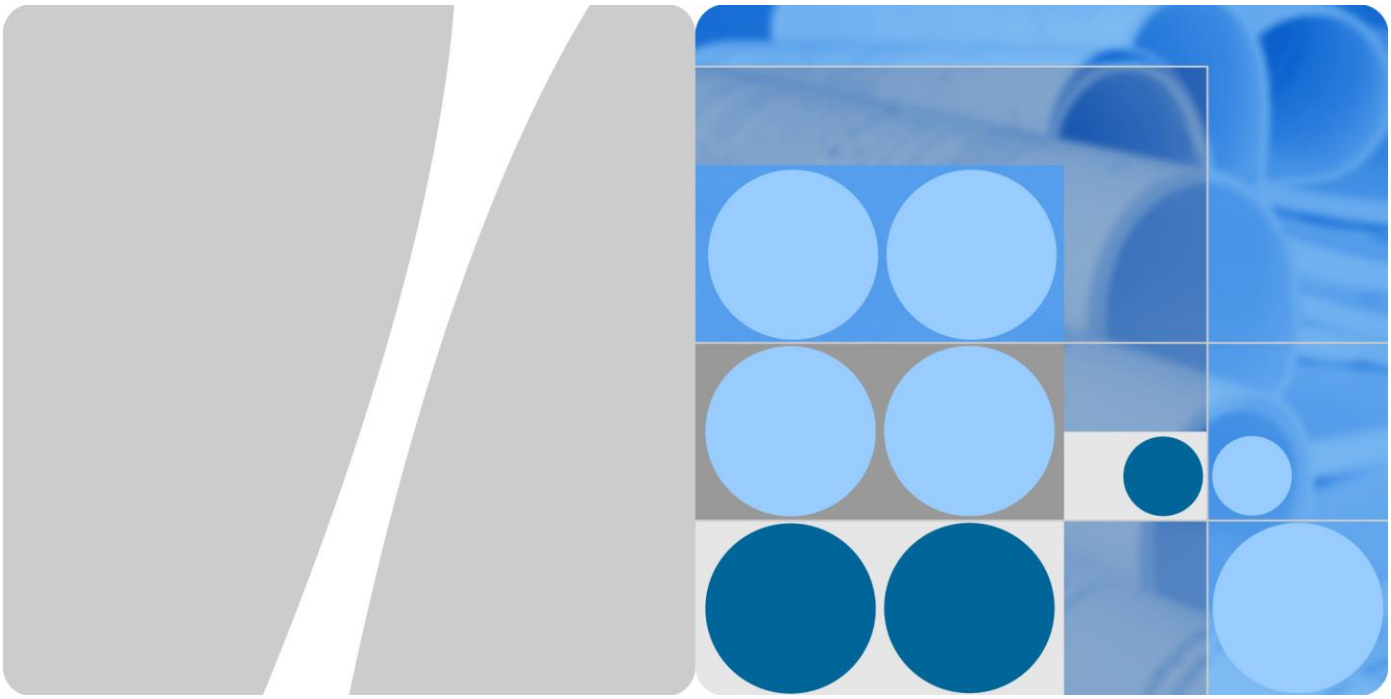

IPTV Index System White Paper

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HUAWEI TECHNOLOGIES CO., LTD.

Huawei Technologies Co., Ltd.

Address:	Huawei Industrial Base Bantian, Longgang Shenzhen 518129 People's Republic of China
Website:	http://www.huawei.com
Email:	support@huawei.com

About This Document

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Contents

1 The Trends and Challenges of Video

1.1 The Golden Age of video is coming

The experience economy has moved towards the social stage, the service industry has gradually taken experience as the core competitive power and the most important means of profit. Telecom operators are also transferring their focus from the network operation to the experience operation. The key requirement of Operators is how to construct the differentiated experience based on network capacity and obtain additional business value.

The video is the inevitable choice for the development of social information and the ultimate pursuit of experience. It is the main channel for transmitting information in the future, the universal demand and rigid demand of human perception of the world. Video technology is continues to innovate, it's ranging is evolving from black and white to color, from standard to high-definition, 4K, and AR/VR/MR... Video demand is far from being met.

1.2 Video traffic and experience has become the most important role

- Global IP video traffic: 2019, 134.8EB per month. Between 2014 and 2019, IP video traffic will grow by 3 times. By 2019, consumer IP video traffic will account for 84% of consumer IP traffic, and commercial IP video traffic will account for 63% of commercial IP traffic.
- Global Internet video traffic: 2019, 105EB per month. From 2014 to 2019, Internet video traffic will grow by 4 times. By 2019, consumer Internet video traffic will account for 80% of consumer Internet traffic, and commercial Internet video traffic will account for 65% of commercial Internet traffic.
- The HD and Ultra HD (4K) Internet video traffic: 2019, monthly 66EB. From 2014 to 2019, the compound annual growth rate was 53%. By 2019, HD and Ultra HD Internet video will make up 63% of Internet video traffic. From 2014 to 2019, advanced Internet video (HD and Ultra HD) will grow by 8.5 times.
- The global consumer video on demand (VOD): 2019, 26.8EB monthly traffic. From 2014 to 2019, video on demand traffic will increase nearly 2 times.

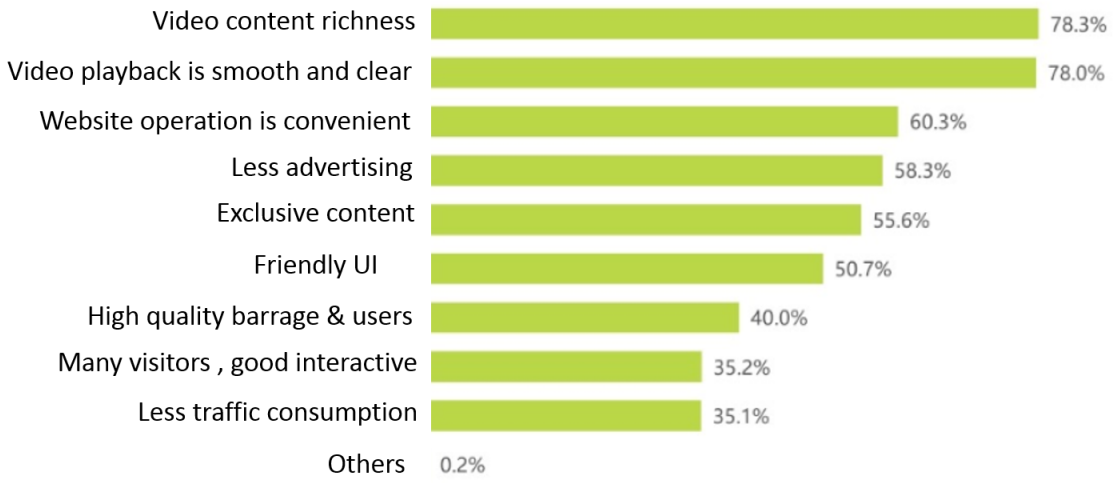
The video will be everywhere in the operator's network, consumers' evaluation of the network

quality is moving from the voice and the Internet speed gradually to the video experience. It is key for commercial success to take video experience as the core power to enhance the brand influence and market competitiveness.

1.3 Taking experience as the goal, to achieve high value network

What degree of premium can the user experience bring? A survey of China's online video shows that 78% of video users are concerned about the video viewing experience.

Mobile video-paid user's major considerations in 2016, Q2



Source: iReserch《China Mobile pay video users white paper》

However, users are usually willing to pay for HD, 4K, and VR experiences, but not necessarily willing to pay for numbers, just like 4M, 8M, and 16M. The user experience is subjective, and cannot be evaluated by rate, but the user experience must be defined, measured and managed. Video is a basic telecom service of data age, we need to define a unified index system to measure video service under different networks, different terminals and different application scenarios, to guide the network planning and construction.

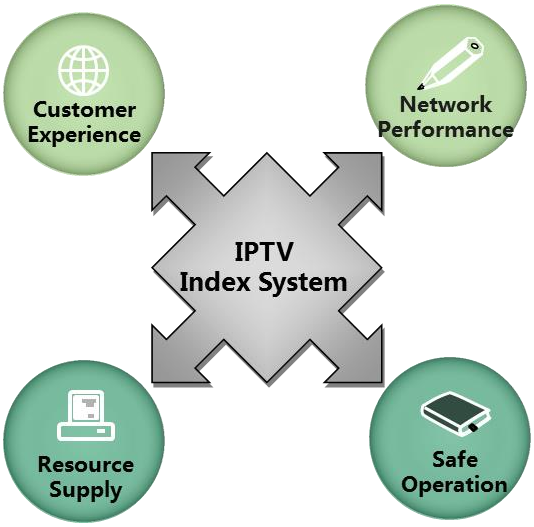
2 Background to Introduce IPTV Index System

2.1 What is the index system

The index system refers to a number of interrelated statistical indicators which make an organism. The index system is a basis to predict or evaluate the network and the service on it, which is decomposed into operative structure from abstract study object, and define the weights for every index.

2.2 The concept of the IPTV index system

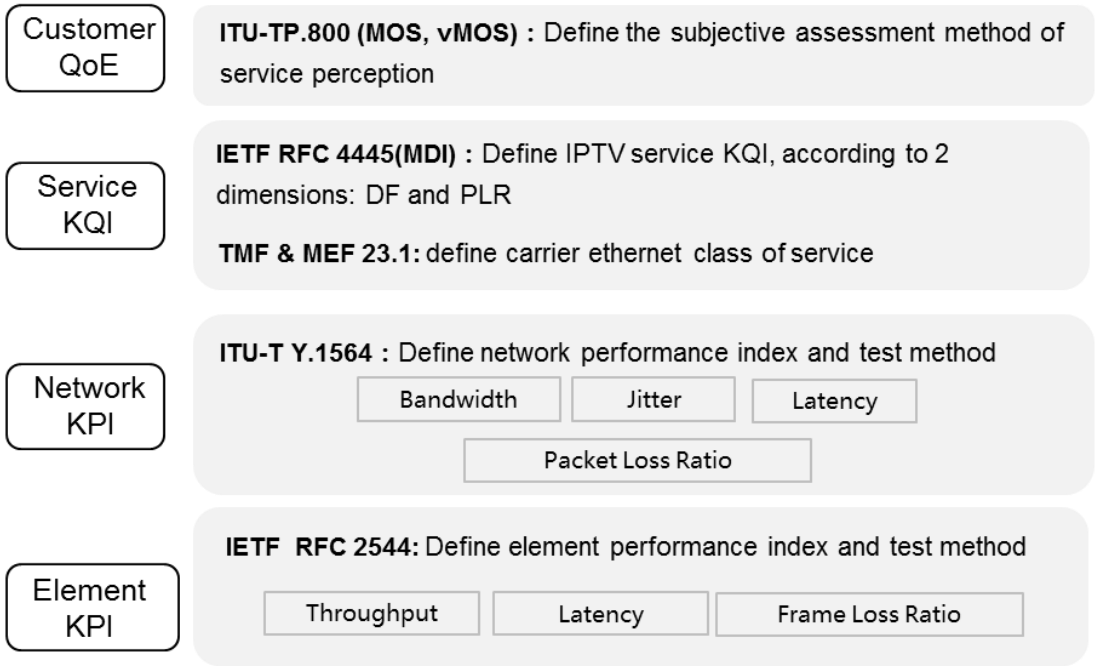
How to analyze and evaluate the IPTV service status of operators? The more important is quantitative description and analysis, rather than qualitative description and analysis. The quantitative analysis is to find or build a measurement scale, by which to measure the status of operators to develop IPTV service. The IPTV index system is full-size, as shown in the following figure, including customer experience, network performance, resource supply and safe operation. The white paper is focus on the customer experience and the network performance index, and the resource supply and safe operation index will also be introduced.



2.3 Why to introduce IPTV index system

With the development of video service, some operators which have good development of the video service began to focus on how to guarantee customers video experience, and they need an IPTV index system to guide their daily operation and maintenance of video services, support the daily department assessment.

Currently, different standard organization has defined different index system for specific level, but in the field of fixed network, especially in the video service domain, there is no unified system and standards, as show below:

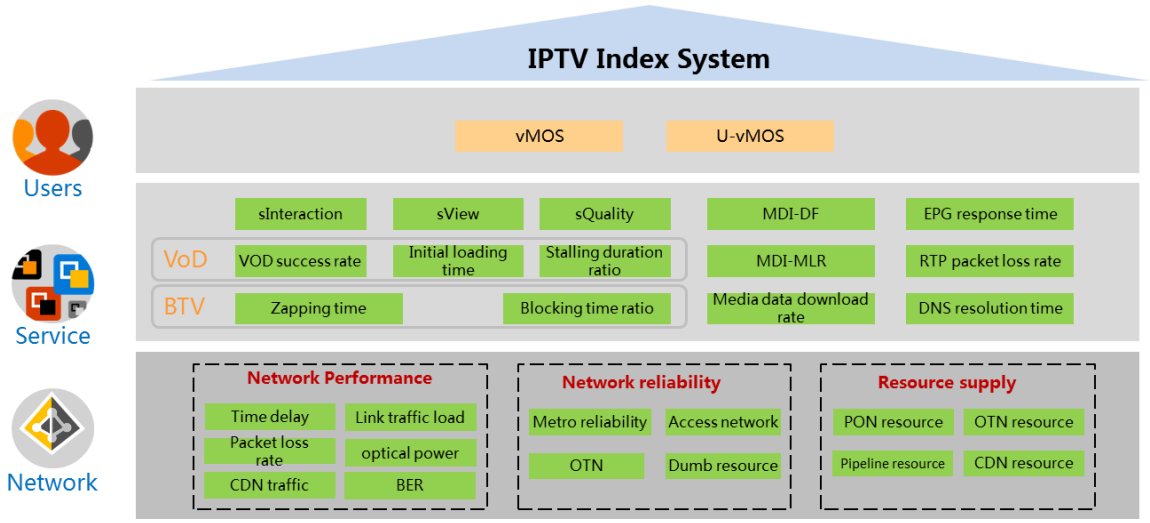


Based on the current industry status, the white paper referred to the relevant index system defined by standard organizations, and constructed the relationship between different levels to form a measurable IPTV index system based on experience. Also based on the measurement method of the IPTV index system, the IPTV video service can be visualized, managed and improved.

3 Design Ideas of IPTV Index System

Firstly, we will introduce the hierarchical structure of the index, the key index, and the relationship between the indexes of the hierarchy. Then, the laboratory simulations results will be provided to verify the results and analysis. Finally, the typical standard for good video experience will be introduced which is decomposed into network performance.

3.1 Layered architecture of IPTV index system



IPTV index architecture

Video services on the telecom network is developed from the traditional voice and broadband services. So network KPI and service KQI are also two important features for video service. Beside this, the QoE layer based on the user experience is also important for video service.

IPTV index system is divided into three levels: user experience QoE layer, service KQI layer and network KPI layer. At present, the white paper has covered view experience of video, but not contain those experience: the convenience of play/search, preferences of content, friendly EPG operations, and interface, package richness of package, price, ease acquisition of popular program etc...

IPTV index system is used for evaluating managed IPTV of operators (including BTV, VOD, playback, TSTV) and OTT TV. The scenario that viewing Internet OTT by mobile terminal and PC also can refer to the index system.

The service quality KQI layer covers the main indexes for measuring IPTV and OTT video. In addition, in order to better measure the network ability for video, Network KPI also contains some E2E network and device indexes for the analysis, monitoring, diagnosis, fault location and optimization.

Network indexes is usually objective and original, that mean these indexes can be directly collected, such as port optical power, bandwidth utilization.

Service indexes is partly objective indexes, such as MDI, media streaming download speed, EPG response time etc. These indexes partly introduced subjective factors, for example, the initial buffer time need to define beginning and ending time point (first I-Frame, GOPs, several second buffer, etc...); the stalling duration time ratio need to define rule and calculate the ratio with view time.

For the video viewing experience indexes, it is usually a fitted value, such as vMOS and U-vMOS, which is calculated by several indexes modeling.

Because of the subjectivity of experience, it is closer to the network, the index is more objective. It is closer to the experience, the index is more subjective. But the indexes are not isolated, there is a certain association between indexes in the same layer and different levels.

3.2 Recommend key indexes for IPTV video

This chapter specifically defines the performance of IPTV video QoE, mainly contain service KQI and network KPI.

QoE refers to industry standard vMOS and HUAWEI's U-vMOS. The service quality KQI contains interaction quality, view quality, content quality indexes and MDI. The KQI are both from original data and calculated value. The former can be collected directly from the network elements (STB probes, EPG, CDN, etc.), and the latter can be calculated by original data.

Bearer network (refers to network from the home gateway to the platform servers) KPI are usually collected by network element statistics or external probe statistics, these statistics are usually from NMS, NPM (usually SNMP or CLI) and other management system.

Through the relevancy of QoE, KQI and KPI, it not only can comprehensively measure the key points of video services that affect the user experience, but also can support troubleshooting and experience optimization.

<table>
<tr><th>QOE(Users)</th><th colspan="2">Service KQI (Service）</th><th colspan="2">Network KPI (Network)</th></tr>
<tr><td rowspan="20">vMOS
U-vMOS</td><td rowspan="9">interaction quality</td><td>sInteraction</td><td rowspan="2">E2E network</td><td>Bearer network E2E two-way delay</td></tr>
<tr><td>VOD success rate</td><td>Bearer network E2E packet loss ratio</td></tr>
<tr><td>Initial loading time</td><td rowspan="5">Transport layer</td><td>TCP RTT</td></tr>
<tr><td>Zapping success rate</td><td>TCP connection success rate</td></tr>
<tr><td>Zapping time</td><td>TCP retransmission rate</td></tr>
<tr><td>EPG request success rate</td><td>TCP out-of-order rate</td></tr>
<tr><td>EPG response time</td><td>RTP packet loss ratio</td></tr>
<tr><td>DNS resolution success rate</td><td rowspan="11">Network element</td><td>Link bandwidth utilization (IP Domain)</td></tr>
<tr><td>DNS resolution time</td><td>Port packet loss ratio (IP port)</td></tr>
<tr><td>Media data download rate</td><td>Port transmit and receive optical power (IP optical port）</td></tr>
<tr><td rowspan="4">view quality</td><td>sQuality</td><td>QoS queue loss ratio</td></tr>
<tr><td>Code type</td><td>Pre-FEC BER (OTN)</td></tr>
<tr><td>Bitrate</td><td>OTU input optical power (OTN)</td></tr>
<tr><td>Resolution</td><td>Multiplexed-wavelength nominal output optical power</td></tr>
<tr><td>Frame rate</td><td>ONU PON optical power</td></tr>
<tr><td rowspan="4">video source quality</td><td>sView</td><td>ONU PON line BER</td></tr>
<tr><td>Stalling frequency</td><td rowspan="3">CDN</td><td>CDN request hit ratio</td></tr>
<tr><td>Stalling duration ratio</td><td>CDN storage resource utilization</td></tr>
<tr><td>Blocking frequency</td><td>CDN outbound bandwidth utilization</td></tr>
<tr><td>Blocking time ratio</td><td>Home</td><td>Home network packet loss ratio</td></tr>
</table>

	MDI	MDI-MLR	network	Home network delay
		MDI-DF		

IPTV video key indexes

3.3 Indexes relationship between layers

There are many research and released standards about video QoE, KQI and KPI in the industry. However, these standards basically provide propose of indexes and application recommendations in the specific level. It is certain that the performance of the lower layer is the necessary condition for the performance of the upper layer.

Based on current research, we have not yet to find a precise quantitative relationship between different layers. In order to better use the relevant indexes in the video service operation, to achieve service quality monitoring and troubleshooting, this white paper gives the relationship analysis between KQI, or between KQI and KPI.

Classification	KQI	Relationship between KQI , or between KQI and KPI
Interaction Quality	EPG response time	Network KPI: Bearer network two-way delay, Home network delay
	VOD success rate	KQI: DNS resolution success rate KPI: Bearer network two-way delay, Bearer network packet loss ratio, TCP retransmission rate, Media data download rate, Home network packet loss, Home network delay
	First initial loading time	KQI: Bitrate, DNS resolution success rate, MDI-MLR KPI: Bearer network two-way delay, Bearer network packet loss ratio, TCP retransmission rate, TCP out-of-order rate, Media data download rate, Home network packet loss ratio, Home network delay, CDN request hit rate
	Zapping time	KQI: Bitrate, MDI-MLR KPI: Bearer network two-way delay, Bearer network packet loss ratio, RTP packet loss ratio, Home network packet loss ratio, Home network delay
	DNS resolution time	Network KPI: Bearer network two-way delay, Home network delay
View Quality	Stalling frequency	KQI: Bitrate, MDI-MLR KPI: Bearer network E2E time delay, Bearer network packet loss rate, TCP retransmit rate, TCP out-of-order rate, Media data download rate, Home network packet loss, Home network delay
	Stalling time duration ratio	KQI: Bitrate, MDI-MLR KPI: Bearer network two-way delay, Bearer network packet loss ratio, TCP retransmission rate, TCP out-of-order rate, Media data download rate, Home network packet loss ratio, Home network delay
	Blocking time duration	KQI: Bitrate, Frame rate, Code type, MDI-DF, MDI-MLR

	ratio	KPI: Bearer network packet loss ratio, RTP packet loss ratio, Home network packet loss ratio, Home network delay
MDI	DF	KQI: Bitrate, Code type KPI: Bearer network two-way delay, Home network delay
	MLR	KQI: Bitrate KPI: Bearer network packet loss ratio, RTP packet loss ratio, TCP retransmission rate, TCP out-of-order rate, Home network packet loss ratio

Association analysis table between KQI, or between KQI and KPI for video service

3.4 Laboratory verification results and analysis

In order to more intuitive understand that the different video content require different platform and bearer network, we have simulated part of the typical network environment in the laboratory, measure the service quality on two dimension of subjective experience and objective monitoring. sView is mainly used for evaluating blocking and stalling during video viewing, which can reflect the influence of the network KPI, 5 point means outstanding experience, 1 point means bad experience. Verification results shows that the necessary network capabilities and good performance are important factors to affect the video quality.

The test results mainly shows the trends due to the otherness of network environment, test duration, the chip of STB and media player's ability, which will not affect to verify the relationship between KQI and KPI.

Testing environment：

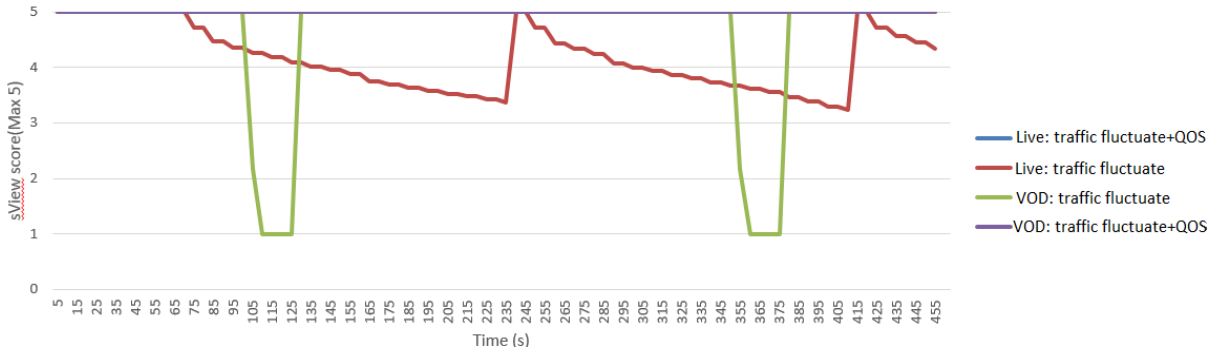
Video Play Mode	Bearer Protocol	Bearer Mode	Other Conditions
Live broadcast	RTP over UDP	Multicast	Not enable FEC or RET
VOD	HTTP over TCP	Unicast	The encode type is CBR, Not enable Quick buffering

The IXIA Anue network impairment emulator was used in our experiment. It has simulated a two-way delay and unidirectional downlink packet lost.

3.4.1 The impact of bandwidth capability on service quality

- **Test condition**
  - The network bandwidth is 1Gbps; the bitrate of 4K video source is 20Mbps, the video is respectively played through live broadcast and VOD.
  - The background traffic rapidly fluctuates between 970M and 990M, the average value is 980M, to test sView score without Qos.
  - The background traffic rapidly fluctuates between 970M and 990M, the average value is 980M, to test sView score with Qos.

- **The test result**

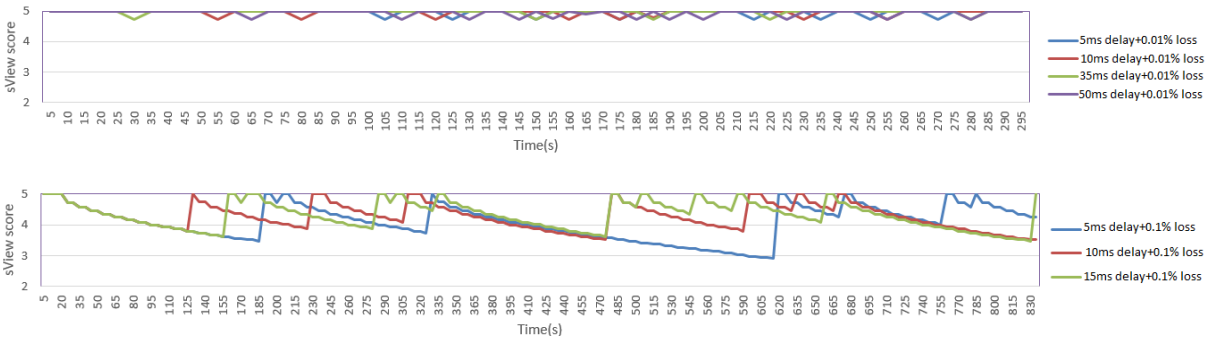


- **Test result analysis**
  - When there is a slight network congestion caused by background traffic fluctuations, the sView score trend of live broadcast and VOD is changed in different way. The trend of live broadcast trend is longer deterioration, but lesser serious; while, the influence of VOD is rapidly deterioration and quickly recovery.
  - When we deploy QoS, slight network congestion will not affect the KQI.

3.4.2 The impact of delay on quality of service

1) Live broadcast

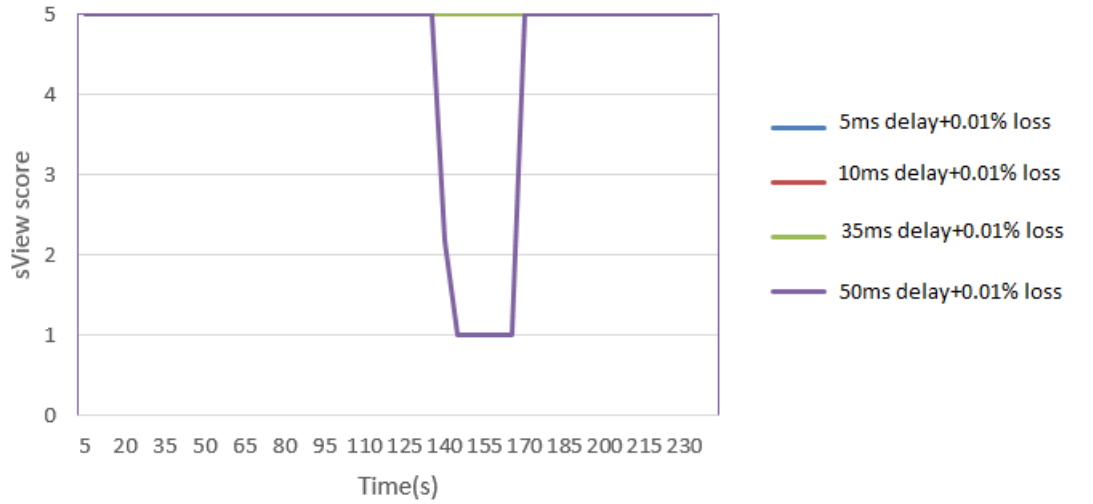
- **Test condition**
  - The network bandwidth is 1Gbps; Video source: live broadcast 4K video, bitrate is 20Mbps
  - Delay damage: downlink packet loss rate is 0.01%, bidirectional delay is 5ms, 10ms, 35ms, 50ms, test scores of sView
  - Delay damage: downlink packet loss rate is 0.1%, bidirectional delay is 5ms, 10ms, 15ms, test scores of sView
- **Test phenomenon**

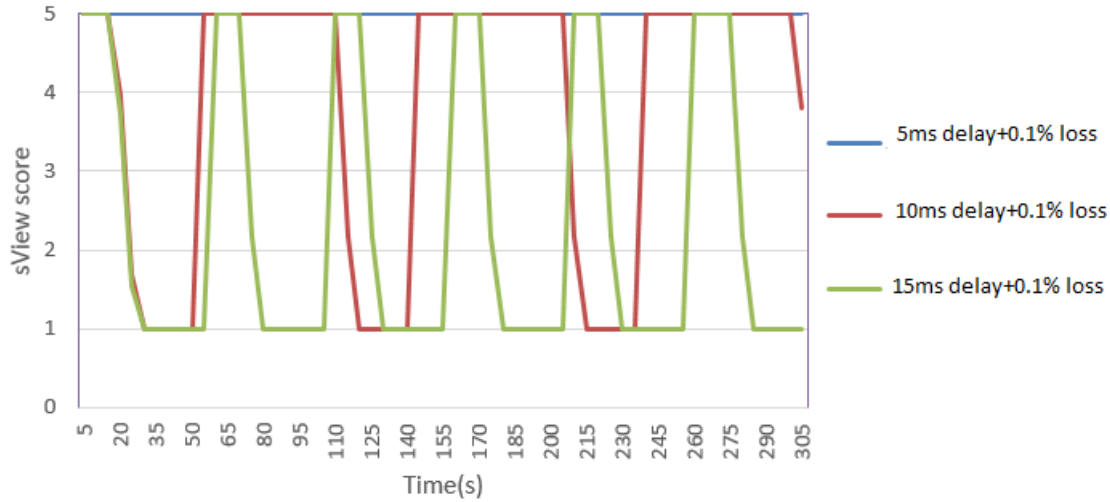


- **Test result analysis**
  - For live broadcast, when the network packet loss rate is fixed, with the delay increases, the deterioration frequency and degree of the KQI index are similar.
  - When the packet loss rate is 0.1%, with the increase of delay, the deterioration of KQI index is more serious, and the duration was longer than those when the packet loss rate is 0.01%.

2) VOD(20Mbps)

- **Test condition**
  - The network bandwidth is 1Gbps; Video source: VOD 4K video, bitrate is 20Mbps
  - Delay damage: downlink packet loss is rate 0.01%, bidirectional delay is 5ms, 10ms, 35ms, 50ms, test scores of sView
  - Delay damage: downlink packet loss is rate 0.1%, bidirectional delay is 5ms, 10ms, 15ms, test scores of sView
- **Test phenomenon**



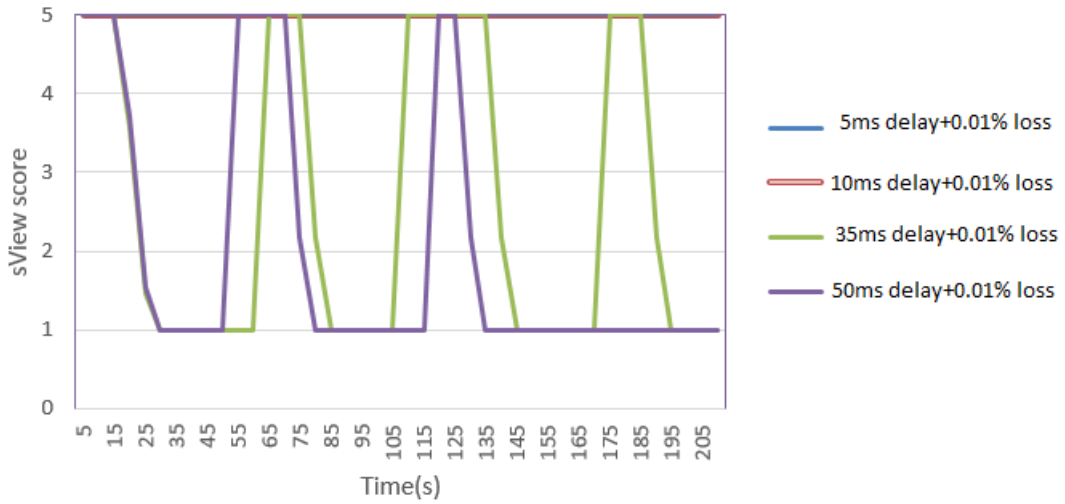


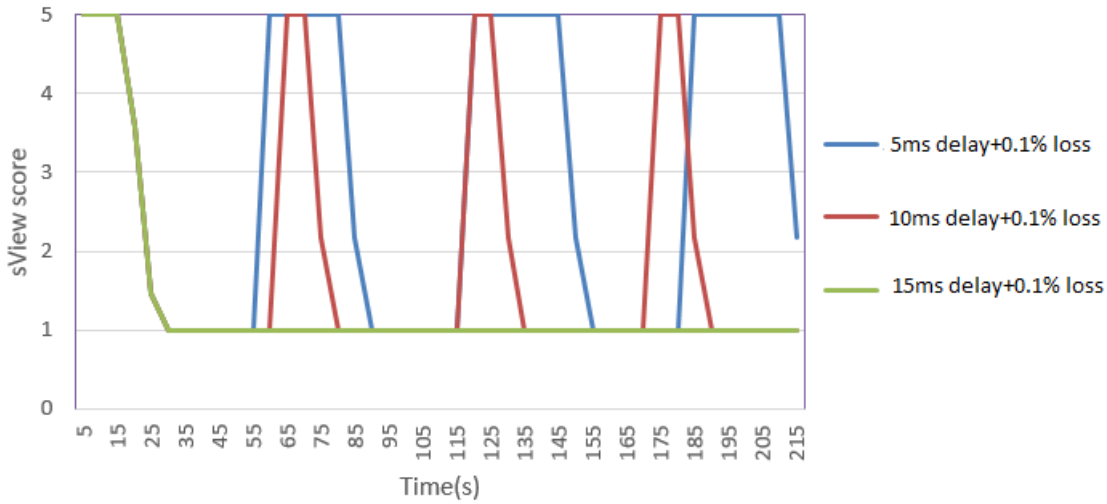
- **Test result analysis**
  - For VOD video, when the network packet loss rate is fixed, a short deterioration occurs with the delay increasing.
  - When the packet loss rate is 0.01%, deterioration occasionally occurs when delay increase to 50ms, no obvious deterioration when delay is 5~35ms.

- When the packet loss rate is 0.1% and delay is more than10ms, KQI will deteriorate with larger degree and higher frequency, but quick recovery.

3) VOD(40Mbps)

- **Test condition**
  - The network bandwidth is 1Gbps; Video source: VOD 4K video, bitrate is 40Mbps
  - Delay damage: downlink packet loss rate is 0.01%, bidirectional delay is 5ms, 10ms, 35ms, 50ms, test scores of sView
  - Delay damage: downlink packet loss rate is 0.1%, bidirectional delay is 5ms, 10ms, 15ms, test scores of sView
- **Test phenomenon**



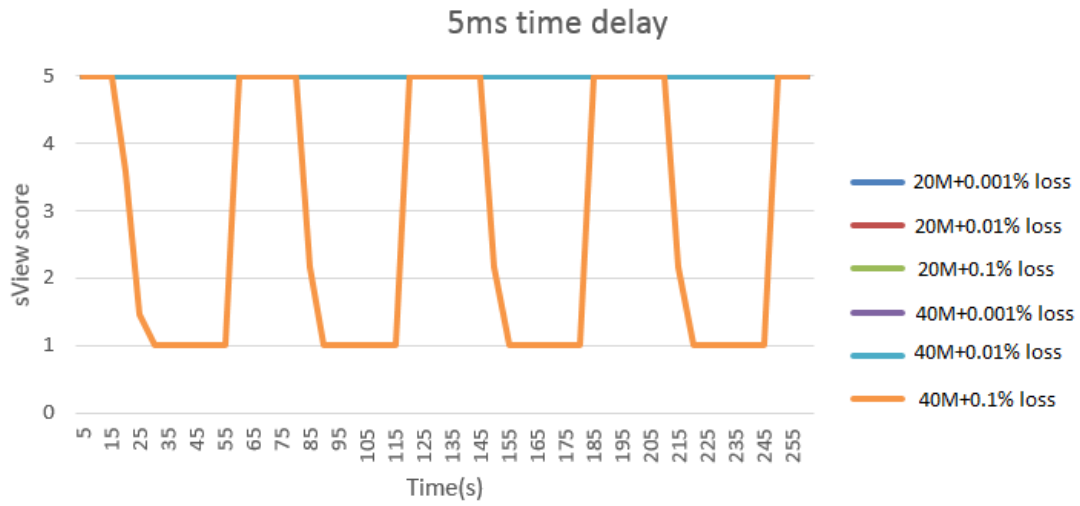


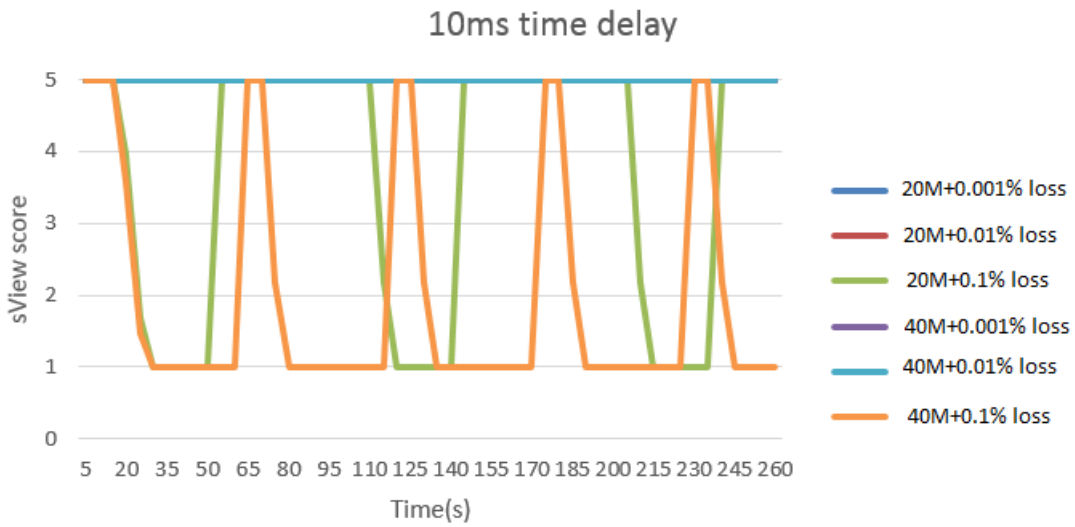
- **Test result analysis**
  - For VOD video, when the network packet loss rate is fixed, deterioration occurs with a longer duration and higher frequency as the delay increasing.

- When the packet loss rate is 0.01%, deterioration occasionally occurs when time delay increase to 35ms, no obvious deterioration when delay is 5~10ms.
- When the packet loss rate is 0.1%, KQI will deteriorate with large degree and high frequency even though the delay is 5ms.

3.4.3 Bearer network requirements for different video bitrates

- **Test condition**
  - The network bandwidth is 1Gbps; Video source: VOD 4K video, bitrate are 20Mbps and 40Mbps
  - Delay damage: bidirectional 5ms and 10ms, downlink packet loss rate is 0.001%, 0.01%, 0.1%, test scores of sView
- **Test phenomenon**





- **Test result analysis**

- For VOD, when the delay is 5ms and the packet loss rate increases to 0.1%, the effect of 40M rate is greater than that of 20Mbps.
- When the delay is 10ms and the packet loss rate increases to 0.1%, KPI of 40Mbps deteriorates with higher frequency and recover more slowly.
- The higher the rate, effect of delay and packet loss rate is more obvious

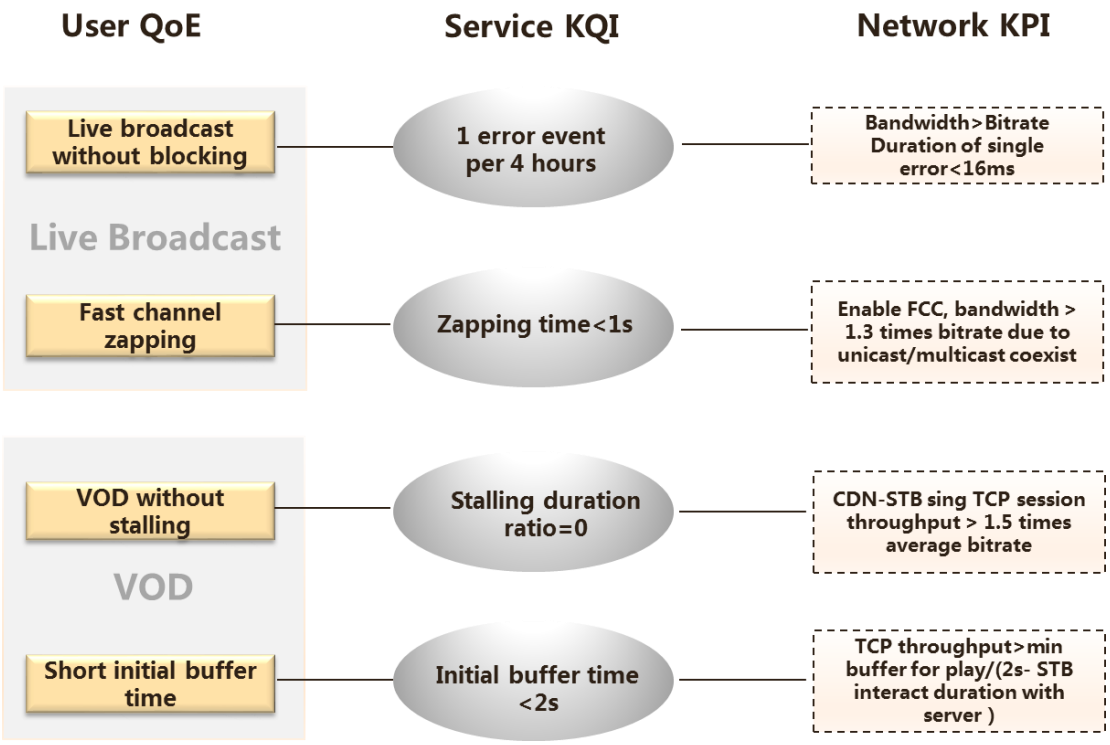
3.4.4 Laboratory test

- **Background traffic overlay test (bandwidth)**
  - Bandwidth is the key factor that affects the user's video experience;
  - In the network congestion scene, deploying QoS for video services can enhance the user's video experience.
  - In the network congestion scene, the live broadcast is better than the VOD video experience;
  - In the network congestion scene, the larger the video bitrate, the worse the KPI index of VOD service is.
- **Network KPI damage test by impairment emulator (delay, packet loss)**
  - For live broadcast service, the influence of delay on KQI is not obvious, and the packet loss rate of network has more influences on KQI index;
  - For VOD services, as the delay increases, KQI will meet short-term degradation, and the packet loss rate will have worse impact on the KQI index. Low delay can counteract the influence of packet loss rate in some networks;
  - The greater the video source bitrate, the stricter the requirements of network KPI, the more sensitive to perception.

3.5 Network requirements for video experience

Video services are characterized by high bandwidth, high concurrency, high burst, high perception and low latency, and experience is the result of the E2E interaction of "platform", "network" and "terminal". When the video source quality is stable, with interactive quality and viewing quality target, we can give the requirements of TCP/UDP throughput and typical network KPI.

Base on the research of industry and Huawei iLab, for live and VOD video, we define a typical good experience evaluation standard, as the basis of TCP throughput formula and test data, decompose into network performance.



The following table is network KPI target (including user bandwidth, delay, packet loss rate E2E) based on the HD /4K sources, Take 4K as an example, require the user E2E bandwidth＞40Mbps，RTT ≤20ms，PLR≤5.0E-5

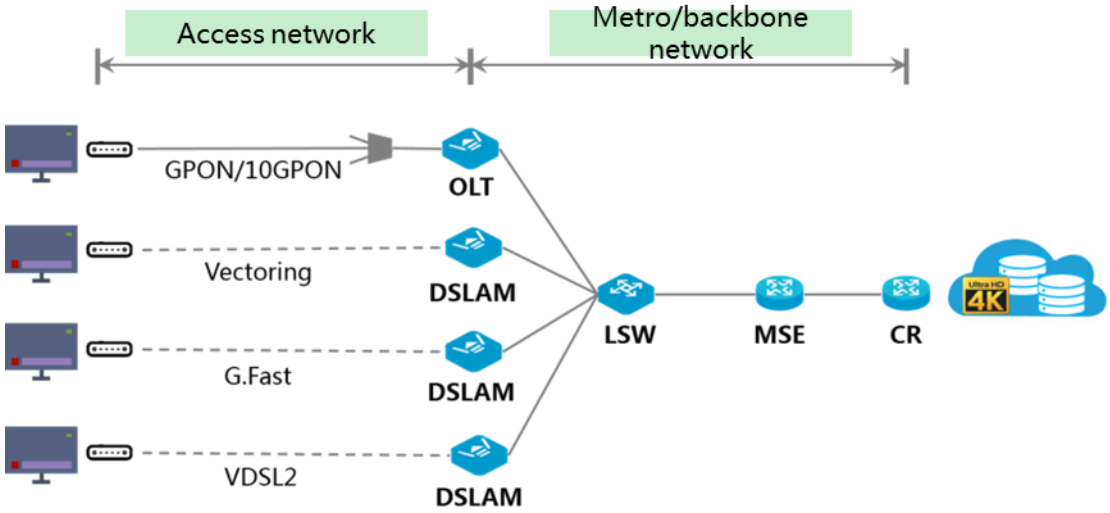
Service type			FHD	Entry-level 4K			Operational 4K		
Code Type			H.264	H.265			H.265		
Resolution			1920*1080	3840*2160			3840*2160		
Frame Rate			25P/30P	25P/30P			50P/60P		
Live (CBR/UDP/Multicast)	Bitrate range		8~10Mbps	25~30Mbps			25~35Mbps		
	Bitrate reference value		10Mbps	28Mbps			30Mbps		
	Network KPI requirements(Multicast replication point)	User bandwidth	>10Mbps	>28Mbps			>40Mbps		
		Delay	<100ms						
		Packet loss rate	Without RET: 10-6 / With RET: 10-3						
VOD (VBR/HTTP/Unicast)	bitrate range		6~8Mbps	12~16Mbps			20~30Mbps		
	bitrate reference		8Mbps	16Mbps			25Mbps		
	Network KPI requirements (CDN to STB)	Bandwidth	>12Mbps	>24Mbps			>38Mbps		
		Delay	60ms	20ms	40ms	60ms	20ms	40ms	60ms
		Packet loss rate	2.0E-4	6.6E-5	4.0E-5	2.0E-5	5.0E-5	2.0E-5	1.0E-5

For each fixed bearer network, metropolitan and backbone architectures are similar, with variable access network. For different access networks, time delay, packet loss rate and bandwidth always change within a range.

Access Network	RTT	PLR	Bandwidth per User@Distance
VDSL2	10~20ms	$10^{-4\sim-5}$	50Mbps@<1000m
Vectoring	10~20ms	$10^{-4\sim-5}$	50~120Mbps@<800m
Super Vector	10~20ms	$10^{-4\sim-5}$	100~300Mbps@300~500m
G. Fast	2~6ms	$10^{-4\sim-5}$	200M~1.2Gbps@100~500m
FTTH	2~3ms	$<4*10^{-7}$	20M~1Gbps
Metro/Backbone	**RTT**	**PLR**	**Bandwidth**
SDH	50~120us/hop	0/hop(no network congestion)	no network congestion
WDM	25us/hop	0/hop(no network congestion)	no network congestion
Router	30~50us/hop(no network congestion)	0/hop(no network congestion)	no network congestion
Switch	<5us/hop	0/hop(no network congestion)	no network congestion
Fiber	~5us/km	$<4*10^{-7}$	no network congestion

Typical fixed network element KPI value

For a typical video bearer network, metropolitan area network consists of 1 Switch + 2 Router + 200km Fiber, and the RTT delay is usually less than 10ms, even may reach 30ms for cross metropolitan or hierarchical networks. For access network, the key of the cable technology is the bandwidth. The key factors that affect the bandwidth are the copper wire technology, the distance from the end users, the packet loss and delay caused by the line quality. FTTx access usually satisfy video services on KPI, and the main factors are fiber access technology and PON split ratio.

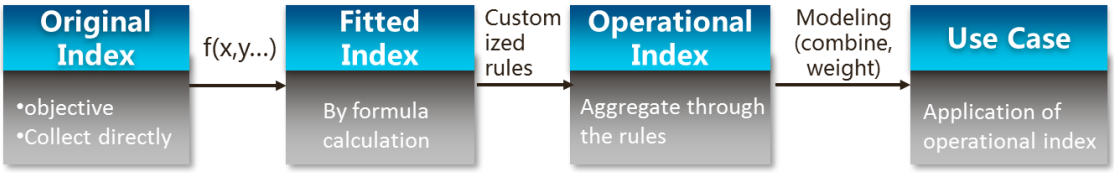


Considering the time delay, packet loss rate and bandwidth, the FTTH and G.FAST access networks can support the carrier-class 4K in the case of bandwidth satisfying. For the Super Vector, Vectoring and VDSL2, the throughput may be not enough when the home and metro networks are considered, so a reasonable network planning and line quality optimization are needed.

4 IPTV Index System Application Scenarios

The original index of the IPTV network is objective, and the index quantity is relatively stable. The fitted index of the evaluation service experience is formed by fitting the original index with some subjective factors.

In addition, due to the network attributes of fixed network, the operation index is more abundant. By introducing the threshold value, the statistical method is defined, and the single session, single user and single network element indexes are structured. Modeling combination of operation index, can realize the establishment of scale, optimization of network construction and maintenance specifications target.



Below, we will introduced the application scenarios of the IPTV index system from three aspects: video experience visible, manageable and optimizable.

4.1 Experience visualization-Region ranking of VAP ratio

1. VAP ratio (IPTV)

Use U-vMOS as the user experience evaluation when watching the video, design poor quality ratio, support telecom operators to get the user experience in time in various regions, through regional rankings, prompting each area improve the user experience and network.

Original and fitted index	Operational index	Customized factor
U-vMOS	Video user poor quality ratio	Definition of poor quality(U-vMOS threshold), U-vMOS sampling period

- **Index acquisition**

The set-top box probe calculates the U-vMOS of the video every second, and reports to SQM periodically, including N*60 U-vMOS histograms in N minutes.

- **Modeling**

Single user poor quality duration = U-vMOS < threshold time.

Single user healthy rate = 1 - (poor quality duration/video watching time)

Video user poor quality ratio = single user healthy rate < threshold IPTV account number / IPTV account total number

Threshold setting:

Poor quality U-vMOS threshold: less than 2.5 points

Set-top box probe repot cycle: 5 minutes

Regional video user poor quality ratio statistics cycle: 5 minutes /24 hours

Single user healthy rate: less than 95%

1. Stalling duration ratio (OTT)

For the OTT operation of video, video services using unicast bearing, the key index of user experience is stalling duration ratio.

Original and fitted index	Operational index	Customized factor
Stalling duration time	Stalling duration ratio	Standard threshold, statistics period

- **Index acquisition**

The set-top box probe calculates stalling duration time and watching time per second, and reports to SQM periodically, including total stalling duration time and watching time in N minutes.

- **Modeling**

Single user stalling duration ratio = total stalling duration time / total watching time

Stalling duration percent of pass = Single user stalling duration ratio < threshold IPTV account number / IPTV account total number

Threshold setting:

Stalling duration ratio percent of pass: less than 1%

1) No failures: 0%;

2) Occasional failures: 0%~1%;

3) Sometime failures: 1%~2%;

4) Serious failures: greater than 2%

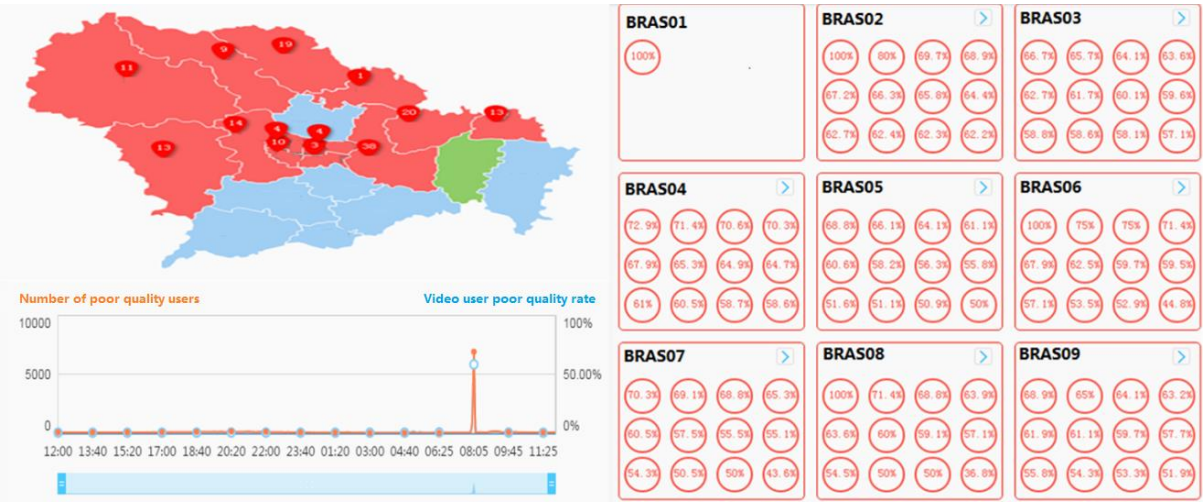
Set-top box probe report cycle: 5 minutes

Regional video user poor quality ratio statistics cycle: 1 hours /24 hours

- **Application and presentation**

Regional video user poor quality ratio: 24 hours

Poor quality rate in OLT: Number of poor quality video user / total video watching user in OLT



4.2 Experience management- Effective fault location

There are many elements in the video service end-to-end path, and the operation and maintenance capabilities are necessary. According to the analysis in Chart 3, the video experience of the user is closely related to the KPI (delay, packet loss, and bandwidth) of the network. According to the network planning and maintenance experience, the network KPIs are mapped to the network element or port performance index, including optical power, bit error rate, queue packet loss rate, bandwidth utilization, split ratio and other indexes. Through the change of video user poor quality rate and the change of network KPI, the fault factors can be quickly located or identified, and the network potential risk can be eliminated in advance.

Original and fitted index	Operational index	Customized factor
U-vMOS	Video user poor quality ratio	Definition of poor quality(U-vMOS threshold), U-vMOS sampling period
Optical power	Port received and sent optical power	Statistics scope(OLT upstream port, switch port, transport device port, router port), optical power threshold, statistic period
	ONU PON optical power	Statistics scope(ONU PON port), optical power threshold, statistic period

	OTU input optical power	Statistics scope(Ochs OTU board), optical power threshold, statistic period
	Multiplexed-wavelength nominal output optical power	Statistics scope(OA board), normal optical power of an OA board
BER	ONU PON line BER	Statistics scope(between the OLT PON and ONU PON), line BER type, statistics period
	OTU Pre-FEC BER	Statistics scope(OTU Line-side port), line BER type, statistics period
	Port packet loss rate	Statistics scope(Ethernet port inbound CRC, Symbol error), normal threshold, statistics period
QoS queue packet loss rate	QoS queue packet loss rate	Statistics scope(Ethernet port with QOS), packet loss threshold for variable bitrate, statistics period
Inbound/outbound bandwidth utilization	CDN outbound bandwidth utilization	Statistics scope(direction from Edge CDN to bearer network, CDN upstream), threshold, statistics period
	Link bandwidth utilization	Statistics scope(PON port, OLT upstream port, switch port, transport device port, router port), statistics type(average, peak, average of peak time), bandwidth utilization threshold, statistics period

- **Index acquisition**

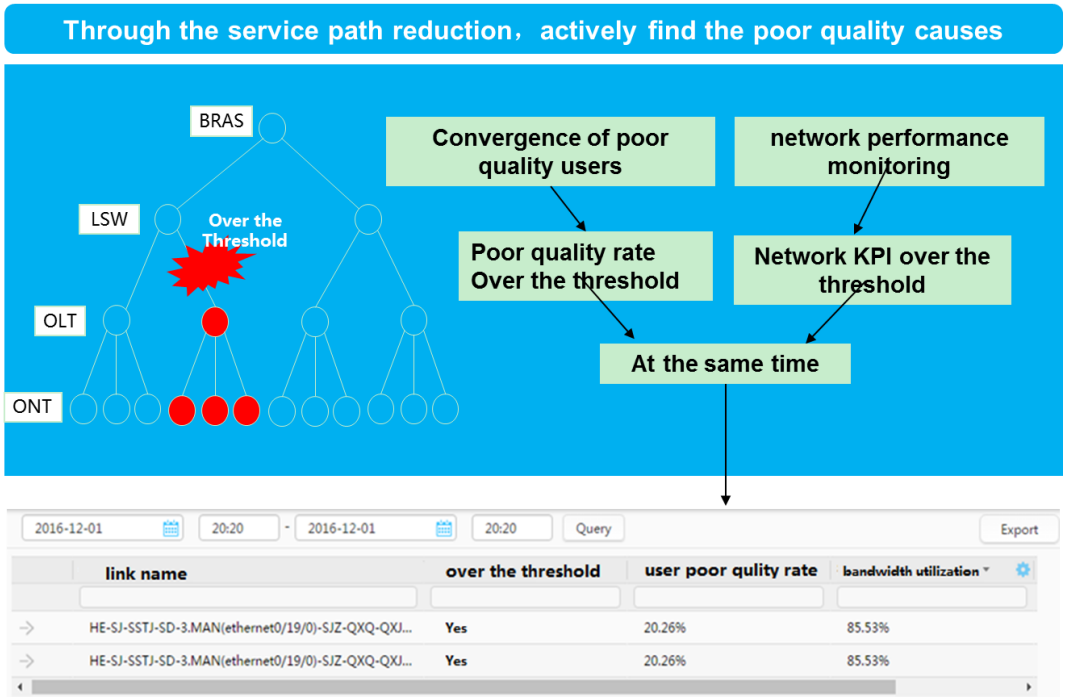
The set-top box probe calculates the U-vMOS of the video every second, and reports to SQM periodically.

NMS or NPM system collects periodically: Ethernet port received optical power, ONU received power, PON port line error rate, QOS queue packet loss rate of port and bandwidth utilization.

The OTN NMS collects: OTU Pre-FEC BER and OTU input optical power, etc...

- **Modeling**

When the video quality of one specific region suddenly turns to be poor, by the relative service path reduction, find out the fault factors quickly.



Threshold setting:

Video user poor quality ratio: greater than 2%

Inbound bandwidth utilization: greater than 80%

Outbound bandwidth utilization: greater than 85%

Port packet loss rate: greater than E^{-5}

Qos queue loss rate: greater than E^{-5}

ONU PON port line error rate: greater than E^{-5}

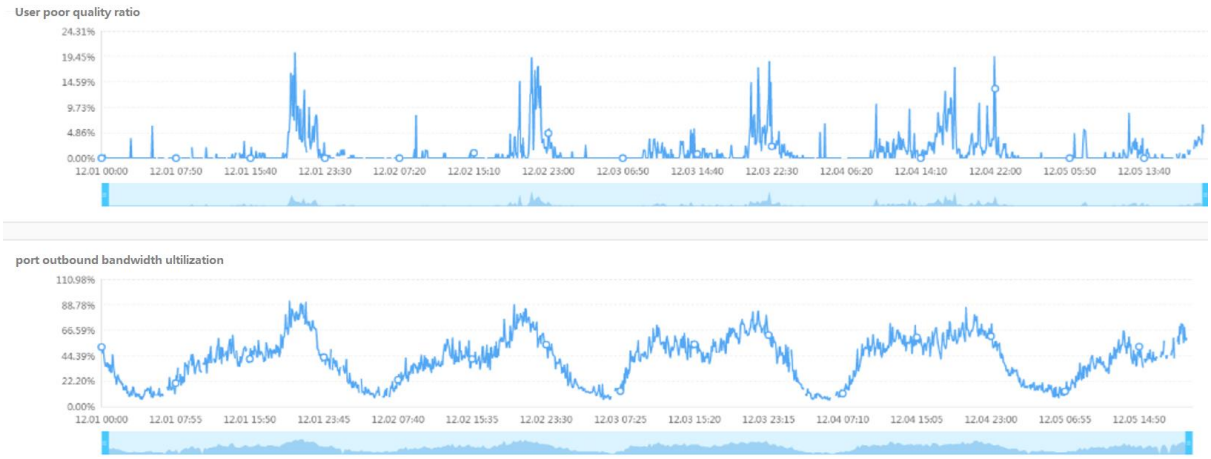
ONU PON port weak optical power: less than -27dbm

Ethernet port optical power: optical module specification threshold

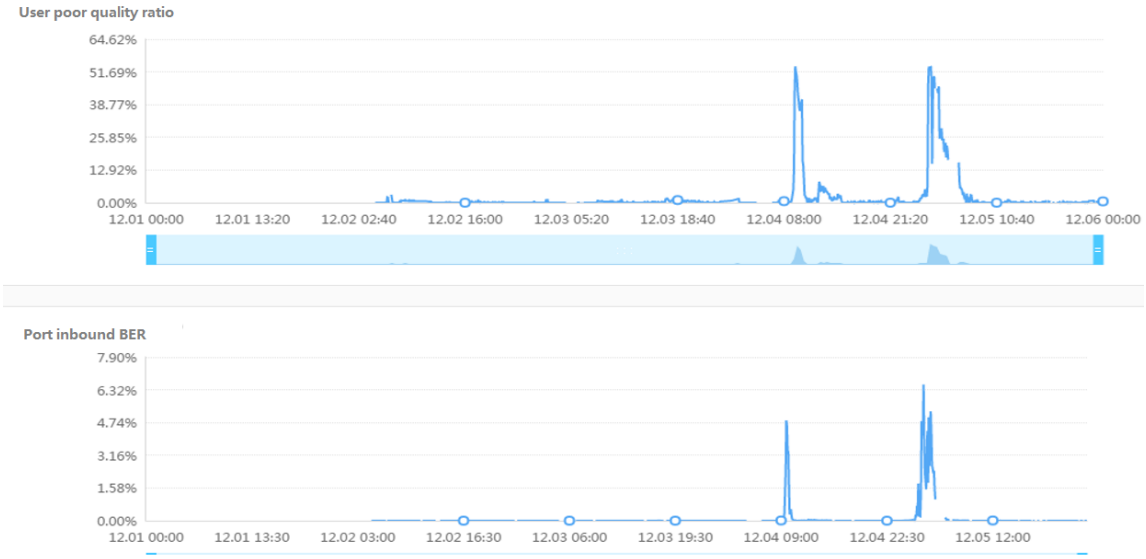
OTU circuit board received signal optical power: target range [-12dBm, -5dBm]

- **Application and presentation**

1) BRAS and OLT devices connect through the Eth-Trunk, Trunk member port GE1/1/14 peak flow raise up to 90%+ in service peak time. With the growth in traffic, video user poor quality rate rise due to overflow. Finally, migrate users to other devices and solve the problem.



2) BRAS and OLT devices connect through the Eth-Trunk, there are port packet loss on Trunk member port ethernet0/20/0, resulting in video user poor quality ratio on this Trunk suddenly increase, the reason is OTN (between BRAS and OLT) optical power problem.

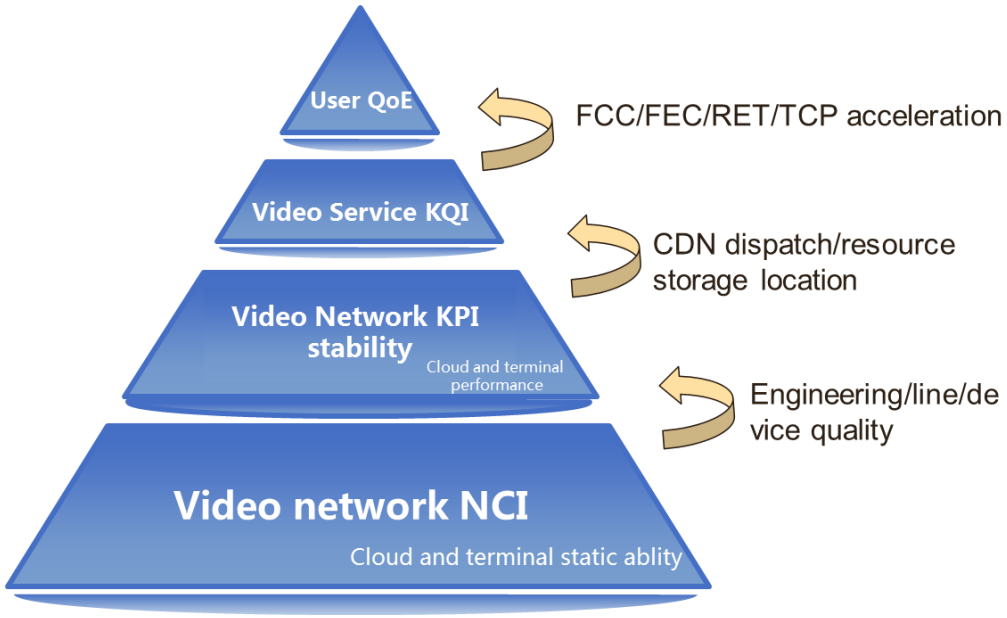


4.3 Network promotion- Video network capability measurement

Compared with home broadband service, video service has unique business model and user model, and then needs the adaptation of network model. Video experience puts forward higher requirements for resource supply and network security, and network planning determines the ceiling capacity of video services.

The bearer capacity of video network, can be measured by the supply of resources (including access network coverage ability), network security and other aspects. According to the modeling of

network capacity index (NCI, Network Capability Index. NCI=f (index item, index value, score formula, weight score), provide a useful reference for the planning of video network.



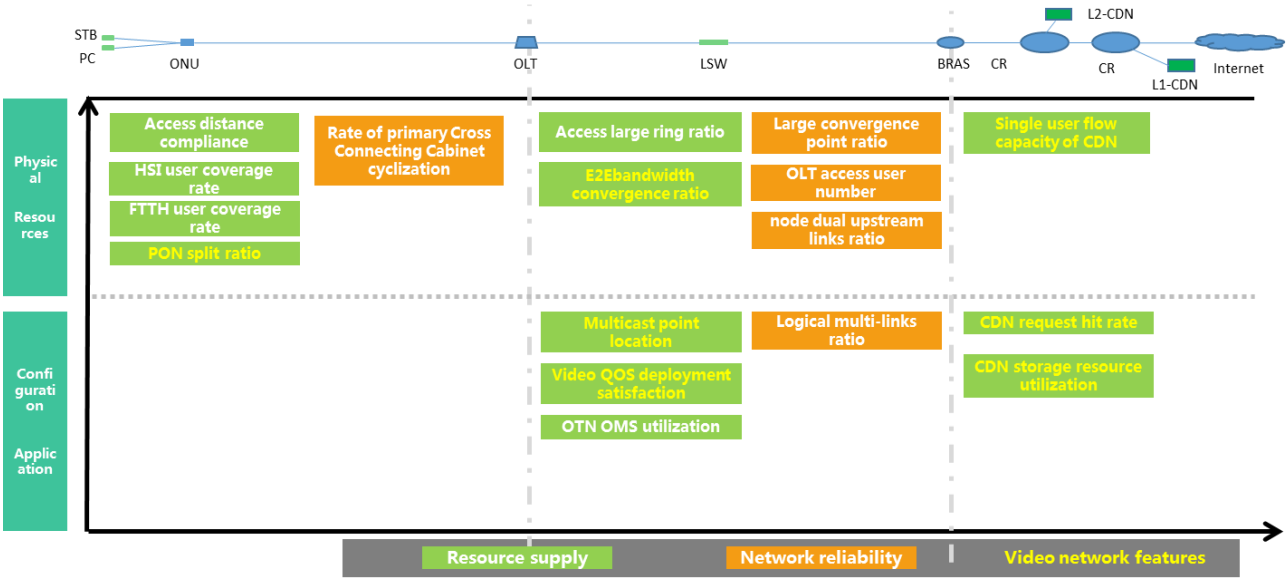
- **Index acquisition**

Transport network management	PTN, OTN scripts and report forms for performance
SNMP/CLI	network element configuration, user model (user type and number of users)
CRM/ resource management system	Video account information, dumb resource information
TV service platform (including CDN)	CDN bandwidth capacity and performance report

- **Modeling**

Weight scores: use AHP algorithm to calculate the relative weights of NCI index factors

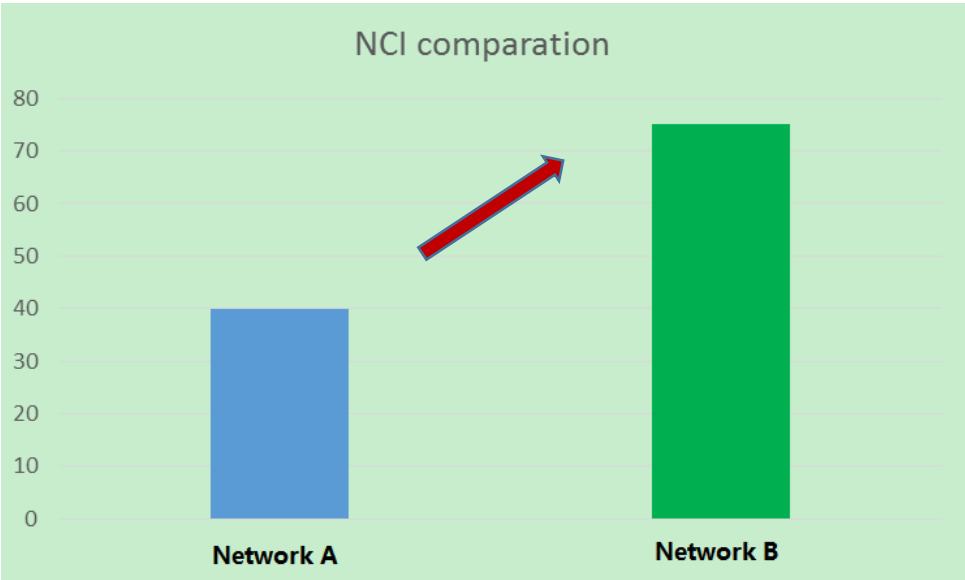
Scoring formula: single index score modeling (linear function, piecewise function, normal distribution, and custom model)



Key indexes that show video network capability

- **Application and presentation**

Take horizontal comparison of different network and longitudinal comparison of the same network. By NCI evaluation, comparison is carried out on the network for optimization of video network.

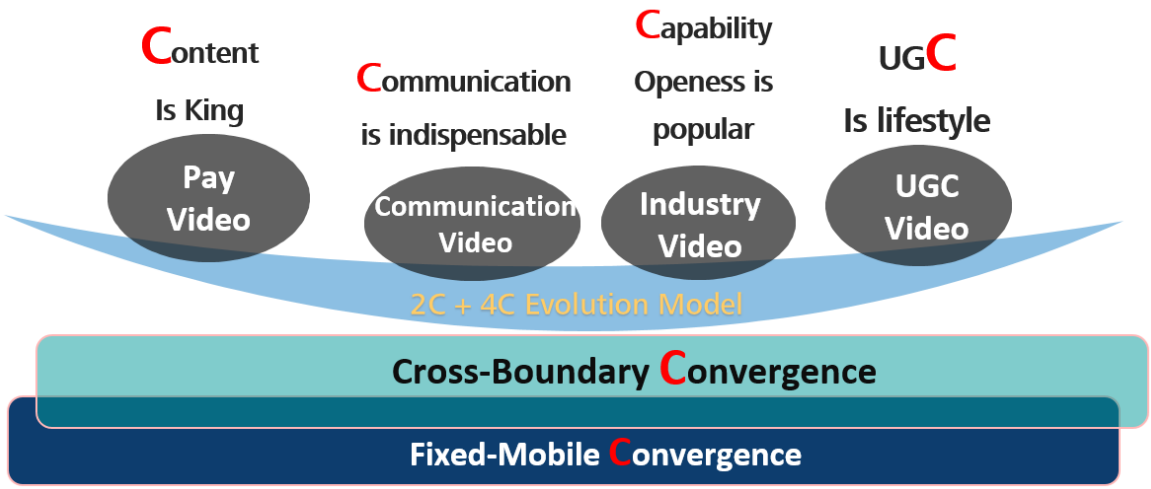


Network A capability: FTTH user coverage rate 50%; node dual upstream links ratio 70%; single user flow capacity of CDN 2Mbps...

Network B capability: FTTH user coverage rate 90%; node dual upstream links ratio 95%; single user flow capacity of CDN 10Mbps...

5 Future Evolution

The video is a large ecosystem, bringing together all business. In the future, telecom operators will take the entertainment video as a basic mainstream, the business scope will extend to communication, industry domain gradually. Taking 2C+4C as the evolution route, they will gradually move towards convergence, continue to explore the blue ocean market of pipeline.



Huawei L.I.V.E video service will work with the industrial to optimize the IPTV index system together. One sides, we will provide unified evaluation system for video experience of cross-screen, cross-domain network, multi-service, to help video industry realize a benign development. Other sides, along with the video service gradually heads for integration and ecological, IPTV index system will be constantly expanded and adapting to new service, gradually covering communication video, industry video, and UGC, finally constructs experience-oriented index system, which includes network evaluation, planning, optimization and construction. Finally, we can realize a video connected world, achieve a magnificent goal of enriching people's communication and life by video.

6 References

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4. DSL Forum TR 126: Triple-Play Services Quality of Experience (QoE) Requirements
5. IETF RFC4445: A Proposed Media Delivery Index (MDI)

7 Acronyms and Abbreviations

Acronyms and Abbreviations	Full Name
U-vMOS	User, Unified, Ubiquitous, Video Mean Opinion Score
KQI	Key Quality Index
KPI	Key Performance Index
RTT	Round-Trip Time
QoE	Quality of Experience
QoS	Quality of Service
MDI	Media Delivery Index
DF	Delay Factor
MLR	Media Loss Rate
STB	Set Top Box
OTT	Over The Top
VOD	Video On Demand
EPG	Electronic Program Guide
CDN	Content Distribution Network
SQM	Service Quality Management
NMS	Network Management System
NPM	Network Performance Management

Acronyms and Abbreviations	Full Name
UDP	User Datagram Protocol
RTP	Real-time Transport Protocol
HLS	HTTP Live Streaming
VBR	Variable bitrate
CBR	Constant bitrate
FEC	Forward Error Correction
RET	Retransmission
FCC	Fast Channel Change