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Research Article

An Efficient Data Delivery Using Content Aware Service Discovery in Wireless Networks

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Abstract: The increasing consumer demand for access to communication services, everywhere and anytime, accelerates technical development to the incorporation of different wireless access technologies. Wireless technologies with the standards of anywhere and anytime present the users of being all the time attached to the network. A multiplicity of present and future network applications require low latency communication. The extremely active environment of infrastructure-less ad-hoc networks poses new problems during service discovery. It is apparent that in present and upcoming environments, dynamic content information from network side entities is tremendously required for the vertical handoff decision procedures. In order to provide absolute connectivity between the new wireless access technologies, the existing context-aware information server store, manage and deliver real-time dynamic information retrieved from both the network and the terminal side entities. It is still necessary to improve the bandwidth and minimize the error rate. To overcome the issues, the study presents Content Aware Service Discovery (CASD) which drops less important message fragments whenever the wireless network is congested with nodes and improves the end-to-end data delivery among information flows. This study presents the integration of prioritize message fragment dropping during bottlenecks and targets end-to-end data delivery integrity between users with improved bandwidth rate. The CASD framework provides clear analysis on the experimental factors such as improved bandwidth rate, increasing the end-to-end data delivery ratio and average utilization while providing services in wireless network when compared to the state-of-the-art.

Keywords: Content aware service discovery, context aware information server, data delivery scheme, wireless technologies

INTRODUCTION

The recent progress in broadcasting the information, exhibiting the images and abundance storage capability in the Internet and end-user devices have ushered an unprecedented growth of traffic over the wireless network. The user generated content and social networking is driving up this data traffic demand on the network every day. In contrast to the web and traffic generated during e-mail, the abundance of data is characterized by its huge requirement of bandwidth and metrics related to the Quality-of-Service (QoS) that results in higher delay. This causes different levels of network engineering different from data and voice dominated traffic.

Increasingly, a number of wireless sensors with dissimilar capabilities are being compactly deployed on users' environments or in their personal areas. In order to address the substantial coverage and attain the increasing accuracy level, personal sensor networks results in increasing size, complexity and diversity. In such environments, the mobile tool plays a significant role as a full-fledged, integrated personal service agent, incorporating personal sensor networks and running several applications concurrently (Kang *et al*., 2010). Hou *et al*. (2012), the problem of identifying the maximum available bandwidth path, that remains a significant issue in providing quality-of-service in WMNs is discussed but at the cost of available bandwidth. If the bandwidth considerations varied, the quality-of-service provided also varied accordingly.

A wireless network is a network in which nodes communicate with other nodes with the help of unregulated short range wireless technologies. Service discovery, particularly, is critical in the design of a wireless network where nodes do not have any prior knowledge of the obtainable resources in the network. In addition to the random mobility of nodes, information searching becomes an incredibly demanding task in wireless network. As nodes travel roughly through the network, they repeatedly results in different transient connections with other peers along

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the way and exchange necessary messages with their neighbors.

The selfish replica allocation presents a selfish node detection algorithm that considers partial selfishness and provides replica allocation techniques to suitably cope with selfish replica allocation (Choi *et al*., 2012). Mobile body sensor networks with autonomous wireless sensor networks allow a permanent and context aware health monitoring for patients for their routine life scenarios with an unparalleled precision and flexibility of sensing (Chiti *et al*., 2009). A Delay Tolerant Network (DTN) is a system where connectivity in the middle of mobile nodes was not always guaranteed with the random movement of mobile nodes. In order to assure message delivery even in the existence of network partitions, a DTN defined specified routing mechanisms to forward message (Dini and Duca, 2012).

The superior feature, predictable with higher mobility, brings many challenges to the pervasive computing community. For better understanding of the challenges with the existing approaches, a classification and assessment framework provided with the four dimensions of design concerns in application migration, namely temporal, spatial, entity and other concerns (Yu *et al*., 2013) when compared to the conventional framework. Framework to augment user context awareness with the social network domain exploit the open stack to extract a user's PSN from heterogeneous sources of Internet (Rahman *et al*., 2011). But context awareness failed to address the issues related to the dynamically selected services.

Context aware domain purely based on the logical analysis on the corresponding text and services may not be sufficient. But the context aware domain has to be enriched with the qualitative demonstration of context under data by means of Fuzzy Logic in order to routinely recognize the context and as a result to identify the appropriate set of healthcare services among the available ones (Fenza *et al*., 2012). With the increasing use of the Semantic Web service technologies, a lot of public and private registries demand and offer semantic web services. The design, definition and evaluation of a knowledge-based system use Common KADS (CKADS) methodology to formally represent contextual information for the Appear platform (Sanchez-Pi *et al*., 2012). This study (Yang *et al*., 2012) addressed the problem of data packet delivery under the constraints of highly dynamic mobile ad hoc networks and the results were performed in a reliable and timely manner.

Data Routing for In-Network Aggregation, called DRINA addressed certain solution aspects such as a condensed number of messages for setting up a routing tree, maximized number of overlapping routes, high aggregation rate and reliable data aggregation and broadcast. In order to address the spatial and temporal correlation between the data being aggregated, construction of a routing tree was presented in Villas *et al*. (2013) that meet the specific application needs. Incel *et al*. (2012), the author addressed the method for collecting information from wireless network when organized as a tree using a TDMA protocol but with the fixed amount of data. The scenarios with variable amount of data remained unaddressed.

Novel context monitoring approach offer competent processing and sensor control mechanisms. At the current rate of development, personal sensor networks are probably integrated up to hundreds of sensors of different types (Kang *et al*., 2010). Radio tomography is of highly used in blocked areas for tracking moving objects. MIMO radar measures the dispersion rate of the transmitted signal based on the object of interest with radio tomography methods based on the measurements of transmission through a medium. But the integration of the two modalities was not performed (Wilson and Patwari, 2011). Liu and Cao (2011), maximization of the coverage during a specific network lifetime is studied where the objective is to maximize the spatial temporal coverage by scheduling sensors' activity after they have been deployed but at the rate of time complexity.

There also occurs greater level of challenges on the other hand from using these types of mobile sinks to accumulate the different sensor data for different samples. One disadvantage lies in controlling the development that sensors use to respond to a request for sensor data from a mobile sink. Moreover as the sensor nodes have a considerably slighter transmission range than the mobile objects, sensor nodes highly rely on multi hop transmission of sensor data when they respond to the single-hop reception of the mobile object's sampling signal. In order to have control over the broadcasts directions, a new method called as the Band-based Directional Broadcast (Li *et al*., 2011) was introduced that initiate from the sensor nodes but cannot seek additional sensor nodes for data aggregation in combination with band scheduling. Three alternative control algorithms (Abrantes *et al*., 2011) were designed in transmission media with variable or unknown capacity with low queuing delay and stable throughput.

Mounting customer requirements for access to communication services anywhere and anytime accelerates highly with the technological development towards the integration of various wireless access technologies. The combination of several wireless network techniques is of high significant so that it can result in the faultless interoperability, deployment and integration between these heterogeneous technologies and, as a result the application of Vertical Hand Over (VHO) techniques were required (Márquez-Barja *et al*., 2011; Yan *et al*., 2010) extensively. Handover involves with the development of or initiating a user's active sessions when a mobile terminal transform is connected to the access network, for example, a base station or an access point. A Trajectory-based Statistical Forwarding (TSF) scheme (Jeong *et al*., 2012) was presented for multi-hop data delivery from the access points in vehicular ad hoc networks that minimized the packet delivery delay. But the cost incurred during the design of TSF scheme was high.

In proposed work, the Content Aware Service Discovery (CASD) framework integrates both the temporal scalability of the source coding at the application layer to the structure control at the transport layer for efficient data delivery scheme. For multi user transferring the data using multi path networks a small random movement is performed in CASD framework. The existing context aware information server (Neves *et al*., 2011) is limited to bandwidth and results in higher error rate. CASD framework makes users drop less important frames when the network is blocked and as a result higher level of bandwidth efficiency is provided when the network is congested.

Structural designing of CASD data delivery scheme illustrates, that the end user performs lesser dropping of packets with more bandwidth efficiency of links. The end-to-end path of a user consists of several links that identifies the data blockage during the transmission. Each nodes are shared by different users, decides a general threshold of dropping packets for its users, while links are heterogeneous, on its end-to-end path. User observes the links, each with a different threshold of dropping frames and the distortion level of dropping frames for a user are be decided by the exacting one. CASD framework presents an algorithm with a provable and small number of iterations for users and links to cooperate, to achieve the higher level of integrity.

MATERIALS AND METHODS

The main contribution of content aware service discovery framework is to develop multi-hop multiuser efficient data delivery in wireless networks. The proposed work with the joint transformation of data source and measuring network resources integrates the temporal scalability of the data source coding designed at the application layer to the congestion control designed at the transport layer. The CASD framework makes users drop less important message fragments when the network is congested.

The design consideration of CASD framework is provided in such a way that it targets only the temporal scalability of data traffic as more advanced scalability features that includes structure size and SNR scalability are widely adopted. During the time of congestion over the Internet links, certain blockage in the data stream (message fragment) is dropped with limited loss in data quality. The goal of CASD framework is to count the loss and have a metric that permit multiple data sessions to perform quality fair streaming. Scalability is

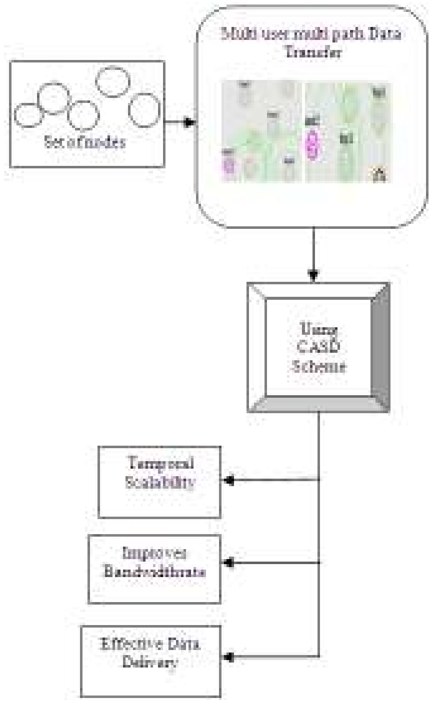

Fig. 1: Architecture diagram of CASD data delivery scheme

achieved using temporal, structure size and SNR quality of data with the help of CASD framework.

The architecture diagram of CASD data delivery scheme is illustrated in Fig. 1 that drops the less important message fragments with more bandwidth efficiency than the method of links dropping blockage of message fragments when the network is congested. Multiple users transfer data using multiple paths for effective packet transmission. Based on these design considerations, an algorithm is designed in subsection D with a provable and minimum number of iterations for users and links to cooperate, to achieve the min-max distortion integrity.

The following subsections describe in brief about the design considerations included for max-min service discovery followed by min-max service discovery.

Preliminaries of max-min service discovery: Let us consider a network with ‘R’ rational links, each links with a stable amount of bits per second (bps), with a source-destination pairs ‘SD’, each transmitting at a rate of bps. Each source node in the network S discharges one flow, with the help of a stable amount of links ‘L’ and has a service function $S_p = (y_p)$. Each link ‘L’ is then shared using a set of sources ‘S’. The objective of CASD with Max-Min Service Discovery now lies in the maximization of network resources or Network Resource Maximization (NRM).

The basic consideration of NRM lies in the maximization of the total service over the source rates (i.e., total available service to the amount of source ready to sent the data) subject to horizontal movement inhibition, $\sum_{p\in P(c)} y_p \leq D_c$ for every link. With the basic consideration of Network Resource Maximization, the enhanced NRM provides with an integrated solution that iterates on control of the source rate (i.e., the arrival of source) and adaptation to the link. The objective of the conventional NRM is to achieve efficiency in service, but efficiency doesn't mean integrity, which is very important in resource allocation in wireless network. As a result the framework of CASD is designed keeping in mind the Max-Min service discovery which maximizes the minimum network resources subject to link capacity constraints as given in (1) and (2):

$$\text{MaxMin}S_p = (y_p) \quad (1)$$

$$\text{Subject to Constraints } \sum_{p\epsilon p(c)} yp \leq D_c, x \geq 0 \quad (2)$$

The main emphasis of CASD concentrates on the data adaptation and traffic shaping or adaptation to the link during the blockage of drop mechanisms. For a successful data session to be achieved, the data adaptation and traffic shaping or adaptation to the link are achieved through structure pruning, dropping blockage with structure indices SI = {α1, α2, α….αn} whenever there occurs congestion. The resulting data traffic rate reduction using CASD is characterized in (3) and the distortion is characterized in (4):

$$Q\,(SI) = \sum_{k=1}^{m} Q\,(g_{\alpha k}) \quad (3)$$

where, $Q(g_{\alpha k})$ is the rate of structure and resulted distortion is associated with set SI are characterized as:

$$E\,(SI) = (g_k, g_k^{'}) \quad (4)$$

For a given data segment with 'n' structure, there are totally $\sum_{k=1}^{n} \binom{n}{k}$ different combinations of blockage drop options (with message fragments). As because of certain structure have certain amount of dependency level during decoding then the structure is pruned. As a result, it defines the importance of a structure g_k or the service of a structure as the resulting distortion summation if this structure is lost, considering the dependency during coding.

The CASD framework instead of optimizing all the combinations of structure, the drop sequences are considered to approximate its rate-distortion curve. The individual structure is sorted according to its importance, followed by the resulting distortion sum if it is lost. Followed by this during the start of relational changes, the process starts with an empty blockage drop set and keep adding structure to SI in the increasing order of its distortion $E(SI(^{g_i}))$. Then the iterative process of adaptation of traffic to the link is referring to (5) and (6):

$$SI^0 = \emptyset \quad (5)$$

$$SI^i = SI^{i-1} U \{SI(f_j = argmin\, E(SI(^{g_i})))\} \quad (6)$$

Preliminaries of min-max service discovery: For aggregate NRM, the dual decomposition (i.e., data adaptation and traffic control) gives it a distributed solution that allows source node to adapt its rate based on the rate of congestion at each links, in an iterative fashion. But the design consideration of CASD look at the formulation of fair level of distortion, i.e., to give equal priority to all the nodes in the wireless network with the same amount of QoS as possible, given the network resource constraint. The first constraint states that the flow should not exceed the capacity of link whereas the second constraint states that during each flow, the set of the blockage dropped in the succeeding hop should contain such set at the current hop in the wireless networks. In a similar manner instead of optimization over all combination of data adaptation, the framework of CASD follows min-max service discovery. The basic principle of min-max service discovery is to maximize the minimum importance level of links among all flows, where the structure with higher importance are pruned first during each flow whereas the remaining total flow after pruning of each flow over link should be not be greater than the total capacity.

Hence, the problem attains solutions to identify the threshold of dropping blockage during for each flow, where the blockage with less importance than the threshold is pruned, such that the link capacities are not exceeded after each such pruning. In this way, it gives us the solution with the distortion level based on the threshold.

Structure dropping scheme: Once the service discovery using min-max and max-min are identified the structure dropping scheme is performed. The strategy involved in the design of structure dropping using CASD framework is to send additional information indicating the type of service and length of each structure to the link. Then the relations or links and users decide the value of the optimal threshold of dropping frames in a cooperative manner for each user, where the structure with less importance than the threshold is dropped. The users define the utility of each structure based on the distortion induced if the structure is lost and also taking into account the prediction structures during the blockage.

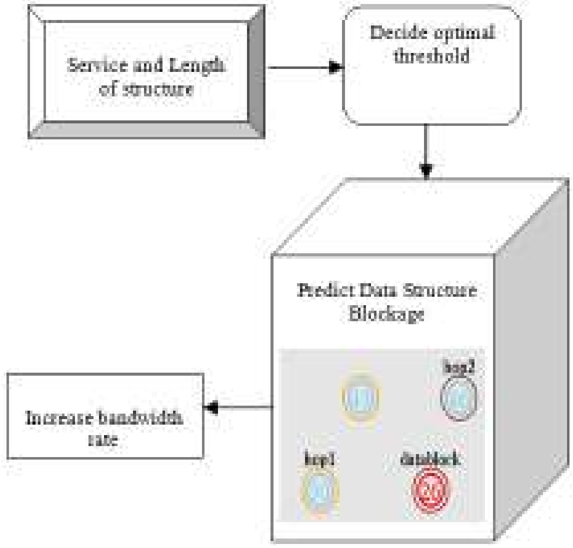

Fig. 2: Structure of blockage dropping

In case when only one relation is shared by multiple users then the relation derives a common threshold of dropping message fragment for every user in a such a way that the total amount of traffic through the relation is less than the relation capacity. The same threshold of dropping message fragment makes users experience a min-max service discovery. In this manner, each user gets a distortion that is as low as possible and the distortions of the user who experience bottleneck achieve the min-max service discovery.

Figure 2 describes the blockage structure. With the help of the type of service and length of the structure, the data blockage is identified between the nodes with the optimal threshold value. Followed by this the data structure blockage is prediction to derive the max-min or min-max service discovery in order to increase the bandwidth rate.

Algorithm for CASD data delivery scheme: The CASD algorithm finds the optimal threshold of dropping structure for each user.

```
Begin
Initialize relation for the structure boundary

Do Threshold computation at relationship:
If relation prepared, relation reduces its capacity
    by the rate determined by users
Relation calculates a common threshold for the
    remaining users within the remaining capacity
If relation current link set then the relation sets all
    its users
End If
End If
Performs threshold updating
If User = 0
User set the structure dropping level over all the
    relations on its path.
Effective Delivery of data
End If
End
```

Using the CASD algorithm, each relation finds an equal adaptation level to its users for effective bandwidth in wireless network. Each user sets its structure dropping level as the most stringent one over all the relations on its path. Afterwards, if the link is bottlenecked based on the users updated dropping level, the relation marks itself and the user performs with the other relations efficient bandwidth, followed by the iteration reaching to the next round. The algorithm iterates among relations and then flows, until the thresholds cannot be decreased further. The criterion to decide whether a relation is bottlenecked or not is dependent on the following factors: if the relation is fully loaded or if the dropping level is zero or, equivalently, if the current threshold would not change in the next iteration.

RESULTS AND DISCUSSION

The simulation for CASD framework is based on the network package successively using the NS2 simulator. The simulation scenarios used 60 sensor nodes and two Access Point (AP). The event node represents a moving object, which is being tracked by the sensor nodes. The nodes use the DSR as the routing protocol. The movement of all nodes except the base station was randomly generated over a 900×900 m field, with a maximum speed of 2 m/sec and an average pause of 0.01 msec. Each simulation was run over a time period depends on the processing time. In order to evaluate the effectiveness of dropping during blockage, identify the blockage during transmission and targets end-to-end users with the improved bandwidth rate.

Experiment is conducted against the generated recommendations using the data files over the existing context aware information server. Bandwidth rate is defined as the rate of data transfer through the nodes from source to destination (i.e.,) access point using Content Aware Service Discovery (CASD) and Context aware information server. It is measured in terms of bits per second (bps). Delivery ratio is the measure of effective data delivery using CASD without any loss or blockage of data (i.e., message fragments) during the transmission. It is measured in terms of percentage (%).

The existing context aware information server (Neves *et al*., 2011) is able to store, manage and deliver real-time dynamic information but with the help of limited bandwidth and the higher data blocks arises. Data blocks as shown in Fig. 3 arises in node 14, 17, 26 and 48, respectively. User 1 and 2 transfer the data packets with higher packet loss.

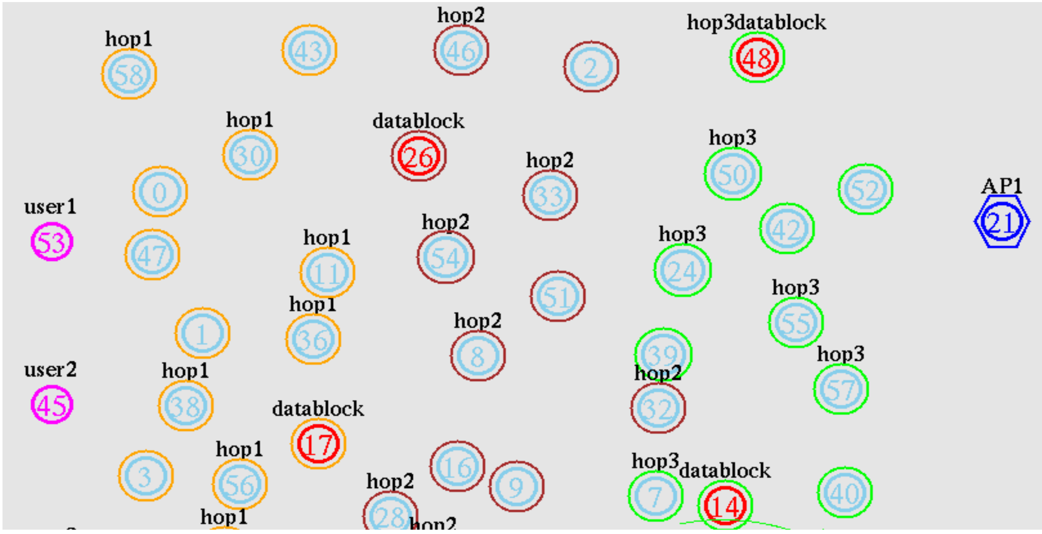

Fig. 3: Existing context aware information server method with data blocks

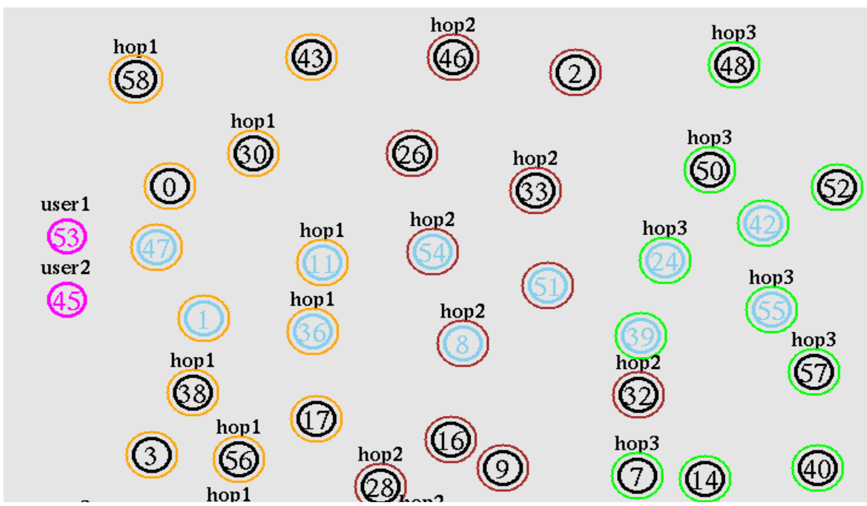

Fig. 4: Content Aware Service Discovery (CASD)

Table 1: Tabulation of bandwidth rate

	Bandwidth rate (bps)	
No. of nodes	Existing context aware information server	CASD framework
100	36	42
200	48	61
300	70	93
400	86	105
500	102	128
600	123	155

The data delivery using Content Aware Service Discovery (CASD) framework attains the blockage-free packet transfer. Users transfer the data effectively in an intermittent manner through hop counts to reach the destination point.

The proposed delivery ratio in Fig. 4 is 12.25% higher when compared with the existing context aware information server method. Experimental graph is shown in Fig. 5. Average energy utilization is defined as the amount of energy consumed to transfer the information from source node to destination point in wireless network. It is measured in terms of joules (J):

$$\text{Energy consumption} = Ts^2$$

where,
T = Total no. of packets
s = The speed of transferring effect of data

The Table 1 describes the bandwidth rate of the CASD against Context aware information server.

The bandwidth rate is measured using CASD and context aware information server based on the number of sensor nodes in wireless network.

Figure 6 describes the measurement of bandwidth rate in wireless network. Compared to the existing context aware information server, the proposed data

Table 2: Tabulation of energy consumption

	Energy consumption (J)	
No. of packets	Existing context aware information server	CASD framework
5	18	12
10	26	20
15	35	26
20	42	31
25	49	38
30	56	45
35	60	48

Table 3: Tabulation of delivery ratio

	Delivery ratio (%)	
No. of iterations	Existing context aware information server	CASD framework
1	65	80
2	68	81
3	69	82
4	70	82
5	71	83
6	73	85
7	75	85
8	77	88

delivery scheme, CASD achieved better bandwidth efficiency rate. This is because the CASD data source discharges one flow, using a fixed set of links and has a service function $S_p = (y_p)$. Next, each relation is shared by a set of sources to increase the bandwidth rate using the Network Resource Maximization (NRM). NRM using the CASD framework increases the bandwidth rate from 15-25% when compared with the Context aware information server.

The average utilization of energy required to transmit the data between the nodes is measured based on the total number of nodes in the network environment. The average utilization of energy is tabulated in Table 2. The value of the proposed CASD scheme is compared with the existing Context aware information server.

Figure 7 describes the measure of energy consumption based on the number of packets in the wireless network. Compared to the existing Context aware information server, the proposed CASD framework for efficient data delivery consumes lesser energy during packet transmission in wireless network. The dual decomposition solutions of the NRM give average energy utilization rate that iterates on data source rate control and link adaptation. The objective of NSM is to achieve energy efficiency in wireless network service with the help of CASD framework that instead of optimizing all the combinations of structure, the drop sequences are considered to approximate its rate-distortion curve by minimizing the energy consumption.

As a result of this, significantly the energy consumption is reduced by reducing the data blockage. The energy consumption using the proposed CASD framework performed better packet transmission with

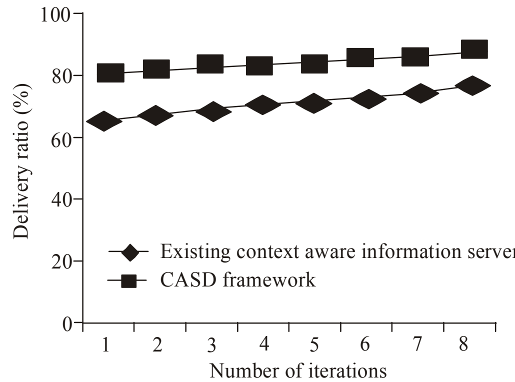

Fig. 5: Measure of delivery ratio

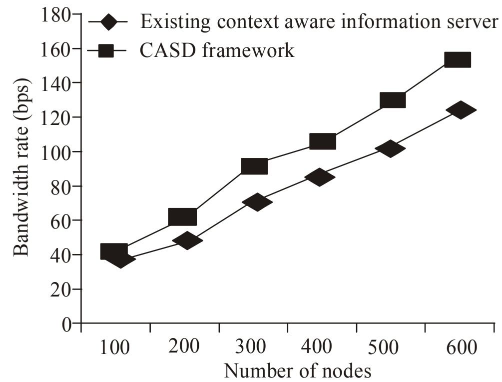

Fig. 6: Measure of bandwidth rate

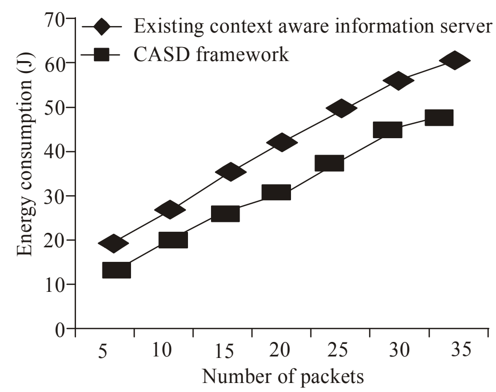

Fig. 7: Measure of energy consumption

minimizing the consumption of energy from 25-50% when compared to the existing context aware information server in wireless networks.

Table 3 describes the data delivery ratio values based on the rate at which the data are delivered without any dropping of packets from the source to destination using CASD framework. The value of the proposed CASD data delivery scheme is compared with the existing context aware information server in wireless network.

Figure 5 describes the delivery ratio of the Content Aware Service Discovery (CASD) framework. The iteration process for the measurement of delivery ratio varies from 1 to 8. The iteration starts from $^{\wedge 0} = \emptyset$ to $^{\wedge 7} = \emptyset$. The distortion is regarded as the percentage of dropped packet reduced and then the delivery ratio is improved from 11-19% using CASD framework when compared with the context aware information server (Neves *et al*., 2011). This is because with the help of the type of service and length of the structure, the CASD framework for efficient data delivery identifies the data blockage between the nodes using an optimal threshold value. As a result, if finally made the transmission of packets easy for the sensor nodes in the network than the existing system. Error rate is negligible using CASD framework.

Finally, it is being observed that the Content Aware Service Discovery (CASD) framework reduces the information dropping by blockage or message fragments and targets end-to-end users with the improved bandwidth rate, minimal energy consumption and higher delivery rate. The proposed scheme leads to the efficient bandwidth rate of links by reducing blockage when the network is congested.

CONCLUSION

A framework of Content Aware Service Discovery (CASD) is presented that drops less important message fragments whenever the wireless network is congested and improved the end-to-end data delivery between information flows with the help of min-max and max-min service discovery. This study integrated both the temporal scalability of the source coding at the application layer and the structure control at the transport layer for efficient data delivery and provided end-to-end data delivery integrity between users with improved bandwidth rate. It provides the possibility to obtain a fair quality-of-service when they share the resources. The proposed scheme leads to efficient bandwidth rate of links reducing blockage when the network is congested. The users drop (i.e., message fragments) is based on computed thresholds, where the thresholds are obtained by the cooperation's between the users and links. Each nodes is shared by different users, decides a general threshold of dropping packets for its users, while links are heterogeneous, on its end-to-end path. The experimental result of CASD data delivery scheme is evaluated to attain an improved bandwidth rate, increasing the average utilization of energy and 12.25% increases the delivery ratio while providing the services in wireless network. The threshold value of dropping packet is computed based on the time varying period using CASD framework.

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