A
Project Presentation on

Provisioning of QoS to Multimedia Traffic in Cellular Networks

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Overview

Introduction

Motivation

Introduction

Provisioning of QoS to Multimedia Traffic in Cellular Networks

Where ?

1. In Wireless networks the most critical components are data compression, quality-of-service, communication protocols and effective digital management. We are providing QoS to cellular networks.

2. **Quality-of-service** is described as well-defined and controllable behavior of a system according to quantitatively measurable parameters.

Overview

Introduction

What ?

Provisioning of **QoS** to **Multimedia Traffic** in **Cellular Networks**

Media

Services

Applications

QoS Model (Components)

Source Traffic Information

Table 1: Types of Multimedia Services

Application	Description
Movies-on-Demand	Customers can select and play movies with full VCR capabilities.
Interactive Video Games	Customers can play downloadable computer games without having to buy a physical copy of the game
Interactive News Television	Newscasts tailored to customer tastes with the ability to see more detail on selected stories. Interactive selection and retrieval.
Catalog Browsing	Customers examine and purchase commercial products.
Distance Learning	Customers subscribe to courses being taught at remote sites. Student tailor courses to individual preferences and time constraints.
Interactive Advertising	Customers respond to advertiser surveys and are rewarded with free services and samples.

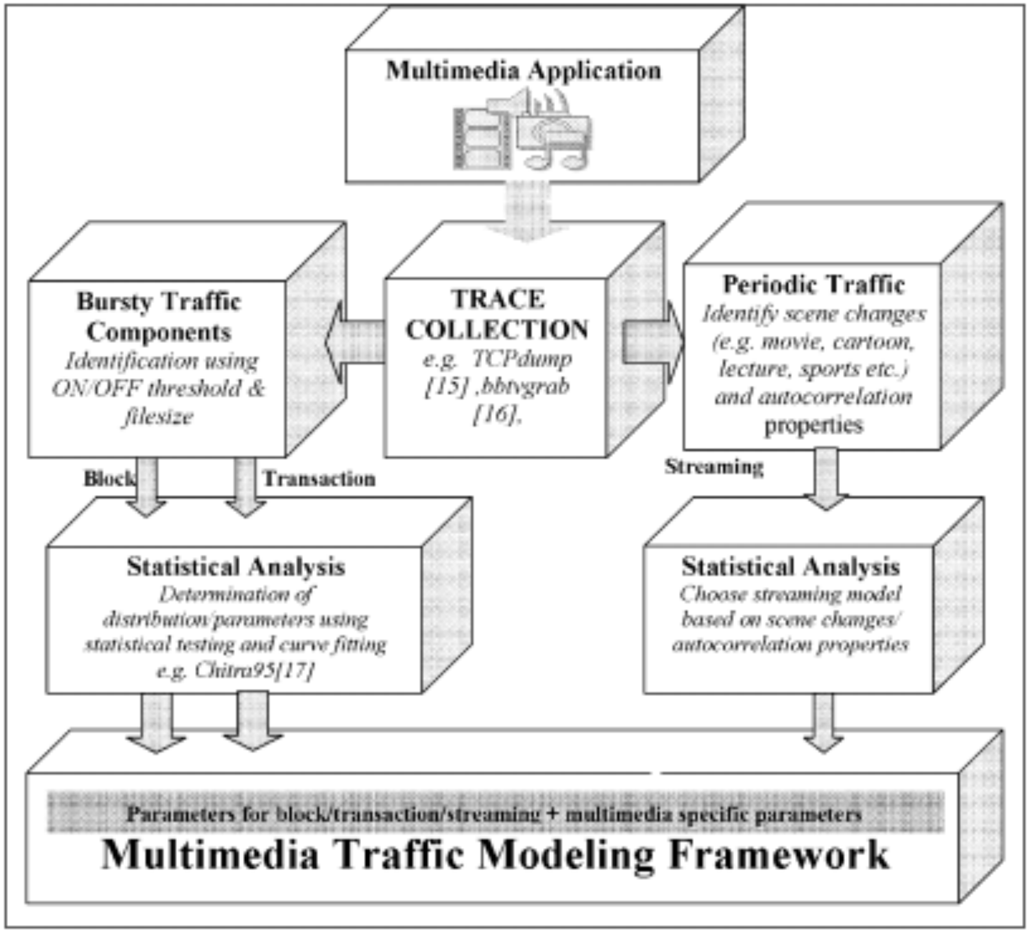
Multimedia QoS model for each multimedia application is more valuable to identify QoS patterns. (2 or more components)

Indicate the transmitted information

Literature Survey

Multimedia Applications
Bandwidth Model
Time Duration Model

Literature Survey- Multimedia Application



The multimedia traffic modeling process and the role of the proposed framework in this process.

Fig. Multimedia Traffic Modeling [2]

Overview

- Introduction
- Literature Survey
  - Multimedia application
  - Bandwidth Model
  - Time duration Model
- Proposed Work
- Analysis of Application groups
- Results
- Conclusion and Future Works
- Dissertation
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Bandwidth Reservation Model

Uniform and Bandwidth-Based Reservation Model:

In this model, it is assumed that user movement patterns are unknown, and the same amount of bandwidth is reserved in all neighboring cells. In addition, the amount of bandwidth to reserve is calculated based on the requested bandwidth of existing Class I connections. Specifically, the *largest of all* of the requested bandwidths, is used as the amount of bandwidth to reserve.

Movement- and Bandwidth-Based Reservation Model:

In this model, it is assumed that user movement patterns are known, and different amounts of bandwidth are reserved in different neighboring cells based on user movement patterns.

Highest Directionality is given connection.

Movement- and Number-of-Connections-Based Reservation Model:

The amount of bandwidth to reserve is calculated as a *function* of the number of existing Class I connections instead of the requested bandwidths.

Literature Survey- Duration Model

Distribution functions used in framework

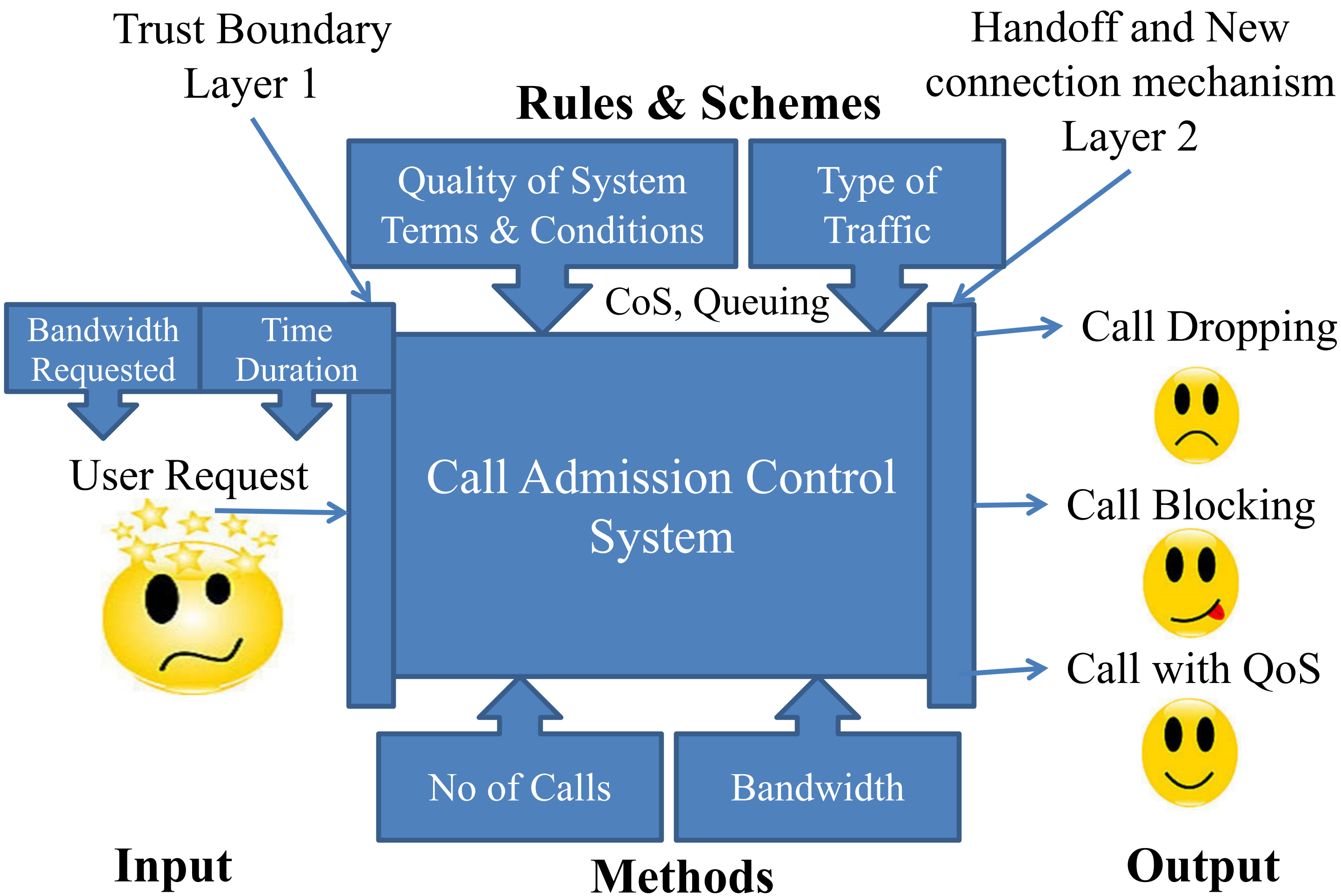
Continuous distributions	Cumulative distribution function (CDF)	Parameters to define
Exponential	$F(x) = 1 - e^{\frac{-x}{\mu}}$	• Mean (μ)
Weibull	$F(x) = 1 - e^{-(\frac{x}{\theta})^k}$	• Parameter θ • Parameter k
Pareto	$F(x) = 1 - \left(\frac{m}{x}\right)^{\alpha}$	• Parameter α. • Minimum value m
Normal	$F(x) = \int_{-\infty}^{\infty} x f(x) \, dx$, where $f(x) = e^{\frac{-(x-\mu)^2}{2\sigma^2}}$	• Mean, μ • Variance, σ^2
Lognormal	$F(x) = \Phi(\ln(x))$, where Φ is the CDF of the normal distribution	• Mean, μ • Variance, σ^2
Discrete distributions		
Poisson	$F(x) = \sum_{i=0}^{x} \frac{e^{-\mu}\mu^i}{i!}$	Mean, μ
Geometric	$F(x) = \sum_{i=0}^{x} p(1-p)^{i-1}$	Mean $= 1/p$

Fig. Mathematical Distribution functions [2, 10]

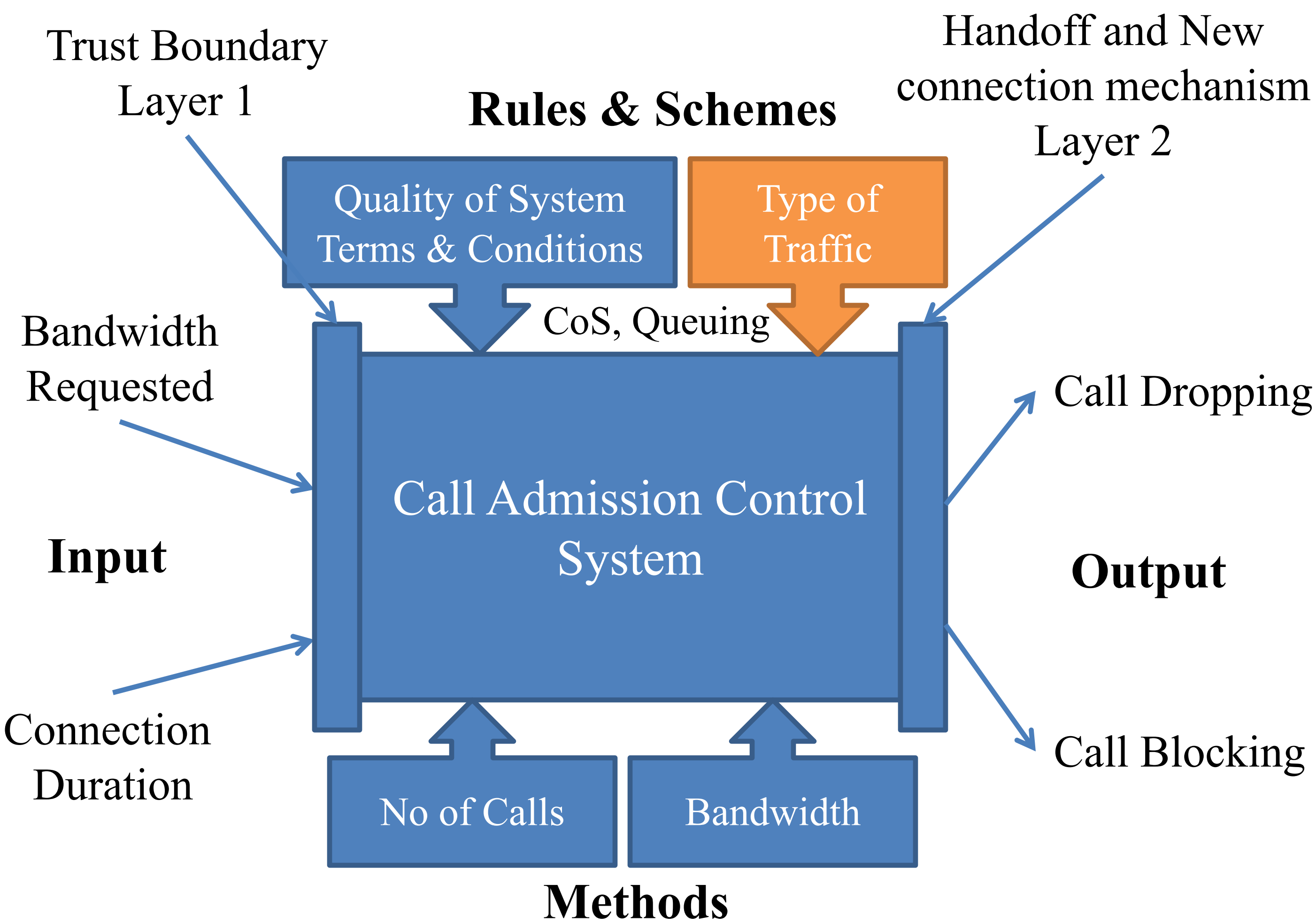
Proposed Work

- CAC Architecture
- Bandwidth Request Model
- QoS Allocation Model
- Connection Duration Model
- CAC System

CAC Architecture



Multimedia Traffic



Variable Bit Rate Traffic

What is?

Compression Schemes

Where it is used?

Multimedia Applications

Why this is used?

Characteristics of Application (LRD and SRD properties).

Who are included?

Video Streaming, VOIP and Online gaming,
often demand seamless real time delivery.

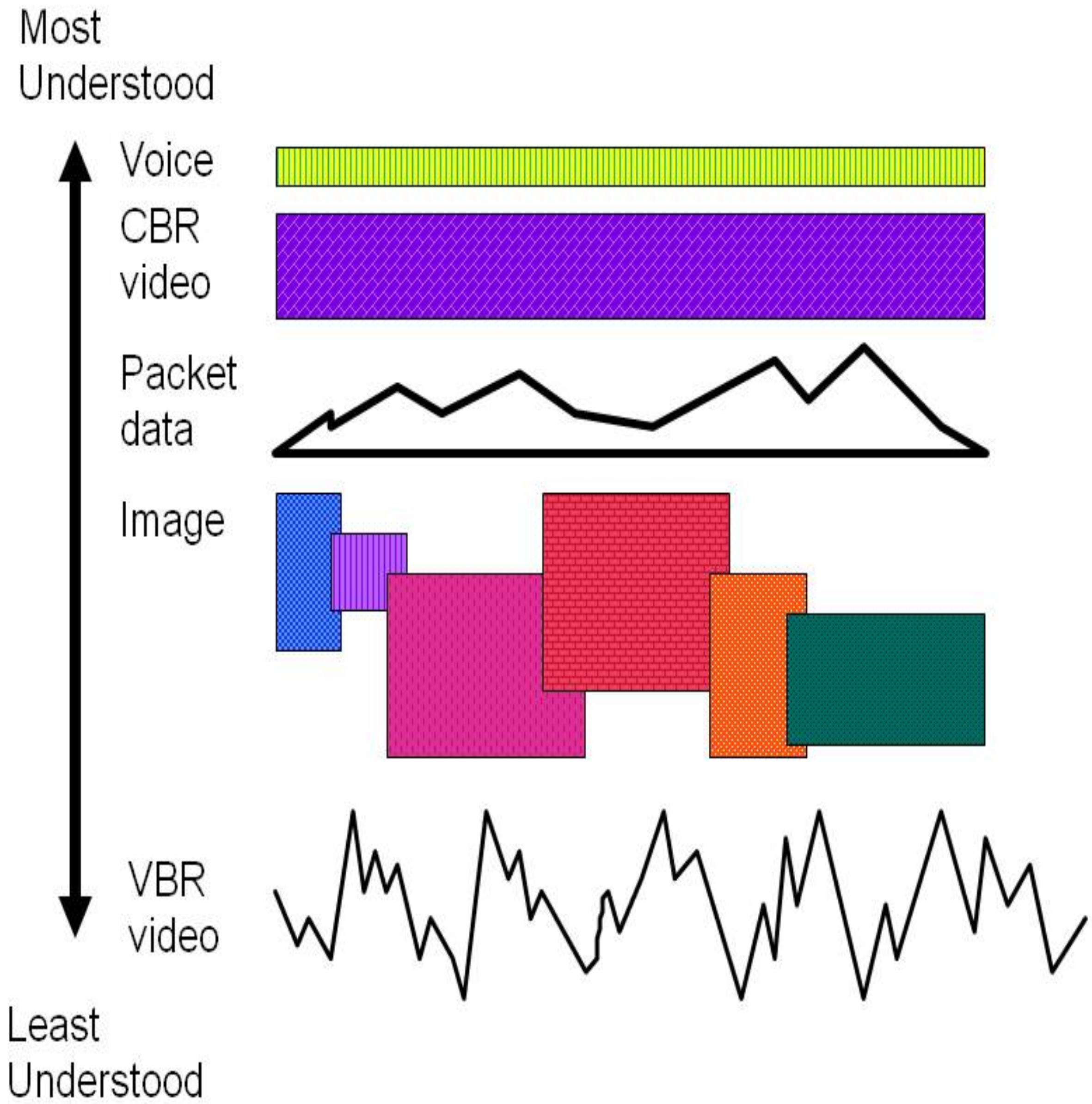
When it is used?

For better understanding of traffic.

How it is used?

It is used as a stochastic process (Numerical Variable).

Traffic Characterization



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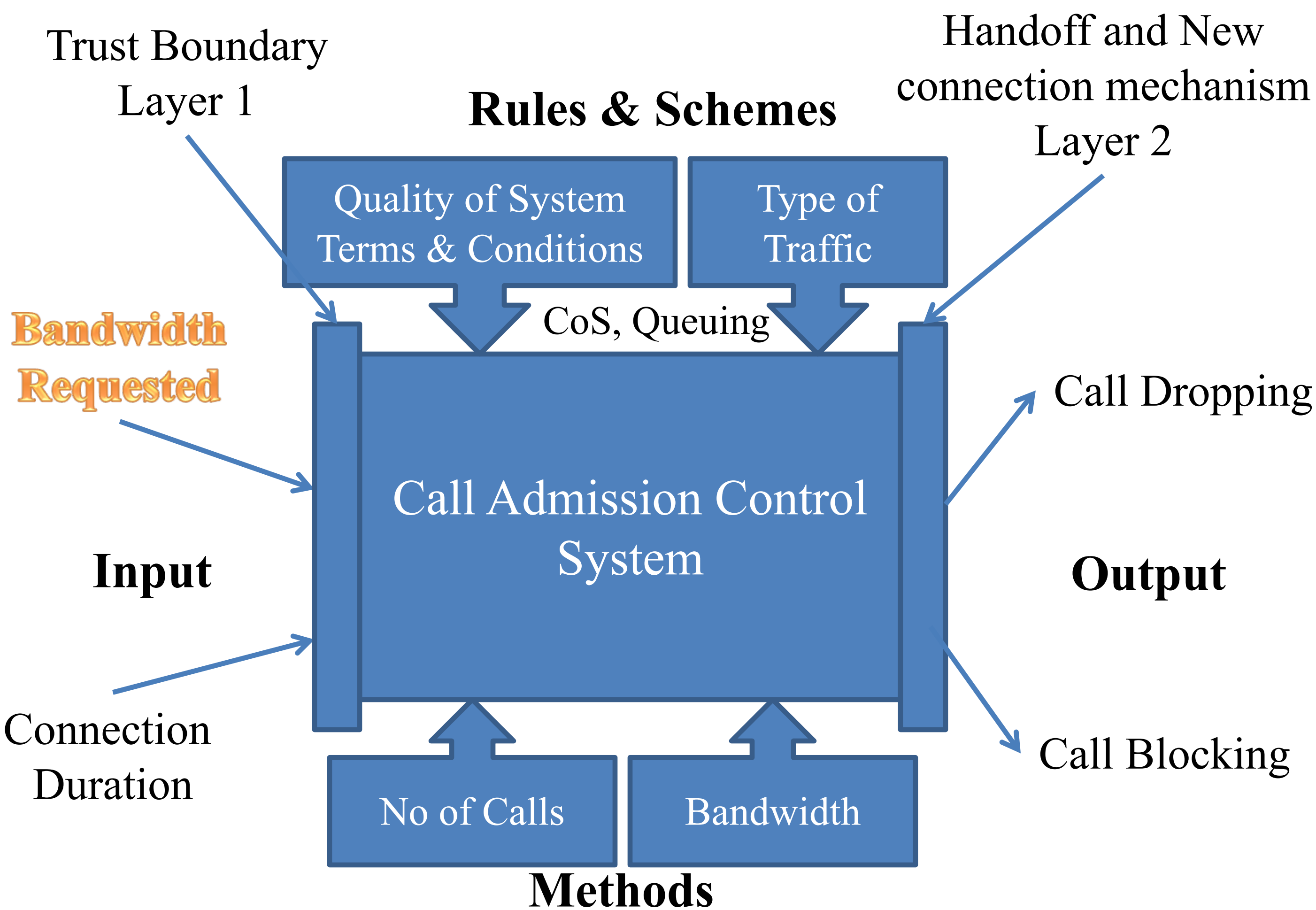
Bandwidth Request Model



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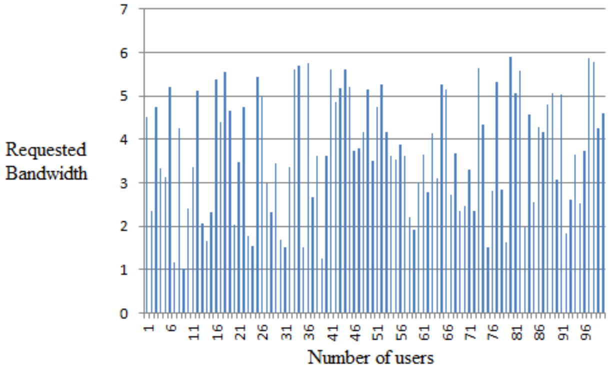
Bandwidth Request Model

1. Observation



2. Classification

Applic. Group	Traffic Class	Bandwidth Requirement	Average Bandwidth Requirement (b_i)
1	I	30 Kbps (CBR)	
2	I	256 Kbps (CBR)	
3	I	1-6 Mbps (average) 2.5-9 Mbps (peak) (VBR)	3 Mbps
4	II	5-20 Kbps (UBR)	10 Kbps
5	II	64-512 Kbps (UBR)	256 Kbps
6	II	1-10 Mbps (UBR)	5 Mbps

3. Analysis

Bandwidth Requirement

It is found that bandwidth requirement follows Rayleigh distribution.

$$f(x) = \begin{cases} \frac{x}{\sigma^2} e^{\frac{-x^2}{2\sigma^2}} & x \geq 0 \\ 0 & otherwise \end{cases}$$

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4. Proposed Function

The random variable B_{req} is said to be distributed with parameter
B_{min}: Minimum Bandwidth requested by the user.
B_{max}: Maximum bandwidth requested by the user.
B_{req} : Bandwidth requested by the user.

Case 1: If $B_{req} < B_{min}$ then $B_{req} = 0$;

$$f(B_{req}) = \begin{cases} \frac{B_{req}}{\sigma^2} e^{\frac{-B_{req}^2}{2\sigma^2}} & B_{req} = 0 \end{cases}$$

So, $f(B_{req}) = 0$

Case 2: If $B_{min} \leq B_{req} \leq B_{max}$;

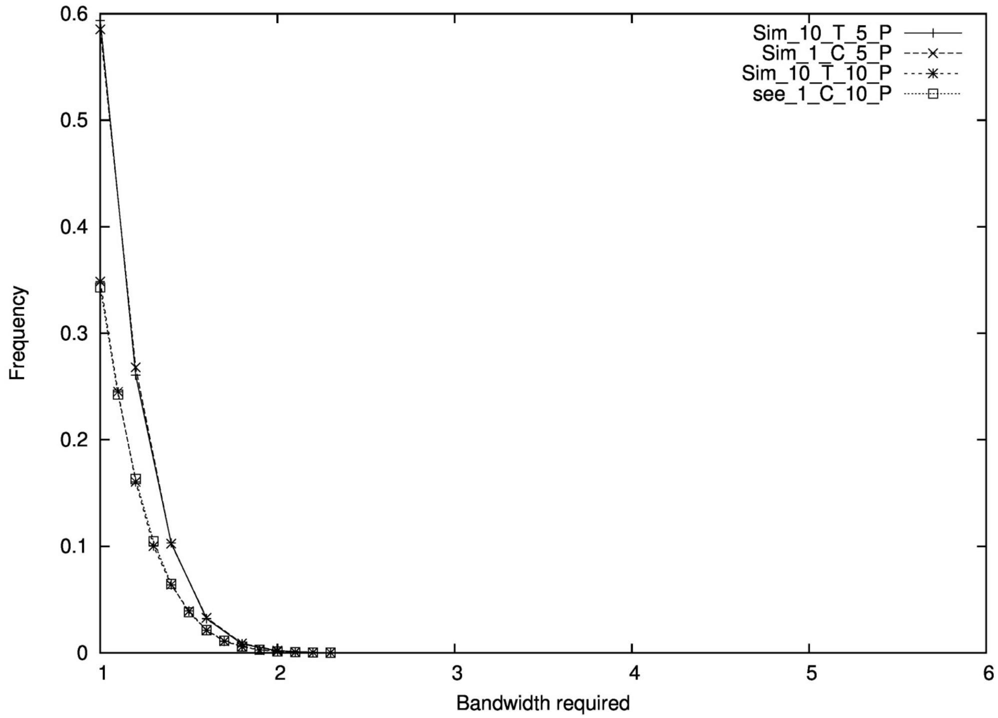
$$f(B_{req}) = \begin{cases} \frac{B_{req}}{\sigma^2} e^{\frac{-B_{req}^2}{2\sigma^2}} & B_{req} > 0 \end{cases}$$

Case 3: If $B_{req} > B_{max}$

$$f(B_{req}) = \begin{cases} \frac{B_{req}}{\sigma^2} e^{\frac{-B_{req}^2}{2\sigma^2}} & B_{req} = 0 \end{cases}$$

So, $f(B_{req}) = 0$

5. Results



6. Performance Evaluation

Less number of Samples		Large number of Samples	
10,000		10,000,000	
Precision		Precision	
Case 1: Small (5)	Case 3: Large (10)	Case 2: Small (5)	Case 4: Large (10)

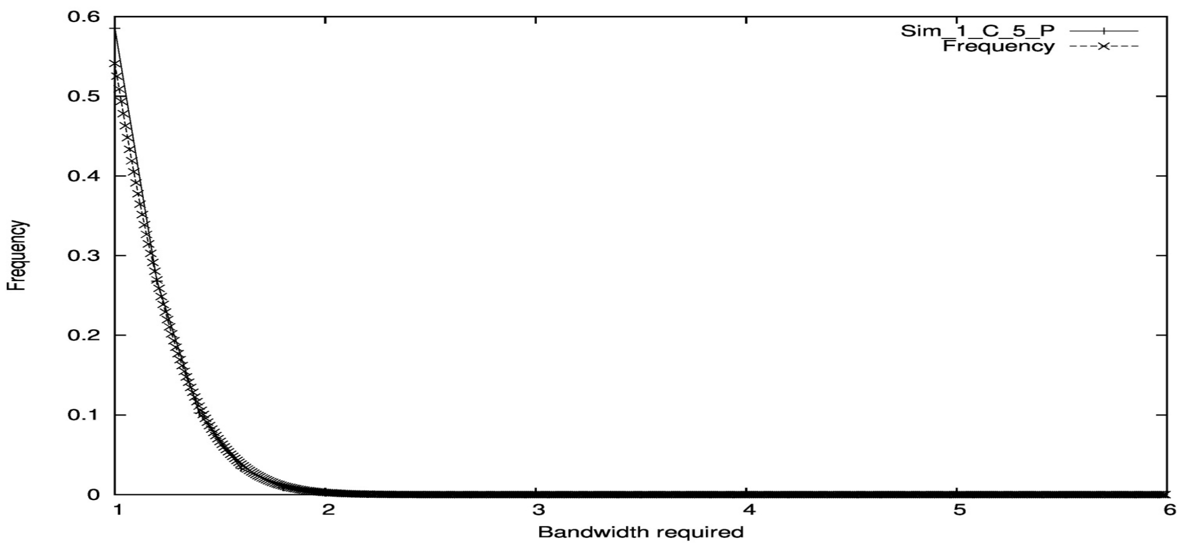
7. Verification

Random Number Generation

By Inverse transform Sampling method, we obtain random number generation is obtained efficiently from the distribution. We use the U and σ as parameters to obtain the random numbers.

Steps to obtain random number generation:-

1. Firstly, generate the distribution function U.
   $$U \sim U\ (0, 1) \sim f\ (B_{req}).$$
2. For generating random numbers for B_{req}. We obtain it by
   $$B_{req} = \sigma * \sqrt{(-2\log(1-U))}$$



8. Further Investigations

Average Bandwidth Requirement (B_{avg}):

The average bandwidth requirement B_{avg} of the connection which is defined as mean of the distribution:

$$\mu = \sigma^k 2^{\frac{k}{2}} T(1 + \frac{k}{2})$$

$$\mu = \sigma\sqrt{\frac{\pi}{2}}$$

Where k is the number of repetitions.

Where as the σ simulation parameter which is defined as follows:

$$\sigma = \sqrt{\frac{1}{2N}\sum_{i=1}^{N} {x_i}^2}$$

Where N is total number of samples.

Bandwidth Request Model

Table 1: Application Group 3

Traffic Class	: Real Time Traffic (Adaptive)	
Parameter	**Values**	**Description**
B_{min}	1 Mbps	Minimum Bandwidth requested by the user
B_{max}	6 Mbps	Maximum Bandwidth requested by the user
σ	2.677069	Simulation parameter
B_{avg}	3.355884	Average Bandwidth Requirement
Example: Interactive Multimedia		

Table 2: Application Group 3

Traffic Class	: Real Time Traffic (Adaptive)	
Parameter	**Values**	**Description**
B_{min}	2560 kbps	Minimum Bandwidth requested by the user.
B_{max}	9216 kbps	Maximum Bandwidth requested by the user.
σ	4379.583 984	Simulation parameter
B_{avg}	5490.098 145 kbps	Average Bandwidth Requirement
Example: Video-on-demand		

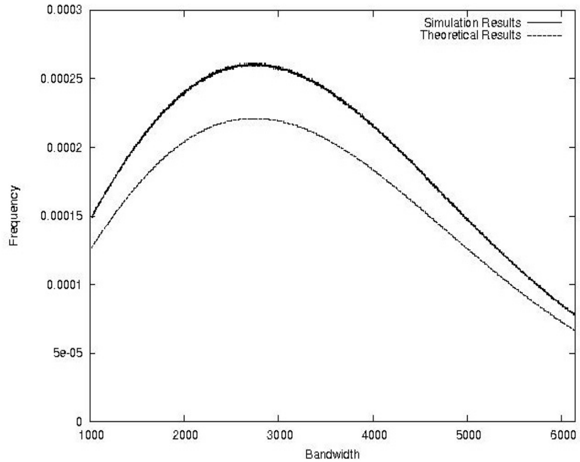


Fig 1. Bandwidth Requested by the user vs. Frequency distribution of theoretical and simulation results of Table 1.

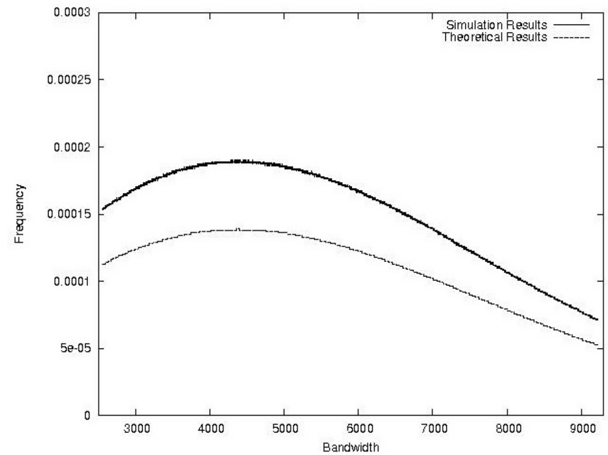
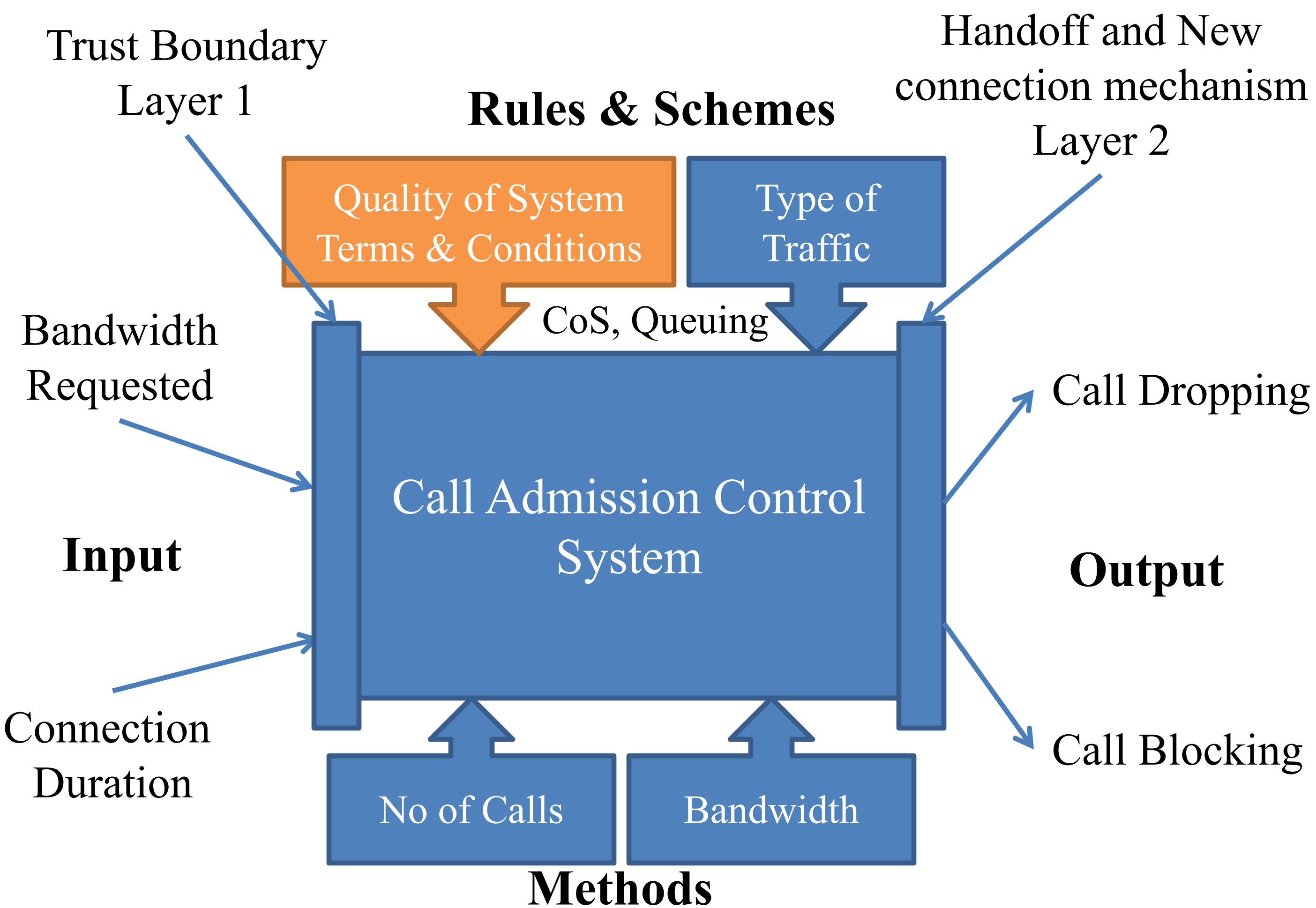


Fig.2. Bandwidth Requested vs. Frequency distribution of theoretical and simulation results of Table 2.

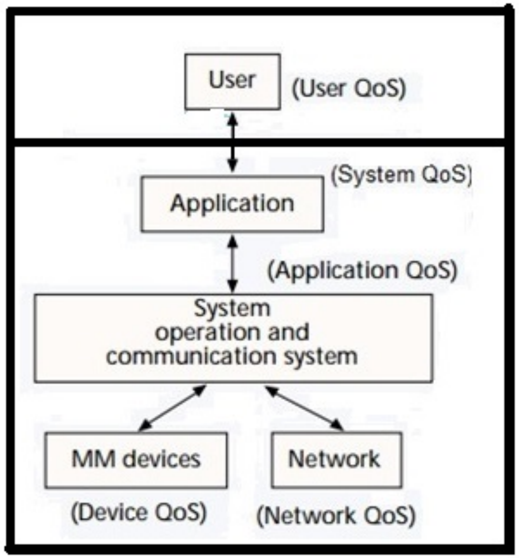
Overview

QoS Allocation Model



Overview

1. Observation



2. Classification

Application	Description
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Distance Learning	Customers subscribe to courses being taught at remote sites. Student tailor courses to individual preferences and time constraints.
Interactive Advertising	Customers respond to advertiser surveys and are rewarded with free services and samples.

3. Analysis

QoS Allocation

It is found that bandwidth requirement follows Geometric distribution.

If $p_k = pq^{k-1}$, k = 1, 2, 3, q = 1-p, then

$$G_X(s) = \frac{ps}{1 - qs} \text{ if } |s| < q^{-1}$$

4. Proposed Function

Let us Consider a random variable B_{alloc} (Bandwidth requested i.e., a discrete Random variable taking non negative values). It is written as follows:

p: Value generated from pseudo random numbers from the system

q:Value generated from pseudo random numbers from the system

(q=1-p)

B_{min}: Minimum bandwidth requested for the user

B_{max}: Maximum bandwidth values is acceptable for the connection

B_{req} :Bandwidth requested by the user

B_{alloc}: Bandwidth allocated by the system

Case1: If $B_{alloc} < B_{min}$ then $B_{alloc} = 0$ and

$$G_{QoS}(B_{alloc}) = 0$$

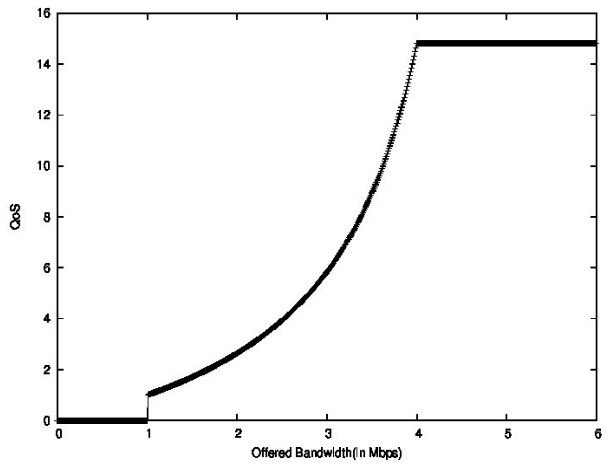
Case 2: If $B_{min} \leq B_{req} \leq B_{max}$ and if $|B_{alloc}| < q^{-1}$

then $B_{alloc} = B_{req}$ and $G_{QoS}(B_{alloc}) = \frac{pB_{alloc}}{1-qB_{alloc}}$

Case 3: If $B_{max} < B_{req} < \infty$ and if $|B_{req}| < q^{-1}$

then $B_{alloc} = B_{req}$ and $G_{QoS}(B_{alloc}) = \frac{pB_{max}}{1-qB_{max}}$

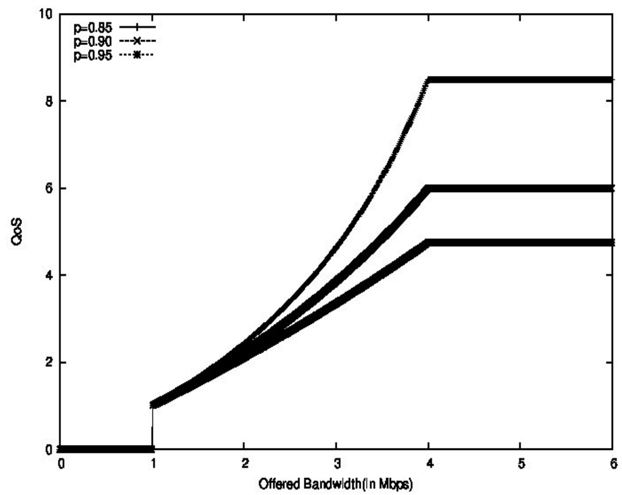
5. Results

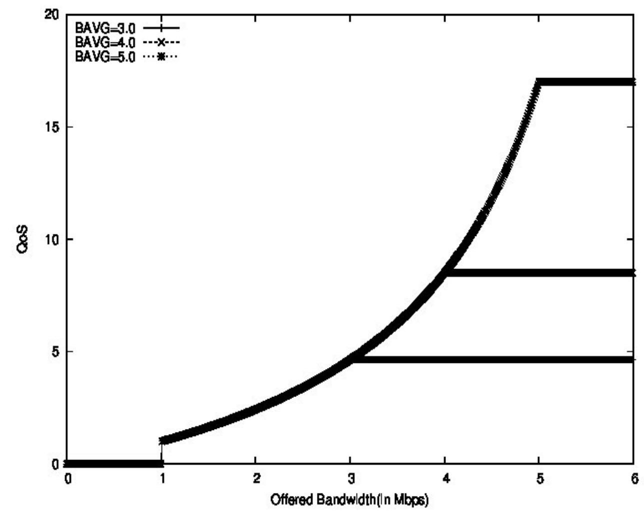


Simulation Parameters

Parameter	Values	Description
p	0-1	Pseudo-random value generated by the system
q	0-1 (q=1-p)	Pseudo-random value generated by the system
B_{min}	1 Mbps	Minimum Bandwidth which is required for the connection.
B_{max}	6 Mbps	Bandwidth values which are above the acceptable condition B_{avg}.
B_{avg}	3 Mbps	Maximum Bandwidth value which is accepted by the connection.
B_{alloc}	Random Variable	Requested Bandwidth allocated to the connection

6. Performance Evaluation

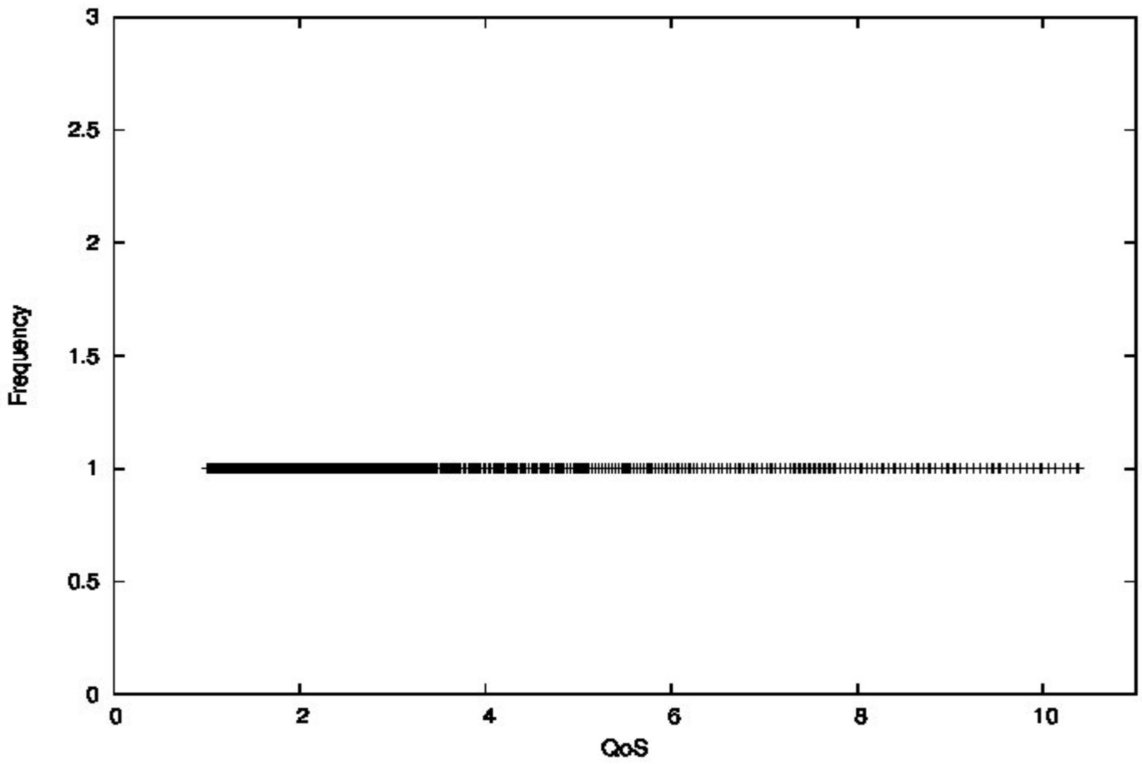




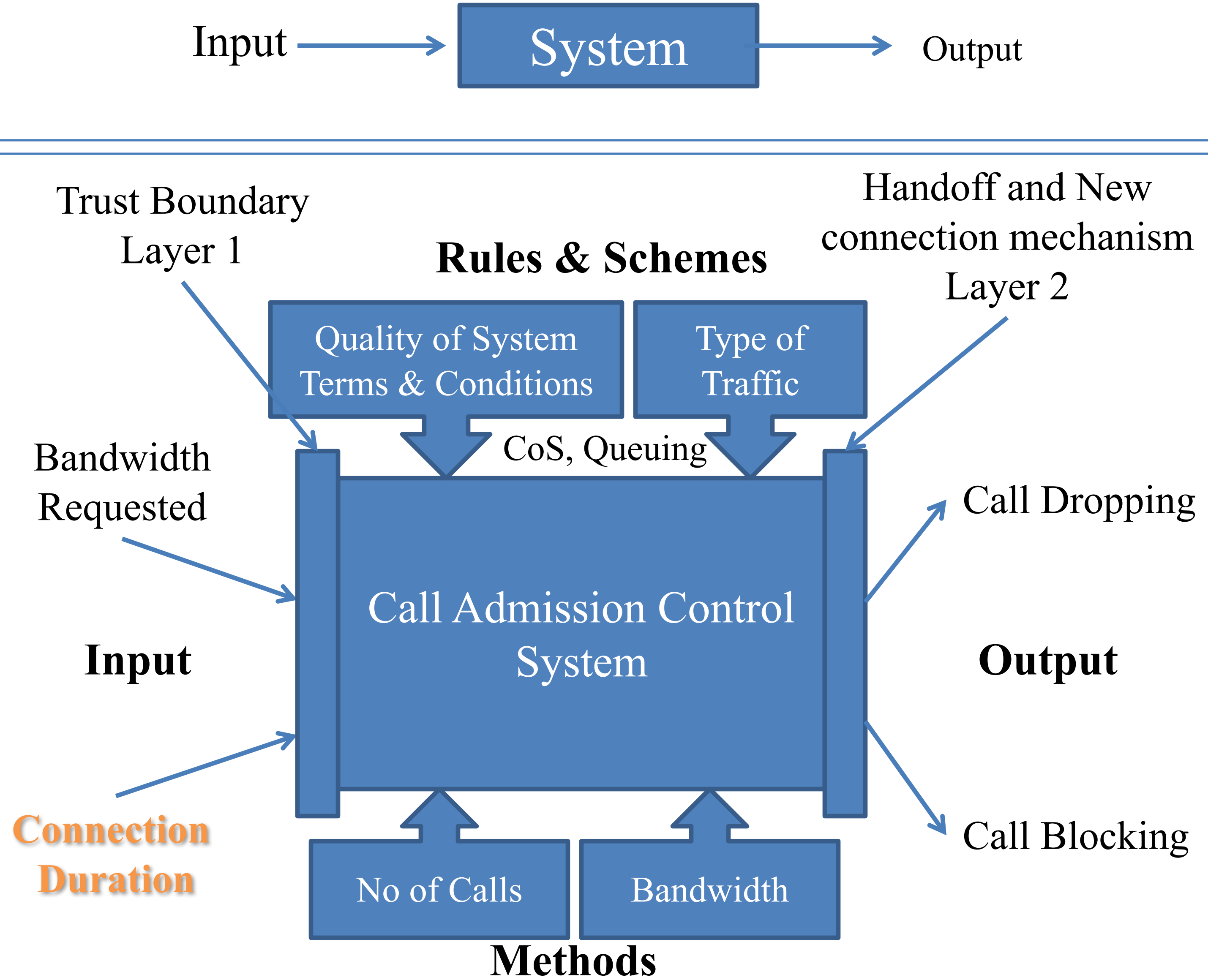
7. Verification

Uniqueness Theorem

If X and Y have G_X and G_Y respectively, then $G_X(s) = G_Y(s)$ for all s iff $P(X=k) = P(Y=k)$ for k=0, 1, i.e. if and only if X and Y have the same probability distribution.



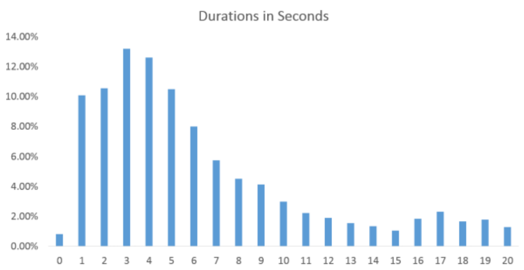
Connection Duration Model



Overview

Connection Duration Model

1. Observation



2. Classification

Applic. Group	Traffic Class	Connection Duration	Average Connection Duration (t_i)	Example
1	I	1 - 10 m	3 minutes	Voice Service & Audio-phone
2	I	1 - 30 m	5 minutes	Video-phone & Video-conference
3	I	5 m - 5 h	10 minutes	Interact. Multimedia & Video on Demand
4	II	10 - 120 s	30 seconds	E-mail, Paging & Fax
5	II	30 s - 10 h	3 minutes	Remote Login & Data on Demand
6	II	30 s - 20 m	2 minutes	File Transfer & Retrieval Service

3. Analysis

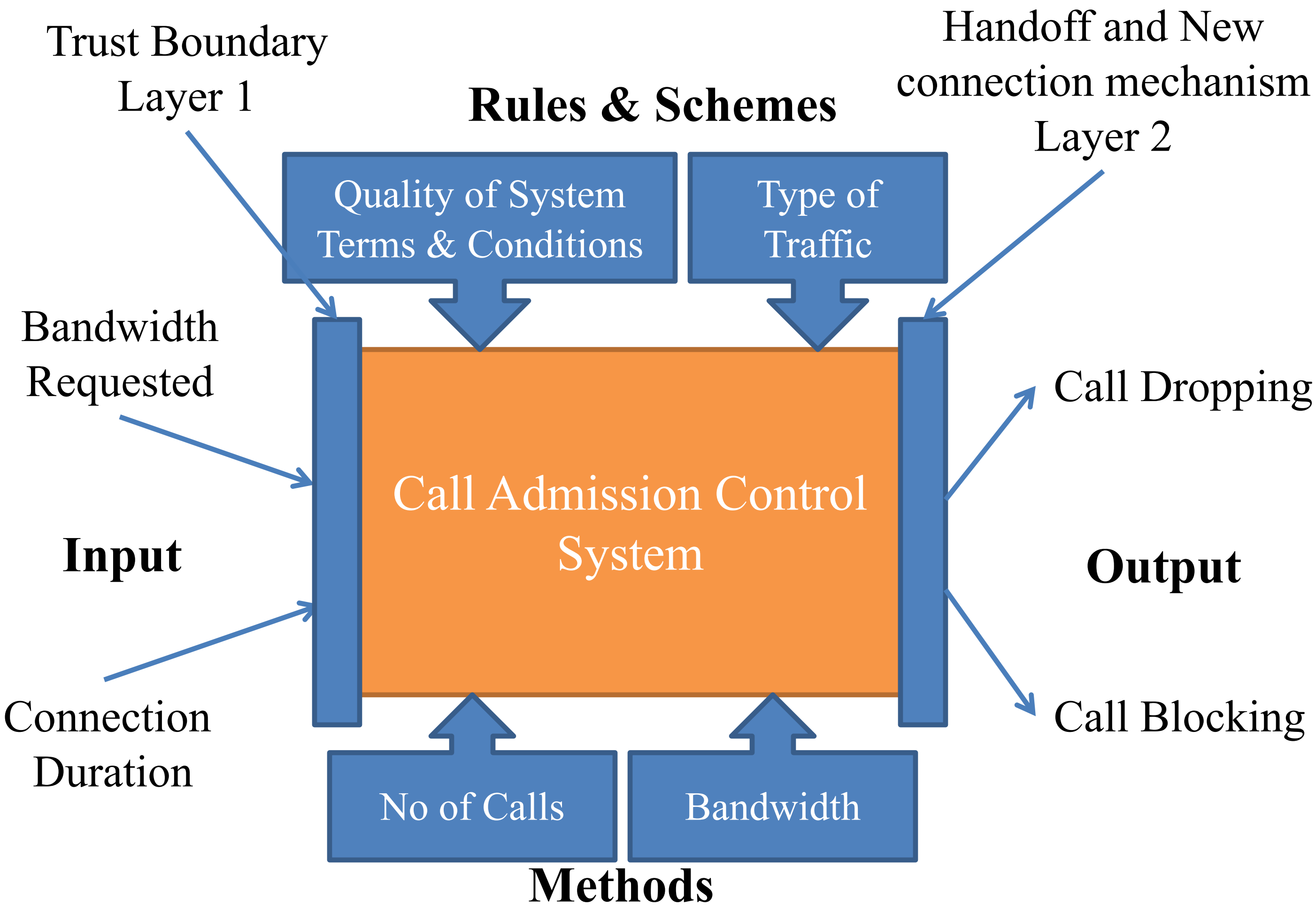
Connection Duration

It is observed that connection duration follows Poisson distribution.

$$f(x) = \frac{\lambda^k}{k!} e^{-\lambda}$$

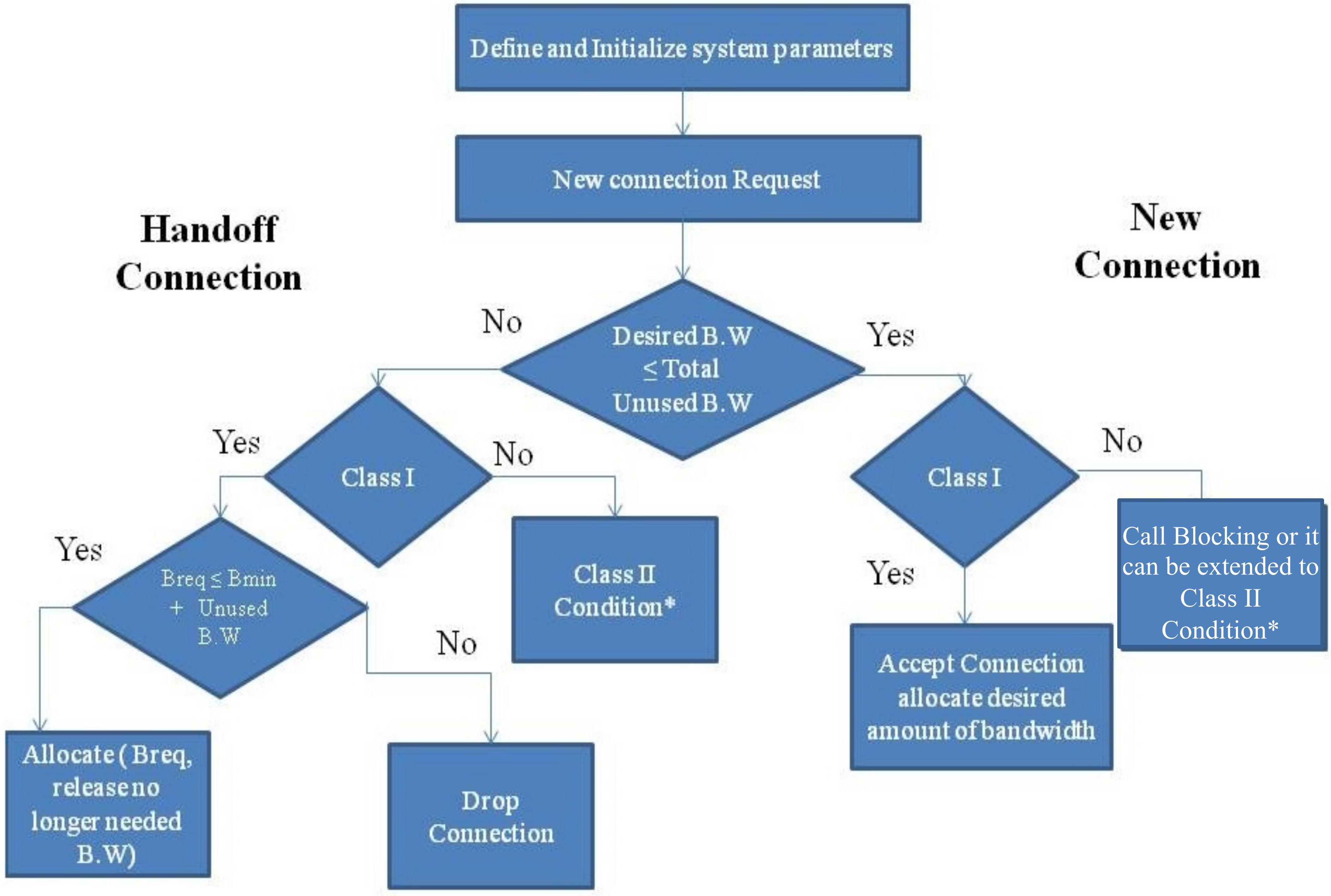
CAC System

Input
System
Output



Trust Boundary
Layer 1
Rules & Schemes
Handoff and New connection mechanism
Layer 2
Quality of System Terms & Conditions
Type of Traffic
Bandwidth Requested
Call Dropping
Call Admission Control System
Input
Output
Connection Duration
Call Blocking
No of Calls
Bandwidth
Methods

Flow Chart of CAC System



Analysis of Application Groups

Real Time Application Group
(Interactive Services and Video on Demand)

Analysis of Traffic

Table 1: Application Group 1

Traffic Class	: Real Time Traffic (Hard)	
Parameter	**Values**	**Description**
B_{req}	30 Kbps	Bandwidth Request for CBR Traffic
σ	0.5	Simulation parameter
$f(B_{req})$	0-1	Uniform distribution values
Example: Voice Service and Audio-phone		

Time Duration Model

Table 2: Application Group 2

Traffic Class	: Real Time Traffic (Hard)	
Parameter	**Values**	**Description**
B_{req}	256 kbps	Bandwidth Requirement for CBR Traffic
σ	0.5	Simulation parameter
$f(B_{req})$	0-1	Uniform distribution values
Example: Video-phone and Video-Conference		

Time Duration Model

Bandwidth Model

Table 3: Application Group 3

Traffic Class	: Real Time Traffic (Adaptive)	
Parameter	**Values**	**Description**
B_{min}	1 Mbps (Average)	Minimum Bandwidth requested by the user
B_{max}	6 Mbps (Average)	Maximum Bandwidth requested by the user
Σ	0.5	Simulation parameter
B_{req}	Random generation	Bandwidth generated by the system
$f(B_{req})$	0-1	Uniform distribution values
Example: Interactive Multimedia		

Time Duration & Bandwidth Model

Table 4: Application Group 3

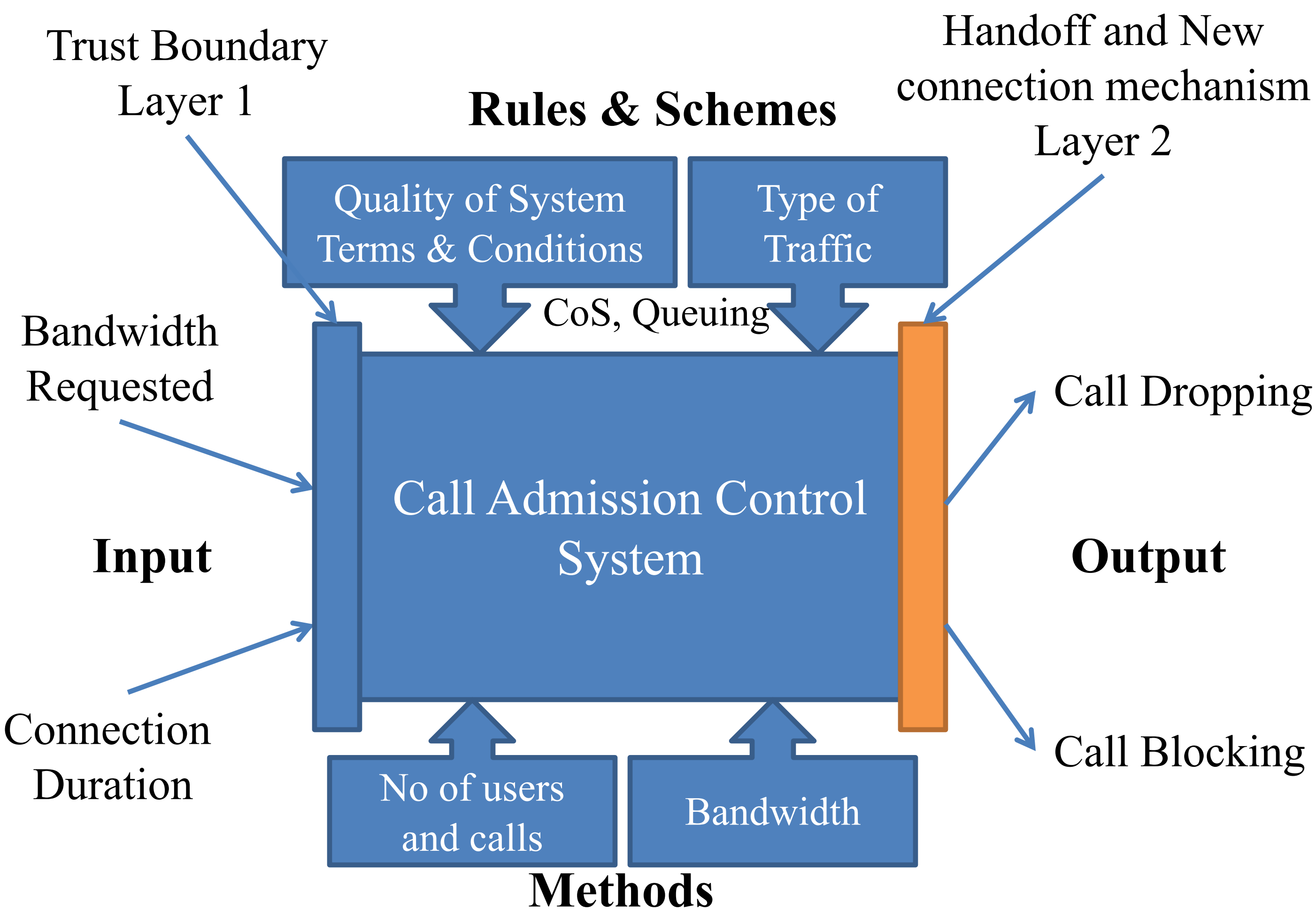
Traffic Class	: Real Time Traffic (Adaptive)	
Parameter	**Values**	**Description**
B_{min}	2.5 Mbps (peak)	Minimum Bandwidth requested by the user.
B_{max}	9 Mbps (peak)	Maximum Bandwidth requested by the user.
B_{req}	Random generation	Bandwidth generated by the system
σ	0.5	Simulation parameter
$f(B_{req})$	0-1	Uniform distribution values
Example: Video-on-demand		

Time Duration & Bandwidth Model

Results

Overview

Results



Overview

Process for CAC

- Call arrival process for new calls and handoff calls are all ***Poisson process***.
- Channel holding times for new calls and handoff calls are ***exponentially distributed***.
- Both the process depends upon the cell residence time distribution. It is to show how call-blocking probabilities can be approximated when the ***channel holding times*** for new calls and handoff calls have different averages

Results for CAC

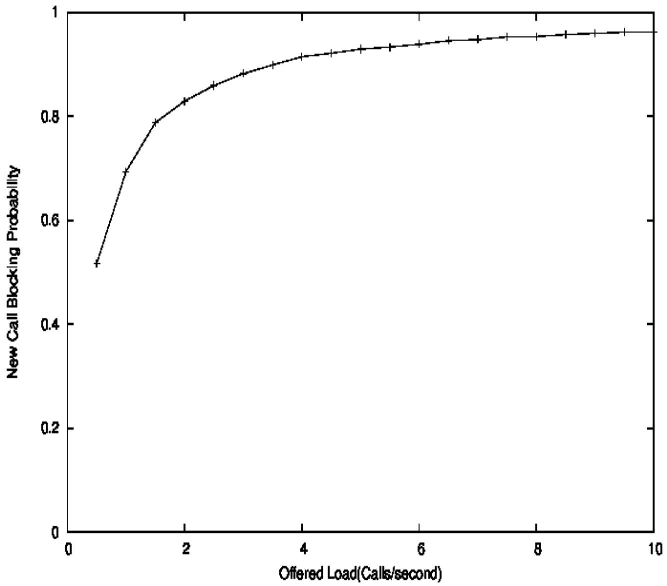
Call Blocking

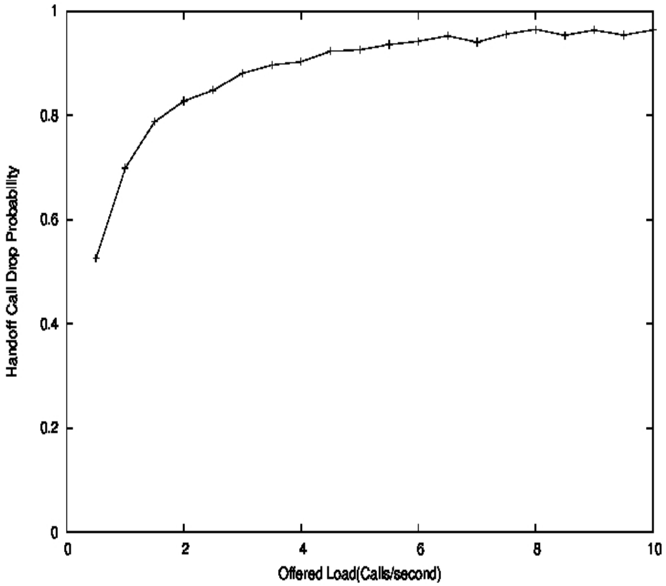
The CAC takes offered bandwidth as input and call blocking probability as output.

Call Dropping

The CAC takes offered bandwidth as input and call dropping probability as output.

Parameter	Values	Description
N	10 Cells	Number of cells in the system
P_{HD}	0.5	Handoff dropping rate
P_{NB}	0.5	Call blocking rate
$thres\_up_1$	1.0	Upper threshold for dropping probability
$thres\_down_1$	0.5	Lower threshold for dropping probability
$thres\_up_2$	1.0	Upper threshold for reserved pool utilization
$thres\_down_2$	0.5	Lower threshold for reserved pool utilization
λ_H	$0.01 sec^{-1}$	Handoff call arrival rate
λ_N	0-10 calls/sec	New call arrival rate.





Overview

Conclusion and Future Works

Overview

Conclusion and Future Works

- To end of my work I have proposed
    1. An Appropriate CAC System
    2. Bandwidth Request Model
    3. QoS Allocation Model

  Considering Real-time Traffic Application Group 3 such as Interactive multimedia and Video on Demand applications.

- In future, I would like to extend my work by using other
    1. Application groups such as real time and non real time traffic.
    2. Call admission control techniques like prioritizing the calls.

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Queries?

Overview


Thank You!