

# 2009

## Key Performance Indicators for Fixed Broadband Services in Pakistan

*The document intends to define the Key Performance Indicators (KPI's) for Fixed Broadband Services in Pakistan. Key Performance Indicators are quantifiable measurements that reflect the critical success factors. They must reflect the goals, must be key to success, and they must be quantifiable. They differ depending on the requisites of a country. Key Performance Indicators usually are long-term considerations; however they maybe updated depending if the goals change, or as they gets closer to achieving a goal. The KPI's may be tested to arbitrate the performance related issues correlated to broadband services in Pakistan.*



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## Key Performance Indicators (KPI) for Fixed Broadband Services in Pakistan [Recommendations]

**K**ey Performance Indicators are quantifiable measurements, agreed to beforehand, that reflect the critical success factors. They will differ depending on the requisites of countries. Whatever Key Performance Indicators are selected, they must reflect the goals, they must be key to its success, and they must be quantifiable (measurable). Key Performance Indicators usually are long-term considerations. The definition of what they are and how they are measured do not change often. The goals for a particular Key Performance Indicator may change as the goals change, or as it gets closer to achieving a goal.

The Broadband Policy for Pakistan was issued by the Government in December 2004, which aimed at proliferation of broadband services in Pakistan. Starting with only a handful of broadband connections back in 2004 the broadband subscribers have leapfrogged to a mark of 267,180 implying a growth of 59% in six months. Along with the growing number of subscribers the quality of broadband services is also a principal concern.

Encompassing the afore mentioned fact together with PTA's vision of "Protecting Consumer Interest and ensuring high quality ICT services" Pakistan Telecom Authority (PTA) desires to define its Broadband Key Performance Indicators (KPI). The KPI's shall act as benchmarks in determining Quality of Service for Broadband in Pakistan from end user's point of view. The objective of laying down these indicators is to create transparency and monitorable standards in services through pre determined Quality of Service norms for broadband which the service provider is required to provide and the user has a right to expect thus invariably enhance consumer satisfaction. KPI's shall be defined keeping in consideration the **Broadband Policy of Pakistan 2004**. Broadband in Pakistan is referred to as "**always on**" services with a data rate greater than **128Kbps**. The Broadband Delivery Technologies in Pakistan as per clause 5.2 of Broadband Policy refer to following technologies (1):

<i>Common Terminology</i>	<i>Technical Terminology</i>
1 Copper Telephone lines	Digital Subscriber Line (DSL)
2 Hybrid of Coaxial and Fiber cable	HFC Network
3 Wireless	Broadband Wireless Access
4 Satellite	VSAT and DTH

Table 1: *Broadband Technologies in Pakistan*

Broadband shall be taken to refer to always-on services with a data rate greater than 128Kbps including technologies referred at table 1.

### 1. Hypothesis

Following shall be considered while defining the Key Performance Indicators (KPI's) for Broadband in Pakistan.

- 1.1. The performance Indicators should be easily understood by the public, and be useful and important to them.
- 1.2. All network related parameters are applicable at the network termination point (Where appropriate).
- 1.3. To be as realistic as possible, real time traffic rather than test lines should be used as a basis of the measurements, wherever possible.
- 1.4. The Key performance Indicators (KPI's) shall be consistent across all operators.
- 1.5. The tests shall exclude mobility. All the wireless broadband tests shall be carried out at a designated place defined by PTA.

- 1.6. The parameters are designed for the statistical and individual applications. The statistical values should be derived by the application of a simple statistical function to the individual values. The statistical function should be specified in the standard. The standard should also contain guidelines on how statistically significant samples should be selected.
- 1.7. The statistical functions should be designed so QoS figures from different service providers can be compared easily by users and in particular consumers.
- 1.8. Test Timings are appended at Para 4. The timings are bifurcated as lean traffic time, peak business hour traffic, peak business time, low business Traffic and Medium Residential Traffic, Low business Traffic & High Residential Traffic and Medium High- residential Traffic. The same can be identified by noting down the data bandwidth usage at PIE.
- 1.9. Test areas shall be identified by PTA.
- 1.10. Stand-by power backup arrangements should be ensured by PTA at the terminal side at the time of test.

## 2. Key Performance Indicators

In order to measure broadband metrics from subscriber's perspective, following metrics are used worldwide for Broadband evaluation and same are suggested for Pakistan as well:

**2.1 Network Availability:** The parameter shall check the availability of the Network or Service, as is claimed or "advertized" by the Broadband Service Providers. The Network availability test shall be checked one time only on a Yes/ No basis. The Network availability shall be checked for all the Broadband Service Providers in a manner identified at Table 1- Annex A.

**2.2 Cost Comparison:** The cost of all the packages provided by each Broadband Service Providers (BSP's) shall be collected on business/residential or any other package plans (if any). The cost shall be calculated in Pak Rs. as identified in Table 2 at Annex A.

**2.3 Link Speed:** The Link speed shall be checked against the advertised speeds. After a successful link establishment, sustainability of the service shall be checked. The link speed shall be checked on a yes/no basis in a manner identified at Table 3 at Annex A.

**2.4 Service Availability (in %):** Broadband availability indicates the number of times we are able to access the Broadband services. Network non-availability can happen due to various reasons like line failure, AAA failure, backhaul failure etc. This metrics indicates the reliability of the Broadband service. Since broadband is referred to an "always on" connection so a lot many times the service is available/connected however the internet is not available. So the metric shall check for the availability of the internet.

During testing if N attempts are made to connect to the Internet and if F times the attempt failed, then

$$\text{Availability} = (1 - F/N) \times 100\%.$$

An attempt is declared as failure, if we are *not able to connect to Internet within 30 seconds*. The availability shall be checked in a manner identified at Table 4(Annex A).

The availability of service shall exclude downtime for the purpose of upgrading or routine maintenance of the network system provided that users are informed in advance of any such up-gradation or maintenance actions. *The availability outage time for maintenance shall not exceed two times in a month and shall be less than 5 hours.*

Following rating shall apply to the statistics:

- 2.4.1 Grade A shall apply to percentages equivalent to 95% or above. This shall imply a very good (VG) performance.
- 2.4.2 Grade B shall apply to percentages <95% and >80%. This shall imply a good performance.

- 2.4.3 Grade C shall apply to percentages <80% and >70%. This shall imply a Average (AV) or satisfactory performance.
- 2.4.4 Grade D shall apply to percentages <70% and >50%. This shall imply a non satisfactory performance.
- 2.4.5 Grade E shall apply to percentages less than 50%. This shall imply non availability of the service.

## 2.5. Bandwidth:

**2.5.1 Download Speed (kbps/Mbps):** One of the key metrics in broadband services is the download speed, which defines how much traffic a subscriber can receive to the maximum. Also the performance of many residential applications like Web-browsing, downloading content etc, depends on this metric. The actual download speed available to the subscriber shall be measured. Keeping the reasonable loading level in the intra network links up to ISP node, and the fact that in general for normal broadband operations data rate is lower than the advertised/plan data rate. The data speed must be at least 60% of the advertised speed of broadband service plan, both download and upload, and this must be experienced at least 70% of the time. For example, if your broadband service plan is 512/128 Kbps, a pass result shall be considered if data speed is 307.2/76.8 Kbps or better. *The Download Speed shall be checked in a manner identified at Table 5(Annex A).*

**Data download speed =Size of the test file (data) in ISP Server (in MB): Transmission Time required for error free transfer of the entire data.**

**2.5.2 Upload Speed (kbps/Mbps):** Upstream speed for the Internet connection. This metrics define the speed in which the subscriber can send traffic to Internet. Plays a significant role in responsiveness and real-time applications. Additionally this metric is important for Business development. *The Upload speed shall be checked in a manner identified at Table 5.2(Annex A).*

### 2.5.3 Upload/Download Speed Ratio:

Ration of Download speeds/upload speed ratio shall be calculated as indicated in Table 5.4. (Annex A).

### 2.5.4 Total Bandwidth/ No. of Subscribers:

The Total Bandwidth per operator/Total No. of subscribers shall be recorded against Table indicated in Table 5.5 (Annex-A).

## 2.6. RTT (milli-sec):

Round Time Trip or Round Trip Delay. Time taken for the traffic to reach a particular destination and return. Round-trip delay time is significant in systems that require two-way interactive communication where the round-trip time directly affects the throughput rate.

In general a ping command is used which ensures that Ping traffic to test-sites is not blocked by the local firewall and the sites are reachable. Ping is a very common tool to measure the RTT. The Ping application generates a packet with a timestamp; RTT is calculated finding the difference between the current time and the received packet time-stamp. The higher the round trip time in milliseconds, the higher the latency, which may indicate a network problem between the computer and the server, pinged. *A packet must have a delay no longer than <85 ms based on a minimum standard packet size of 32 bytes. RTT shall be checked in a manner identified at Table 6(Annex A).*

## 2.7. Jitter (milli-sec): (Next phase and surveys for second half of 2010 and onwards)

Jitter is the fluctuation/variation of end-to-end delay from one packet to the next packet within the same packet stream/connection/flow. Jitter experienced by the packets is more relevant for

Real-time traffic. The metric is important and can seriously affect the quality of streaming audio and/or video.

Jitter is the variance in one-way latency and is calculated based on sending and receiving time stamps of consecutive packets sent out.

<i>Time Stamp</i>	<i>Sender</i>	<i>Responder</i>
<b>T1</b>	send pkt1	
<b>T2</b>		recv pkt1
<b>T3</b>		send back reply for pkt1
<b>T4</b>	recv reply for pkt1	
<b>T5</b>	send pkt2	
<b>T6</b>		recv pkt2
<b>T7</b>		send back reply for pkt2
<b>T8</b>	recv reply for pkt2	

For packet 1 and packet 2 above, use the following source and destination calculations.

- Jitter from source to destination =  $(T6-T2) - (T5-T1)$
- Jitter from destination to source =  $(T8-T4) - (T7-T3)$

Jitter is calculated using time stamps of every two consecutive packets. For example:

Router1 send packet1 T1 = 0  
 Router2 receives packet1 T2 = 20 ms  
 Router2 sends back packet1 T3 = 40 ms  
 Router1 receives packet1 response T4 = 60 ms  
 Router1 sends packet2 T5 = 60 ms  
 Router2 receives packet2 T6 = 82 ms  
 Router2 sends back packet2 T7 = 104 ms  
 Router1 receives packet2 response T8 = 126 ms

Jitter from source to destination =  $(T6-T2) - (T5-T1)$   
 Jitter from source to destination =  $(82 \text{ ms} - 20 \text{ ms}) - (60 \text{ ms} - 0 \text{ ms}) = 2 \text{ ms}$

Jitter from destination to source =  $(T8-T4) - (T7-T3)$   
 Jitter from destination to source =  $(126 \text{ ms} - 60 \text{ ms}) - (104 \text{ ms} - 40 \text{ ms}) = 2 \text{ ms}$

## **2.8. Packet-Loss (%):**(Next phase and surveys for second half of 2010 and onwards)

Number of packets (in percentage) which doesn't reach the destination. Packet-loss can result in highly noticeable performance issues with Streaming Technologies, Videoconferencing, etc, and may affect all other network applications. The benchmark of packet loss shall be <3%. (7)

## **2.9 Customer Service:** (7)

### **2.9.1 Unplanned Outage Automation Notice**

The unplanned outage Automated notice shall be less than 15 minutes. Reasons for outage to be recorded by the Operator and intimated to the Authority.

### **2.9.2 Planned Outage Notice**

Planned outage notice shall be intimated 2 days prior to the outage. Reasons for outage to be recorded by the Operator and intimated to the Authority.

### **2.9.3 Automated Ticketing System for Complaints**

The availability of Computerized Customer Complaint Database is mandatory as per the license requirement. The system should be capable of generating automated tickets to the



complainants. In case automated system is not available the reasons to be recorded by the Operator and intimated to the Authority.

## 2.9.4 Response to Assistance Requested

The response to provide assistance should be available 98% of the time. Complaint shall be recorded within 2 minutes.

The response for complaint handling shall be as follows:

90% of the complaints shall be solved within 24 hrs.

95% of the complaints shall be solved within 48 hrs.

98% of the complaints shall be solved within 72 hrs.

## 2.10 Billing Complaints: <sup>(7)</sup>

90% of the billing complaints shall be solved within 24 hrs.

95% of the billing complaints shall be solved within 48 hrs.

98% of the billing complaints shall be solved within 72 hrs.

## 2.11 Service Provisioning Complaints: <sup>(7)</sup>

90% Service provisioning shall be solved within 24 hrs.

95% Service provisioning shall be solved within 48 hrs.

98% Service provisioning shall be solved within 72 hrs.

## 3. Broadband Service Providers(BSP) and Packages

3.1 The testing plan will benchmark all Broadband Service Providers of Pakistan who offer similar Connection Plan. The following shall apply to all or few of the KPI's mentioned above.

Speed/BSP	BSP- A		BSP-B		BSP-C		BSP-D		BSP-E		BSP-F		.....	
	B	R	B	R	B	R	B	R	B	R	B	R		
128 Kbps														
256 Kbps														
512 Kbps														
1 Mbps														
2 Mbps														
....														
....														
*B= Business      *R= Residential      *BSP= Broadband Service Provider														

3.2 With each ISP the metrics shall be collected by residential-Package and Business-Plan. For instance

	BSP-A
128 Kbps(Business)	

**128Kbps(Residential)**

3.3 Each Business package shall be tested for T timings defined below at para(4) for a period of 15 days.

Test Plan for BSP- A							
	<i>T1</i>	<i>T2</i>	<i>T3</i>	<i>T4</i>	<i>T5</i>	<i>T6</i>	<b>Mean</b>
<b>128 Kbps(Business)</b>							M1
<b>128Kbps (Residential)</b>							M2

Test Plan for BSP- A							
	<i>Day 1</i>	<i>Day 2</i>	<i>...</i>	<i>...</i>	<i>...</i>	<i>...</i>	<i>Day15</i>
<b>128Kbps(Business)</b>							
<b>128Kbps(Residential)</b>							

## 4. Time for Repetition of Experiments

Each test shall be carried out on alternate day for a total of 15 days over the below mentioned time Schedule:

	<b>Measuring Time</b>	<b>Remarks</b>
<b>1.</b>	<b>T1</b>	Lean Traffic Time
<b>2.</b>	<b>T2</b>	Peak Business Hour Traffic
<b>3.</b>	<b>T3</b>	Peak Business Time
<b>4.</b>	<b>T4</b>	Low Business Traffic and Medium Residential Traffic
<b>5.</b>	<b>T5</b>	Low Business Traffic and High Residential Traffic.
<b>6.</b>	<b>T6</b>	Medium-High Residential Traffic

## 5. Measurement Techniques:

Some or all of the metrics shall be measured. These are shown in below mentioned table:

<b>Sr.</b>	<b>Metrics</b>	<b>BSP</b>
<b>1</b>	Availability	Yes
<b>2</b>	Data Rate	Yes
<b>3</b>	RTT	Yes
<b>4</b>	Jitter	No
<b>5</b>	Packet Loss	No



## Glossary

<b>AAA</b>	An AAA server is a server program that handles user requests for access to computer resources and, for an enterprise, provides authentication, authorization, and accounting (AAA) services. The AAA server typically interacts with network access and gateway servers and with databases and directories containing user information. The current standard by which devices or applications communicate with an AAA server is the Remote Authentication Dial-In User Service (RADIUS).
<b>ADSL</b>	<b>Asymmetric Digital Subscriber Line (ADSL)</b> is a form of DSL, a data communications technology that enables faster data transmission over copper telephone lines than a conventional voice-band modem can provide. It does this by utilizing frequencies that are not used by a voice telephone call.
<b>Asymmetric</b>	Not identical on both sides of a central line; unsymmetrical; lacking symmetry.
<b>Bandwidth</b>	In computer networks, bandwidth is often used as a synonym for data transfer rate - the amount of data that can be carried from one point to another in a given time period (usually a second). This kind of bandwidth is usually expressed in bits (of data) per second (bps).
<b>BSP</b>	Broadband Service provider
<b>DSL</b>	<b>DSL</b> or <b>xDSL</b> , is a family of technologies that provides digital data transmission over the wires of a local telephone network. DSL originally stood for <b>digital subscriber loop</b> , although in recent years, the term <b>digital subscriber line</b> has been widely adopted as a more marketing-friendly term for ADSL, which is the most popular version of consumer-ready DSL. DSL can be used at the same time and on the same telephone line with regular telephone, as it uses high frequency, while regular telephone uses low frequency.
<b>DTH</b>	<b>Direct broadcast satellite (DBS)</b> is a term used to refer to satellite television broadcasts intended for home reception, also referred to more broadly as <b>direct-to-home</b> signals. The expression <i>direct-to-home</i> or DTH was, initially, meant to distinguish the transmissions directly intended for home viewers from cable television distribution services that sometimes carried on the same satellite
<b>FTTH</b>	<b>Fiber to the x (FTTx)</b> is a generic term for any broadband network architecture that uses optical fiber to replace all or part of the usual metal local loop used for last mile telecommunications. This generic term originates as the generalization of several configurations of fiber deployment (FTTN, FTTC, FTTB, FTTH...), all starting by FTT but differentiated by the last letter, which is substituted by an x in the

generalization.

- HFC**      **Hybrid fibre-coaxial (HFC)** is a telecommunications industry term for a broadband network which combines optical fiber and coaxial cable. It has been commonly employed globally by cable TV operators since the early 1990s.
- KPI**      **Key Performance indicators-**A key performance indicator (KPI) is a business metric used to evaluate factors that are crucial to the success of an organization. KPIs differ per organization; business KPIs may be net revenue or a customer loyalty metric, while government might consider unemployment rates. KPIs are applied in business intelligence (BI) to gauge business trends and advise tactical courses of action.
- QoS**      **Quality of service-** is the ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance to a data flow.
- VSAT**      VSAT is an abbreviation for a Very Small Aperture Terminal. It is basically a two-way satellite ground station with a less than 3 meters tall (most of them are about 0.75 m to 1.2 m tall) dish antenna stationed. The transmission rates of VSATs are usually from very low and up to 4 Mbit/s.

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## Annex-A

### Evaluation Tables

<i>Network Available Areas (*Table shall be repeated for all BSP's)</i>												
<i>BSP- A</i>												
	ANA1		ANA2		ANA3		ANA4		ANA5		.....	
	B	R	B	R	B	R	B	R	B	R	B	R
Network Availability	Y/N											
<i>*B= Business      *R= Residential      *BSP= Broadband Service Provider</i> <i>*ANA=Advertised Network Available Areas(By BSP's)</i>												

Table 1: Network Availability

<i>Tariff in Pak Rs.</i>													
Speed/BSP	BSP- A		BSP-B		BSP-C		BSP-D		BSP-E		BSP-F		.....
	B	R	B	R	B	R	B	R	B	R	B	R	
128 Kbps													
256 Kbps													
512 Kbps													
1 Mbps													
2Mbps													
....													
<i>*B= Business      *R= Residential      *BSP= Broadband Service Provider</i>													

Table 2: Cost Comparison

<i>Link Speed</i>													
Speed/BSP	BSP- A		BSP-B		BSP-C		BSP-D		BSP-E		BSP-F		.....
	B	R	B	R	B	R	B	R	B	R	B	R	
128 Kbps	Y/N												

256 Kbps														
512 Kbps														
1 Mbps														
2Mbps														
....														
*B= Business    *R= Residential    *BSP= Broadband Service Provider														

Table 3: Link speed

Service Availability BSP-A (*Table shall be repeated for all BSP's/ Package)							
	T1	T2	T3	T4	T5	T6	Average %
Day1							*Availability = (1-F/N) × 100%.
...							
*N= Total No. of times the experiment is done for a single BSP/ Package *F=No. of times internet is unreachable							

Table 4: Service Availability

Service Availability				
Grade A	Grade B	Grade C	Grade D	Grade E
VG	G	Avg/ Satisfactory	Non Satisfactory	No Service
95% or above	>95% and <80%	>80% and <70%	>70% and <50%	<50%

Table 4.1: Service Availability grading

Download Speed														
Speed/BSP	BSP- A		BSP-B		BSP-C		BSP-D		BSP-E		BSP-F		.....	
	B	R	B	R	B	R	B	R	B	R	B	R		
128 Kbps														

256 Kbps														
512 Kbps														
1 Mbps														
2Mbps														
....														
<i>*B= Business    *R= Residential    *BSP= Broadband Service Provider  Table Shall be repeated for T timings in a day</i>														

Table 5: Download Speed

Download Speed				
Grade A	Grade B	Grade C	Grade D	Grade E
VG	G	Avg/Satisfactory	Non Satisfactory	No Service
>Speed*75 %	>Speed*75% and <Speed*60%	>Speed*60% and <Speed*45%	>Speed*45% and <Speed*30%	<Speed*30%
Speed implies to advertised speeds by BSP's				

Table 5.1: Download Speed Grading

Upload Speed														
Speed/BSP	BSP- A		BSP-B		BSP-C		BSP-D		BSP-E		BSP-F		.....	
	B	R	B	R	B	R	B	R	B	R	B	R		
128 Kbps														
256 Kbps														
512 Kbps														
1 Mbps														
2Mbps														
....														
<i>*B= Business    *R= Residential    *BSP= Broadband Service Provider  Table Shall be repeated for T timings in a day</i>														



Table 5.2: Upload Speed

<i>Upload Speed</i>				
<i>Grade A</i>	<i>Grade B</i>	<i>Grade C</i>	<i>Grade D</i>	<i>Grade E</i>
<i>VG</i>	<i>G</i>	<i>Avg/Satisfactory</i>	<i>Non Satisfactory</i>	<i>No Service</i>
<i>&gt;Speed*75 %</i>	<i>&gt;Speed*75% and &lt;Speed*60%</i>	<i>&gt;Speed*60% and &lt;Speed*45%</i>	<i>&gt;Speed*45% and &lt;Speed*30%</i>	<i>&lt;Speed*30%</i>
<i>Speed implies to advertised speeds by BSP's</i>				

Table 5.3: Upload Speed Grading

<i>Ratio of Upload/Download Speed</i>				
	<i>BSP-A</i>	<i>BSP-B</i>	<i>...</i>	<i>...</i>
<b>128 Kbps</b>				
<b>256 Kbps</b>				
<b>512 Kbps</b>				
<b>...</b>				

Table 5.4: Upload/Download Speed Ratio

<i>Total Bandwidth of BSP/ No. of Subscribers</i>			
<i>BSP-A</i>	<i>BSP-B</i>	<i>...</i>	<i>...</i>
<i>Total Bandwidth/ No. of Subscribers</i>	<i>...</i>	<i>...</i>	<i>...</i>

Table 5.5: Total Bandwidth of BSP/ No. of Subscribers

<i>RTT BSP-A</i> <i>(*Table shall be repeated for all BSP's)</i>							
	<i>T1</i>	<i>T2</i>	<i>T3</i>	<i>T4</i>	<i>T5</i>	<i>T6</i>	<i>Average ms</i>
<i>Day1</i>							

...							
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**Table 6:** Round Trip Time (RTT)

<i>RTT(For Local Latency in ms)</i>			
<i>Grade A</i>	<i>Grade B</i>	<i>Grade C</i>	<i>Grade D</i>
<i>V G</i>	<i>G</i>	<i>Avg</i>	<i>Non Satisfactory</i>
<i>Between 30ms and 20ms</i>	<i>Between 45ms and 30ms</i>	<i>Between 65ms and 45ms</i>	<i>Between 85ms and 65ms</i>

**Table 6.1:** Round Trip Time (RTT) Grading