmit range and bit-rates, over and above selecting and parameter the specific movement and routing models to employ. Some simulation settings such as simulation duration and time granularity also need to be labeled.

The simulator is organized using simple text-based configuration files that contain the simulation, event generation, reporting parameters and user interface. All Java code implementation, but the details of their behavior is adjustable using the configuration subsystem. Many of the simulation parameters are configurable separately for each node group but groups can also share a set of factors and only alter the parameters that are precise for the group. The configuration system also let defining of an array of values for each parameter therefore enabling simple sensitivity analysis: in batch runs, a dissimilar value is chosen for each run so that large numbers of permutations can be discovered.

5. CONCLUSION

An opportunistic networking assessment system presents a variety of tools to create difficult mobility scenarios that come closer to reality than many other artificial mobility models. The Working Day Movement model allows restructuring composite social structures and features such as scanning intervals add more aspects of authenticity and heterogeneity to the modeling. The visualization factor is used for immediate sanity checks, deeper scrutiny, or simply to observe node movements in real-time which widens its applicability ahead of DTN.

The intermittently connected networks, where a lot of new functions are viable, vouching for an exciting future if the underlying mechanisms are present are looked out. The use of probabilistic routing using observations of non-randomness in node mobility in such networks is proposed. To accomplish this, delivery predictability metric, reflecting the history of node encounters and transitive and time dependent properties of that relation have defined. Also proposed PROPHET, a probabilistic protocol for routing in intermittently connected networks, that is more sophisticated than previous protocols.

PROPHET uses the new metric to enhance performance over previously existing protocols. Simulations performed have shown that in a community based scenario, PROPHET clearly gives better performance than Epidemic Routing. Further, it is also shown that even in a completely random scenario (for which PROPHET was not designed), the performance of PROPHET is still comparable with (and often exceeds) the performance of Epidemic Routing. Thus, it is fair to say that PROPHET succeeds in its goal of providing communication opportunities to entities in a intermittently connected network with lower communication overhead, less buffer space requirements, and better performance than existing protocols.

All and above the MaxProp protocol is well used and better than all other protocols by giving acknowledgment facility to all the messages received. Hence it will improve the overall performance with efficient routing in the DTN.

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