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Qos Analysis Of Data Communication Using NS2

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Abstract: Performance of recent multimedia transmission over wireless communication systems without affecting its QoS, is a major challenge in recent mobile node communication. Cognitive radio network fulfils this requisite. Spectrum inefficiency problems due to limited spectrum resource allocation are overcome by optimization of spectrum utilization with suitable algorithms. In this paper, the importance of multimedia transmission with required QoS for the secondary users has been justified. The QoS parameters are analysed for the mobile nodes over a wireless network with suitable routing algorithm is considered. The discussions includes providing an efficient QoS support for multimedia transmission with handoff strategies and efficient computation of the performance parameters with suitable simulator. The NS2 approach and its importance in determining the network parameters are also discussed in detail.

Key words: Wireless networks · Multimedia Communication · Handoff · QoS Analysis · NS2 simulator

INTRODUCTION

A mobile node is an Internet-connected device whose location and point of attachment to the Internet may frequently be changed. The demands of mobile multimedia communications have dramatically increased in recent years with the emergence of various mobile devices, e.g., smart phones and tablets. For example, it is now quite common for mobile users to share photo and videos with others. These mobile multimedia applications impose new requirements on the wireless networks.

A specified transmission rate should be achieved to guarantee a certain level of QoS [1]. But nowadays the technologies does not support multimedia applications with guaranteed QoS. CR Etiquette evolved as a solution to these problems to assure reliable QoS improvement with multimedia transmission. It involves spectrum renting, assured backoff, criteria assurance, order-wire network (adhoc signalling). No reliable technology have been supported for guaranteeing the spectrum to the primary users.

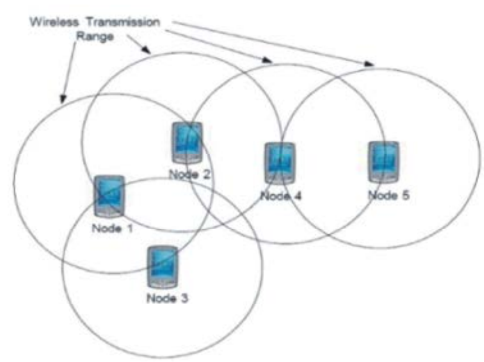

Fig. 1: Simple Wireless Communication Model

Cognitive Radio Networks: The demand for wireless spectrum has increased rapidly in recent years due to the emergence of a variety of applications, such as wireless Internet browsing, file downloading, streaming, etc. Cognitive radio networks [2] have the capability of achieving large spectrum efficiencies by enabling *interactive* wireless users to *sense* and *learn* the surrounding environment and correspondingly *adapt* their transmission strategies.

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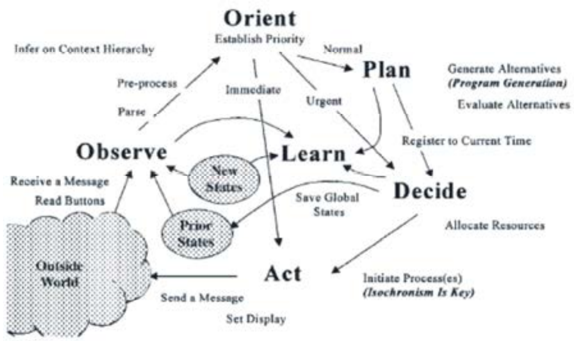

Fig. 2: The Cognition Cycle

Importance of CRN: Prior research such as focus on centralized solutions for the resource management problem in cognitive radio networks [2]. Hence, it is important to implement decentralized solutions for dynamic channel selection by relying on the wireless multimedia users' capabilities to sense and adapt their frequency channel selections.

The vital objective of the cognitive radio is to achieve the best accessible spectrum through cognitive capability [3] and reconfigurability. In other words, CR is also defined as awareness, intelligence, learning, adaptivity, reliability and efficiency.

Spectrum management basically means the capturing of the best available spectrum to meet user communication requirements such as spectrum sensing, spectrum analysis and spectrum decision.

Challenges in Multimedia Communication: Wireless multimedia applications require significant bandwidth, some of which will be provided by third-generation (3G) services. Even with substantial investment in 3G infrastructure, the radio spectrum allocated to 3G will be limited. Present commercial wireless architectures are network centric and constrained by spectrum allocations.

Cognitive radio offers a mechanism for the flexible pooling of radio spectrum using a new class of protocols called formal radio etiquettes. This approach could expand the bandwidth available for conventional uses (e.g., police, fire and rescue) and extend the spatial coverage of 3G in a novel way.

Such a pooled spectrum strategy could accomplish dynamically with distributed control technology what could not be contemplated with today's centralized allocation-based control the cost-effective efficient pooling of formerly scarce mobile radio spectrum for fair and equitable use when and where needed.

Table 1: Multimedia Implications of pooled spectrum

Feature	Implications
Sharing of narrowband channels	Reduces costs of new uplink channels for Internet browsing and other multimedia services
Spectrum block rentals (e.g., 1 - 5 MHz)	New spectrum for multimedia downlinks
Increased infrastructure density	Greater availability of affordable multimedia
Short term spectrum rentals	Accommodate peak demand; Introduce new services incrementally

Spectrum pooling both increases the number of sites and integrates the multi-mode spectrum so that the quantities needed for multimedia wireless applications are more affordable.

Handoff Efficiency in Wireless Networks: Wireless mobile networks are being evolved and integrated into IP based core network, so it is necessary to provide sufficient QoS (Quality of Service) mechanism to provide enhanced user's satisfaction.

One fundamental issue for spectrum handoff modeling in CR networks is the multiple interruptions from the primary users during each secondary user's connection. The issue of multiple interruptions results in the requirement of designing the target channel pool for a series of spectrum handoffs in a secondary connection [1].

Spectrum handoff mechanisms can be generally categorized into two kinds according to the decision timing of selecting target channels. The first kind is called the proactive-decision spectrum handoff which decides the target channels for future spectrum handoffs based on the long-term traffic statistics before data connection is established. The second kind is called the reactive-decision spectrum handoff scheme. For this scheme, the target channel is searched in an on-demand manner.

After a spectrum handoff is requested, spectrum sensing is performed to help the secondary users find idle channels to resume their unfinished data transmission. Both spectrum handoff schemes have their own advantages and disadvantages.

In order to characterize the multiple handoff behaviors in CR networks, we should consider the three key design features, consisting of 1) general service time distribution; 2) various operating channels; and 3) queuing delay due to channel contention from multiple secondary connections. The interrupted secondary user can resume its unfinished transmission on the suitable channel.

However, in other scenarios, the interrupted secondary user may need to retransmit the whole connection rather than resuming the unfinished transmission. In this situation, a CR network should be modeled by the preemptive repeat priority queuing network and is worthwhile to investigate the latency performance resulting from this policy. Furthermore, how to apply the concept of priority queuing to other applications, such as electronic health (e-Health) applications, is also an interesting issue.

QOS Analysis

QoS Mechanisms: QoS class is defined according to service types and mapping between QCI (QoS Class Identifier) and DSCP (DiffServ Code Point). In the class oriented QoS mechanism, the QoS class is defined in the network operator's view point and then, QoS mechanism allocates the fixed bandwidths to the user through the mapping between the amount of resource and QoS class belonged to user's service.

In the current class oriented QoS mechanism, however, it is unable to differentiate the user's preference regarding the available network resources. The existing class based QoS mechanism is not able to differentiate the heterogeneity of user's preference to a certain QoS and treat these two users alike a new adaptive QoS mechanism providing adaptive resource allocation based on each user's preferences by using the utility function borrowed from the field of microeconomics.

The utility function qualifies the value that a user perceives for all possible amount of resources allocated. Above shortcoming in the class based QoS [4] mechanism is the motivation to introduce the utility function to our proposed QoS mechanism. The reason we prefer this approach is the utility function can be utilized as a mean to differentiate the user's preference regarding the available network resources and it provides a mean to manage an adaptive resource allocation for each user.

- Continuous utility functions should be represented in discrete functions in order to utilize the utility values as a main parameter of network QoS management
- Resource allocation should be done based on discrete utility function.

Spectrum Analysis: In the secondary usage scenario, the availability of the radio spectrum is dependent on the PUs' usage statistics. So in order to transmit multimedia content, first we need to isolate a portion of the radio spectrum that is not in use by the primary users. The spectrum pooling concept is the basis for the secondary usage system architecture called cognitive radio for virtual unlicensed spectrum (CORVUS).

The terminology of *spectrum hole* is a frequency band which can be utilized by secondary users (cognitive radio users) when it is not being used by primary users (incumbent user). By using empty spectrum bands that are originally assigned to a primary user, spectrum bands can be shared among many users and spectrum utilization can be improved. This is the basic philosophy of cognitive radio. In the case of real-time service, it is even more harmful for providing QoS.

Issues in QoS: Some spectrum matching algorithms which consider user QoS and spectrum characteristics to assign spectrum efficiently. The most important issue for QoS provision of cognitive radio systems is to match the most suitable spectrum hole to a secondary user.

The optimal matching can provide QoS and improve the system performance by minimizing the spectrum handover probability.

NS2 Simulation: Wireless technology is advancing rapidly and new enhancements are proposed on a regular basis. In computer networks, new, untested protocols cannot be launched on a large scale due to uncertainty of its successful outcome. Therefore, the new protocols/schemes are tested with analytical modelling or simulation tools [5]. After the simulation, if the new protocols show promising results, the protocols are implemented in the real world.

Evolution: Network simulation is the most useful and common methodology used to evaluate different network topologies without real world implementation. Network simulators are widely used by the research community to evaluate new theories and hypotheses. There are a number of network simulators, for instance, ns-2, ns-3, OMNET++, SWAN, OPNET, Jist and GloMoSiM etc. Therefore, the selection of a network simulator for evaluating research work is a crucial task for researchers.

Selecting the appropriate network simulator is a crucial task for researchers. There are researchers who have been testing different routing protocols in different simulators with different network parameters to evaluate the precise performance of network protocols.

Importance of ns-2: Network Simulator-2 (ns-2) is an open source, discrete event network simulator. It is used for the simulation of network protocols with different network topologies. It is capable of simulating wired as well as wireless networks. NS-2 was built in C++ and provides the simulation interface through OTcl, an object-oriented dialect of Tcl. The user describes a network topology by writing OTcl scripts and then the main NS program simulates that topology with specified parameters. In ns-2, network animator (NAM) is used for the graphical view of the network. ns-2 is the most common and widely used network simulator for research work. NAM interface contains control features that allow users to forward, pause, stop and play the simulation [5].

Selecting a Routing Protocol: The ad hoc on demand distance vector (AODV) routing algorithm is used to compare the performance of the simulators. AODV is selected be-cause of its pre-availability in the selected net-work simulators. AODV is a reactive routing protocol that establishes the route on demand (when the route is required by the source node) and maintains the route as long as required by the source node. It avoids the count to infinity problem by using sequential numbers on route up-dates.

In addition, AODV maintains time-based states at each node and discards (expires) routing entries that are not recently used. AODV is relatively fast in terms of topological network changes and updates only the nodes that are affected by topological changes.

The main advantage of this protocol is that the routes are established on demand and destination sequence numbers are used to find the latest route towards the destination. The disadvantage of this protocol is that intermediate nodes can lead to in-consistent routes if the source sequence number is very old. If the intermediate nodes do not have the latest destination sequence number, stale entries may exist.

In addition, multiple RouteReply packets may be created in response to a single RouteRequest packet that can lead to high control packet overhead. Moreover, AODV periodic beaconing leads to unnecessary bandwidth consumption. To evaluate the performance of state of the art simulators, we simulated AODV routing protocol on selected simulators and evaluated the performance.

Simulation and Results

Simulation Setup: Before the start of a simulation, we configure connection establishments between pre-determined nodes. As the communication starts, the source node starts transmitting at a regular interval of 0.2 seconds. In addition, each simulation was executed for 300 seconds in a simulation area of 900 * 900 (X * Y).

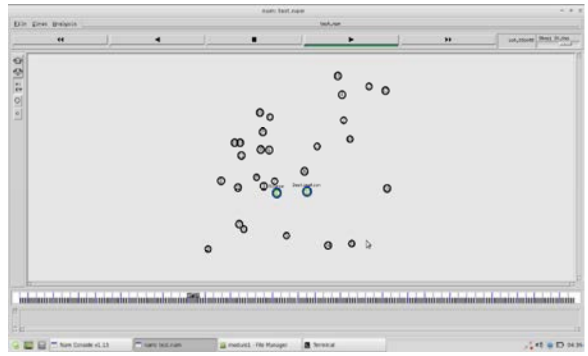

Fig. 3: Start of Simulation

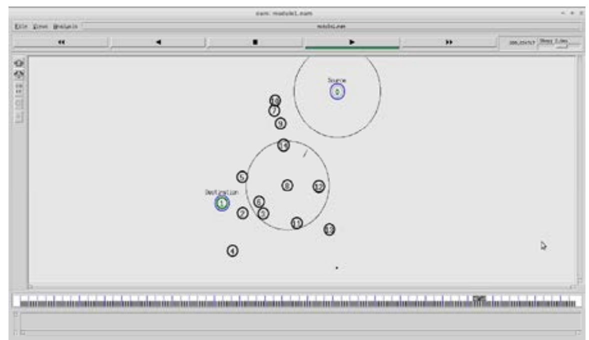

Fig. 4: End of Simulation

RESULTS AND DISCUSSION

The performance comparison was done based on the following parameters: throughput, delay, packet drop ratio, average delay and computation time (seconds).

Throughput: thru1=(nBytes*8)/(Delay[idPacket]*1000)

Packet Delivery Ratio: pdr = no. of Received Packets / no. of Sent Packets * 100

Delay: Delay[id Packet] = ReceivedTime[idPacket]-SentTime[idPacket]

Average_End_toEnd_Delay: Total End To End Delay/number Of Received Packets;

The simulation results show that the QoS parameters observed to be maintaining a steady performance over the end of the computation time. The parameters may become inefficient with increased number of nodes and the variation in the mobility level and also the type of data packet shared between the nodes.

In CRN, the handoff comes into influence of the wireless mobile node communication with spectrum management efficiencies. The future enhancements will

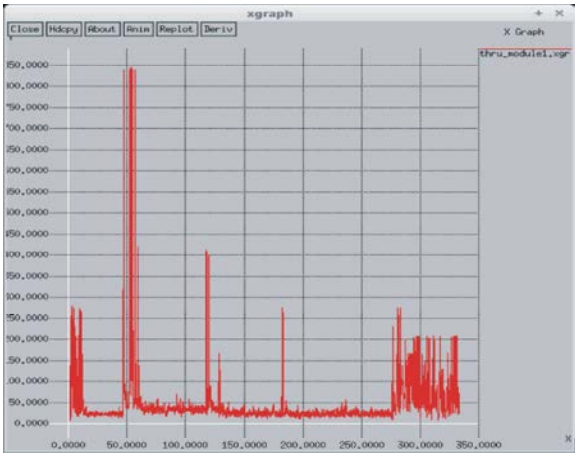

Fig. 5: Throughput Vs Computation Time

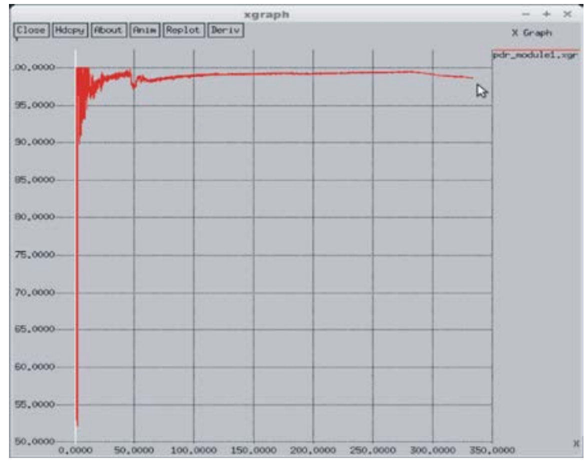

Fig. 6: Packet drop ratio Vs Computation Time

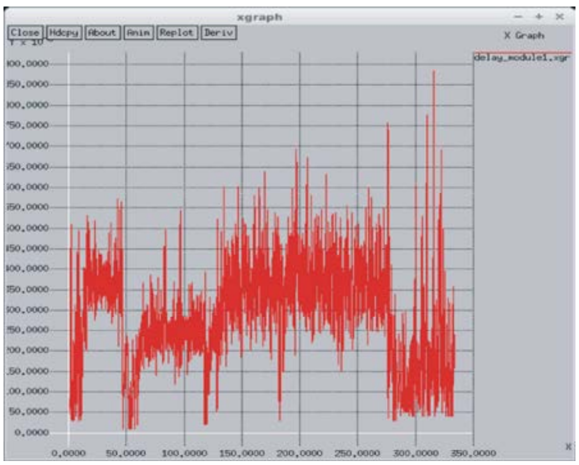

Fig. 5: Delay Vs Computation Time

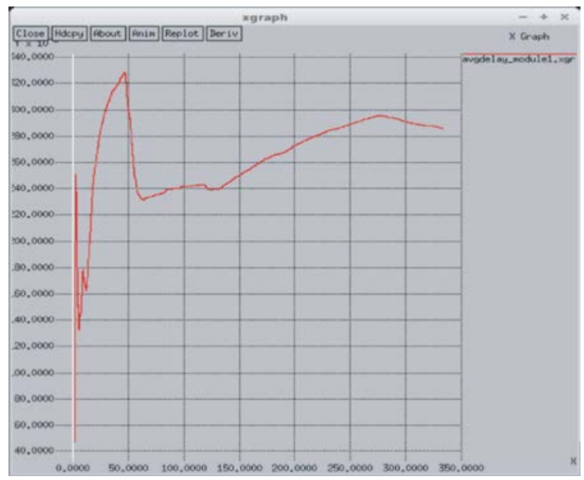

Fig. 7: Average Delay Vs Computation Time

include the CRN handoff with Qos performance improvement in the environment of multimedia transmissions.

The simulations tools were executed on the Linux platform. As shown in the above Figures, ns-2 does efficient simulation of wireless mobile nodes and as the number of nodes increases, there is a linear growth in memory consumption for the simulator which will be further area of research and analysis. Also, the multimedia transmission finds major challenges for wireless node communication.

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