QoS Monitoring and Compliance

DAY 2

1. Measurement of QoS Parameters
2. Performance of QoS Measurements
3. Measurement Methods and Tools
4. QoS monitoring process
5. Data Collection, Analysis and Publication

Measurement of QoS Parameters




QoS Parameters

- Parameter : A quantifiable characteristic of a service with specified scope and boundaries. [ITU-T E.800]
- Example: the parameter for estimating the 'misdialling probability' is expressed as: 'The number of misdialled calls per 100 call attempts'.
- Network-by-network: individual networks are considered in isolation
- End-to-end: combination of individual networks are considered




QoS parameters

- QoS parameters: user-oriented and end-to-end (i.e., service),
- NP parameters may or may not be end-to-end.
- QoS and network performance parameters are different in nature and serve different purposes.
- The exist intrinsic relationships between QoS and NP parameters:
  - Direct influence;
  - Indirect influence;
  - Inverse influence.




QoS Parameter Confusion

- Confusion brought about because the counters are vendor specific should be avoided.
- Network Performance (NP) parameters measured by vendor specific counters are standardized due to their specific implementations.
- KPIs describe NP parameters of which a very limited number are truly related to end-to-end QoS.




Measurement of QoS parameters

- QoS parameters are measured by:
  - objectively; technical means - by measuring physical attributes of circuits, networks, network elements and signals
  - subjectively: perceived QoS- by surveys and subjective tests amongst users.
- Subjective measurement approach is a time-consuming and expensive procedure.
- The results of subjective measurements often provide highly variable results that need to be carefully analysed.




Measurement of QoS parameters

- Since QoS is a measure for "the degree of satisfaction of a user of a service", one would assume that ideally subjective measurement methods should be used to measure the quality of a service.
- Subjective measurements bear the risk that individual opinions are overestimated and that human judgments and misunderstandings falsify the results.
- Subjective measurements are complex and time consuming.
- Wherever possible, objective measurements are preferred since they often provide a good correlation to the results of subjective measurements.

QoS Measurement Policy

- Takes into account parameters influencing the resulting quality of a service including both ends of the communication and telecommunication network architecture aspects.
- Both objective and subjective measurement methods have to be considered to get the whole QoS picture.
- It is recommended to use objective measurements- in case where NP parameters and other QoS parameters can be quantified.
- Subjective measurements are carried out in the case of subjective aspects and for quantifiable parameters to determine how the customers perceive the quality they think they receive.[ITU-T Handbook on QoS).








Objective measurements

- Performed where specific network-related technical parameters –NP parameters- are measured,
- Used when the parameters can be correlated to the user's perception of QoS either directly or by the use of models.
- The QoS criteria can be identified, measured with appropriate probes in appropriate locations, and examined for specific network-related problems like:
  - call set-up time,
  - call failures and
  - interruptions




Objective measurements

- Address increased complexity of networks and services in mobile networks
- Use network-independent monitoring, non-intrusive Signalling System No. 7 (SS7) and IP probes to provide more real-time and more service-related xDRs, KPIs/KQIs and alarms related to QoS.
- The advantage is that a large volume of records can be collected to allow day-to-day evaluation of NP.
- The disadvantage is that the method does not have the capability of detecting tones or speech and therefore cannot present a complete representation of all call dispositions.

Objective measurements

- Can be made either on real traffic or on artificially generated traffic on public traffic or private networks.
- The geographic location of the network matters since QoS may be different with respect to location
- A compromise between the choice of sampling rates to reflect an adequate confidence and the costs .
- Optimization to focus on some key points of the network or to perform the measurements at the busiest hours of the day, week or year.







Objective measurements

- **Intrusive measurements**
  - Performed on artificially generated traffic and can provide more information since the traffic can be tailored to check almost everything.
  - Its drawback is to add traffic to the actual one and therefore can lead to additional costs and some possible disturbance.
- **Non-intrusive measurements**
  - Performed on real traffic conditions and expected to give a more realistic vision of the QoS.
  - Its drawback is that some deficiencies might be missed since not all the possibilities are checked.





Application of Objective Models

- To map objective measures of network performance to subjective opinions.
- As input values for the mapping function taken from INMD measurements.
- To relate the network performance such as speech level, echo loss, etc. to customer perceived performance represented by an opinion score.
- Monitoring and analysis of signalling information performed on real customer live traffic based on counters or CDRs from network elements.




Subjective measurements

- Subjective measurements are performed in order to measure the QoS as perceived by the user.
- Subjective measurements are the only means to assess the user perception aspects of the QoS,
- Used for those aspects that cannot be measured easily by technical means or those missed due to a reduced number of measurement points.
- Used in the case for billing accuracy, quality of customer care or relevance of the answer of the help desk.
- Subjective compared to objective measurements indicate:
  - improvements in the network or customer education are needed. However, due to the characteristics

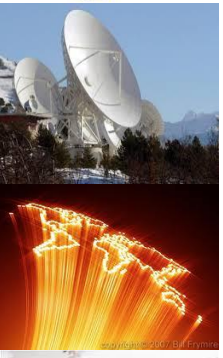
List of Proposed Parameters

Customer interface	Network infrastructure	Service functionality
1. Customer complaint submission rate	4. Coverage	8. Call set up ratio
2. Customer complaint resolution time	5. Service supply time	9. Call retention ratio
3. Customer service call answer ratio	6. Fault report submission rate	10. Listening voice quality
	7. Fault repair time	11. Value added service call answer ratio
		12. Message transmission ratio
		13. Packet transmission ratio
		14. Packet transmission rate
		15. Data transmission




Performance of Measurements

Performance of QoS Measurements



WHO Measures QoS

- Who is interested in Quality?
- Who is responsible for Quality?
- Who is responsible for Standards?

Performance of QoS Measurements

- Service Provider
- Contract by service provider to a another party
- Third party other than the service provider:
  - Direct Measurements and
  - Indirect measurements:








Measurement Methods

- Measurement Tools
- Four view points of QoS
- Quality Matrix
- QoS Interfaces
- QoS Monitoring Process

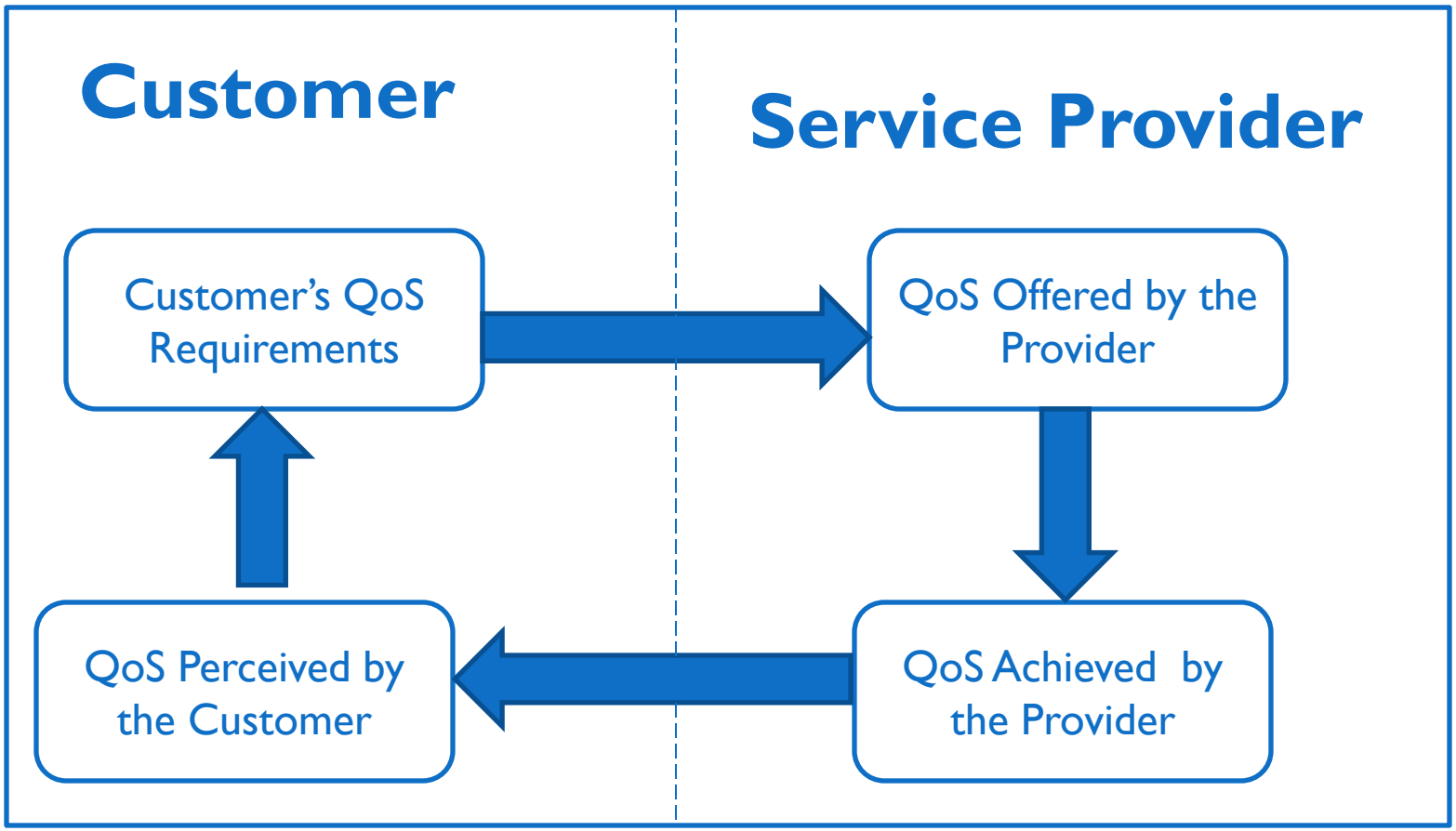
Methodology for identification of QoS criteria and parameters

- Management of QoS may be sub-classified into four viewpoints that cover all aspects of QoS [ITU-T G.1000].
- The four viewpoints are:
  - Customer's QoS requirements;
  - Service provider's offerings of QoS (or planned/targeted QoS);
  - QoS achieved or delivered (QoD);
  - Customer perception (survey ratings of QoS).





Four Viewpoints of QoS



Source: ITU-T G.1000

Service provider's offerings

- Service provider offerings of QoS are formal terms specified unambiguously and used for the following:
  - Basis for SLA between the service provider and clients on a bilateral basis agreement.
  - Public declaration by the service provider about the level of quality that can be expected by the users at large.
  - Basis for planning and maintaining the service at the level of performance being offered.
  - Basis for users to choose a level of quality to meet their particular requirements among the service provider's offerings.





QoS achieved or delivered

- The QoS delivered (QoSD) is the actual level of quality achieved or delivered by the service provider and may be used for the following:
  - Basis to compare the delivered with the offerings by the users, regulators and as a check in the SLAs by the service providers.
  - Basis for any corrective action by the service providers.





Customer's QoS requirements

- An expression of the level of QoS required by the customer
- This is expressed in the form of a statement by the customer.
- The criteria and parameters identified to express these reflect the requirements.








Customer/User perception

- QoS perceived by the user may be expressed by ratings based on customer surveys and is an indicator of what the user thinks the level of quality received or experienced
- May be used for:
  - Comparison with delivered quality and identifying causes of any ambiguities.
  - Planning any corrective actions.

Choice of QoS Parameters

- The choice decision should take account:
  - The precise purpose for which the parameters will be used.
  - The quality and performance as expected by the users of state-of-the-art technology.
  - The usefulness and relevance of the parameters from the users' perspective.
  - The degree to which the parameters will provide a reliable comparison of performance.
  - The cost and resources needed in order to measure and report each parameter.
- The usage and application of internationally agreed upon parameters should be aimed at.
- Use of already existing standards as a basis for further work for the determination of additional parameters,




Application of QoS parameters

- Monitoring of telecommunication services and cross-checking whether quality objectives/goals have been met.
- Used by the service providers to manage and improve how they offer their services,
- Used by the customers to ensure that they are getting the level of quality according to their contractual agreements.
- Used in call-minute trading, where price is determined by volume and quality grade.





Application of QoS parameters

- Used by regulators:
  - To define quality levels for regulatory purposes of interconnection and interoperability aspects of networks and services.
  - To assess the quality of certain aspects of a service.
  - To measure the overall quality of a service as perceived by the user.
- The usage may range from an in-depth quality assessment to a simple assessment of the general perception of a service.








Application of QoS parameters

- Parameters characterize the quality level of a service being offered, and ultimately the user satisfaction
- They represent subjective and user-perceived quality expressed in numeric ratings
- Used as the basis for SLAs as well as in a public for promotion purposes
- Service providers and network operators may use parameters as the basis for planning purposes
- NP parameters derived from the end-to-end QoS requirements or planning targets may not be of interest to the users
- Pparameters may be used to specify the delivered quality

Models for Identification of User Criteria – Quality Matrix

- Before defining QoS parameters, the relevant QoS criteria relevant to the users must be identified.
- Three models for identification of users' criteria are:
  - Universal Model
  - Performance Model
  - Four-Market Model
- The basic approach to the models is to provide a matrix or table;
- By filling in each field of the matrix or table, quality criteria can be identified and allocated to functional elements of the service.
- The intention is to establish a list with all (relevant) aspects that might have an influence on the quality of service.





Universal model

- Universal model is generic as well as conceptual.
- In this model all QoS criteria may be grouped under four categories (Table 1):
  - performance criteria,
  - aesthetic, criteria
  - presentational aspect and
  - ethical aspect




Table 1: Universal model-Quality Matrix

	Quality Component and Criteria			
	Performance criteria	Aesthetic criteria	Presentational aspects	Ethical aspects
Functional elements				
1.				
2.				
3.				
....				
....				
n				

Source: ITU-T E.802








Universal model

- The QoS criteria for telecommunication service determined by an iterative process of evaluation of issues of the four categories against the functional elements of a service.
- The functional element of a service is a uniquely identifiable segment of a service, collectively comprises all features of a service.
- One functional element may need to be considered in more than one column.
- All cells may not be populated for every element.
- In the end, the model produces a list of functional elements of the telecommunication service with associated quality criteria.
- The functional elements are then specified as parameters with suitable measures, where necessary, to represent indicative values.

Universal model

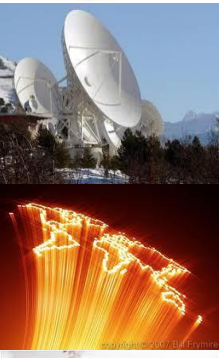
- QoS criteria may be reached at for each of the cells arising out of the resulting matrix by breaking down a service into uniquely identifiable functional elements,.
- The objective is to provide a structured approach and the template in the model should facilitate this activity.
- Each functional element of the service is cross-checked against the four predefined quality components and criteria.
- There is no fixed list of functional elements on the y-axis as the nature and number of elements depend on the service under investigation and could change with the service chosen.





Universal model

- Functional elements comprise all the uniquely identifiable components of the service when put together, cover all the functional aspects of the service.
- Functional elements essentially cover the product life cycle from the provision of the service to the end of its life.
- By going through each cell of the matrix, the quality criteria of a service may be determined.
- It may be necessary to indulge in an iterative process and to check relevance before determining one or more set of quality criteria.




Performance criteria

- Performance criteria covers technical and operational elements inherent to a telecommunication service.
- The criteria is used to assess the characteristics of these elements, the way how they perform and meet the expected results and modes of operation.
- The criteria may be quantitative or qualitative or a combination of both.




Aesthetic considerations

- The criteria and considerations relate to the ease of interaction between the user and the telecommunication service/product and sensual perception of the service/product by the user.
- Examples of aesthetic criteria are:
  - ergonomic considerations,
  - simplicity,
  - functionality and
  - clarity of design, optimum use of resources, style, etc.
- The aesthetic quality criteria are less quantifiable than the performance criteria;
- The aesthetic criteria play an important part in how an entity is held in esteem or otherwise.




Presentational aspects

- Presentation criteria determines the quality aspects of the manner in which a service is marketed or supplied to the customer.
- Examples of presentational aspects are:
  - service surround;
  - packaging of entity to the user;
  - customization of bills;
  - tariff packages/options, etc





Ethical aspects

- Ethical aspects criteria associated with how a service or product is offered to the user.
- These aspects may be classified as quality components, such as:
  - acceptable use of labour (evidence of lack of exploitation of labour) and
  - 'green' issues.
- Examples of ethical aspects are:
  - conditions for cutting off services,
  - subsidies for the poor and the disabled,
  - services for the disabled, etc.




Performance model

- The Performance Model (Table 2) is a direct expansion of the portion of the Universal Model comprising performance criteria and functional components.
- The Performance model uses a different concept from Universal Model but the results obtained fulfil the determination of QoS criteria of a service.
- The performance model is more suited for determining the performance criteria of a telecommunication service.



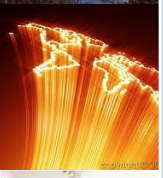

Performance model

- The model is basically a matrix with a list of service functions on the y-axis and quality criteria on the x-axis.
- The service functions are uniquely identifiable performance elements of a service, when put together, cover most, if not all, aspects of a telecommunication service.
- For each service function, it can be determined what kind of quality criterion is applicable by going through the 77 cells of the matrix (Table 2).
- Each cell of the matrix is investigated in an iterative process.

Table 2: Performance model – Quality Matrix

		Service Quality Criteria						
		Speed (1)	Accuracy (2)	Accuracy (3)	Reliability (4)	Security (5)	Simplicity (6)	Flexibility (7)
Service function								
Service management	Sales & pre-contract /S(1)							
	Provision (2)							
	Alteration (3)							
	S/support (4)							
	Repair (5)							
	Cessation (6							
Connection quality	Connection establishment 7							
	Information transfer (8)							
	Connection release (9)							
Billing (10)								
Network/service management by customer (11)								









Performance model

- The objective is to provide a structured approach to analyse the performance aspects in detail.
- The benefit is that the quality criteria identified can be easily transferred into QoS parameters
- The model is very detailed and close to the understanding of NP and management functions.
- The definitions and measurement methods of the QoS parameters can be expressed on commonly used and well-understood technical terms.




Performance model

- All cells may not be populated for every service function.
- The number of cells to be populated depends upon the kind of service under investigation or the desired granularity of the quality criteria.
- It would be rare for all cells to be populated for any one function.
- After determining the quality criteria, quality and performance parameters can be defined by conversion of criteria to parameter.




Four-market model

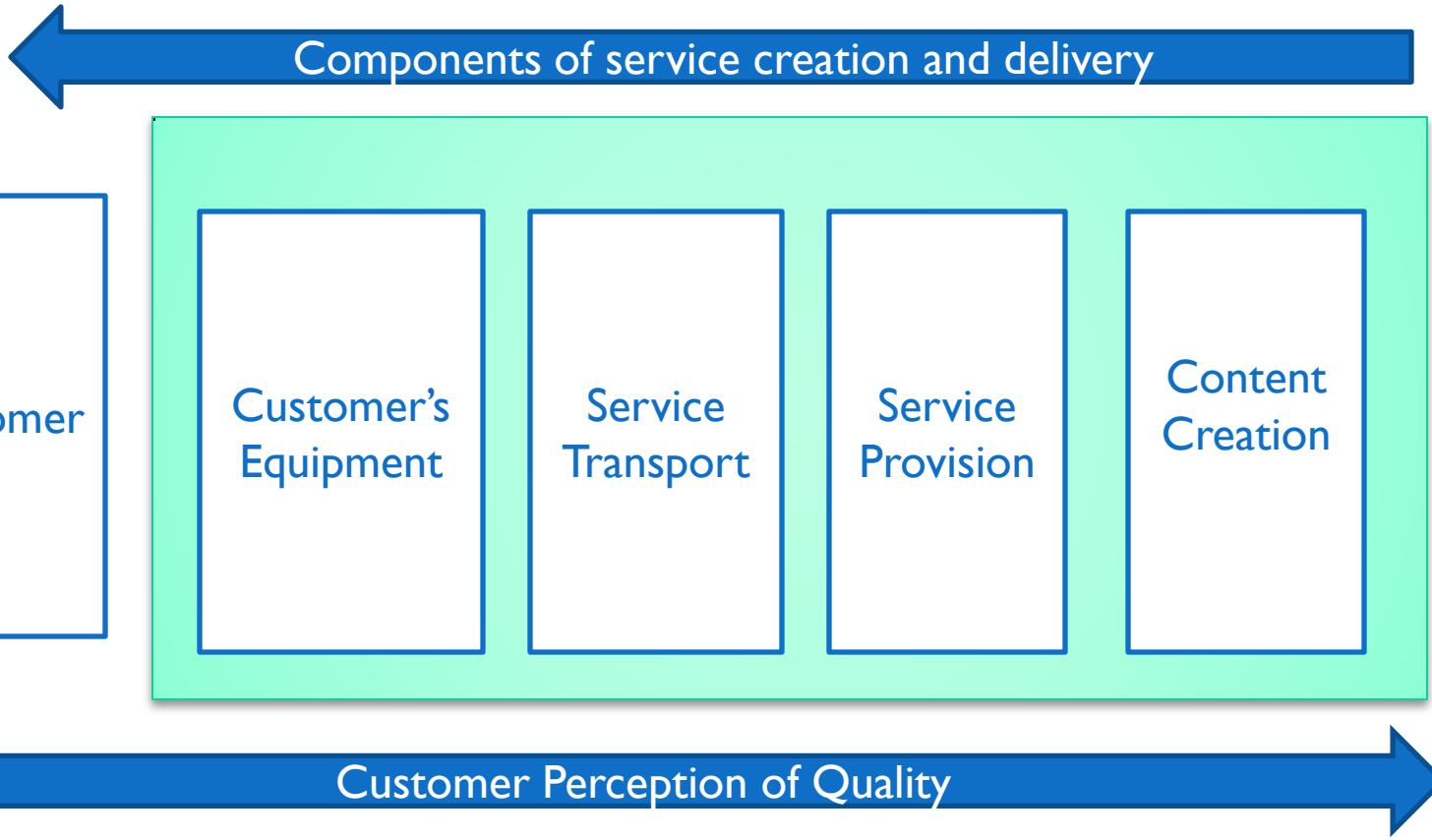
- The four-market model consists of four components that are used to describe the different elements of the services that contribute to the QoS provides a solution.
- The four components (Fig 4) are:
  - Customer equipment
  - Service transport
  - Service provision
  - Content creation

Fig. 4: Four-market model

Fig 4: Four Market Model







Source: ITU-T E.802




Four-market model

- There is a complex chain of actions for multimedia services, from content creation, service management, delivery network and customer equipment.
- Four-market model is especially suited for multimedia services offered on IP-based network since the separation between the transport and service layer is taken into account.
- Different parties may be in charge of transport, provision and content and the supply of terminal equipment.

Four-market model

- The overall quality of a service (as perceived by the user) is a combination of different elements that are working independently of each other.
- A model allows for a separate investigation of the different elements and identification of respective quality criteria.








Four-market model

- The four-market model enables to identify and categorize more easily the QoS criteria that are pertinent to this type of services.
- For a given telecommunication service, the model can be used to focus on each of the four components separately and to identify quality criteria.
- It may be not necessary to analyse all components.

Four-market model

- it may be sufficient to only identify quality criteria of one or more components depending on the aspects of a service under consideration.





Customer's equipment:

- All kinds of equipment for the user to gain access to the network and the service.
- The equipment consists of:
  - personal computers,
  - television sets,
  - set-top boxes,
  - video recorders,
  - modems,
  - multimedia kiosks, etc.
- Not only the hardware but also the software for correct operation of the equipment.





Service transport

- All kinds of telecommunication networks that are used for the distribution of telecommunication services:
  - terrestrial – fixed and wireless access networks and
  - satellite broadcast networks, etc.





Service provision

- All activities and functions related to the telecommunication services:
  - packaging ,
  - presentation and
  - management





Content creation

- All activities related to the generation, distribution and packaging of content that is offered via a telecommunication service.
- Example of QoS criteria for a multimedia service obtained using Unversal Model is provided (Table 3)
- Use of performance model can be found in ITU-T E. 802.





Table 3: Use of Universal Model for mobile telephony

	Quality components and criteria			
	Performance criteria	**Aesthetic criteria**	**Presentational aspects**	**Ethical aspects**
Functional elements				
1) Hardware (terminal equipment)		Ergonomic design of handset usability		Disposal and ecological aspects
2) Service usage	Connection set-up and release Transmission quality Fault repair time Service availability		Customization of service features Customization of billing and payments Bill presentation quality	Security features
3) Contract	Supply time			
4) Customer relations	Hotline availability Response time Complaint resolution			Disabling mobile set when reported stolen

Source ITU-T E.802





QoS Monitoring Process

QoS Monitoring Process

- Defining Parameters
- Identifying Parameters
- Measuring Parameters
- Setting Targets









Defining QoS Parameters

- The following factors, among others, should generally be taken into consideration:
  - The practicability for operators to make the required measurements;
  - The practicability for regulators or any independent entity to audit the results;
  - The measurement being made should retain the customer experience aspect.

Identifying QoS criteria and parameters

- Basic aspects of QoS criteria and parameters when identifying the criteria and determining the scope and measurement methods of parameters are:
  - service-by-service basis.
  - end-to-end basis, and
  - terms understandable to the customers.









Identifying Parameters

- QoS parameters should be easily understood by the public, be useful and important to them.
- All parameters are applicable at the network termination point.
- Parameters should be capable of verification by independent organizations.
- The accuracy of QoS parameter values should be set to a level consistent with cost-effective available measurement methods.
- The parameters are designed for both statistical and individual application.




Identification of user's QoS criteria

- Depending on the granularity of the QoS criteria to be identified, the number of criteria for a given service may be specified.
- For basic POTS as many as 43 QoS criteria have been identified using the model in Figure 2. However, in practice as few as 10-13 criteria are adequate for management of the service for most of the population.
- All models or a combination of models may be used for a particular service to enable most, if not all, QoS criteria to be identified.
- For a particular purpose, a selection of QoS criteria may be chosen from the list identified.

Identifying QoS criteria and parameters

- Where necessary, are specified in more technical terms for use within the industry.
- Both customer terms and industry terms may use ITU-T recommended definitions to eliminate ambiguity and to provide the most efficacious understanding.
- Different segments of the customer population may require different orders of priorities for the various performance parameters.
- The preferred levels of performance for diverse segments of the population may be different for various user population segments.
- The QoS profile of a customer segment may vary with time and it is essential for the service provider to ascertain the customer's changing requirements, and the profile to consist of order of priority




Conversion of QoS criteria to QoS parameters

- Quality criteria identified from one or more of the above models have to be converted into quality parameters before use to express quantitatively or qualitatively the QoS.
- The conversion is is done in order to:
  - exactly specify the scope of the quality to be determined
  - to allow for reproducible measurements and comparable quality figures.
- The aim is to:
  - arrive at a harmonized set of quality parameters that can be used for evaluating the QoS
  - allow for the comparison of different service offers in a specified population.





Conversion of QoS criteria to QoS parameters

- A quality criterion is descriptive and needs to be tightly defined both in its scope and boundary to enable an unambiguous understanding of its functionality.
- When specified defined both in its scope and boundary, the criterion becomes a parameter.
- It is essential that QoS parameters are defined so that there are no ambiguous interpretations and any service provider may be able to carry out the measurements.
- Where parameters are defined quantitatively, explicit calculating rules have to be recommended.
- When parameters are defined qualitatively, definition based on opinion rating has to be recommended.





Conversion of QoS criteria to QoS parameters

- Different possibilities for the specification of the definition and measurement method:
- A user may state the number of outages she/he may put up with over a period of one year specified as a parameter as:
  - number of outages over a cumulative period of one year = n;
  - a period in which the user cannot use the service for more than = 'b' units of time;
  - maximum duration of any one outage = not more than 'p' seconds;
  - minimum duration between outages = 'q' hours.
- A single, all or a combination of the specifications may be chosen depending on the intended use and purpose of the parameter.





Parameter Definition and Measurement Method

- The definition of a parameter determines the range of application and its intended use.
- To ensure repeatable and comparable performance values, an aligned definition/scope and a recommended method of measurement need to be specified.
- The definition of parameters and the recommended measurement method have to be seen as a package.
- Even if the scope of two parameters is the same, a difference in measurement methods may lead to different aspects of the QoS criteria being measured.
- A universally agreed measure enables comparisons to be made between various organizations within a country as well as internationally.







Prioritization of QoS parameters

- Besides identifying quality criteria, a prioritized list of parameters and the preferred performance values are required to complete the user's QoS requirements.
- The basic aspects that should be considered are:
  - Different segments of the population could have differing priorities for the QoS parameters
  - A preferred value of performance for each parameter for each segment Different quality expectations for different pricing levels.
  - Profiling the segments of the user population by order of their own priorities and preferred performance values to complete the mapping of user requirements of QoS.
  - Identifying the groupings, if not already known, by finding out the QoS requirements of the user groupings of the Standard Industrial Classification (SIC).

Prioritization of QoS parameters

- The service provider may consider the following:
  - geographical aspects for monitoring trends in different development levels in different areas of a country.
  - A reasonable number of criteria/parameters to achieve the right compromise between the number of parameters and a meaningful QoS evaluation.
- Too many parameters will bring unnecessary high costs while too few will result in overlooking some key aspects.
- QoS parameters are defined or measured according to the target study area.
- Identification of the quality criteria is done carefully in accordance with the purpose of the study and usage of the service
- The results are weighted according to the type of user.




Publication of QoS parameters

- Explanatory text provided to facilitate the understanding of the statistics [ITU-T E.802].
- Information provided for parameters that require knowledge of basic technical and operational background of function of telecommunication services.
- The scope of parameters chosen to minimize misinterpretation of measurement results.
- Reference be made to the document, to provide definitions and measurement methods.
- A fair and justified comparison of the published data of the different services be offered.







Publication of QoS parameters

- Parameters should be measured with high precision and published in ways which suggest that measured differences are perceptible to users when they are not.
- The auditing of the processes be done in accordance with international standards,
- The determination of raw data and the presentation of results for publication are recommended for establishing the credibility of the published QoS data [SO/IEC Guide 62; ISO/IEC Guide 65]
- The frequency of publication of QoS parameters is left to the individual nations and/or the service providers.
- For international comparisons, a 6-month or yearly interval be considered for the publication of the delivered quality for each of the main services.
- The publication media may be left to the individual organizations.




Practical issues of QoS parameters

- Difficulty in the preparation of comparison and benchmarking of different networks and services
- The impact of individual ways of implementation/application of technology and equipment of the network operator and service providers on the significance of the QoS parameters.
- Adoption of the measurement concept, post-processing of the data and presentation of the statistics of the quality campaign.




Practical issues of QoS parameters

- The following aspects should be considered:
- Different concepts depend on the purpose and field of application of QoS parameters:
- Explicitly measure the quality of a service aspect with high accuracy to provide precise results.
- Suitable for comparison of a wide range of service offers with less significant results.
- Measurement methods triggered by certain technical processes and service events (physical parameters, protocol information, operational processes).




Practical issues of QoS parameters

- The trigger points may vary or have tolerances.
- The variability of trigger points can lead to different implementations or use of different technologies,
- The results may not be directly comparable even if the same quality criteria are measured (or intended to be measured).
- QoS parameters are not intended to provide quality statements for individual users (e.g., as used in SLAs).
- Understand the context the parameters are used is important
- The design concept of the parameters followed and the underlying measurement and publication policy for producing final QoS statistics is of importnce.

Performance of the measurements

- **Performed by service provider or contract to another party:**
- QoS parameters are used by a service provider for own purposes, e.g., SLAs, promotion purposes and service monitoring,
- The service provider may wish to improve the confidence in the quality of the statistics, by having the measurements audited by an authorized body in accordance with international standards.
- QoS measurements carried out in order to compare the quality provided by different service providers, to comply with quality requirements and to produce regular QoS reports.
- QoS measurement is done for regulatory purposes on for independent organizations interested in quality statistics.







Performance of the measurements

- **Performed by a third party other than the service provider:**
  - In principle two ways to perform the measurements; direct and indirect measurements:
- **Direct measurement** :
  - The third party, e.g., a national regulatory authority (NRA), itself performs the measurements.
  - NRA takes all the necessary steps to conduct the measurements and to analyse the data and to calculate the quality ratings of the parameters.




Performance of the measurements

- **Indirect measurement** :
  - The third party authorizes other parties to perform the measurement.
  - This may be by the service providers themselves or any other independent party, e.g., independent audit companies, organizations of certification.
  - The quality information is obtained by the third party without intervening directly in the process.
  - It has to be considered whether the measurements should be certified.
  - The certification of the QoS measurements have to be done by qualified independent organizations.

Performance of the measurements

Table 3: The advantages and disadvantages of the direct and indirect measurements

Measurement		Advantages	Disadvantages
direct		High confidence in the information provided Immediate proactive action by the third party is possible (e.g., adoption of measurement methodology, additional parameters if needed)	High costs mainly if measurements have to be performed on a number of providers and services
indirect	certified	Confidence in the information provided	Another party is involved that has to be managed. (e.g., independent certification offices
	uncertified	Low cost	Low confidence in the QoS statistics provided

One good commitment between cost and confidence of the information is to use indirect measurements (with certification) and to perform additionally direct measurements randomly.





Setting Target

Setting Target

- Guidelines for Defining Quality
- Defining Initial Quality Objectives
- Defining Target Values
- Tuning Quality Objectives







Guidelines for Defining Quality Objectives

- Quality objectives are used to determine minimum and maximum performance limits and the desired (optimum) performance level of QoS parameters.
- A reference value can be specified for each parameter.
- Use of generally accepted reference values for the main services and mandatory parameters or international comparisons for interoperability issues.
- Reference value can consist of a threshold value (e.g., the performance should be better than a minimum threshold)
- Threshold value be better than an acceptable performance range, depending on the QoS parameter under consideration




Guidelines for Defining Quality Objectives

- The final determination of a specific reference value depends on the kind of parameter (e.g., whether it is based on network performance parameters or subjective aspects), the technology involved and the kind of verification methodology used.
- The intended purpose of the reference value should also be taken into consideration.
- Quality objectives can be used in order:
  - to report on the present quality,
  - cross-checking whether quality obligations have been fulfilled
  - setting targets in order to improve the quality of general available services within a certain time-frame.

Guidelines for Defining Quality Objectives

- Since the QoS parameters are focused on the user requirements with regard to quality, the user must:
  - Able to understand the meaning of the reference value
  - be capable of comparing the (subjectively) perceived quality with the reference value.
- The end user's perspective should be considered before deciding for which QoS parameters quality objectives should be set and how they should be specified.





Defining Initial Quality Objectives

- In case of no quality reference – either in standardization or by experience – for a specific service available, one has to determine quality objectives from scratch.
- Quality objectives from scratch process involves the following steps:
  - Analysis of the service under consideration and the quality criteria
  - Identification of the resulting QoS parameters.
  - Determination of a set of QoS parameters that are thought of being of utmost importance, depending on the intended purpose.
  - Specify quality objectives for QoS parameters of utmost importance.
  - Set a time period for measurements , to collect data to acquire information on the present performance of a service.
- A first impression on reasonable limits for the quality objectives can be obtained based on the data collected,.
- The methodology used to collect data has to be clearly defined in order to eliminate doubt in the validity of the data obtained.








Defining Initial Quality Objectives

- Elimination of doubt in validity is is especially important in a multi-operator environment.
- The surveys among users must be conducted to assess the users' perception and demand of the service quality.
- In a conciliation process, the quality references obtained from the collected data (the service providers perspective) and the surveys (the user's perspective) to be combined into final quality objectives.




Defining Target Values

- Target values are determined in order to improve the quality of a service within a specified period of time.
- Target values are fixed for specific QoS parameters depending on the service aspect that is subject for improvement.
- The target values should be realistic, i.e., the service provider should be capable of achieving the quality level within the fixed time period.
- The efforts needed and the degree of improvement to be achieved should be well-balanced.
- The target values should be beneficial to the users, i.e., the QoS parameter targets should be meaningful to the users and aim at quality aspects relevant to the users.
- The users should be able to perceive easily an increase or decrease in quality.

Defining Target Values

- The accomplishment of the target can be verified by surveys, and problems be identified in an early stage through user complaints.
- The target values should be based on well measurable QoS parameters to allow for a straightforward verification procedure.
- Clear objectives directly linked to network performance objectives or service operational aspects
- The accomplishment of the targets be easily verified
- Failures dedicated to specific service/network elements.




Defining Target Values

- The establishment of target values should consider diversities of services.
- Target value that is appropriate for a specific situation may not be good for another.
- If target values are determined for services available in huge areas and/or many customers, the intrinsic diversity of the service shall be analysed.
- Diversities may be presented, for example, in terms of geography, user expectation, social aspects, applications.
- The implementation stage of the service should be considered.
- Services that are in a transitory stage have to be treated in a different way than those whose operation is already in a stable phase.
- This may occur if new technology is introduced or technology is changed (e.g., GSM to WCDMA) or if a substantial rate of growing of the service in terms of users or infrastructure takes place.







Tuning quality objectives

- Auditing values on a regular basis to adopt/adapt to changes in technical development and user perception, and to verify their fitness for purpose.
- The value should be cross-checked whether:
  - the quality objectives reflect the user perception and expectation;
  - Validity of the original/initial quality objectives check ;
  - the quality objectives adjusted to reflect improvements in technology;
  - additional quality objectives are needed to cover additional services or service elements;
  - there are mismatches between the underlying QoS parameters and the intention associated with the quality objectives;





Tuning quality objectives

- the target values reviewed constantly;
- the target values correspond to internationally agreed performance levels;
- the frequency of evaluation of parameters or target value appropriate to the type of service and the geographical area (region) under consideration.

- The adjustment of quality objectives is a process of management of quality policy and involves a process of information feedback.
- The perception of customers and the information provided by service providers have to be taken into consideration.

DATA COLLECTION AND PRESENTATION

Data Collection and Presentation

- Data Sources
- Expert Panel
- Customer Centric Parameters
- Service Provider Data




Customer Centric Parameters

- Customer Survey Parameters
- Opinion Rating
- Selection of Appropriate Data Sources
- Data Samples
- Data Analysis and Presentation





Common basis for QoS parameter assessment [ITU-T Rec. E.803]

- Opinion rating (OR)
- Selection of an appropriate data source
- Samples sizes and examples
- Guidance on the presentation of the results








Opinion rating (OR)

- OR is a quantitative value (a number) assigned to a qualitative performance criterion on a predefined rating scale to reflect the merit of that criterion to a user/customer
- Examples of qualitative criteria are:
  - User friendliness of man-machine interface of services,
  - Empathy shown by service provider's employees towards customers,
  - Ergonomics of terminal equipment,
- 7-point scale is considered most suited for recording opinion ratings, for example, a 0-6 scale may be chosen for rating qualitative criteria.

Examples of Opinion Rating

- Unipolar

Very poor	Poor	Below average	Average	Above average	Good	Excellent
0	1	2	3	4	5	6

- Bipolar

Very poor	Poor	Below average	Average	Above average	Good	Excellent
-3	-2	-1	0	1	2	3





Categories of Communication Quality in Terms of Users' Satisfaction Classes

R	MOS-CQE	
100.0	4.5	Very satisfied
93.2	4.4	
90.0	4.3	Satisfied
85.0	4.2	
80.0	4.0	
75.0	3.8	Some dissatisfied
70.0	3.6	
65.0	3.4	Many dissatisfied
60.0	3.1	
55.0	2.8	Nearly all dissatisfied
50.0	2.6	
0.0	1.0	

Voice Quality Continuum





Selection of Appropriate Data source

- The most common data sources are:
  - expert panel,
  - customer survey,
  - service provider (SP) data.








Expert Panel

- **Advantages:**
  - Only few experts address a certain topic.
  - The high level of expertise guarantees a high qualitative feedback
  - Feedback to one specific subject can be collected rather quickly (during an experts' meeting).
  - Customers' viewpoint is reflected: Experts are used as highly-trained customers
  - Subjective feedback might give additional information to objective feedback (emotions, first thoughts, etc.)
  - Data can be generated by anyone who is interested in a specific topic.

Expert Panel

- **Limitations:**
  - Additional expenses are generated by the involvement of experts.
  - Significant effort needed to find the right experts
  - Organizational effort needed to gather all required experts together at the same place and same time.
  - Experts could be blinded by their routine
  - Expert judgements may heavily differ from the feedback given by customers.








Customer Survey:

- **Advantages:**
  - Reflects the "real" customer experience.
  - Subjective feedback might give more information than objective feedback (emotions, first thoughts, etc.)
  - Data can be generated by anyone who is interested in a specific topic.

Customer Survey

- **Limitations**
  - Additional expenses are generated by the involvement of market research institutions.
  - A certain level of customer attendance should be reached to assure the desired level of representativeness of data.
  - In general, customer panel interrogations need a longer period of time (up to several weeks).





Service Provider Data

- **Advantages:**
  - No additional cost for data generation since the data are available from the usual day-to-day business.
  - A large amount of data sets may be available (mass data), depending on the number of customers the SP has and depending on their activity.
  - Automation of evaluation procedures may be achievable.
  - Objective data are free of individual and subjective influences.




Service Provider Data

- **Limitations:**
  - Limited reflection of the customer perspective since customer relevant processes already mapped to numbers.
  - Data only accessible after being released by SP.
  - The conditions under which the data is generated to be carefully checked.
  - Representativeness of the data has to be considered.
  - Lack of data for sensitive areas where service providers do not release internal data.
  - Lack of data for areas which are not covered by the observation of internal processes.
  - In general, subjective components do miss.








SAMPLE SIZES

Sample Sizes

- Statistical Consideration
- Mean Value versus Median
- Confidence Level
- Accuracy of Indicators
- Observation period
- Selection of Panels
- Boundary conditions





Statistical Consideration

- Low sample size(<100)
- Medium sample size(100 to 200)
- Large sample size (>300)





Confidence Level

- To describe the quality of a given data set with respect to a certain statistical measure, often the terms "confidence level" or "confidence interval" are used.
- In general, only a smaller part of all available data sets are used for these considerations.




Accuracy of Indicators

- For parameters which estimate a ratio of two values, the width of the confidence interval can be determined using confidence level and confidence interval.

- For other parameters like time parameters or opinion rating parameters, the width of the confidence interval must be determined on an individual basis.





Observation Period

- Make use of observation periods with a limited time duration.
- Every event which occurs after this time-out period is not taken into consideration for calculation of parameters.
- Furthermore, this concept allows one to plan the duration of data retrieval phases which will reduce the organizational cost for these evaluations.





Selection of Samples

- **Residential customers**:
  - Young people aged between 11 and 21 years
  - Adults aged between 21 and 65 years
  - Elderly aged 65 years and older
- **Business customers**:
  - Business customers aged 21 years and older





Boundary conditions

- Determination of the boundary conditions prior the assessment of parameters
- Time-out values:
  - Any kind of period that will be taken into account to terminate a measurement period in a predefined manner.
  - This avoids deadlocks caused by infinite waiting of expected events which will not occur.
- Weighting of results for compound parameters:
  - The weight of each contribution should be determined in advance if a composite parameter consisting of different contributions.









GUIDANCE ON PRESENTATION ON RESULTS

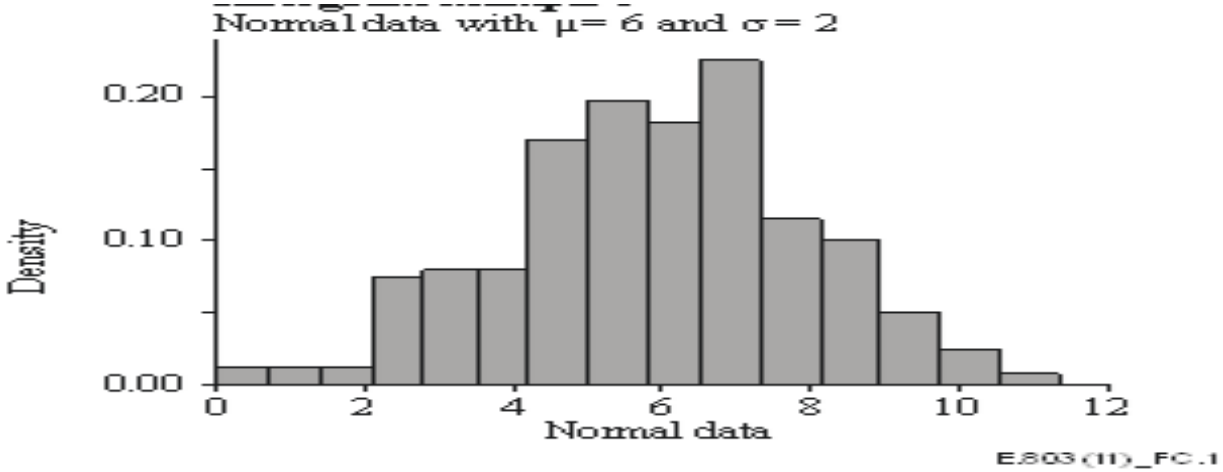
Guidance on the presentation of results

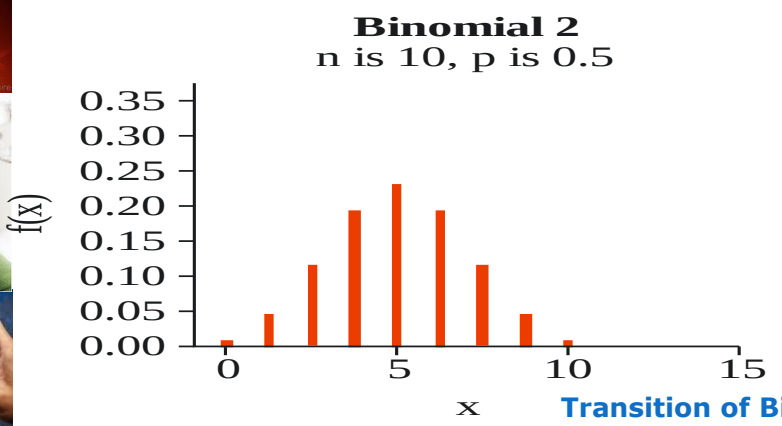
- Histogram
- Distribution functions
- Mean value
- Quantile
- Chart
- Table

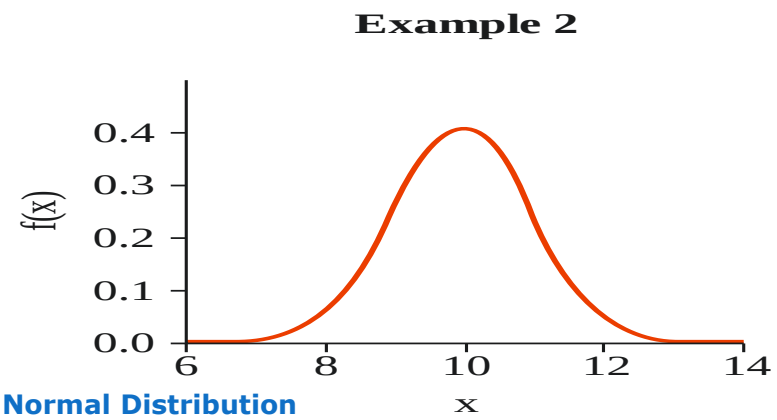



Low Sample Size

Histogram







Transition of Binomial to Normal Distribution

Medium Sample Size

- Calculation of Success or Failure Rates
- Mean Values***
- Calculation of quantile values is not recommended



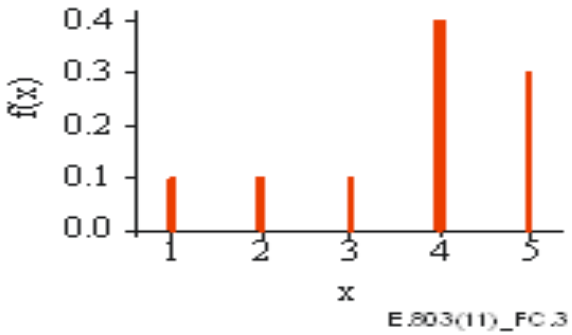


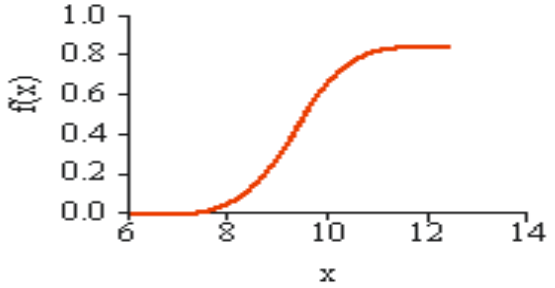


Large Sample Size

- Calculation of Quantile Values
- Representation by Probability Density Functions(PDF) and Cumulative Density Function(CDF)

$f(x) - P(x)$ $\quad$ $f(x)=P(x \leq x_0)$



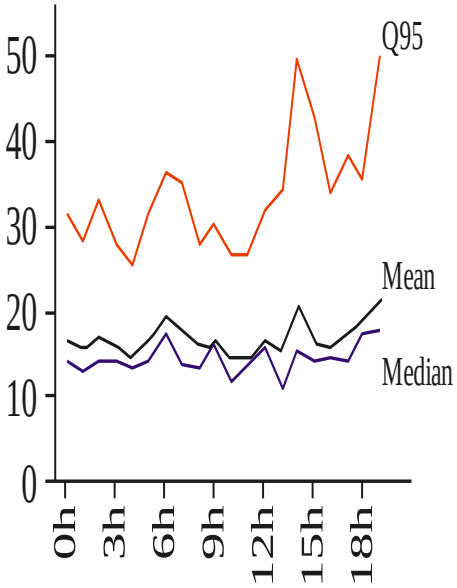




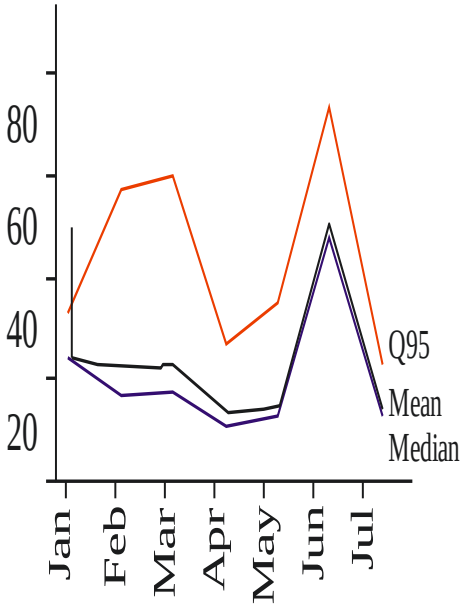


Mean Value Versus Median

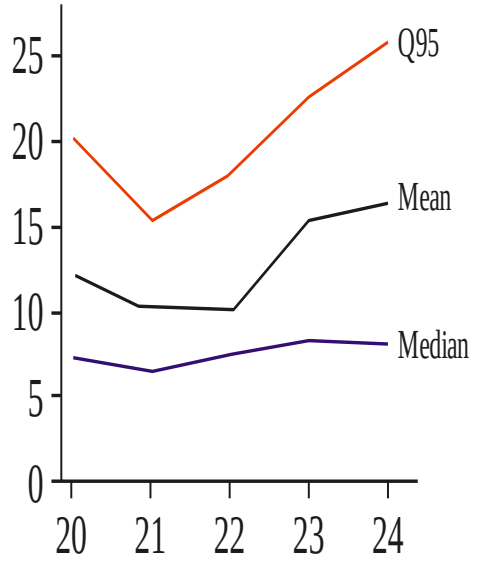
MMQ-Plot example 1
SMS E2E-Delivery time (probing trials) per hour (sec)



MMQ-Plot example 2
Reaction time by month (minutes)



MMQ-Plot example 3
Delay (minutes) per calendar week



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Choice of best suited Presentation

- Histograms provide the most useful statistical information to the consumers.
- Where applicable the PDF, CDF and quantile should be given to provide additional information.
- Charts could help to visualize and better understand the results, in particular for composite indicators.





Customer Survey Parameters

No	Parameter Name	Target
1	% of customers satisfied with the service availability.	>90%
2	% of customers satisfied with the service accessibility.	>90%
3	% of customers satisfied with the reliability.	>90%
4	% of customers satisfied with billing performance.	>90%
5	% of customers satisfied with the help/ enquiry services.	>90%





End of Session 3

Q & A