# Quality of Service profile for performance aspect validation

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## ABSTRACT

At the current rate of information communication technology development, **It is now widely recognized that the non-functional or extra-functional properties of multimedia system are at least as important as its somewhat more classical functional properties and that they must considered as early as possible in the development life cycle in order to avoid costly failures**. we can anticipate that there is a need to assimilate user requirements in developing user- oriented systems. With Multimedia Systems being integrated in almost every aspect of our daily lives, we become more dependents on such systems to provide efficient and effective delivery of information. This calls for the introduction of a QoS management system that provides the facility to specify a desired service. Thus far, many research bodies have contributed to the development of communication protocols such as: RSVP [Br97], ATM [Ha96]) and architectures (such as: QoS-A [CC97], in wireless networks UMTS [NN97]) that cater for QoS provision at the application and/or transmission perspective.

In this paper we present QoS management from different views based on [8] future recommendation by identification & definition e standard QoS modeling elements, create graphical notations for those elements, argue and testing the usability of the developed elements by simulating the VoD case study.

I will narrowing the scope of the study to examine the conceptual model I'm proposed here and prove the applicability of this model for the design of multimedia applications using case study for

Keywords: wccais, Quality management ,QoS, modeling elements, UML, application profile, user profile,VoD.

## 1. INTRODUCTION

The development of software that requires guarantees of Quality of Service (QoS) is an emerging area of object-oriented software engineering, due to the confluent current interest in QoS from networking, multimedia, distributed systems, and real-time systems perspectives.

Quality of Service generally covers system performance, as opposed to system functionality. QoS requirements do not specify what the system does, but how the system satisfies its clients while doing what it does. Support to manage QoS is emerging in infrastructure components (e.g., networks, operating systems), but apart from real-time methodologies that address issues of timeliness, most software development methodologies focus on system operation, ignoring system performance. However, QoS is crucial for instance in multimedia applications, and methodological

Support for QoS is needed when developing applications in this domain.

The QoS specification is increasingly important in distributed systems due to the need to address non-functional properties for the design of DS (Distributed systems) such as performance, reliability and security. Birman [10] has long argued for the importance of these quality aspects and provide some interesting perspectives of their impact on system design. Once the users are provided with the functionality that they require of a service such as file service in DS (distributed system), we can go on to ask about the QoS provided [7].

Video on demand is an electronic video rental system in which client's request and play videos on-demand.
A typical VOD system consists of a video server with digitally stored videos, stored on high capacity storage devices such as optical disks and a communication network connecting the users to the server. The components of a typical VOD system are shown in Figure 1. The Customer Premises Equipment (CPE)


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consists of personal computer connecting via network or a set-top box and a monitor. The functions of a set-top box include decoding a compressed video, demodulation, de-scrambling, program storage, and others [l].

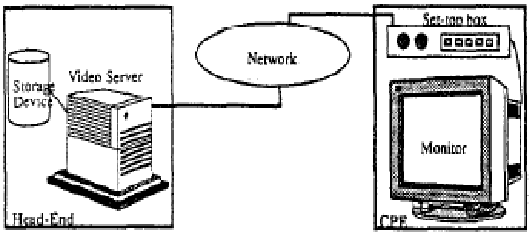


Figure 1. The components of a typical VOD system

In the next section we define the problem, in section 3 we outline the related work, in section 4 we review our extended graphical notation proposed model and Applying new QoS profiles and attributes on VoD system ,And We conclude our discussion in section 5.

## 2. PROBLEM STATEMENT

Most traditional software methodology model the functional side of software at the design level and neglecting the nonfunctional side which affecting the effectiveness of functional properties especially for distributed multimedia application.

QoS for the non functional properties of distributed application **is not tackled at design level and always neglected at the implementation phase.** As QoS is important in real time application especially multimedia application, in this *section we aim to address the QoS performance aspect at the application design level* **for the video on demand system** showing how we can design a simple VoD system considering the functional and non functional sides for such application ,since UML in its current state lacked of QoS notations to model the nonfunctional side of the multimedia application , the following pointes showing why UML couldn't model the nonfunctional properties of the system:

***UML Lacks Modeling High Quality Systems***

Some UML lacks for the description of QoS architectures and requirements are[2]:

• In UML**, Use Cases** provide support for the description of functional requirements. They focus on functions, and real-time and QoS systems focus on non-functional requirements (e.g., end-to-end delays, time to repair). There is not standard way of associating such non-functional requirements with Use Cases.

• **Class diagrams** are very abstract and sometimes leave out crucial system information (e.g., QoS dependencies of classes). The interfaces and class features provide support to describe functional properties of classes. However, they do not support the description of QoS characteristics that their implementations must achieve (e.g., timing properties, fault recovery capacity).

• **Interaction diagrams** (Sequence Diagrams and Collaboration Diagrams) provide support for the description of time ordering of messages and the relationships of objects. However they do not support the description of QoS properties of messages and objects (e.g., probability of availability of messages). They describe instants in the state of the systems, but they do not describe the adaptation of objects to the resources available in the system that is a basic concept of QoS-aware objects.

• **Deployment and component diagrams** do not provide support to describe quantitative quality characteristics of resources and components. The links between components do not provide support for the description of qualities provided or required between components.

current solutions for the description of non-functional concepts in UML are informal Approaches. **The profile "the proposed QoS profiles for performance aspect of multimedia application*".[6]*** provide support for the description of QoS characteristics directly related to **performance**. But there is not support for other types of characteristics. This proposal looks for the improvement of the performance for multimedia application.

Furthermore, UML is extensible through user-defined stereo-types to outfit to special purpose modeling needs. Many CASEtool vendors have already committed to supporting UML, and it has become a common notation for object-oriented design. However UML does not support standard notation for QoS in its current state, thus there is an urgent need to define standard QoS modeling elements and develop graphical notation to capture the common features for such applications in more effective manner.

Our aim in this research is to respond to that need. In particular, we try to build a set of graphical notation that can provide such specifications standard for QoS modeling elements. This involves the specialization and extension of existing UML notations to produce frameworks that are both abstract and precise, showing that by applying the modeling elements on VoD case study on each component of VoD system.

### 2.1 Why UML: UML is a specification language.

What is a Specification? A Model: We construct models to learn about the interesting properties of a system**:**

**Advantages & benefit for modeling:**

- Without having to construct the actual system (cost)
- Without having to experiment with the actual system (availability)
- Without having to view the entire system: because it may be too complex to understand.


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- Enhancing communication with end user since the model easily reflect the functional & nonfunctional requirement .

**A Definition:** from which more specialized definitions (such as code for a specific platform) can be generated.

***there are other specification languages too***

In this paper I would like to concentrate on both modeling & definitions as they are an efficient and effective way for specification of the new developed multimedia application, since that this paper proposed new QoS profile that used for further modeling to the system integrate the nonfunctional requirement with functional requirement for multimedia applications **.**

3. PREVIOUS WORK AND LIMITATIONS

There are several work using UML (Unified Modeling Language) for modeling QoS (non functional properties) aspects for application requirements we will consider the most recently related work to our work in the following paragraphs of this section.

Vittorio Cortellessa & Antonio Pompei [9] they intend to further contribute to the integration of UML with non-functional aspects, and they had a devise a lightweight extension of UML (i.e. stereotypes, tagged values and constraints) to represent issues related to the reliability modeling of component-based systems. To a certain extent they lay on other profiles to make easier the embedding of such issues and to work toward a unifying UML profile for Quality of Service and Fault Tolerance.

There are two papers that propose related extensions to UML. T. WEIS, C. BECKER, K. GEIHS, AND N. PLOUZEAU [15] proposes a "UML Meta-model for Contract Aware Components" and J. J. ASENSIO AND V. A. VILLAGRÁ [7] proposes a UML profile for QoS management information specification in distributed object-based applications J. J. .ASENSIO , AND V. A. VILLAGRÁ in [7] focused on the QoS management of IT systems based on object-oriented distributed applications. They present a way of specifying application –level QoS information during the development of object-oriented distributed applications: a UML profile based on QoS concepts and principles defined by (ISO & ITU-T framework) whose contents are generic enough so as to be applied to basically all aspects of IT.

They propose an extension of UML called UML-Q. They recognize the need to make QoS specification independent of the definition of computational objects (orthogonality), which they model with a QoS assignment meta-class. Unfortunately, the way they model QoS assignment might require heavyweight extension mechanisms. Furthermore, UML-Q introduces at least 20 virtual meta-classes, including, for example,QoSValue,QoS_Contract,QoS, CharacterizedFeatureQoS,QoSCharacteristic,QoSChara cteristic Type and QoSType. This leads to a virtual meta-model that seems unnecessarily complex.

T. WEIS, C. BECKER, K. GEIHS, AND N. PLOUZEAU in [9] state that relationships between required and ensured contracts can become quite complex, especially when QoS contracts are involved. As a assistant tool an appropriate UML notation is needed. Further, [9] states that there currently there is no need to derive a QoSContract from the Non-Functional Contract, but "once there is a UML standard to describe QoSContracts and the like in UML directly it might make sense to introduce a QoSContract subclass. [9] Uses heavyweight meta-model modifications to extend UML.

JAN ǾYVIND AAGEDAL1 AND EARL F. ECKLUND in [8] present a conceptual object model for specifying Quality of Service (QoS) that forms a basis for a UML profile for QoS. The conceptual model is based on CQML, a lexical language for QoS specification. In this paper Jan Ǿyvind Aagedal1 and Earl F. Ecklund present a consistent set of concepts for modeling QoS through all phases of the software development process, and give an example of how these concepts can be used. The paper is based on [10] and addresses the limitations for [7] and [9]. Our work is mainly based on the approach in [6] and the improvement in our work followed guidelines suggested in the future work stated in that paper, and this paper used case study approach to validate the new software concepts and to clarify the importance of modeling using the proposed QoS profile and sub-profiles that proposed in [6] at the design level which is based on [8] .

**4. Applying QoS profiles and attributes on VoD**

profiles for performance aspect of multimedia application" provide support for the description of QoS characteristics directly related to performance. But there is not support for other types of characteristics. This proposal looks for the improvement of the performance for multimedia application.

## 4.1 Specification of Quality of Service (QoS) attributes

In order to make QoS aware components (Audio, video) useful for real-time systems, the Non-functional, QoS properties of the components, also called operational Characteristics must be known.

Therefore, a QoS aware components should Provide a specification of its QoS attributes in order to be reusable. This specification of QoS attributes strongly dependent on the context of the QoS- aware component. Based on the QoS attributes of the individual components, a system developer can better verify if the QoS constraints of the overall


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System is met. QoS attributes for performance aspect of multimedia applications, can also include estimation information, time measurements, maximum response delay (worst-case time complexity), average response time, precision and quality resolutions of the result and error rate etc. figure 4.2 showed the interrelation of these Quality concepts.

**Figure 4.1 the conceptual view of QoS profile and the implementation of Quality concept on VoD system**

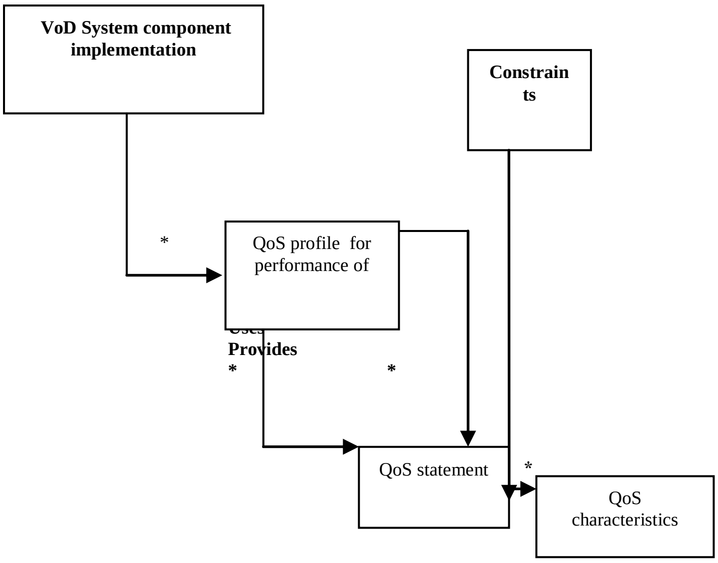


**Figure 4.1** shows the conceptual structure of QoS profile, represented as a UML class diagram. The basic building block of the QoS profile specification is the quality characteristic. It represents an entity to be constrained by the specification.

Quality characteristics have a name, a domain, value, and a semantic, examples for characteristics are frame rate, jitter, screen resolution …etc. ,Based on these quality characteristics, quality statements are used to specify constraints on quality characteristics. Because both quality characteristics and quality statements are parameterized, they allow for reuse of parts of the specification in different contexts. The specification is completed by associating quality statements with Quality aware software-components (Audio ,video ) of the system.

**A profile**, therefore, describes the relationship between the qualities of services received by a system from its environment, the resources allocated to the system, and the quality of services the system provides. Profiles can contain multiple sub- profiles, which essentially represent different quality level of the system. Sub-profiles are used as a means to express adaptively by allowing the runtime environment to switch between profiles—for example, when resource availability changes. For this purpose a profile can have a `transitions` operation, which defines all allowable transitions between sub-profiles, and specifies different quality level for the targeting system based on the received quality from system environment.(see figure 5.1 the proposed conceptual model section 5.1 )

## 4.2 General Architecture for Modeling High Quality Systems

The development of high quality VoD systems must pay attention to the non functional requirements related to different types of quality categories (e.g., performance , reliability, security ),and sometimes these requirements are interdependent, the especially important in these types of quality categories for VoD system based on the gathered information in the Questionnaire information analysis section is **performance** which is concentrate on the time latencies (e.g., end-to-end deadlines, jitters and delay), and other related quality parameters that affect the effectiveness and efficiencies of such Quality aware system(such as VoD system ) , as a result the overall functional properties of such system influenced either in negative or positive direction based on the associated Quality requirement constraints .

**Figure 4.2 General architecture for QoS**

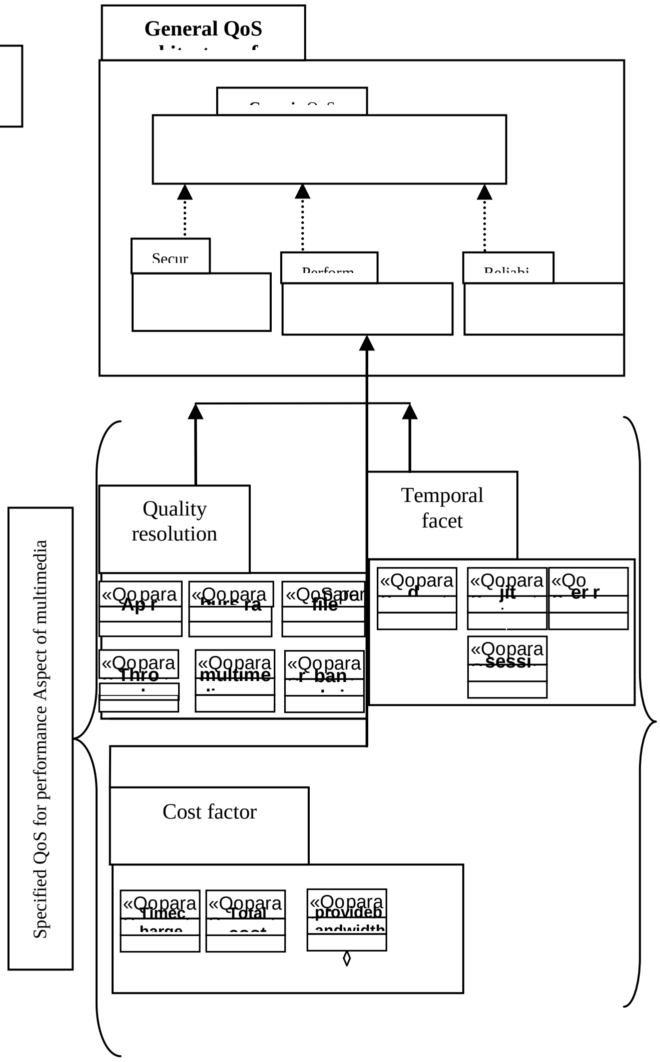

Figure 4.2 represents the General QoS Framework (QoS framework) that provides support for the descriptions of specific QoS characteristics and domain supports.
The QoS analysis provides support for the management of non-functional aspects in general, the early specification of Quality requirements are new design approach to improve and detect problems in the architectures, and to ensure that the Quality aware

Some examples
Of QoS characteristics are performance, security and reliability.

software will respond and operate correctly in effective manner . to implement these design approach we showed here simple Video on Demand System design using these design concepts ,the following section clarify the design example specifications.

Non-functional properties must be considered throughout the complete process of developing software. Figure 4.3 shows an overview of a development process which explicitly takes into account non-functional properties and components.

**4.3 Video on Demand system Design using new design approach [6]:**

## 5.3.1 A Software Development Process for Quality aware Software with Non-functional, QoS Properties

**Figure 4.3.1** shows that after the requirements analysis, the application designer begins to model the system, this includes modeling of non-functional properties by specifying non-functional constraints and attaching them to QoS -aware system such as our example VoD system modules and components. Measurement

definitions (i.e., quality characteristics).can be very complex, but on the other hand will be developed only once. Therefore, we separate the roles of measurement designer and application designer in our process. Their combined efforts lead to a specification of the system including its non- functional properties.

**Figure 4.3.1 general a development process**


1. **Definition of measurements** at different levels of abstraction by the measurement designer. The measurement designer can do so independently of application development and even at earlier time.
2. **Use of measurements** during the specification process by the application designer. The application designer constrains measurements and binds these constraints to elements of the functional model.
3. **Revision and verifications of measurements**. The application designer verify the suitability and correctness of measurements.
4. **Development of the overall design** for the quality aware application.
5. Implementation of the quality aware application by system developer, based on the provided overall design.

Note: we only concentrate on the specifications & design process of quality aware application not on implementation of such system.


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## 4.3.2 VoD System Basic Functional & nonfunctional Requirements:

| | |
|---|---|
| **VoD System Basic Functional Requirements :s** | |
| **R0** | Users should be able to display a list of available movies and select one from the list |
| **R1** | Play movie immediately after selection from list |
| **R2** | User should be able to pause a movie |
| **R3** | User should be able to start a movie |
| **R4** | User should be able to stop a movie |
| **VoD System Basic Non Functional, QoS Requirements approximate assumptions:** | |
| **R5** | Provide VCR-like user interface |
| **R6** | 3 seconds max to load movie list(delay ) |
| **R7** | user required 3 seconds max to load textual information about a movie(delay) |
| **R8** | 1 second max to start playing a movie(efficiency, response time) |
| **R9** | Novices should be able to use the major system functions (selecting movie, playing/pausing/stopping movie) without training (Understandability) |
| **R10** | Maximum error rate 1% |
| **R11** | Minimum Application bit or frame rate 25 per second |
| **R12** | Minimum picture resolution, color resolution, |
| **R13** | Max Jitter between tow sequence of bit -packet 1% |

### 4.3.3 VoD System Basic Functional component static structure:

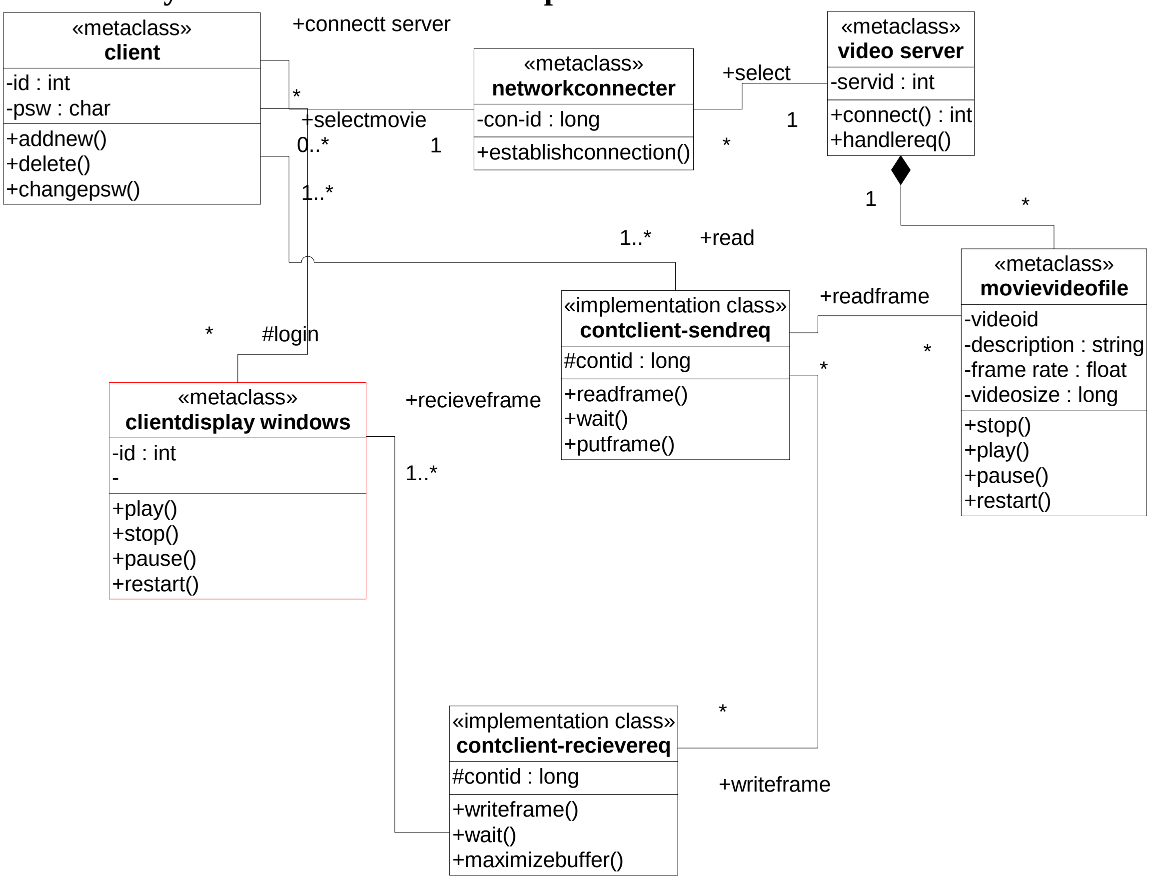


Figure.**4.3.3 static structure of VoD system**

Figure.4.3.3 shows the structural specifications of VoD system , In this section we provide briefed description for a distributed video on demand (VoD) service. For the sake of simplicity we will keep the example as small as possible, just considering the reproduction of a movie file of any given format into a display window. In order to design the system, we need to identify first the components and connectors (association and


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relationship) of the system to be designed, and then specify its structure (as shown in figure 4.3.3.).

The classes defining the system entities, there are three kinds of components: UserVideoWindow, video File, and Virtual Connection. The first one models the user's Web window for displaying the movie and controlling its reproduction (via the start(), play(), pause(), and others operations). The video File component models the video movie, independently from its data format and storage location. This component receives requests for reading frames, and delivers the requested frames. However, all of these components only offer partial design solutions, and none of them provides with an overall documentation for the video on demand system. There are only describe the structure of VoD system and ignore the other nonstructural and functional side on how much the system satisfies its clients while providing the VoD services and functions and how we can customize it. **In this respect, we believe that QoS profiles that describing the nonfunctional requirements of the systems sit at the right level of abstraction, allowing the description of most of the QoS characteristics for performance aspects for each component of the VoD system, in which these QoS information needed for documenting a system framework at early design phase in order to gain the customer satisfaction by achieving the preferable QoS –level from end user point of view.[3].**

diagram describes the state transition for the VoD system which start in initial state at early design time at early design time then the user select a targeted server ,establishing connection, select a movie from movies list based on the textual information of the movie , then the user can playing movie using the VoD main windows play button. User can also stopping, pausing movie using the main window buttons and finally he/she can Quit VoD system which closed the main windows (display).

This figure reflect the basic state the system can behaves but as we show we add new constraints on some characteristics of the system components to achieve the nonfunctional requirements for the VoD system related to its efficiency and performance improvement(such as delay when displaying the movie textual information after 1 second selecting movie from the list) .as we achieved the basic functional requirements we can achieve and monitoring the QoS (nonfunctional) requirements to preserve the coherence and effectiveness of the system which improving the overall system performance (thinking about resource efficient utilization).

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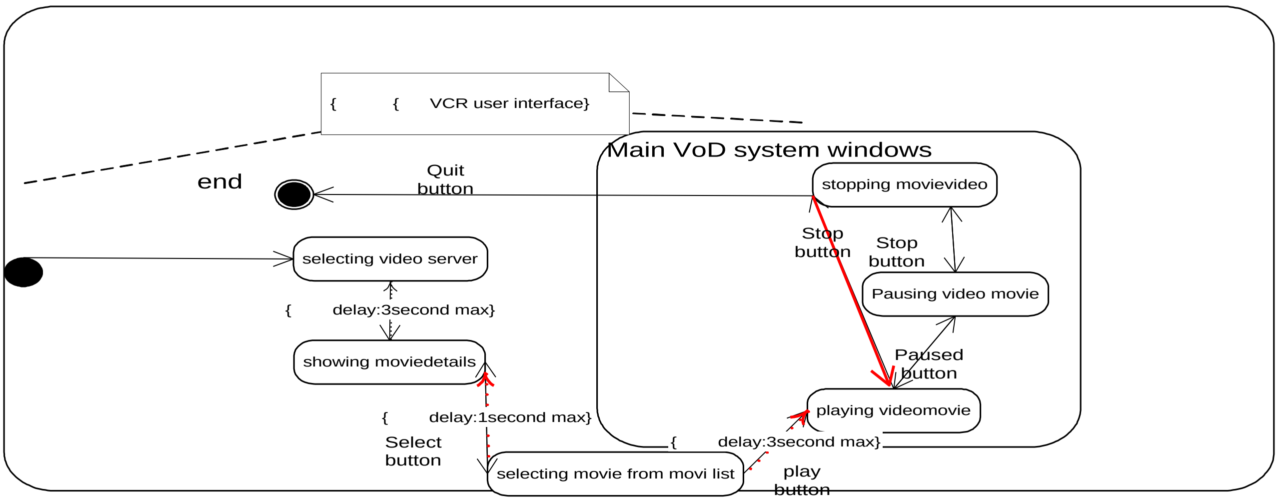


4.3.4 VoD System Basic operation and states


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### 4.3.5 VoD System expressing QoS requirements (nonfunctional properties) for Basic component& characteristics:

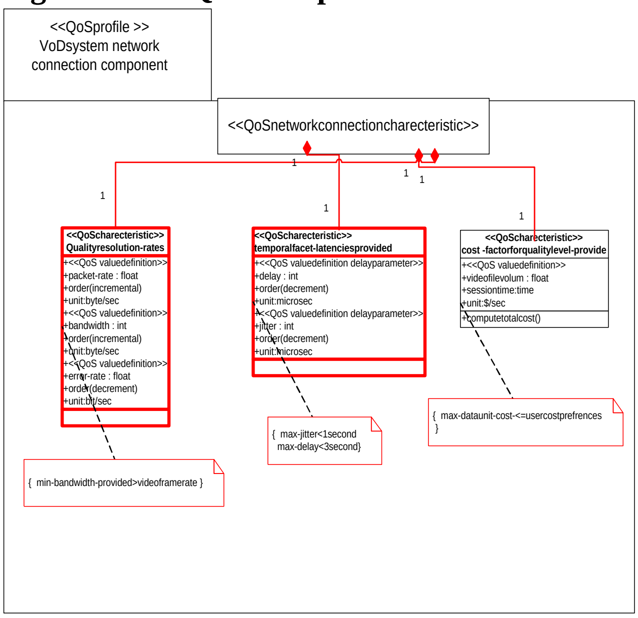
### 5.3.5.1 VoD System QoS sub-profile for network connection channel component:

Quality of Service QoS is a key concept in today's high speed communications and distributed real-time applications especially multimedia applications, which are need powerful constructs to express their performance and quality needs(nonfunctional requirements ) ,the existing notations and facilities are not suitable for this purpose, and the application programmer on the other hand required ease to use QoS parameter, and powerful notation to simply and usefully expressing these Quality of Service characteristics & parameters to simplify their work, and user expect meaningful parameter to express their needs easily. All of the above requirements have very useful and efficient positive consequences which are narrowing of the communication gap between client user and designer, also between designer and programmer .save time and reengineering effort.

**To proof these concepts** we showed in the next section the QoS profile and its related QoS-sub profile for Video on Demand system as we shown in the previous section the functional behavior and structure of such system, we wanting to express the usability, usefulness, learn-ability, meaningfulness, efficiency, and effectiveness of the QoS profile for performance aspect and other related concepts such as QoS characteristics & parameter, QoS value level, and other related concepts.

**Figure 4.3.5.1 shows the notations and concept to** express and defined the QoS requirements for network connection channel component for VoD system.

**Figure 4.3.5.1QoS Sub profile for network connection channel component for VoD system.**




Based on the static structure of VoD system the **connection quality** is critical non functional requirements and have exert great influence on the efficiency and the satisfaction of the services provided by VoD system and affecting the **overall functionality and quality of the system services**. So we provide here simple diagram to express the most important factors (QoS characteristics parameter) affecting the network connection quality .the QoS sub profile for network connection components as shown above consisting of three important characteristics affecting the quality of network (**flow rates the affecting the first one is Quality resolution characteristic parameters** of the overall system such as packet size and error rate, **second** is **latency** QoS value and directions, the **third cost factor** passed on the clients paying power and preferences for the services provided based on **session time** and the **charge** enforced for each time unit cost) is affected the most important factors is **latency** which includes two characteristics for the description of latencies. The characteristic latency is based on general dimension for the description of latencies for any kind of software elements. **The delay** defines a response time with a minimum and maximum ending time. **The jitter** specifies the maximum variation in the time a computed result is output from cycle to cycle. It worst value must be less than the window; in some cases the difference from cycle to cycle is known and less than the window. The criticality represents the importance of the event to the system.

Figure **4.3.5.2** reflect the QoS characteristics and related QoS value and constraints for the second structural component of VoD system the Video file components , which focus on the QoS characteristics related to the frame rate and loss rate and compression criteria focusing on the Quality issue related to stored and delivered data that is finally received and displayed on user display windows.

## 4.3.5.2 VoD System QoS sub-profile for video file component: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NNGT

## 4.3.5.3 VoD System QoS sub-profile for throughput-characteristic:

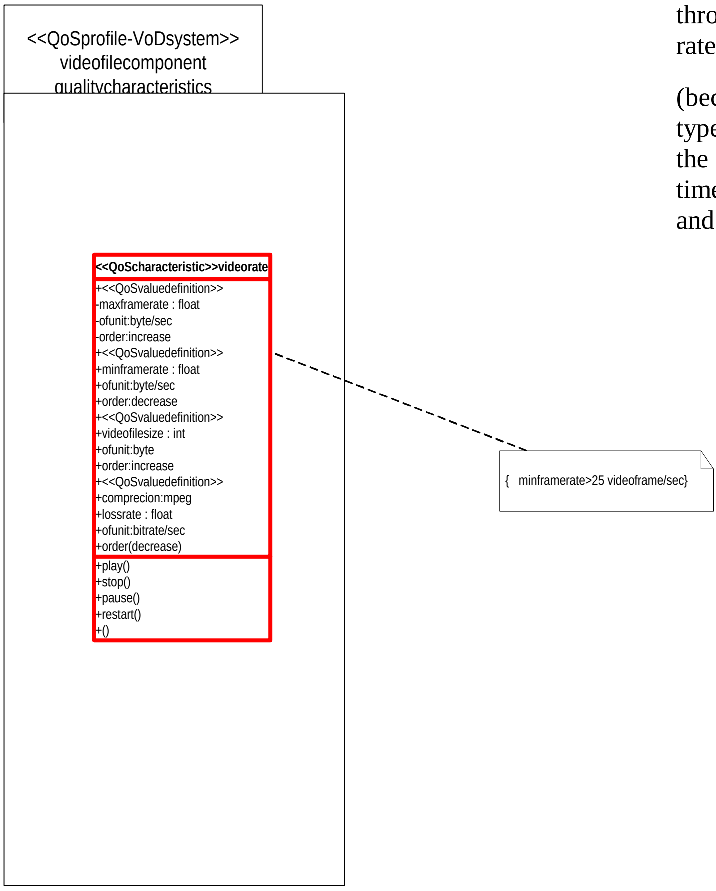


Figure 4.3.5.3 Includes a model for the description of different types of parameters and dimensions for

throughput characteristic for VoD system.. An abstract QoS Characteristics (throughput) represent the throughput in general, during an interval of time and a rate, whose units or direction are not defined

(because of it is abstract). This diagram considers three types of throughputs: **input-data-throughputs** represents the arrival rate of user data input channel, averaged over a time interval. The rate unit for this throughput is bit/sec, and the direction of this dimension is increasing.


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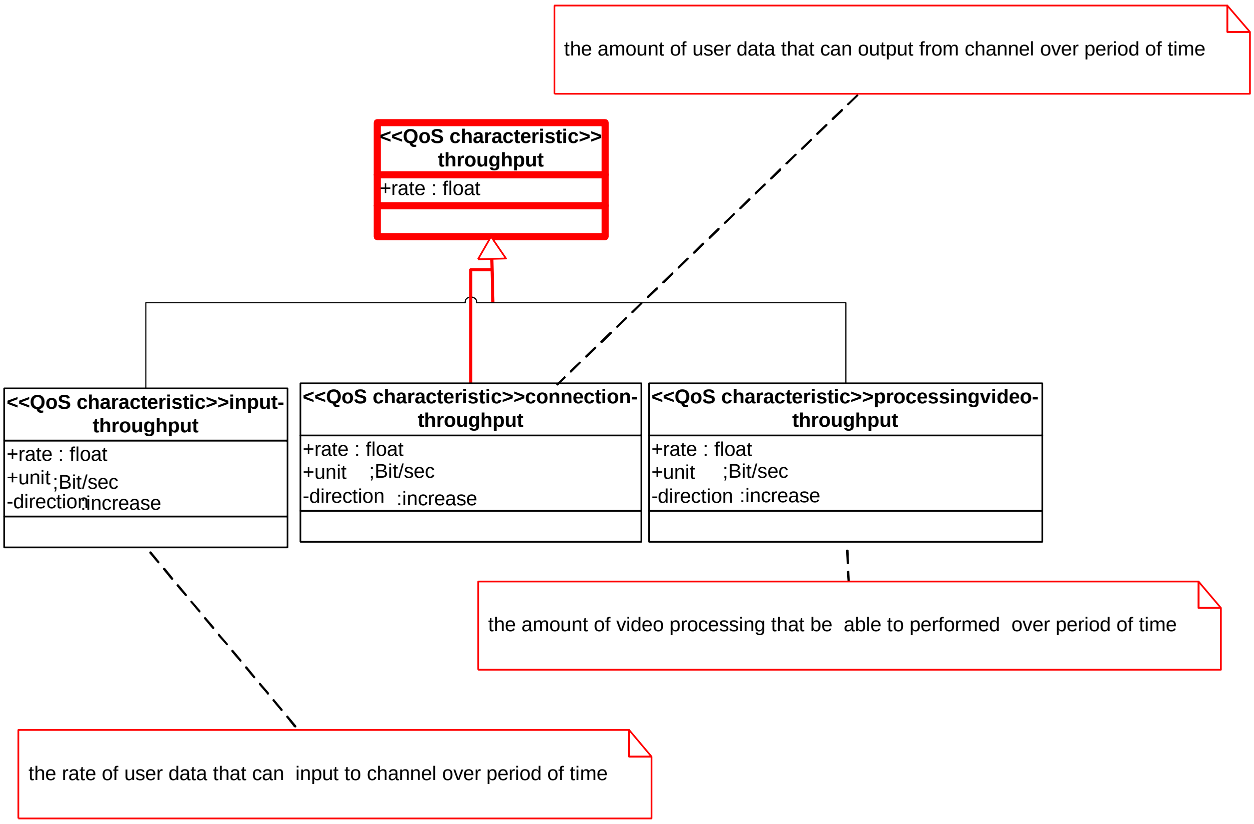


**Figure 4.3.5.3 :Throughput characteristics for VoD System**

**Communication-throughput** represents the rate of user data (video frames) output to a channel averaged over a time interval (**video file display rate**). The units and direction of rate are the same as input-data-throughput (frame rate the channel can input in the buffer for control-costumer-receive component).

**Video-processing-throughput** represents the amount of video processing able to be performed in a period of time.

The unit of rate is instructions/sec and the direction increasing.[2]

## Conclusion

we showed how we can applied the QoS profile concepts at application design level using Video on Demand system as a case study to reflect the implementation of such concepts.

We conclude from such implementation and consideration of nonfunctional requirements of the system at design phase and through out the development process that QoS profile must operate and expressed end to end QoS, i.e. it is not sufficient to consider the QoS of one system component, and neglecting the QoS requirements for others, since the QoS for one component may affecting the functionality of another component ,so QoS profile for a system consisting one to many QoS Sub-profiles for system components , which must be considered as a whole to model a coherent system, this coherence properties affecting the overall system performance , and the efficient and effective expression for QoS requirements for all system components ensure and guarantee the improvement of overall system performance which increase the usefulness ,learn ability and simplicity ,and usability of the system for system designer and developer by reducing the communication gap among the development team by providing meaningful concept and notations, the results and consequences of effective and efficient design and development process are reduction in system development cost since we eliminate the need to reengineering effort and costs, and achieving customer satisfactions by considering preferences of our king at early design time .

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