Artificial & Computational Intelligence / Published online: Dec 2019
http://acors.org/ijacoi/VOL1_ISSUE1_02.pdf

Artificial & Computational Intelligence

Detailed Architectural Review on Routing Protocol of Delay Tolerant Network

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Abstract
Delay tolerant Network (DTN) is developed by mobile ad hoc networks over MANET. This is rare & often connected MANET with no end-to-end (E2E) connectivity via reliable communication and message exchange. Delayed networks do not guarantee end-to-end connectivity. Simply high-latency applications are utilized into DTN. Latency can be in hours or days. Store& forward approach supports to improvethe likelihood of message delivery into DTN without taking time to transmit more messages from common MANET. In DTN, two or more nodes are capable of transmitting messages, because they transfer into each other's transmission range. The routing problem is mostsignificantbecause of limited resources available via message storage & forwarding. Problem of this route has been studiedthroughseveral researchers, resulting in several routing protocols based on flooding and forwarding approaches.

Keywords: Wireless sensor network,MANET, Delay Tolerant Network, DTN Protocols, Architecture, Applications, Routing Approaches.

1. Introduction

Wireless NWsdenote to NW in which communication occurs in the air into form of a radio signal, infrared, Bluetooth in place of cable as into wired NW. “A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to the main location.” [1].

Wireless & mobile technologies have developed so ubiquitously in today's world that it has become a part &way of people's lives in all sectors of society due to the proliferation of affordable wireless devices now available. MANET [2] has gained its place in view of the increasing popularity of wireless NWs, due to its ability to communicate better in many areas, such as strategic NWs, sensor NWs, disaster recovery & home networking.

2. What Is Dtn

DTNs may be subject to frequent disconnections or disconnections with NWs that are often interconnected. NWs experiencing disruption & disconnection & high delay NWs are under DNT. Examples of DTN comprise sensor-based NWs, satellite NWs, terrestrial wireless NWsby medium delays & periodic connectivity, medium underwater

digital NW delays, & frequent disruptions because of environmental issues. DTN architecture describes a novel layer beyondthe transport layer (TL) &below application layer (AL) labeled "Bundle layer", which is utilizedvia stores, messages, and forward bundles. This architecture may be useful in various challenging environments [3]. The challenging environment into networking denotesNWs such as disruptions such as lack of basic functions, disconnection, disruption & lack of resources.

2.1Existing Research Activities of DTNs

As yet, research activities into DTNs are being inspectedviaALdesign [4], convergence layer (CL) design [5], congestion control[6], routing [7], security[8] &flow control [9], which are conciselypresented as ensues:

Application Layer Design: Design of AL protocol is a verystimulating problem because NW architecture wants to handle a system module, which is consistent &recognized. But, applications must manage user interest, which is more dynamic.

Convergence Layer Design: It research problem is classified in terms of space DTN (or IPN) and terrestrial DTN. More precisely, long delay space is further cautious via DTNs while connectivity is existent. In contrast, communication into terrestrial DTNs is sometimes disturbed. Also, these assetswant to be studiedvia these 2kinds of applications.

Routing: In contrast to routing into MANETs, routing into DTNs is verycomplexbecause ofthe lack of most freshNW topology data.

Congestion Control: Congestion control into DTNs is preciousthrough acknowledgment strategy as once a message is recognized, cached message may be discarded towardsimproving buffer space collapse.

Flow Control: Rather than traditional E2E based method, flow control into DTNs needs hop-by-hop behavior towardsdeliveringdata on traffic and local sourceaccessibility that maytoo be utilizedbythe upper layer.

Security: it would be hard via certificate authority towards exchange cryptographic messagesbyspecific nodesin DTNs. As well as key management, DoS attacks, access control, anonymity&privacy are to being inspected.

3. EVOLUTION OF DTN

In the previous few years, there have been more great emphasis on research activity into mobile, wireless, MANET. MANETs are infrastructure-less, and nodes into this NWdesign are frequentlyaffecting. Nodesmay directly communicate with each other even while nodes enter each other's communication rangein MANETs. A node may terminate or forward packets. Therefore, packet changes into ad-hoc NWthrough being traversed by one node to additional, up to it spreads its identified destination. Such nodes keep affecting, & architecture savesaltering, itdevelopsstimulating tasks. How to discover+destination, how to route packet via source to destination (into scenario where source & destination nodes themselves are at constant change), how to confirmreliable, robust, secure communication in this constant topology change are maintasks into ad hoc NWs [9].

Data unit into DTNs may be called a message, bundleor packet. Generally scientific community refers to it as a bundle, which can be definite as no. of messages that can be distributed interchangeably. When we compared to DTNs with traditional internet we have the following basic characteristics are discussed.

Protocols of DTN

Duplicate-based protocols exist to achieve high delivery rates & low delivery latencies by copying messages over a network in a single copy-based protocol, asseveral copies occur on NW.

A. Epidemic Routing: It [10] is an epidemic that spreads in humans when people see each other [10]. In widespread routing, whenever 2 nodes come in contact area, nodes by low ID may initiate an anti-entropy session & broadcast messages between them. Every node must store hop count, a message identifier, &a summary vector containing optional ACK requests for every message. Increase distribution ratios, reduce average latency, & maximize resource consumption.

B. PROPHET Algorithm: This algo[11] is a predictive & probabilistic-based routing protocol [11]. Every node stores vector of delivery unpredictable evaluates&utilizes it towards determining if NTN is carrier via DTN packet. Giving to this protocol source node, firstly messages are filled into NW, with nodes having probability p-value. History of encounters&Transitivity (PROPHET) routing protocols are based on the past history of contact with value of this possibility, before forwarding a copy of message towardsevery neighbor, infectious disease, & delivery to its highest point message considered to be reached is given only to unpredictable nodes.

C. Spray and Wait Routing protocol: It [19] was suggested to decrease resource consumption with controlling level of message delivery duringNW. With convolutional routing protocols, network resources are more likely to be wasted because messages are delivered to NW in an uncontrolled way. It is also unaware of NW topology, mobility patterns & future encounter schedules. Unlike infectious diseases, it spreads L copies of messages to NW. Sprinkling & waiting aims to broadcast far less than epidemics & further flood-based projects [12].

D. Encounter Based Routing (EBR):EBR is a quota-based replication protocol with high message delivery ratio, low overhead ratio, &optimal delivery latency. EBR is created on encounter-based metrics to optimize message delivery, which increases delivery ratio & reduces overhead ratio by providing additional copies of a well-connected node.

Architecture Of Delay Tolerant Network

The architecture of DTN is consideredas a way that it counters maximumexpectations&circumstances that conventional TCP/IP based NWs are based on [12]. DTN architecture is founded on succeeding design ethics:

- Utilize variable-length (probably long) messages (not streams or limited-sized packets) like communication abstraction towardssupportimprovethe capability of NW towardscreating good scheduling/path selection decisions whileprobable.

- Utilize naming syntax that helpsa broad range of addressingandnamingconventions towardsincrease interoperability. - Utilize storage intoNW towards support store andthe forward operation completedseveralways, &donepossibly long timescales (that is, towards support operation into environments where several and/or no E2Ewayscan ever occur); do not needE2Econsistency.

- Deliver security devices that defend infrastructure by unauthorized utilizationwithremoval traffic likerapidly as probable.

- Deliver coarse-grained classes of service, delivery selections, andaway towardsshowvaluabletime period of information towardsagreeing withNW towell deliver information intohelpingrequirements of applications.

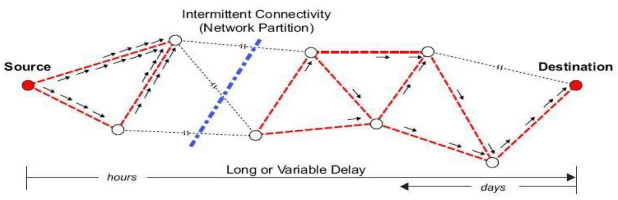

Fig 1: DTN Architecture Principles

a. Concept of Bundle Protocol

DTNmay be thought of as an overlay on the remaining local NW. It overlay is called bundle layer (BL). BL is meant towards function on top of remaining protocol layers & delivers a gateway function while2 nodes are interconnected. A majoradvantage of this kind of protocol is flexibility. Thismay simply link to obtainable TCP / IP protocol NWs, or it may be utilized towards link two or more NWscomposed. The position of BL is presented in the succeeding figure. 2.

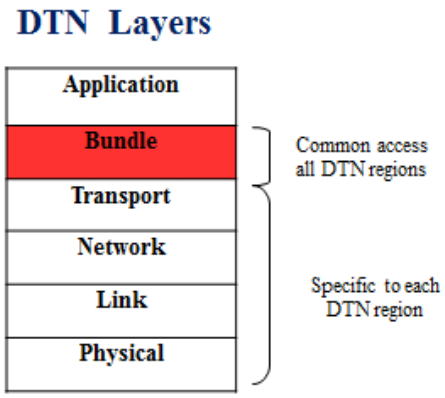

Fig 2: Bundle Layer

A bundle is also known as a message. Informationmay be transferred by one node to additionalwith storing & exchanging complete bundles among nodes. Bundles are 3 things, source node's clientinformation, control data (for example, destinationnode ID, source node ID, TTL & so on)& bundle header. In addition to bundle transfers, custodial transfers are also performed. Custodian node via bundle will hold message up toitsfruitfully transferred towardsthe next node and it will take custody as of that message or TTL of message will expire.

b. Store and Forward Technique

DTNs overcome problems associated with conventional protocols based on NW connectivity constraints, random delays, &asymmetric bidirectional data rates. The store-forward technique is similar to real-life postal service. Each letter must pass bya set of post offices before arriving at destination, where it is processed & forwarded. Now entire message or part of it is continuously forwarded &kept on nodes up to it spreads destination. Succeeding fig (Fig. 3) delivers graphical representation of how a message is transmitted over NW. [13].

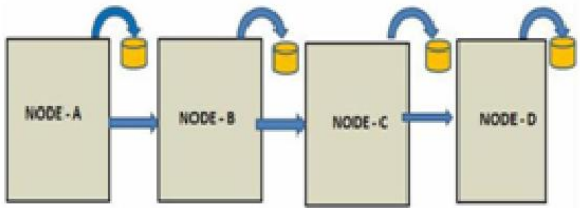

Fig 3: Store and Forward Approach

c. Types of Contacts

The store & forward mechanism be contingent on whether nodes are in contact with each other. Contacts usually fall into one of the varioustypes, primarily built on unpredictability of their presentation features &even ifcertain action is vital to maintain them. Mainkinds of contacts that can be definite[14]:

a. Permanent contacts are always available (that is no connection-initiated steps are required immediately to establish permanent contacts). An 'always-on' Internet connection, like DSL or cable modem connection, should be demonstrative of this class.

b. On-Demand Contacts need certain functionality immediately, but function as permanent contacts until they are finished. An example of an on-demand connection is a dial-up connection (at least, my dialer's point of view; it can be seen as an opportunistic contact; from point of view of dial-up service provider below).

c. Intermittent - Scheduled contact is a contract towardscreating contact viaa specified period of time. An instance of scheduled contact is a satellite orbiting lower Earth. A node list of contacts by satellite may be generated by satellite's viewing time, capabilities & latencies.

d. Intermittent - Opportunistic Contacts Opportunistic

contacts are not arranged, thenmoderatelyexisting themselves unpredictably. Such as an unscheduled aircraft flying aboveand beaconing, publicizing its accessibilityvia communication, would extent an opportunistic contact.

e. Intermittent - Estimated contacts are predefined contact time & length predictions, not based on a particular event, but based on a history of contacts of previously viewed or some other information. If you are confident enough in an approximate contact, routes can be selected based on this data.

Traditional Internet Vs Delay Tolerant Networks (DTN) [14]

1. Intermittent Connection Since the node has limited energy and mobility, DTN disconnects with other nodes frequently and hence it results in a continuous transformation in DTN network architecture and topology. In other words, we can say that the network keeps changing its state and hence there is no way to guarantee E2E connectivity.

2. Low efficiency due to high/ consistent delay we can define end-to-end delay intoDTNs as a sum of complete delay encountered at every hop into complete route. Delay is comprised of waiting time, transmission time, &queuingtime. Hop delay is so high at times due to inherent nature of Delay Tolerant Networks. It keeps changing and makes the other nodes unreachable for a very long time & hence leading towards low data rate. Apart from this, the concept of queuing plays a key role and it keeps on increasing whenever the network becomes unreachable.

3. Limited resources: The capacity of Node and its ability to compute, process, communicate, store the data is weaker than the normal computer due to the cost, power constraints. Due to this restricted storage space, DTN faces a high packet loss rate resulting in low reliability.

4. Limited Lifetime of node In a few circumstances of DTN, node has a very limited lifetime. When there is no power, a node can never guarantee its normal functioning. In other words, the lifetime of node is very important parameter while designing the Delay Tolerant Network architecture and security.

5. Dynamic topology Delay Tolerant Network topology changes dynamically due to various reasons, for example,environmental changes, depletion of energy, NW failure,etc. 6. Poor Security DTN is susceptible to threats such as eavesdropping, routing spoofing, message modification, Denial of Service (DoS), &additional security attacks. 7. Heterogeneous interconnection DTN is coverNWvia transmission of asynchronous message. With introduction of an additional layer, i.e., bundle layer, the network stack, and gateway run more reliably ensuring the transmission of message at the right time.

The remainder of this paper is prearranged as occurs. We review various threats, requirements, and characteristics related to DTN security. Finally, we come up with few research challenges for DTN security one of which would by my research proposal.

4. Applications Of DTN

The store-carry-forward architecture of DTN was initiallycluing that was considered towards fulfil necessitiesof Interplanetary Internet (IPN). DTN is an onlyeasy form of this NA. Hence, primary objectives of DTN were towards surviving composite and stimulating NW environments anddisappointments into hardware along with software maybe protocol failures [15]. Though DTN was initiallyintended to be other of tactical determination. It can& will have extrememore applications into real everyday world. Certain such applications are recordednow:

Space Agencies: International Space Station communication (presently operational via research), interplanetary communication, future space-debris monitoring.

Military and Intelligence: MANETsvia wireless communication and monitoring, rescue&search communication,cargo tracking, unmanned aerial vehicle (UAV) controlandcommunication.

Commercial: Cargo and vehicle tracking (withthe road, rail, sea, &air), in-warehouse asset trackingandin-store, data transactions (for example, reservations, financial), agricultural crop monitoring, processing-plant monitoring, communication intoalternative mines.

Public Service and Safety: disasterandSecurity communication, save&search communication, smart-city event-response, humanitarian relief monitoring, smart electric-power NWs,smart transportation NWs, global airport-traffic control, infrastructure-integrity monitoring, remote learning, control& unmanned aerial vehicle (UAV) communication.

Personal Use: Personal communication & monitoring into urban & wilde rnessareas, fire &-forget text messaging.

Environmental Monitoring: seismological events, soil&stability properties, atmospheric &oceanographic conditions, Animal migration.

Engineering & Scientific Research: NW subject-matter experts, academic research throughstudentsandfaculty.

Multicast Routing Approaches in DTN

In this paper [16], we classify certain recently proposed DTN multicast routing protocols (MCRP) based on the purpose of the routing algorithm suggested in extant study. Implementation of multicast routing protocols into DTN is challenging because ofsporadic nature of DTN as well as the limitations of IoT devices. Multicast in DTN requires efficient data transmission to a group of intended receivers without neglecting the overall performance of the networks.

Given the wide variety of DTN applications in different fields, there is no single DTN multicast solution capable of addressing all the multi-faceted limitations of DTN in different situations. Each proposed solution is focused on addressing particular aspects of a given scenario or addresses specific issues in an application. Different multicast routing approaches are studied to understand the design aspect of multicast algorithms. We discuss some of the significant multicast approaches in DTN that have been proposed recently into this section.

Figure 4 demonstratesthe classification of DTN routing approaches. In this taxonomy, the surveyed multicast DTN routing approaches are grouped into four main concepts: Social-aware, buffer-efficient, energy-aware, and geographical routing strategies under multicast DTN routing approaches [17]. The Unicast DTN routing approaches are outside the scope of this paper but are significant within the comprehensive literature under the DTN umbrella.

5. Literature Review

Sobin et al. [6] classified existing DTN routing protocols according to relay selection strategies in forwarding messages to the destinations. The protocols are grouped into social-based routing and pure opportunistic routing categories and are discussed in terms of source injection (i.e., single-copy or multi-copies schemes) and communication strategies based on the number of receivers (e.g., unicast, multicast, or anycast). Only a few multicast routing protocols, up until 2014, are listed in their paper.

In [18], presented a more comprehensive survey on multicast routing for DTN. The following four categories of multicast routing protocols are discussed: Flooding, tree-based, probabilistic, and intelligent protocols. Multicast messages can be flooded in the network or forwarded along a multicast tree towards reach destinations. Probabilistic approaches select best relays based on the encounter history. Intelligent approaches combine flooding and forwarding techniques for better use of the available resources. A brief performance comparison between different multicast routing

approaches is also provided in the survey.

In [19], discussed the following three models related to multicast DTNs: multiple-copiesmodel, single-node model, & single-copy model. In first, a ferry node that moves around holds message bundles intended for all destinations and delivers them to the destinations upon contact. Several copies model replicates destination set when it encounters a node that satisfies some conditions. In single-copy model, single copy of every destination is conserved, in which destinations may be distributed at several nodes. Here, a copy is forwarded towardsmet nodes whenever there is a higher delivery probability.

In [20], provided an overview of multicast models for DTNs. They distributed multicast in DTNs into following 4types: broadcast-based, Unicast-based, group-based, &tree-based multicast.

[21], presented a general overview of multicast routing schemes in DTN, but the performance evaluation is done using an old algorithm. Lastly, in our previous work [24], a taxonomy of DTN multicast routing strategies is introduced, and we discussed some of the common protocols briefly.

In [22], social network-based protocol uses extended semantic centralization to creating more effective routing decisions. Betweenness centrality is a collective metric that measures how the central node is towards additional nodes into NW.

Due to limitations of DTNs, it calculates centrality between extended ego using local ego social NWs, as presented in Kim et al. (2012) [23] are greatly correlated with intermediate center of entire network. Messages are sent to the center between overweight and/or highly developed meaning that marks more social node.

6. CONCLUSION

DTNs are collected of mobile wireless tools&so do not have persistent connectivity duringNW. Several routing protocols (RPs) have been recommended that try towardsformationvia delay into connection, by store-carryforward technique. Severalnew protocols use social aspects to creating routing veryeffective.

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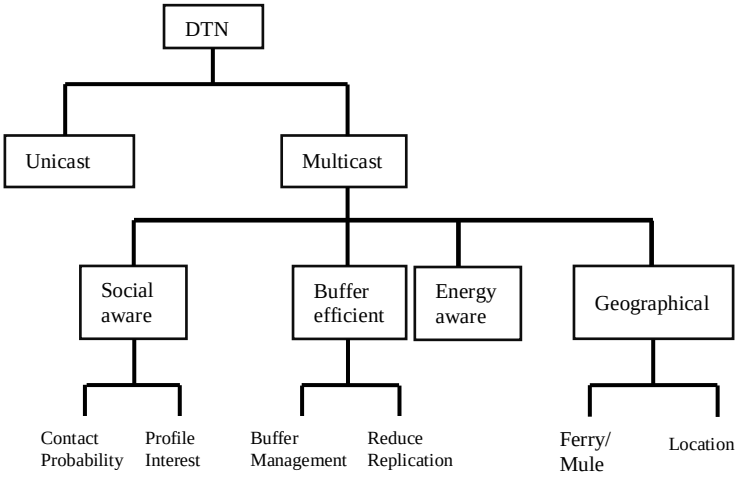

Figure 4: Classification of DTN multicast routing strategies.