Queuing Model Based on Scheduling Strategies Affect Local Network Services

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Abstract: This paper is a comprehensive study of some queuing scheduling strategies that operates on a local network. The study addresses the most convenient strategies used in operating systems. It indicates a new queue model based on some scheduling strategies that affect a local network services. The model was propose by us and entitled as Queuing Model Based on Scheduling Strategies in Local Network Services (QMBSSLNS). The aim of this model is to accelerate the arriving jobs in a local queue. Jobs sent through a local network suffers always from delays caused by several reasons, one of these reasons we believe is the scheduling strategies used. We are going to investigate the most common strategies used in queuing jobs on local network and some interesting properties including the arrival theorem, exact aggregation and insensitivity. This will motivate us to represent a particular system features such as batch arrivals and departures and finite capacity queues in a visual mode. Some scheduling strategies such as first come first serve (FCFS), last come first serve (LCFS), overall throughput, resource path, average queue length and average waiting times will be indicating as well. Average Performance measures will be evaluating based on Generic Cell Rate Algorithm (GCRA) algorithm and Markov process. A framework form will be implemented to improve the model, this framework will simulate the job priority, the queue length distribute, average responding, job state, resource path and throughput. Performance evaluation often involves the use of queuing network models. QMBSSLNS has been also proposing to analyze and schedule queuing job on a local network structure in a comfortable and easy-to-use environment.

Key words: Queue strategy. Queue jobs, Network services, First come first serve, Last come first serve, Strategies performance.

1 Introduction

A queuing local network model is a collection of service centers representing the system resources that provide service to a collection of customers that represent the users. The customers' competition for the resource service corresponds to queuing into the service centers. The analysis of queuing local network models consists of evaluating a set of performance measures, such as resource rate, throughput customer response time, Generic Cell Rate Algorithm (GCRA) and Markov process. The popularity of queuing local network models for system performance evaluation is due to a good balance between a relative high accuracy in the performance results and the efficiency in model analysis and evaluation. In this framework, the class of product form networks has played a fundamental role. Product form queuing local networks have a simple closed form expression of the stationary state distribution that allows defining efficient algorithms to evaluate average performance measures. We will introduce product form so called Queuing Model Based on Scheduling Strategies in Local Network Services (QMBSSLNS) for queuing local network jobs and their properties as well.

The basic idea of network queue model was extend from a stochastic model introduced firstly to represent the entire system by one service center. The basic queuing systems applied to analyze the congestion in LAN networks, telephonic systems to study the congestion in computer and communication systems [3], [8].

Simulation is a general technique of wide application, but the main drawback is the potential high development and computational cost to obtain accurate results. Our goal is to simulate the outgoing results via a particular simulation implemented by us called ‘QMBSSLNS’. Analytical methods require that the model satisfy a set of assumptions and constraints based on a set of mathematical relationships that characterize the system behavior. The product form networks analyze via various computational algorithms to evaluate the performance indices. These algorithms provide a powerful tool in the efficient analysis of large
queuing local network models. The most significant ones are the *convolution algorithm* [13], and the *mean value analysis algorithm* [5, 13, 14, and 17] provided for local networks. They afford the evaluation of average performance indices with a polynomial space and time computational complexity in the network dimension, service to allocate the number of service centers and network population. Those algorithms are uses for product form networks with multiple classes of customers because it is difficult to analyze while we are working with local network services.

2 Objective of QMBSSLNS model

The main goal of our framework limited further by the following objectives:

1. Using simplified vision of the problems of queuing systems strategy stochastically via local network services.

2. Evaluating set of performance measures such as resource paths, throughput and customer responds time in our proposed model.

3. Representing a particular common system features such as negative customers, batch arrivals and departures in the QMBSSLNS model.

4. Applying common queuing scheduling strategies stranded on GCRA algorithm and Markov process to evaluate our QMBSSLNS model.

5. Giving priorities to the arrival jobs located on the local network to be serving in an appropriate manner.

3 Methodologies

We suggest using a set of methods to specify different applications that uses the quality of services. These methods consider the main network operation used, the main proposed themes, the estimation and evaluation of these themes as follow:

1. We will use the (GCRA) algorithm to measures cell rate at a specified timescale. Moreover, it uses for monitoring CBR services or any service where the cell rate is fixed over a given period. This measure helps us to identify the quality of services used.

2. The network operation will be denoted bases on its decision to accept or reject the next connection based of its estimation.

3. The proposal themes are to explore more accurate model of such network operations to estimate both the risk and the loss of utilization as a function of the characteristics of the estimators. Preferably, we expect to be able to measure the trade-off between risk and loss of utilization for various estimators. We also suggest comparing our analytical results as a trace-driven simulation with actual experiments.

4. The estimating themes using (GCRA) algorithm and Markov process will involves the following: measuring the bandwidth used by the connection instead of the loss rate, measuring the bandwidth needed by the sources. This estimation in our model monitors the following aspects:

   a. The loss rates that would occur from using transmission rate smaller than *C* (where *C*: transmission rate), Based on Markov process.

   b. Achieving the speed up by grouping the connection into two virtual bins with 40% and 60% of the connections each served with transmission rates of 40% and 60%, respectively using the form described in [5] to seed up the grouping.

   c. Calculating the parameters of Bahadur-Rao to asymptotic the loss rate and infer the maximum number of sources[5].

5. The intended QMBSSLNS model expected simulator drive us to evaluate the following performances:

   a. The stochastic model used for queuing local network performance evaluation uses the evaluation resource path, system throughput and customers' response time in local network.
b. In single services center we evaluate queuing systems using Kendall's notation. These notions classify the queuing systems into different types. Systems are described by the notation as follow: A/B/C/D/E, where A is the distribution of the inter-arrival time of jobs, B the distribution of the service times, C the number of servers, D the system capacity and E the queuing discipline, i.e. the rule by which customers are served. When D = ∞ and E is “First Come First Served,” they are usually omitted [1],[6],[9],[10].

c. Jobs types in local networks set by customer behavior in the queue denoted by the chain. Where the chain is efficient algorithms and strategies can solve a set of classes that product form for local networks queuing will be simple and intuitive models that it based on each customer in the chain.

The theorem behind the obligatory of our system proposal is mentioned as follow:

- There are two important times in queuing theory. The inter-arrival time, which is the time between consecutive arrivals, and the service time, which is the time taken in serving a customer.
- The state of the system at time t is often denoted by N(t) or Nt.
- The queue length is the number of jobs in the queuing system which is the number of customers waiting to be served (waiting and in serving case).
- \[ \lambda n \] is the mean arrival rate when the system is in state n. Where \( [\lambda n] = 1/\text{Time} \).
- \[ \mu n \] is the mean arrival rate (for all servers combined) when the system is in state n. Where \( [\mu n] = 1/\text{Time} \).
- When the mean arrival rate is independent of n, it is denoted \( \lambda \). In this case, the mean inter-arrival time is \( 1/\lambda \).
- When the mean service rate per busy server is independent of n for \( n \geq 1 \), we denote it by \( \mu \). In this case, the mean service time for a customer is \( 1/\mu \). If there are \( s \) servers and the system state is \( n \geq s \), then \[ \mu n = s \mu \]
- The utilization factor is \( \rho = \lambda n/\mu \).
- The initial period of rapid fluctuation of a queuing system called transient. The system settles down to a steady state. In the steady state, the system is essentially independent of its initial condition and it reached an elapsed time.
- In the steady state we denote the following:
  1. \( P_n \) is the probability that there will be exactly \( n \) customers in the system.
  2. \( W \) is the time in the system (queue + service) for a customer.
  3. \( W_q \) is the time in the queue for a customer.
  4. \( W = E(W) \) is the expected time for the customer in the system.
  5. \( W_q = E(W_q) \) is the expected time for the customer in the queue.
  6. The expected number of customers in the system will be defined as:
\[
L = \sum_{n=0}^{\infty} n P_n
\]
  7. The expected numbers of customers in the queue were denoted as:
\[
L_q = \sum_{n=s}^{\infty} (n-s) P_n
\]
- In Little’s formulae we denote it as:
\[
L = \lambda W \text{ and } L_q = \lambda W_q.
\] And since \( 1/\mu \) is the expected service time, \[
W = W_q + \frac{1}{\mu}
\]
When \( \lambda \) depends on n, we define the time-averaged arrival rate:
\[ \hat{\lambda} = \sum_{n=0}^{\infty} \lambda_n p_n \]

Little’s formulae become

\[ L = \hat{\lambda} W \quad \text{and} \quad L_q = \hat{\lambda} W_q \]

Note that when the mean arrival rate does not depend on \( n \),

\[ \hat{\lambda} = \lambda \sum_{n=0}^{\infty} p_n = \lambda \]

### 4 Recent Research work

More recently, research work has denoted to the extension of the class of product form network model and to its characterization. Some interesting new features have been defined such as networks with positive and negative customers proposed by Gelenbe [5],[14] that can be used to represent special dynamic of actual systems. Some other more complex models include various functions of state-dependent routing and several special cases of queuing networks with finite capacity queues, finite population constraints and blocking [1],[7],[15],[16]. Product form solution has been extended to queuing networks with batch arrivals and batch services [4],[9],[12],[14] that are also related to discrete time queuing network models. Another recent work conducts a queue models for each category and event classifications to compare it from both the SEMI E10 and queue theory points of view [18]. A more likely work considers the influence of potential behaviors on the access cost, and proposes a data-intensive job scheduling algorithm with potential behaviors [19], [20]. A more comprehensive work propose AQCS, adaptive queue-based chunk scheduling, that can support the maximum streaming rate allowed by a P2P streaming system with small signaling overhead and short startup delay[ 21].

### 5 Background of the strategies used

The considered queuing local networks consist of one or more nodes with a given structure. The jobs that want to served move between these nodes.

"The nodes consist of a waiting queue and one or more servers" [17]. If an arriving job does not find a free server, it joins the queue. The members of this queue will served by a pre defined serving method. When a job is finished, it moves to another node with a given transition probability or it leaves the node.

The help of Kendall notation can describe the queuing systems as follows:

\textbf{A/B/c-serving principle, Where is:}

- \( A \) is the distribution of arrival times of jobs.
- \( B \) is the distribution of serving times.
- \( c \) is the number of servers.

If the considered distribution is exponential it is denoted by \( M \) (Markovian) and in case of general distribution it is denoted by \( G \) Serving principles can served as follow:

- \textbf{FCFS} - First Come First Served.
- \textbf{LCFS} - Last Come First Served.
- \textbf{Resource path}.
- \textbf{Average queue length}.
- \textbf{Average waiting times}.

\textbf{FCFS PRE, (FCFS NONPRE)} jobs with higher priority may interrupt jobs with lower priority.

\textbf{FCFS ASYM servers} works with different serving times.

The \( M/M/m \) FCFS, \( M/G/1 \) pS, \( M/G/inf \) IS and \( M/G/1 \) LCFS PRE nodes are called as product form nodes. For queuing networks which consist of only these types of nodes an precise solution can be given described in [2],[10],[11].

The local network is called open network one if jobs come from a remote node (with a given strength) and after visiting the suitable nodes depart it. In case of closed local networks given number of jobs flow within the network

### 6 QMBSSLNS implementation

The QMBSSLNS is a new proposed model named by us for queuing local networks services. This model uses some scheduling strategies based on GCRA algorithm and Markov process to evaluate average performance measures. The framework will formulate the model in a visual implementation to improve the performance of the model. This implementation will simulate the queue length distribute, average responding, resource paths and throughput.

This proposal work demonstrates the importance of embedding QMBSSLNS model, which will illustrate the following:
What types of queuing networks can be examine?

What analysis methods will be available?

What performance measures calculated?

Which visions design used to simulate our results?

Therefore, we indicate in this paper the main theorems and methodologies behind the proposed model without excluding any graphical views of the QMBSSLNS implementation. A graphical representation of the system will be presented in a future work.

7 Conclusion

In this paper work, we introduce a proposed queuing model, which could characterize the product form in local network services, and their properties in a new model called a queue model based on scheduling strategies affect local network services (QMBSSLNS). An empirical assumption to the system performance evaluation considered to simulate the model. We represent the basic ideas such as the objectives, methodologies and the background of the strategies used in the model. Nearby we redirect our focuses to the important of the class of models in system performance evaluation. Some scheduling strategies such as first come first serve (FCFS), last come first serve (LCFS), overall throughput, resource path, average queue length and average waiting times will be indicating as well.

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