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Improvement on Quality of service in WIMAX using OPNET Simulator

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Abstract – In the last few years there has been significant growth in the area of wireless communication. Quality of Service (QoS) has become an important consideration for supporting variety of applications that utilize the network resources.

In this project study of the WiMAX QOS fairness and its architecture is considered and understanding the mechanism of QoS deployment in WiMAX under fairness. These applications include voice over IP, multimedia services, like, video streaming, video conferencing etc. IEEE 802.16/WiMAX is a new network which is designed with quality of service in mind. This thesis focuses on analysis of quality of service as implemented by the WiMAX networks

A simulation based study is performed in OPNET by deploying a WiMAX network model in subjective sharing same bandwidth to all the users in the network. The simulation considers a simple network topology with three traffic source and destination each of them uses different application the QoS configuration is applied by defining three different classes that are Gold, Silver, and Bronze. And the applications used are the HTTP, VoIP, and Video conference. And then the evaluation is performed by comparing the result with QoS. And from the simulation result it's obvious that QoS mechanism represent the solution of future needs of networking and communication.

Keywords: WiMAX networks, HTTP, VoIP, QoS.

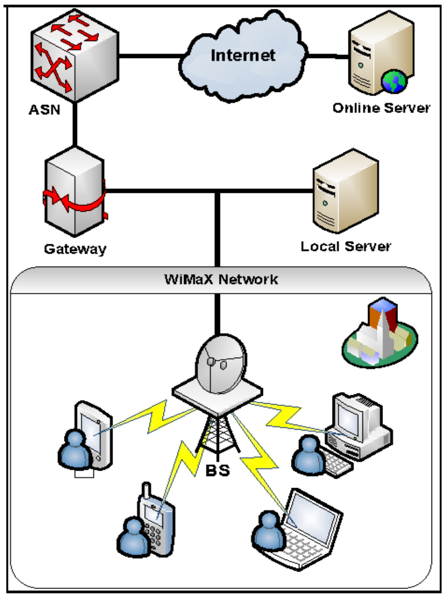
1. INTRODUCTION

WiMAX stands for Worldwide Interoperability for Microwave Access. It is the technology aimed to provide wireless data access over long distances. It is based on Institute of Electrical and Electronics Engineers (IEEE) 802.16 standard [1] [2] [23]. The name WiMAX was created by the WiMAX Forum, which was formed in June 2001 to promote conformance and interoperability of the standard. The WiMAX forum and IEEE 802.16 subcommittee are both involved in the development of open standards based broadband wireless networks. The IEEE 802.16 subcommittee is purely a technical body that defines the 802.16 family of broadband wireless radio interface standards. IEEE 802.16 defines the layer 1 (physical, also referred as PHY) and layer 2 (data link or Media Access Control - MAC) of the (Open Systems Interconnection) OSI seven layer network model. It does not define standardized network architecture beyond the [3-5] base station. Standardized network architecture is essential to ensure inter-working between equipment from different vendors and inter-working between networks of different operators.

WiMAX stands of Worldwide Interoperability for Microwave Access based on IEEE 802.16. It can support both fixed and mobile terminals of VoIP over optimal wireless broadband networks. Due to the increasing demands of wireless broadband services, WiMAX researches [5-7] become one of the hot topics nowadays, i.e.; throughput, speed of transmission, load, delay, jitter, congestion control, coverage area, hand off, cost and others. For that, the main objective is to do tradeoff between the qualities of services with the cost [11][15]. WiMAX gives an outlook and a good indication of successful future and successful technology that will provide last-mile connectivity.

The WiMAX forum fills this gap and creates an end-to-end broadband wireless network. The technology essentially provides basic Internet Protocol (IP) connectivity to the user using mobile broadband data access. The variety of applications used in IP networks has tremendously increased in the recent years [7-9]. Various multimedia applications along with the common email, file transfer and web browsing applications are becoming increasingly popular. These applications send large audio and video streams with variable bandwidth and delay requirements [10]. On the other hand, remote monitoring of critical services, electronic commerce and banking applications, as well as, network control and signaling do not need strict bandwidth guarantees due to the bursty nature of the data transfer. Instead, these applications require reliable and prompt packet routing [11].

In this thesis, the Quality of Service (QoS) as prescribed in WiMAX networks will be studied. The background will cover the information about what is QoS and how it is implemented in WiMAX networks. Also, the current research in this field will be presented to get a feel for the advances in this field [12]. Our objective is to provide a fair and efficient allocation to all the users to satisfy their QOS quality of service in Wimax.[23]. IEEE 802.16 based remote access scheme (commonly known as WiMAX) is considered as one of the most encouraging remote broadband access for correspondence networks in metropolitan territories today.



re **Error! No text of specified style in document.**.1: WiMax network architecture

Since this broadband wireless access system defines the concrete quality of service (QoS) requirement, a fair scheduling (FS) scheme is necessary to meet the QoS requirements. Many Scheduling schemes have been proposed earlier with the purpose of throughput optimization [11] and fairness enhancement. Here we present FS fairness scheduling to determine its exhibition limits. Our examination demonstrates that FS support the delay requirement [12].

This scheduler proposes a new scheduling scheme reflecting the delay requirement of rtps connections with respect to the various nrtps, best effort associations with accomplish the ideal QoS prerequisite, without the exorbitant asset utilization

a) Achieves low average as well as maximum delay for low-throughput applications
b) Provides fairness regardless of variation in server capacity
c) Is computationally proficient.

2. LITERATURE SURVEY

There has been a rapid growth in various wireless networks in recent years. Along with that the demand for wireless data services and multimedia applications has grown. To provide better service to meet the growing demand, there has been lot of research in the field of QoS. As the IEEE 802.16 standard is emerging and maturing, QoS issues have been addressed by many of the papers. In this section, a brief summary of current work in this field is presented.

Guerin and Peris [9] review basic mechanisms for providing QoS in packet networks. They talk about control path mechanisms that are needed to allow the users and network to agree on service definition and data path mechanisms which will enable to provision of differentiated service. These concepts have been adapted into IEEE 802.16 standard in providing the QoS support. Chen et al describe an integrated QoS Control for IEEE 802.16. A fast signaling mechanism is designed to provide cross layer integrated QoS for Point to Multi-Point (PMP) mode. Bosubabu Sambana et al [23] propose a framework of cross-layer QoS support in the MANETs networks. Two novel mechanisms are proposed in the framework for performance improvement and present a general framework of a cross-layer network-centric solution, and describe the recent advances in network modeling, QoS mapping, and QoS adaptation in term of providing end-to-end QoS for video delivery over wireless internet.

In another paper, Bosubabu Sambana et al [23] similar architecture is proposed for 802.11 MAC protocol. It includes the traffic classifier, the SS's upstream scheduler, and the BS's upstream and downstream schedulers [15]. The architecture that provides QoS guarantees for 802.16 systems is based on priority scheduling and dynamic bandwidth allocation. It also proposes efficient scheduling strategy for the schedulers. In another similar paper, Bosubabu Sambana et al [23] propose an inclusive architecture to support QoS mechanisms in IEEE 802.16 standards. They contend that although the IEEE 802.16 standard defines different mechanisms to provide QoS requirements, the challenge lies in developing efficient design to meet those requirements. This makes providing QoS, a challenging issue [13][16].

To overcome this issue, they propose design approach to implement the proposed architecture for all kinds of traffic classes defined in the standard. QoS support in IEEE 802.16 networks has been covered by Cicconetti et al [22]. They evaluate performance of the networks using a prototypical simulation for IEEE 802.16 protocol [15].

Bosubabu Sambana et al [23] describe the MAC protocols used in the WiMAX networks. And then go on to discuss the types of provisioning and Quality of Service (QoS) that can be achieved using the features of this MAC protocol to facilitate the WiMAX deployments. They cover implementation challenges of the WiMAX MAC to achieve QoS goals. Sayenko et al present a scheduling solution for the WiMAX base station. The scheduling policy i.e. the algorithm to allocate slots in not defined in WiMAX specifications. It is open for alternative implementation. Their simulation results reveal that the proposed scheduling algorithm ensures QoS requirements for all WiMAX service classes.

A lot of information about WiMAX network can be found in [17]. They describe salient features of Mobile WiMAX technology and how its distinct capabilities can be applied in enabling broadband mobile services. Provides a comparative study of Mobile WiMAX with 1xEVDO and HSPA technologies. Covers various applications of WiMAX and provide usage scenarios for real life situations [18].

The QoS parameters, shown in Table 2-1, applied to a default bearer are provisioned to an HSS as subscription information by a network operator. And then, when the default bearer is activated, an MME downloads the QoS profile for the bearer from the HSS and sends it to EPS entities appropriately. QoS parameters for the default bearer provided by the HSS can be modified by the MME upon creation of a new EPS session with different QCI index. QoS parameters applied to a dedicated bearer are provisioned by PCRF. The PCRF determines QoS parameters for the bearer based on the subscription information it [14].

QoS Provisioning and Enforcement

As shown in Figure .2 an EPS bearer has to cross multiple interfaces from UE/PDN-GW to PDN-GW/UE. Across each interface, the EPS bearer is mapped onto a lower layerbearer, each with its own bearer identity. Each node must keep track of the binding between the bearer IDs, also called Tunnel End ID (TEID), across its different interfaces [15].

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Best Effort (BE)

BE is concerned to provide data streaming in the case of having no guarantee to deliver the packets on the same time or even with no minimum requirements for the service like in e-mail and internet browsing [30]. In this class there is no guarantee of any delay or even bandwidth and SSs at startup of an uplink sub- frame for their bandwidth requests have to use the contention base area [16]. The number of cells and the coverage area are the main points that may affect on the collisions and congestions between SSs.

3. METHODOLOGY

Generally, the simulation models deployed in this project consist of two scenarios first one treat all traffics as one class and share the resource of the network without any QoS configuration, and the other scenario deploys the QoS procedure by differentiating the application traffic by specific classes [12], three applications are used which

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are HTTP, VoIP, and Video conference. The main simulation model used is shown below in figure [23].

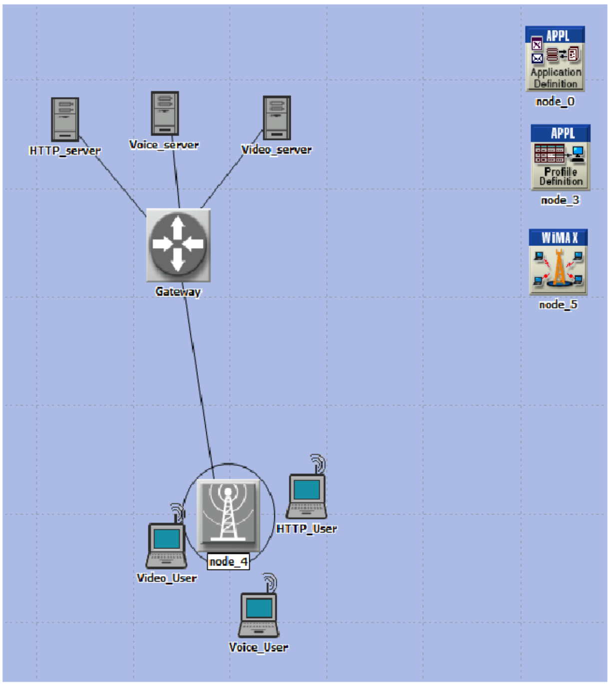

Figure.2 : Main Simulation Model

General simulation parameters are shown in table -1 below, these parameters shows all parameters used in both scenarios.

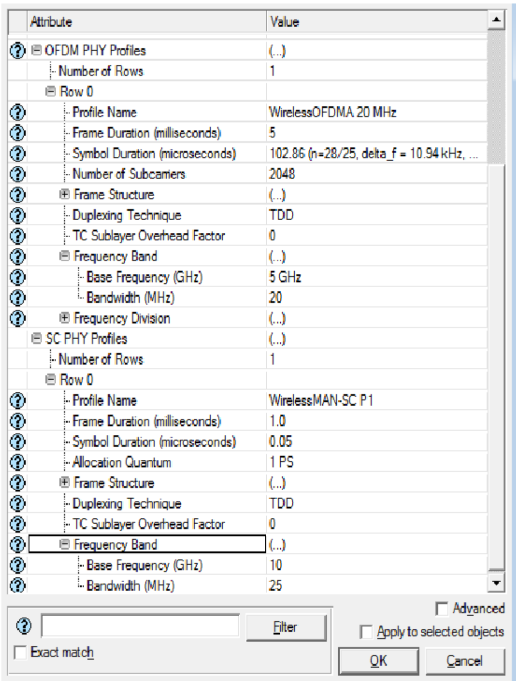

Figure.3: WiMax physical layer attributes configuration

The configuration of the three application used as the network traffic is shown below in figure-3.

Table.1: Simulation parameters

Parameter	Value
Applications	HTTP, VoIP, and Video conference
Number of users	3
No of servers	3
WiMAX bandwidth	20 MHz
Physical Layer	OFDMA
No of Subcarriers	2048
Duplexing technique	TDD
Modulation and coding	QPSK 1/2

WiMax physical layer characteristics attribute configuration used in OPNET is shown in figure (1-3) below.

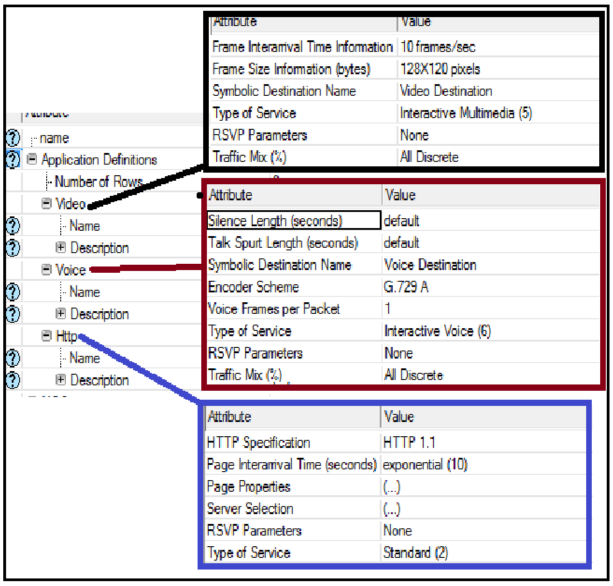

Figure.4: Application configuration in OPNET

The application configuration above describes the traffic modeling of each traffic that need to be simulated, each application has its own set of configuration attributes as shown above [18], all application requires on common attribute which is the Type of Service ToS this attribute gives the traffic a classification label that needed further for QoS processing.

The traffic is set by configuring the users profile in the user equipment and the supported service in the server side as source and destination of the traffic, figure (3-4) below illustrates the actual traffic configuration between the nodes used in this project [19].

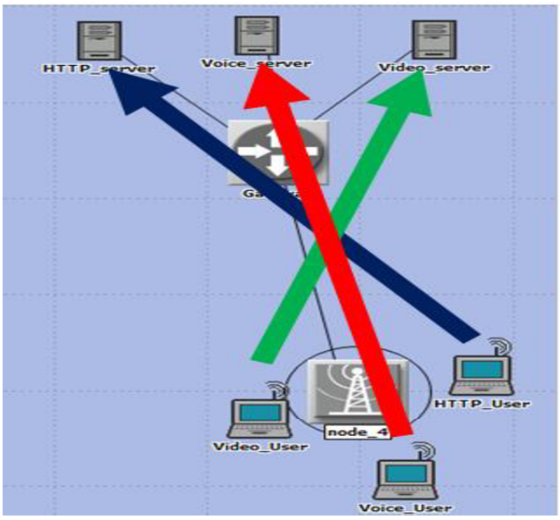

Figure.5: Application traffic sources and destinations

The QoS configuration is deployed by using the predefined QoS classes in the WiMAX configuration shown in figure (3-5) below, which shows three classes Gold, Silver, and bronze. Each class defines set of necessary QoS attributes as traffic rates and scheduling. Gold class uses the UGS scheduling which suitable for video application in addition too high traffic rates, Silver class uses rtPS scheduling that suitable for VoIP application with average traffic rates, while best efforts scheduling is used in Bronze class with lower traffic rates that suitable for HTTP traffic [16].

4. Results and Discussion

Firstly, we show the result of the QoS scenario which just confirms actual result is fear and suitable with the classification configurations, figure (7-8) below shows the HTTP object and page response times in seconds these values are not comparative to each other because they represent same application metric in one scenario.

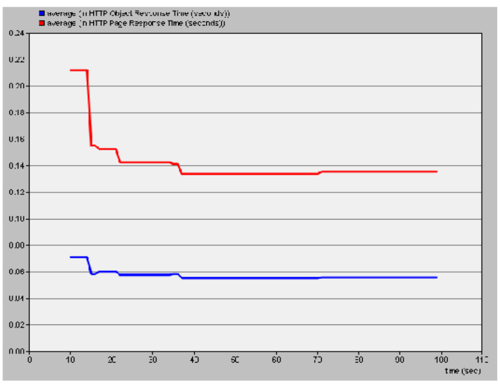

Figure.7: HTTP object and response time in QoS scenario

Also figure (4-2) below confirms the validity of the configuration which shows that traffic sent and received in HTTP application was equal.

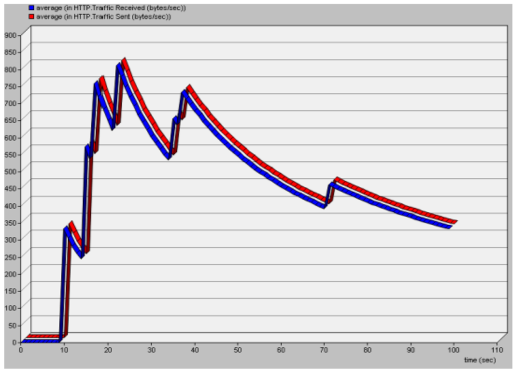

Figure. 8: HTTP traffic sent and received

At the VoIP application result jitter and packet delay variation is shown in figure (6-8) below, which are very low which also represent a positive point of respect in scenario [23].

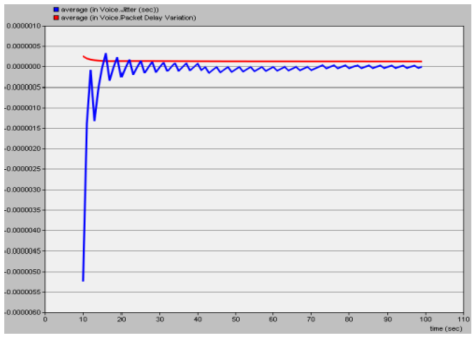

Figure **Error! No text of specified style in document.**.9: VoIP jitter and packet delay variation

VoIP traffic sent and received in QoS scenario also founfd to be identical as shown in figure (8-13) below.

Bar Graphs Validations

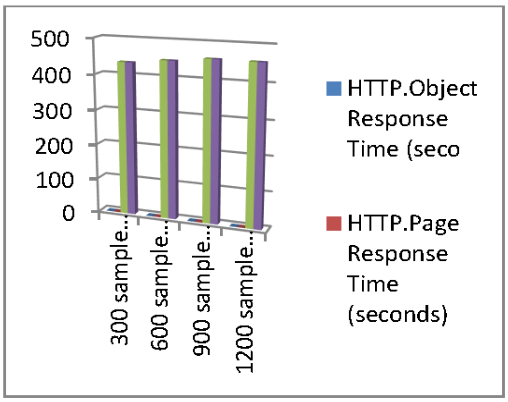

Figure. 10: HTTP browsing data QOS study with Different time intervals

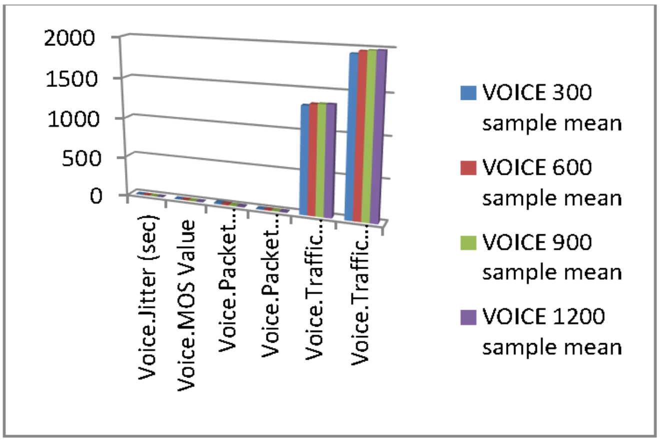

Figure.11: Voice data QOS study with Different time intervals

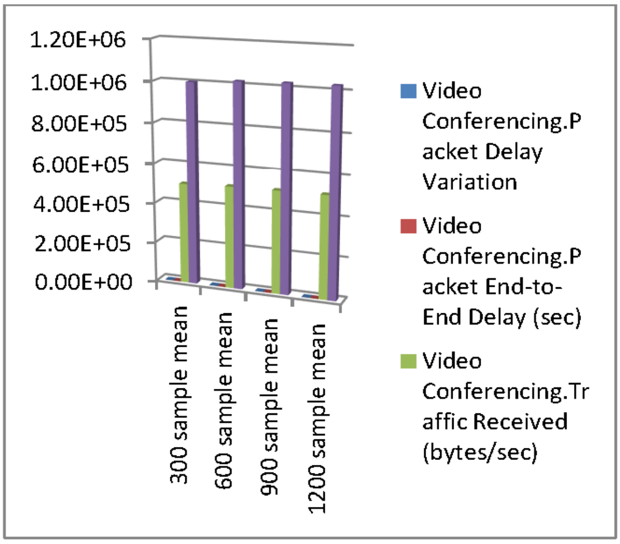

Figure.12: Video conferencing data QOS study with Different time intervals

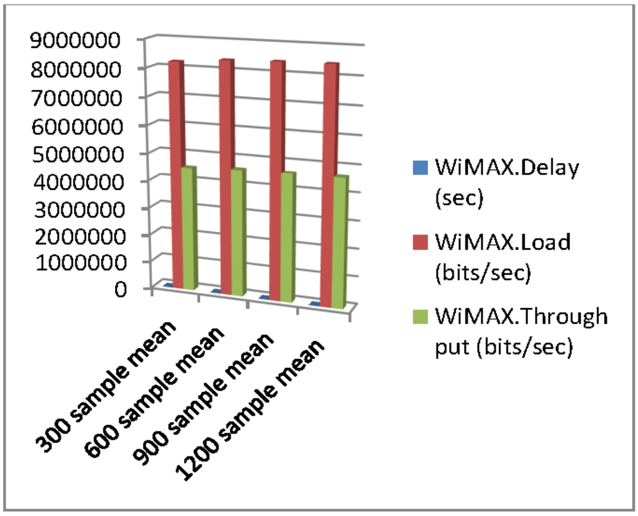

Figure.13: Wimax data QOS study with Different time intervals

5. CONCLUSION

This paper the thesis, the general concepts of Quality of service (QoS) and fairness scheduling in wireless networks were studied. The IEEE 802.16/WiMAX network architecture was presented and the MAC layer features that enable end-to-end QoS mechanism in the network were discussed. Various service flows that are supported in WiMAX were discussed in details. Related literature survey was presented in detail to provide background to the reader.

VOIP traffic and video streaming traffic was analyzed using a simulation based on network simulator, OPNET. The effect of different service flows on QoS parameters like throughput, packet loss, average jitter and average delay was studied. In general, it was observed that the UGS service flow has the least overhead in terms of bandwidth request and it is the highest in rtPS service flow. It can be concluded from the results that the VOIP traffic can be best served with UGS service flow.

The UGS service flow is indeed designed for constant bit rate traffic. Periodic bandwidth is already allocated by the BS to the MS. VOIP traffic generates fixed sized packets at a fixed interval. Thus the UGS service flow handles the traffic generated by VOIP calls in the most optimum way. The rtPS service flow is designed for applications such as streaming audio and streaming video.

During the analysis of the video traffic, as the number of nodes increases, rtPS service flow comes out to be better than BE service flow for average jitter. UGS still has lower packet loss. However, UGS service flow does not utilize the network resources effectively when the traffic is not constant bit rate traffic. Streaming video traffic is variable bit rate traffic.

The bandwidth can be periodically requested in the rtPS service flow instead of fixed bandwidth already being allocated, which may or may not get used.

Recommendations

VOIP traffic and video streaming were the two applications considered in the current analysis. Further analysis could be done for other applications including, video telephony which combines video traffic and VOIP traffic, File Transfer Protocol (FTP) traffic etc. The WiMAX module used in the analysis did not support nrtPS and ertPS service flows that are defined by the IEEE 802.16 standards. ertPS service flow is designed for applications which generate variable rate traffic which are delay dependent. An example of such traffic is VOIP with silence suppression.

In this case, the VOIP application is not required to send packets during silent periods. The capability to stop sending packets during silent periods is known as "Silence Suppression" or VAD (Voice Activity Detection). Variable rate and non-real time applications such as FTP are supported by the nrtPS service flow.

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