Study of Congestion Control Scheme to Improve Communication in DTN : A Survey

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ABSTRACT
The bundles of data packets in DTN are first store and then forward to each node till not reach to destination. The satellite communication in DTN is very effective to send the bundles of messages to destination. The GEO satellite is access by number of stations or nodes for sending as well as receiving data bundles. Although, various copies of messages enhance the message delivery prospect, but concurrently message additional copies of messages occupy finite buffer space and scarce wireless bandwidth. The congestion problem due to limited bandwidth capacity in wireless network is occur and delay and overhead possibility is enhanced. In this survey we highlights the problem of congestion and also solutions with the limitations and applications of DTN. Further, this congestion is annoyed by the buffering of the delivered bundles of data. Since destination based unambiguous acknowledgment packet generation is not reasonable for such networks, therefore nodes have to buffer the delivered messages until their lifetime expires. Such messages significantly contribute in the congestion. To address the congestion happen due to the higher rate and buffering of delivered messages, there are many schemes proposed by various authors discussed in this survey. The nodes in network, contact with each other and exchange information about the delivered messages and update their relative message buffers.

KEYWORDS
DTN, Routing, Congestion, Satellite, Multicasting.

INTRODUCTION
DTN in an emerging research area that takes a different approach to (inter)networking and allows to work in stressed as well as in highly heterogeneous environments. DTN features a number of unique properties which make this concept applicable to challenged networking environments in which traditional communication paradigms would fail or perform rather poorly

- Communication based upon asynchronous messaging
- No reliance on end-to-end path at any point in time
- Store-and-forward delivery as well as physical data carriage
- Deterministic and/or probabilistic routing.

DTN is the end-to-end transmission overlay network that is asynchronous message-oriented. Its architecture is different from the Internet architecture[1]. The DTN introduces the bundle layers between the transport layer and application layer in heterogeneous network [2]. The number of nodes in network are first store then forward data to next node in network. The figure 1 shows the example of DTN communication. Here the Sender S wants to send data to Destination D. The X and Y are the intermediate nodes that first stores and then forward the data to destination by using multitasking as well as unicasting routing procedure.

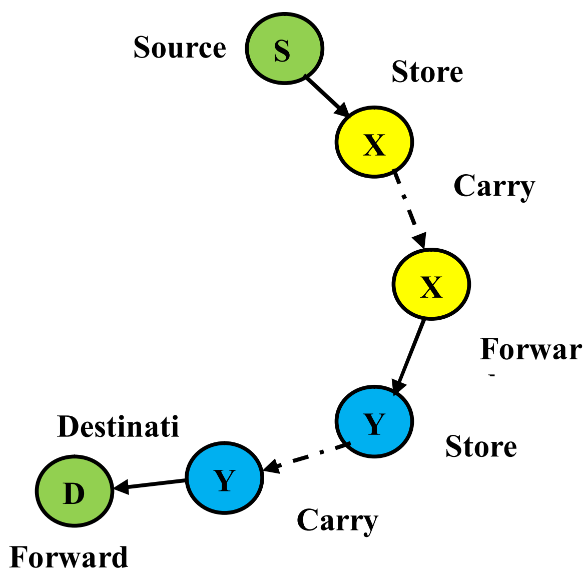

Fig.1 Example of DTN

The bundle layer provides the function of persistent storage due to store and forward mechanism[2]. And to achieve the interoperability among heterogeneous networks, it uses naming mechanism based on URL and message encapsulation mechanism. At very first sight it looks that multiple copies of the messages increases message delivery probability as messages can get an opportunity to reach the destination through multiple paths. But at the same time multiple copies of the messages also create congestion in the network resulting in lower throughput of the network. Even those messages might be dropped due to congestion, which leads to poor delivery ratio and delivery time. Drop of messages is observed as one of the key factor for low delivery ratio in DTNs. Since the messages may get dropped in the network, this can lead to insufficient number of copies of the messages in the network to get a decent delivery ratio[3]. Moreover, message drops affects delivery time as well. The DTNRG has developed an architecture for Delay Tolerant NetwoRkinG that has emerged from the efforts on Interplanetary Internet (IPI) [4]. The basic concepts find their application in sensor networks, interpersonal communication (people or "pocket-switched" networks), and in mobile Internet access.

- Exchange of Bundles hop-by-hop via Bundle Protocol Agents
- Bundle Protocol across different internetworks
- Convergence layer provides mapping to lower layer
- Custody transfer for reliability
- Support for end-to-end semantics at the application layer

Working with DTNs requires reconsidering the way in which application protocols operate since delays and disruptions have to be considered the default. This means that highly interactive application protocols do not operate well in DTN environments, nor does security or reliability mechanisms that require multiple end-to-end handshakes.

II. Applications of DTN

Delay Tolerant Networks has wide spectrum of advantages and applications across terrestrial scenarios ranging from providing connectivity across all environments, Underwater/Acoustic networking, Tactical Military applications and the like [5].

Deep Space Networking

The DINET I, known as Deep Impact Network is an experimental validation of Inter – Planetary Networks, which is the NASA's implementation of Delay Tolerant Networks. NASA (National Aeronautics & Space Administration) has successfully tested the first deep space communication network model using the DTN by transmitting around 200 space images (approx 14 MB) to and from a space craft known as EPOXI – uploaded with DTN software (functioned as a DTN router,) located more than 32 million kilometres from earth. The DTN prioritization has ensured that all high priority images were successfully delivered and no data loss or corruption found anywhere in the network. DINET II is designed to develop and validate additional DTN functionality like extended priority system, contact graph routing management and so on . Along with the European Space Agency, NASA has successfully used DTN protocols to control and drive a small LEGO robot (car) at European Space Operation Centre located at Darmstadt, Germany from the International Space Station (ISS). The Multi – Purpose End – to – End Robotic Operation Network (METERON) is an application of DTN which aims at simulating selected future human exploration scenarios including immersive remote control of a robot by an astronaut in orbit around a target object (such as Mars or Moon).

Tactical Military Applications

With gradual deepening and development of modern military warfare towards Network Centric Warfare (NCW), the performance of Networks and Protocols will play a significant role. The custom network protocols based on end – to – end connectivity is not suited for military communication networks, which is a long/variable delay with high error rates and greatly heterogeneous. Realisation of a robust, intelligent and integrated communication and careful consideration of types of assets that have to be connected will form a solid foundation for Network Centric Warfare. The vast repertoire of military assets include Ground Troops, Armoured – Non armoured vehicles, Naval Platforms, Airborne units, along with Command & Control and Intelligence , Surveillance, Reconnaissance assets that may be fixed or mobile. Moreover the tactical environment is extremely harsh and with marching troops to supersonic tactical aircraft, the huge extent of mobility gap and heterogeneous nature introduces more challenges in traditional protocol design. These conditions results in Intermittent Connectivity with wide ranging communication delays.

Underwater/Acoustic Networking

The underwater acoustic networks are generally formed by acoustically connected ocean – bottom Sensors, autonomous underwater vehicles & surface stations which provide links to or on shore control centre. Underwater Acoustic network is growing rapidly due to its advantages in disaster Prevention, Harbour Portal, Underwater Robotics, Tactical under sea Surveillance, oil or gas pipelines monitoring, Offshore explorations, Pollution monitoring & oceanographic data collection, Salinity Monitoring. But the challenges include slow propagation of acoustic waves, limited bandwidth and very high delays. Multiple unmanned or autonomous underwater vehicles (UUVs, AUVs), equipped with underwater sensors, will also find its application in exploration of natural undersea resources and gathering of scientific data in collaborative monitoring missions. To make these applications viable, there is a need to enable underwater communications among underwater devices. Approaches like Delay Tolerant Network may be a better match to many underwater networks by avoiding end to end retransmission & supporting very sparse & often disconnected networks.

Smartphone Application

The Delay Tolerant Network Approach can be implemented in the Android platform to provide connectivity in environments that lack Efficient Network Infrastructures. The implementation of DTN services and protocol stack on the Android platform is known as "Bytewalla" which allows the use of android phones for the physical transport of data between network nodes in areas where there are no other links available or when the existing links are highly intermittent.

Path and Link Characteristics High Latency, Low Data Rate

If we temporarily disregard processing and queuing delays (we return to queuing delays shortly), the transmission and propagation delays of a link are directly affected by the underlying transmission medium. For some challenged networks, transmission rates may be comparatively small (e.g. about 10kbps for underwater acoustic modems and low-power radios in sensor nodes) and latencies may be comparatively large (to about a second or two). Also, data rates may be largely asymmetric (e.g. remote instruments may have a comparatively high rate downlink channel for relaying telemetry but a small uplink used for device control). In some extreme cases, no return channel at all may be available (e.g. communication with some military assets requiring covert operation such as submarines).

Network Architectures Interoperability Considerations In most challenged networks

The network "architectures" consist primarily of a link and media-access control protocol, and are not designed with interoperability (or very large scale) in mind. The reason for this is that in many cases, merely communicating at all over some links is still an active area for research, and the desire to use such links in an internetwork has not yet become a primary focus. Thus, these networks tend to be comparatively simple and local in scope, and may fail to provide even the baseline abstractions that are well-matched for supporting layered protocol families (such as Internet). Implementations frequently "cut corners" when targeted for deployment on memory and power-limited devices, mixing together data from various system functional blocks into messages that are difficult to disaggregate. They also frequently fail to implement reliability, congestion control, and security.

III. Challenges in DTN

Qualitatively, challenged internetworks are characterized by latency, bandwidth limitations, error probability, node longevity, or path stability that are substantially worse than is typical of today's Internet. We use the Internet's performance as a baseline due to its enormous scale and influence. This section explores the path properties, network architectures and end node resources found across the broad range of challenge networks [6] introduced above and how they influence the design of a network architecture designed to accommodate them.

DISCONNECTION

In many challenged networks, end-to-end disconnection may be more common than connection. Generally speaking, disconnection may be broadly categorized as due to a fault or not. Faults have been studied extensively for conventional networks, and will not be further considered here. Non-faulty disconnections arise most frequently in wireless environments, from primarily two sources: motion and low-duty-cycle system operation. Disconnection due to motion may be highly predictable (e.g. satellite passes, busses that act as data routers, etc) or opportunistic (nodes arrive in communication range due to random walk) and may arise due to motion of either end-nodes, routers, or some other object or signal that obscures the communication. Disconnection due to low-duty-cycle operation is common among low-capability devices (e.g. sensor networks), and is often predictable. Exceptional conditions requiring immediate attention (event responses) can perturb the otherwise periodic low-duty-cycle operation at unpredictable times.

Long Queuing Times

For multi-hop paths in conventional packet networks with statistical multiplexing, the queuing time often dominates the transmission and propagation delays. Queuing time rarely exceeds a second (and is typically much less) and packets are discarded at routers if next-hop neighbors are not instantaneously reachable. In contrast for networks where disconnection may be common, the queuing time could be extremely large by comparison (hours, perhaps days). Furthermore, source-initiated retransmission may be extremely expensive due to the limited number of transmission opportunities. Combined, these issues suggest that messages may need to be stored for potentially long periods of time at (message) routers.

Security
In challenged networks where communication media is frequently oversubscribed, link capacity is a precious resource and access to the "service" of data forwarding should be protected by some authentication and access control mechanism, at least at critical points in the topology. If multiple classes of service (CoS) are available, some mechanism to control access to them is also likely to be required. In such cases, an approach to security which only involves the endpoints is not very attractive, stemming from two issues.

- **First,** end-to-end-only approaches typically require some exchange of challenges or keys, which would be undesirable for high delay and disconnection-prone networks.
- **Secondly,** it is undesirable to carry unwanted traffic all the way to its destination before an authentication and access control check is performed. The later problem has been (and remains) a problem for the Internet, but in that case the issue is significantly worse because of the desire for small end-to-end delays.

IV.Routing Protocols in DTN
DTN routing protocols often attempt to protect communication against unreliable network conditions by creating multiple copies of message to deliver at least a single instance to its destination. Multiple copies can lead to congestion in networks that are typically characterized by scarce resources. To avoid harmful effects of congestion, such as message drops and retransmissions, message copies can be removed once a copy has reached its destination.

Literature Survey
The research work proposed by various authors are discussed in this section. In this paper[10] the congestion control algorithm CCODR algorithm is proposed i.e. based on the rate of change of the satellite history link queue to predict whether the congestion will occur at the time of the next transmission. Each satellite contains a link to the global network of links, but also stores a satellite history link queue rate of change in the form, at a certain interval, the satellite automatically detects the amount of storage in a satellite queue, record the latest two values of the capacity, and then calculate and update the historical queue rate of change and record the time-stamp. When the satellite and other satellites connected, we should exchange team table. After receiving the table, we should select the recent information of all the satellite's to recorded, and discard the other old information. When the selected path does not become congested or the alternative paths are congested, we transmit the packet in the selected path. After receiving the data packet, the satellite first checks whether the buffer is filled.

In this paper proposed algorithm takes this important issue into consideration [11]. Moreover, we select the best candidate for relaying the message (e.g., having strong social ties with the destination or the community of destination) with considering packet level property

TTL. If probability of meeting any member of destination community in the remained TTL is very low, that node is not a good candidate and sending the message to the node is waste of resources. When a selfish node realizes that the message destination is a member of a community it belongs to, it lowers the energy threshold based on its social tie with the destination. However, when the energy level reaches the minimum energy threshold, the individual selfishness takes role and no relay contribution is performed. Also, we consider the buffer congestion of the designated node. In DTNs, nodes might carry messages for a long time, but nodes have limited buffer space, therefore, avoiding this aspect will lead to more packet drops at the relay node, and less delivery ratio

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In this paper, they propose a replication controlled forwarding scheme for Opportunistic Networks, termed Replication Probability-based Routing Scheme (RPRS) [12]. This proposed forwarding scheme integrates an replication probability, allowing to keep an optimal replication count for a message in the network, which maximizes the message delivery ratio, but avoid congesting the network. The probability function uses the message's hop-count, the node's local replication counter, both characterizing the message's overhead in the network, as well as the buffer time as storage and transmutation costs for the integrated drop policy. The replication and dropping criteria of RPRS are calculated based on local message information as indication of the minimum single message delivery probability. The idea of RPRS relies on the assumption that the best delivery ratio is achieved when the rate of forwarding is adapted to the dropping rate, thus the buffer stay optimally filled. The forwarding rate is be adapted through a replication probability to control the number of messages induced and spread in the network, which may then congest the buffers and be dropped. Therefore, RPRS considers the message's hop count and replication count for both forwarding and dropping as invert functions, as we suggest that the forwarding and dropping are complement rates.

In this paper proposed a new efficient algorithm for avoiding congestion[13]. For this purpose, the controller monitor the network stats. When a new flow arrives, it routes the flow to a path which has enough capacity for accepting new flows without being congested. If the utilization of any switch is more than certain point, controller computes how much load must be shifted to another path. The controller selects flows to be rerouted to shortest backup paths which will not be congested by adding these flows. By doing this, the load on the congested ports of over utilized switch are reduced. The rerouting continues until the extra load is shifted to another path and the congestion problem is handled efficiently.

In this paper proposed a novel message acknowledgment mechanism that identifies and removes copies of the delivered messages from node buffers[14]. The proposed approach is independent of the routing protocol. In this approach, each node maintains the information about the messages which have been directly forwarded (i.e. through direct contact) to the destination.

Nodes exchange this information when they come into the contact with each other and update their respective buffers with the information of the delivered messages. In this manner, the information of the delivered messages spread across the network over a period of time. This information enables a node to remove copies of such messages from the node buffers well before their TTL expire. The removal of delivered messages also stops their further replication hence it saves buffer space. Unlike traditional acknowledgment method, flooding is not used to propagate the acknowledgment packet in the proposed approach.

In this paper proposed a novel buffer management and scheduling policy and compared it traditional buffer management schemes[15]. The proposed method uses partial network knowledge so that it is most suitable DTN characteristics. Extensive simulations on data sets show that the traditional buffer management policies fail and are sub-optimal compared to the proposed policy. The unavailability of any sort of global information to DTN nodes regarding the network, e.g, the topology, contact duration, etc. make relay selection an extremely challenging task. There are mainly two solutions adopted to overcome this challenge. The first solution is to predict the future contacts, but it requires a lot of information exchange between nodes and heavy computations which can drain the limited power in DTN nodes. In addition to smart relay selection, effective buffer management and effective utilization of limited encounter duration between nodes are two major factors that affect the performance of DTN routing scheme.

Expected Outcome

The better congestion control mechanism is routing protocol independent as well as it can be easily integrated with other congestion control mechanisms. The scheme is mobility models, routing protocols and congestion control schemes, signify the improvement in message delivery ratio for the proposed mechanism. In this work we will proposed a simple mechanism to avoid congestion in DTN networks that operates proactively before congestion induced message drops arises. The proposed mechanism locally advertises a node's buffer occupancy to adjacent nodes based upon which the latter can take local decisions and avoid sending messages to nodes whose buffers are nearly full. In proposed work GEO satellite communication scenario is used for communication. The congestion control buffer management scheme is proposed to control the jamming of data and improve bandwidth utilization. The proposed congestion control mechanism enables to maximize resource utilization when resources are available. When resources are scarce, however, the mechanism prevents congestion from occurring by postponing message transfers until sufficient resources are available. As our congestion control mechanism performs load reallocation inside the network, there is no need to return explicit feedback to the message source.

CONCLUSION

The DTN network is very efficient for satellite communication because of bundles of data are possible to carry forward to destination. The GEO satellite are covers the almost area and the maximum number of stations are receive or forward bundles of messages. In this paper, we discuss the number of applications, limitations of DTN and congestion control techniques that avoiding link overutilization in DTN environment. This constraint on buffer size degrades the performance of routing protocols in terms of increasing the delivery delay and decreasing the delivery ratio. When the average transmission rate of a port exceeds the certain point then the possibility of congestion is enhanced. The various previous schemes are concentrate on proper buffer management and try to reduce the flows possible for resolving the congestion and reroutes them to the best new paths. Previous mechanism has short running time and is fast and efficient but it is possible to develop a new mechanism to provides more better results . The best path for data delivery is the shortest path that can accept the load of the flow being rerouted. To achieve better performance, routing schemes in DTN have to also effectively utilize of the limited buffer space. Therefore, message flow as well bandwidth utilization in a node's buffer is required, so that messages which optimize the performance must be transferred efficiently. Thus, there is a requirement of a routing scheme which can be applied to reduces the congestion possibility.

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