

# Quality of Service (QoS) Indian Experience & Issues for IP/NGN

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## Agenda

- Regulatory Issues in QoS
- QoS Regulations in India
  - Basic Service (Wire line)
  - Cellular Telephone Services (Basic wireless + Cellular Mobile)
- QoS Monitoring Approach
  - Objective Assessment of QoS parameters achievement reported by Service Providers
  - Objective & Subjective Assessment by Independent Agency
- Telecom Market in India-- Competition level: need for QoS Regulation
- IP/NGN Concepts/Issues
- QoS requirements for IP/NGN
- Conclusions

## QoS Definitions

The term “Quality of Services” (QoS) is defined as “the collective effect of service performance which determines the degree of satisfaction of a user of the service”.

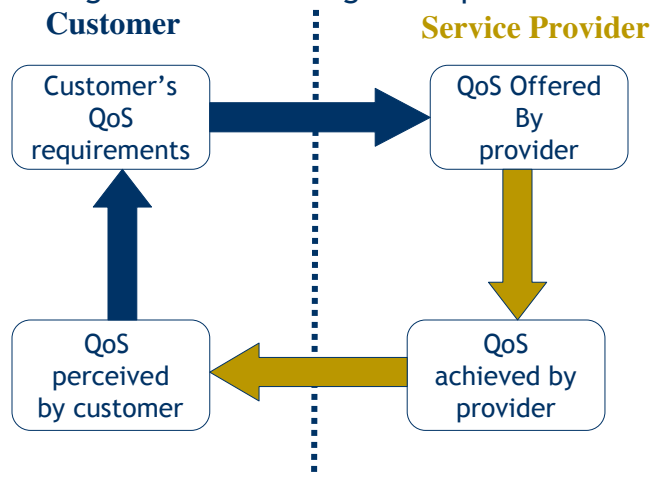
ITU-T Rec. E. 800

A set of quality requirements on the collective behaviour of one or more objects. QoS may be specified in a contract or measured and reported after the event. The QoS may be parameterized.

ITU-T Rec. X.902

## Quality Criteria Perspective

QoS to be truly useful and practical enough, it must be meaningful from following 4 viewpoints:



## Regulatory Issues in Quality of Service

- Regulating Telecom QoS is a challenge
- Price-Quality Trade off - Developing economies has considerable importance when we talk affordability issues, increasing penetration & Teledensity
- **If Quality is not regulated:**
  - Expected result is that quality will get worse and also consumer protection issue will be difficult to address
- **Need for Regulating QoS:**
  - Enable the customer to have information about the quality of service provided by different Service Providers - informed choice
  - Define the set of Parameters & benchmarks depending on the state of development and competition. The importance & priority of parameters may vary and depends on concerns areas like provisioning, call completion rate/ Point of Interconnect (POI) Congestion, tariff & billing and customer care etc

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## Regulatory Issues in Quality of Service

### Approaches to Regulating Quality of Service:

- **Encouragement Approach:**
  - Relies on the power of publicity and level of competition
  - Service Providers are required regularly to measure and publish the specified quality performance parameters achieved
- **Enforcement Approach:**
  - Defining set of QoS parameters and benchmarks
  - Standards may be set at the individual level and customer compensation if standards are not met- example rental rebate (credit policy)
  - Standards may be set at aggregate level with overall penalties to be imposed on non compliances
  - Difficult to design an enforcement system that accurately reflects customers' preferences and avoids distortions
- In the developing economies, how stringent should be the quality of service standards, social objectives of affordability and accessibility need consideration:- Price - Quality Trade off
- QoS standards need periodical review in view of the state of networks development, competition level and fulfillment of social objectives

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## QoS Regulations in India

Telecom Regulatory Authority of India (TRAI) ([www.trai.gov.in](http://www.trai.gov.in))

### Regulations on Quality of Service (QoS):

- Basic Service (Wire line)
- Cellular Mobile Telephone Services (Basic wireless + Cellular Mobile)
- Internet Services
- VoIP based International Long Distance Service
  
- Code of Practice for Metering & Billing Accuracy
  
- Broadband Services (under issue)

## QoS Regulations in India

### Directions(related to QoS):

- Direction on information to customers about complete detail of the tariff plan.
- Direction - submission of periodical reports pertaining to telecom service provision (QoS) - PMR)
- Direction regarding Value Added Services.
- Direction regarding Premium Rate Services.
- Direction for meeting the Quality of Service Benchmark
- Draft Direction on issue of Docket Number for customer complaints and termination of service

## QoS Regulation Parameters: Benchmarks for Basic (Wire line) Services

### QoS Parameters:

Sl	QoS Parameter	(Benchmark)
1	Provision of Telephone	(100% within 7days subject to technical feasibility)
2	Fault Incidences	(No of faults/100 Subscribers/month: < 5 per month)
3	Fault repair by Next Working Day	(> 90%), within 3 Working Days (100%)
4	Mean Time to Repair (MTTR)	(<8 Hrs)
5	Grade of Service	(0.002 Local Jn, 0.005 TAX Jn)
6	Call completion rate within local network	( > 55%)

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## QoS Regulation Parameters: Benchmarks for Basic (Wire line) Services

### QoS Parameters:

Sl	QoS Parameter	(Benchmark)
7	Metering & Billing Credibility	(Not more than 0.1 % of Bills issued to be disputed)
8	Customer Care (Shifts, Closures, Add. Facility)	(within 3 days, 24 hrs, 24 hrs)
9	Response Time to Customer for Assistance	( within 60 Sec= 80%, within 90 Sec = 95%)
10	Time taken for refund of deposits after closures	(100% within 60 days)

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**QoS Regulation Parameters: Benchmarks  
for Basic Services (Wireless) & Cellular Mobile Services**

**QoS Parameters:**

Sl	QoS Parameter	(Benchmark)
1	Accumulated down time of Community Isolation	(< 24 Hrs)
2	Call set-up Success Rate (within licensees own network)	(>95%)
3	Service Access Delay	(< 15 sec)
4	Blocked Call Rate	
	i.SDCCH/Paging Channel Congestion	(< 1%)
	ii.TCH Congestion	(< 2%)
5	Call Drop Rate	(< 3%)
6	Percentage of connections with good voice quality	(>95%)

**QoS Regulation Parameters: Benchmarks for Basic Services (Wireless) &  
Cellular Mobile Services**

**QoS Parameters:**

Sl	Parameter	(Benchmark)
7	Service Coverage (Indoor > -75 dBm, In Vehicle >-85 dBm, Outdoor > -95 dBm)	
8	Point of Interconnect (POI) Congestion	(< 0.5%)
9	Response Time to Customer for Assistance ( within 60 Sec= 80%, within 90 Sec = 95%)	
10	Billing complaints per 100 bills issued	(< 0.1%)
11	% of Billing Complaints resolved within 4 weeks	(100%)
12	Period of all refunds due to customers from the date of resolution of complaints	(< 4 Weeks)

## QoS Regulation - Basic and Mobile

### Customer Perception of Service Parameters:

Sl	Parameter	(Benchmark)
1	% Satisfied with the Provision of Service	(>95%)
2	% Satisfied with the Billing performance	(>90%)
3	% Satisfied with help Services	(>90%)
4	% Satisfied with Network Performance, Reliability and Availability	(>95%)
5	% Satisfied with Maintainability	(>95%)
6	% Satisfied with Overall Customer Satisfaction	(>95%)
7	% Satisfied with Overall Customer Satisfaction with Supplementary Services	(>95%)

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## QoS Monitoring -1

### OBJECTIVE ASSESSMENT OF QoS

- **Performance Monitoring Reports (PMR) on various QoS Network Parameters achievements Submitted by Service Providers**
  - Monthly PMR
  - Quarterly PMR
  - Comparison of data with QoS Benchmarks
  - Press Release and Performance Indicators Published in TRAI Web Site - effective tool for regulation (Publicity)
  - Mainly persuasive approach followed but in few cases intervention through show cause notices or directions
  - Based on the analysis of generic complaints & feedback of consumers new directions issued on concern or new areas

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## QoS Monitoring -2

TRAI engages an Independent Agency to carry out Audit of QoS Performance Monitoring Reports (PMR) & QoS Assessment:

- **Objective Assessment of QoS**
  - ❑ Audit of QoS Parameters at Service Providers Site
  - ❑ Comparison of data with PMR data submitted to TRAI
  - ❑ In addition Drive Tests in Case of Mobile Service
  
- **Subjective Assessment of QoS**
  - ❑ Carry out personal as well as telephonic interviews to assess Customers' Perception of Service provided by Service Providers

## QoS Monitoring: Mobile Service - Objective Assessment (Independent Agency)

- **Operator Assisted Drive Test**
  - Coverage-Signal strength
  - Voice quality
  - Call success rate
  - Blocked calls
  - Call drop rate
  
- City Selection : High, Med and Low population (one each)
- Route Selection : Four Outdoor and One Indoor
- Duration : 200 Km or 5 hrs
  
- **Independent Drive Tests**
- **Inter Operator Call Congestion Assessment**
- **Helpline Connectivity**
  - calls were made to the Helpline number of each operator and response time of IVR and Operator is noted



**Key Findings on QoS Monitoring:  
Basic Service - Objective Assessment** (Independent Agency)

**Telephone Exchange Audit**

**Main Concern Areas**

- Provisioning of Telephone
- Grade of Service
- Request for Closure, shift and Additional facility

**Other Issues need attention**

- Fault Repair by next working day
- Metering and Billing Credibility
- Call Completion rate

**Key Findings on QoS Monitoring: Cellular Mobile Service  
- Objective Assessment** (Independent Agency)

**Mobile Switching Centre (MSC) Audit**

**Positive**

- Service Access Delay
  - Call Drop Rate
  - Call Setup Success
  - Billing Complaints resolved within 4 weeks
  - Period of Refunds
- Above QoS Parameter(s) met by most of the operators

**Concern**

- POI Congestion
- SDCCH/Paging Channel Congestion
- Billing complaints

## Key Findings: Subjective Survey

- Mobile subscribers are relatively less satisfied with the services as opposed to basic subscribers. This is a function of the following factors:
  - Increased market competition & frequent new tariff plans, thus raising the subscriber expectations
  - Network Congestion on Point of Interconnection (POIs) due to rapid growth in the customer base and delay in augmentation of Interconnect Capacity between different service providers' networks hence subscriber dissatisfaction
  - The telecom operators' infrastructure i.e. customer call agents, network elements, billing system etc is not keeping pace with the rapid growth in the customer base.

## Telecom Market in India

- 7 Basic and 14 Cellular Mobile Service operators in Operation
- Basic Licence Service Areas : 23 (Metro=4 + A Circle=5 + B Circle=8 + C Circle=6)
- Cellular Mobile Service Area : 23 (Metro=4 + A Circle=5 + B Circle=8 + C Circle=6)
- Total Number of Basic Licenses in Operation:68  
(Basic 1- 4 Operators)
- Total Number of Cellular Licenses in Operation:129  
( Mobile 2-7 Operators)
- Customers Base as on 30.06.2006
  - ❖ Fixed (Wire line) including WLL (Fixed): 47 Millions
  - ❖ Mobile (Wireless Cellular GSM/CDMA): 105 Millions
  - ❖ Tele-density: 12.9 per 100 population
  - ❖ Internet (Dialup): 7 Millions
  - ❖ Broadband (Internet): 1.55 Millions

### Mobile Market Share & HHI for Top 5 Service Providers at National Level

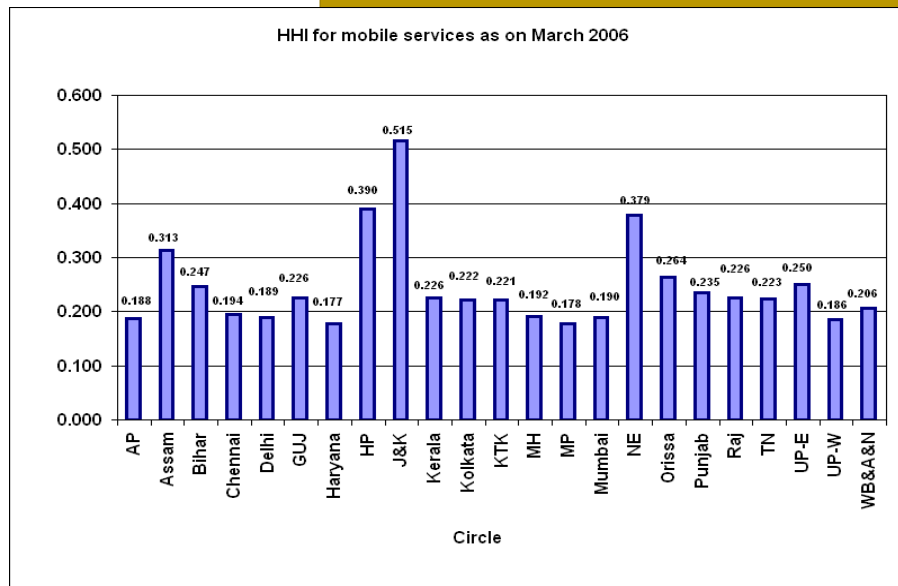
Sl	Name of Service Provider	Customer Base in Millions	Market Share %age
1	Bharati (Airtel)	19.58	21.72 %
2	BSNL	17.65	19.58 %
3	Reliance	17.31	19.21 %
4	Hutchison	15.36	17.04 %
5	Idea	7.37	8.18 %

HHI = Sum of Sq (Market Share%) = 1581

HHI = Sum of Sq (Market Share points) = 0.1581(Closer to 0)

**HHI for Mobile Services for top 5 Service providers in India indicates reasonable level of competition**

### HHI for Mobile Services as on March 2006



## Level of Competition in Indian Telecom Market - QoS issues

- TRAI has made in the past regulatory intervention for promoting competition
- Mobile telephony market achieved a remarkable growth in subscriber base due to competition
- Fixed network market and rural telephony is concern area both for growth & competition
- Broadband penetration has started in major cities
- Due to dispersed geography, it is hard to measure degree of competition in Indian Telecom market
- Attempt is being made to use Herfindahl and Hirschman Index (HHI) to measure degree of competition & concentration on national level/service area level for Mobile Services
- Need is felt for regulatory intervention for Quality of Service due to high growth rate particularly for Point of Interconnect (POI) Congestion/Grade of Service, Service Requests and Metering & Billing related issues

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## IP/ NGN Issues

### NGN Facts Indian Context:

- PSTN-type user devices will continue to remain dominant in near future in wire line and mobile networks
- Full transition to IP and Broadband will be gradual
- Mobile services are growing more rapidly at approx. 70% per annum
- Penetration of the business (SME/SOHO) market remains low
- Transit applications/National & Intl' long distance operations will drive the implementation of NGN in India i.e first Class 4 type
- And thereafter IP Centrex Services for Business and SOHOs/SMEs
- Need to facilitate affordable rural communication both Voice & Multimedia Services through same NGN platform

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## Customer Requirements

### Current Requirements

- ◆ QoS
- ◆ Privacy
- ◆ Availability
- ◆ Reliability

VoIP, IP based Value Added & Multimedia Services requirements cannot be met with today's technology!

### New Requirements

- ◆ Multiple service classes
- ◆ Multiple service options
  - ◆ VoIP & Multimedia Services
  - ◆ Multiple VPN options
- ◆ Lower cost managed services
- ◆ Any-to-any traffic
- ◆ Seamless integration
- ◆ Single sign on for multiple Services
- ◆ Converged Services

## NGN Components

### What is NGN?

- Next Generation Network provides capabilities to provide telecom services by making use of multiple broadband & QoS enabled IP transport technologies as opposed to traditional Circuit Switched Network
- Uses Packet Switching Concepts
- NGN to facilitate convergence of Networks and convergence of Services
- Supports generalised mobility - to allow consistent and ubiquitous provision of services to users

### NGN Components:

- Core Packet Network based on IP over MPLS bearer Transport (IP/MPLS--P/PE Routers)
- Media Gateway /Trunk Media Gateway
- Signalling Gateway (SS7 )
- SoftSwitch/ +Application Servers
- NMS

## Service Network Elements in IN/AIN vs. Next-Generation Architecture

PSTN / IN & AIN Architecture		Next-Gen Architecture
SSP/MSC	➔	Soft switch/Media Gateways
SCP/HLR/VLR	➔	Application/Feature Servers
Intelligent Peripheral (IP)	➔	Media Servers
TDM Switch/Service Node (SN)	➔	Next- -Generation Service Node

- ▶ PSTN/AIN elements not designed to address converged services
- Next-generation architecture focuses on C4/C5 and SCP replacement
- Must address converged service requirements in the context of both the PSTN and next-gen infrastructure

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## QoS Concepts/ Issues for NGN

- When communication networks become congested, the quality of service becomes worse. Traditional approach for the network congestion:
  - ❑ Expanding the network capacity
  - ❑ Reducing the network demand by various traffic engineering techniques such as queuing, routing, shaping, and policing.
- Current Internet can't support the end to end QoS properly since the internet protocol version 4 (IPv4) doesn't have mechanisms to assure the end-to-end reliability of the communication and control of the data flows.

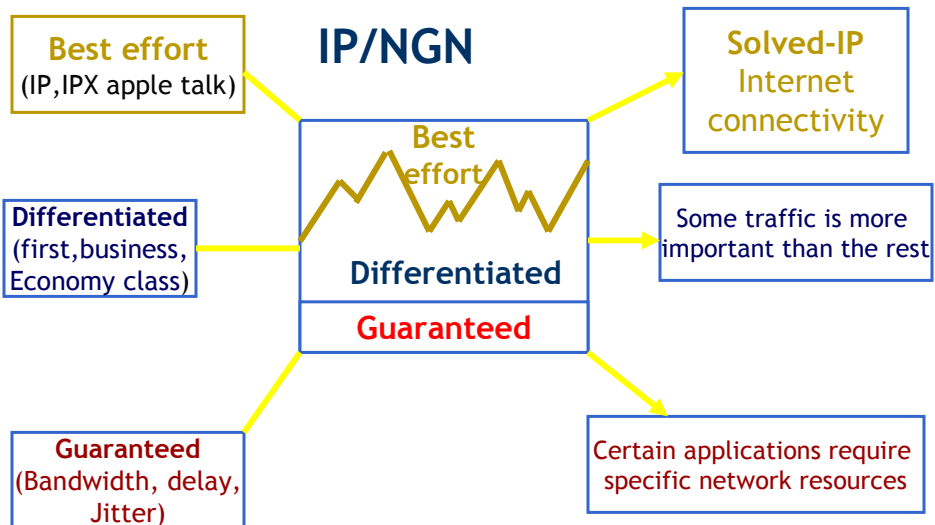
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## QoS Concepts/ Issues for NGN

- Two broad approaches to provide end to end QoS requirements:
  - Connection oriented - in which packets traverse a virtual circuit over the IP
  - Connectionless - in which each individual packet is marked and forwarded through the network
- QoS Models:
  1. Best Effort
  2. InteServ (Integrated Service)
  3. DiffServ (Differentiated Service)

## QoS Concepts/ Issues for NGN



## QoS Concepts/ Issues for NGN

### Need:

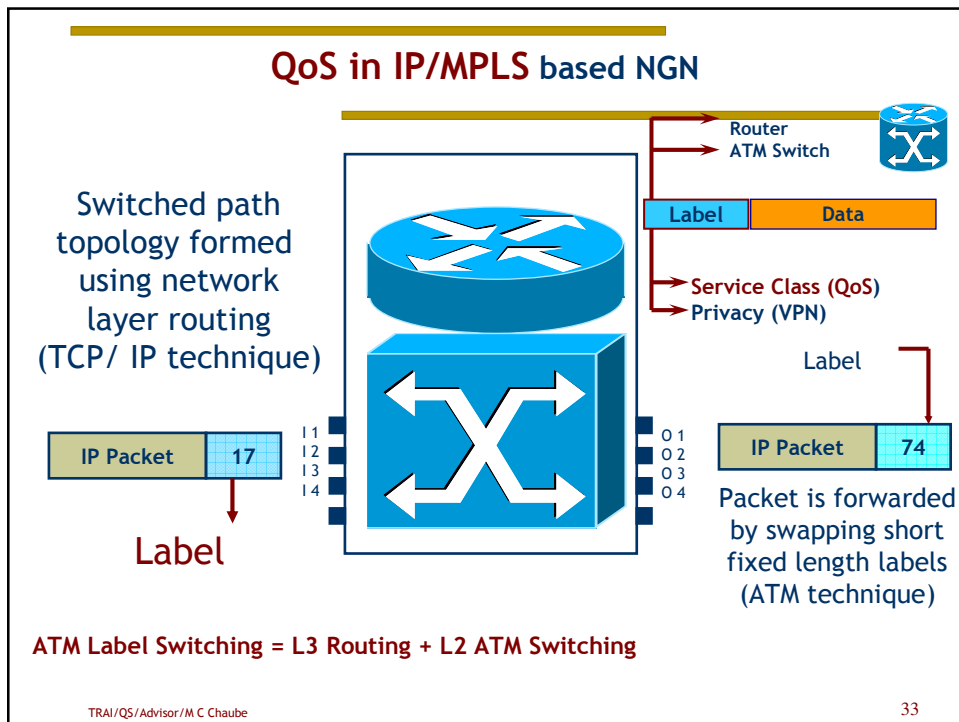
- ❑ Technologies which allow users to request and receive predictable service levels in terms of data throughput capacity(*bandwidth*), latency variations (*jitter*) and delay.
- ❑ Measure of transmission quality and service availability of a network
- ❑ Transmission quality of the network determined on the factors :
  1. Latency
  2. Jitter
  3. Packet Loss

## QoS Concepts/ Issues for NGN

- ❑ Real time applications are sensitive to delay, jitter and packet loss.
- ❑ Voice, Video and Data applications' traffic demand varying service requirements.
- ❑ Over subscription of available bandwidth for multiple applications.
- ❑ Resultant congestion and ensuring of SLAs for priority traffic in networks.
- ❑ Optimization of bandwidth utilization.
- ❑ NGN to use IP/MPLS as bearer-network



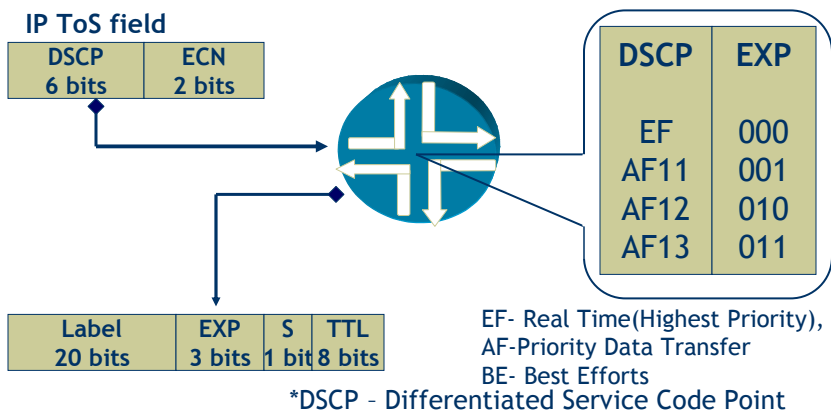
## QoS in IP/MPLS based NGN



## QoS in IP/MPLS based NGN

### ➤ MPLS and DiffServ

- ❑ MPLS and DiffServ together can provide support of QoS over IP/MPLS based NGN. This allows for the mapping of DiffServ behavior aggregates onto LSPs.



## Bearer Network for NGN to support IPv6

- IPv6 has two fields added to the IP header to enhance the QoS capabilities
  - ❑ **Traffic Class field (8 bits)** comes right after the version field to indicate “differentiated services” provided for the data packet it functions similar to type of service (TOS) of IPv4
  
  - ❑ **Flow Label** : Flow label field (20 bits) follows Traffic Class field to identify the packets of the same service flow. The Flow Label in conjunction with the source address uniquely identifies a service flow and resource reservation can be provide with the help of resource reservation protocol (RSVP)

## QoS Requirements of IP/NGN

For a VoIP/NGN, voice quality is affected mainly by 3 QoS parameters

- ❑ Delay
- ❑ Jitter
- ❑ Packet Loss

**Time Delay** : Delay and echo will greatly degrade the voice conversations

- **End to end delay** may be divided in two parts
  - ❑ **Fixed Delay** : Consist of codec delay and packetization delay
  - ❑ **Variable Delay** : Consist of transfer delay bearer network, queuing delay at nodes, service processing delay and de-jittering delay, which are determined by the port rate, network load and route

## QoS Requirements of IP/NGN

- **IP network must meet the following conditions**
  - ❑ End to end one way delay should be less than 150 ms as per G.114 and Y.1541 => acceptable for most applications
  - ❑ Delay of 150-400 ms lower quality voice
  - ❑ Delay more than 400 ms unacceptable
- Larger the number of hop, the longer delay will be, end to end hop count need to be less than 16 with transfer delay for each hop need to be less than 10 ms

## QoS Requirements of IP/NGN

- While considering GW delay(loop-back) the requirement on IP bearer network are (codec delay)
  - ❑ G.729 Delay is less than 250 ms in the worst situation, 75 ms in normal condition
  - ❑ G.723 Delay is less than 200 ms in the worst situation, 50 ms in normal condition
  - ❑ G.711 Delay is less than 280 ms in the worst situation, 90 ms in normal condition

## QoS Requirements of IP/NGN

**Jitter (Delay Variation) :** Jitter stems from variability in packet delay. It may cause end to end delay to be increased and quality of voice to be degraded

- Jitter is due to network congestion
- To solve the jitter problem
  - ❑ Jitter buffer queue : GW and IAD need to have jitter buffer queue to be used for jitter cancellation
  
  - ❑ QoS policy on IP bearer network : Voice data need to have the highest priority by making appropriate QoS policy ➡ allocate sufficient bandwidth for voice data and let this be sent first
  - ❑ Increased jitter buffer ➡ Increased delay  
buffer should be less than 20 ms

## QoS Requirements of IP/NGN

### Packet Loss Rate :

- ❑ Packet loss has negative impact on perceived voice quality and signaling - should be less than 1%
- ❑ Voice quality is unacceptable for packet loss rate >5%

**Network Bandwidth :** Sufficient bandwidth is essential for QoS ➡ network link must be properly sized for example an IP call (G.729) with clear voice needs 32 kb/s

## QoS IP/NGN Mechanisms - Soft switch

- **IP/MPLS Networks Interconnectivity** shall remain key issue in addressing effectively QoS in NGN
- **Measurement** based quality monitoring is the requirement in NGN soft switches/trunk media gateways
  - collection of QoS statistics for each core path - Packet stream in RTP flows needs to be subjected for quality measurements
- **Traffic Management**
  - ❑ Traffic Shaping
  - ❑ Policing
  - ❑ Performance Monitoring

## Conclusions

- **Performance Monitoring Reports (PMR) on various QoS Network Parameters Achievement** need to be submitted by Service Providers
  - ❑ Comparison of data with QoS Benchmarks
  - ❑ Effective Tool for QoS Regulation in competitive market:
    - Performance Indicators Comparison need to be Published -
      - ◆ Press Release for wide media coverage
      - ◆ In Independent Agency or Regulatory Authority's Web Site
  - Need for Regulatory interventions continues in growing markets due to Quantity v/s Quality Paradigm
  - Market Research and Effective analysis of Consumers' complaints & feedback for new Regulatory Interventions
  - **IP/ NGN QoS Issues:**
    - Transition to IP and Broadband will be gradual
    - Mobile services are growing more rapidly at approx. 70% p.a.
  - **Basic QoS Parameters for NGN :Time Delay, Jitter and Packet Loss**
  - Transit applications/National & Intl' long distance operations will drive the implementation of NGN in India i.e first Class 4 type
  - Need to facilitate affordable rural communication both Voice & Multimedia Services through NGN platform

