QoS Monitoring and Compliance





QUALITY OF SERVICE MONITORING AND COMPLIANCE

Vitalis Olunga

ICT Strategy Consultant

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DAY 1

QUALITY OF SERVICE REGULATION

1. Workshop & Programme Overview
2. Fundamentals of Quality of Service
3. Distinction among QoS, NP, QoE and Customer Satisfaction

Workshop & Programme Overview





Workshop Overview

- The Workshop Programme
- Quality of Service Standards and Regulations
- Quality of Service Monitoring
- Compliance with Quality of Service Standards
- ITU Governance of Standards

Governance & Regulations

- The Concept:-Process/system by which organisations are directed, controlled and held accountable
- Governance enshrines:
  - the exercise of authority
  - accountability, stewardship,
  - leadership, direction and control
- Specifies the distribution of rights and responsibilities among different participants
- Provides structure through which objectives are set, the means of attaining the objectives and performance monitoring








ITU Governance Structure

- The ITU is governed by the Plenipotentiary Conference and the Administrative Council
- The Plenipotentiary Conference is the supreme organ of the Union, the decision making body that determines the direction of the Union and its activities.
- Plenipotentiary Conference-Forum of all the member states that meets every 4 years
- The Council acts as the Union's governing body in the interval between Plenipotentiary Conferences.

ITU Governance Structure

- Plenipotentiary Conference
  - ITU Council
    - General Secretariat
    - ITU-R (radiocommunication)
      - WRC
    - ITU-D (development)
      - WTDC
    - ITU-T (standardization)
      - WTSA





Key ITU Conferences

- World Conference on International Telecommunications (WCIT)
- World Telecommunication Policy Forum (WTPF)
- World Telecommunication Standardization Assembly (WTSA)
- World Radiocommunication Conference (WRC)
- World Telecommunication Development Conference (WTDC)
- World Summit on the Information Society (WSIS)

Role of ITU Council

- Considers broad telecommunication policy issues to ensure that the Union's activities, policies and strategies fully respond to today's dynamic, rapidly changing telecommunications environment
- Prepares report on Policy and Strategic Planning of the ITU
- Responsible for day-to-day running of the Union, coordinating work programmes, approving budgets and controlling finances and expenditure.








Role of ITU Council

- Facilitates Implementation of the provisions of:
  - the ITU Constitution,
  - the ITU Convention,
  - The Administrative Regulations (International Telecommunications Regulations and Radio Regulations), and
  - The decisions of Plenipotentiary Conferences and;
  - The decisions of other conferences and meetings of the Union, where appropriate.





Council Membership (2014-2018)

- **Region A (Americas)**: 9 seats
  Argentina, Brazil, Canada, Costa Rica, Cuba, Mexico, United States, Paraguay, Venezuela
- **Region B (Western Europe)**: 8 seats
  France, Italy, Germany, Greece, Lithuania, Spain, Switzerland, Turkey
- **Region C (Eastern Europe and Northern Asia)**: 5 seats
  Azerbaijan, Bulgaria, Poland, Romania, Russian Federation
- **Region D (Africa)**: 13 seats
  Algeria, Burkina Faso, Egypt, Ghana, Kenya, Mali, Morocco, Nigeria, Rwanda, Senegal, Tanzania, Tunisia, Uganda
- **Region E (Asia and Australasia)**: 13 seats
  Australia, Bangladesh, China, India, Indonesia, Japan, Korea (Republic of), Kuwait, Pakistan, Philippines, Saudi Arabia, Thailand, United Arab Emirates

QoS Standards

- Governance of QoS Regulation
  - ITU Study Groups
  - ITU Study Group 12
  - ITU Working Parties
  - ITU Rec. Related to Quality of Service
- Bridging the Standardization Gap
  - The Standard Gaps
  - National Standards Capabilities
  - ITU Activities to Bridge the Standards Gaps
  - Human Resource Development
- Approaching Standardization Development





Governance of QoS Regulation

- Governance of standards to ensure **service quality for users** and to enhance industry.
  - Governance is a sovereignty of each Nation or country.
  - ITU has 193 member states and over 700 sector members and associates available for all communications standards.
  - ETSI is popular with QoS standards for Operational networks.









Identify the Standards Gaps

- Lack of Understanding of the National Importance of Standards
- Relatively Less Private Industry Involvement in Standards
- Inadequate Funding of Standardization Activities
- Insufficient Standardization Human Resources
- Insufficient Involvement in International Standards Development Processes
- Inadequate Technical Infrastructure for Standards Participation

Addressing the Standardization Gap

- Disparities between developed and developing countries in standardization have 5 main components:
  - disparity of voluntary standardization,
  - disparity of mandatory technical regulations
  - disparity of conformity assessment,
  - disparity in human resources skilled in standardization
  - disparity in effective participation in ITU-T activities





Bridging the Standardization Gap

Bridging the Standardization Gap

- BSG is one of strategic goals of ITU-T
- Defined as the disparities in the ability of developing countries, relative to developed ones, to access, implement, contribute to and influence international ICT standards, specifically ITU – T Recommendations.
- Bridging the standardization gap: PP Res 123, WTSA Res 44 and WTDC Res 47




Assist Developing Countries in Standards Implementation





New Actions From WTSA-12

- Assist developing countries to
  - Establish a standardization secretariat to coordinate standardization activities and participation in ITU-T study groups
  - Determine whether their existing national standards are consistent and in accordance with the current ITU-T Recommendations
- Develop implementation guidelines for new ITU-T Recommendations
- Enhance Standards Q&A Forum (webinars to be held before each Study Group meeting)
- E-learning courses on ITU-T Recommendations

Assist Developing Countries in Standards Implementation

- Technical Reports
  - Handbook on Testing (2011)
  - Convergent Networks (2010),
  - ITU-T Manual on Optical Transport Networks from TDM to Packet (2010) and DSL (2010),
  - Deployment of packet based networks (2009)
  - Fibre Optic Cables and Systems Handbook (2009),
  - Security in Telecommunications and IT (2009)
- Standards Q&A Online Forum

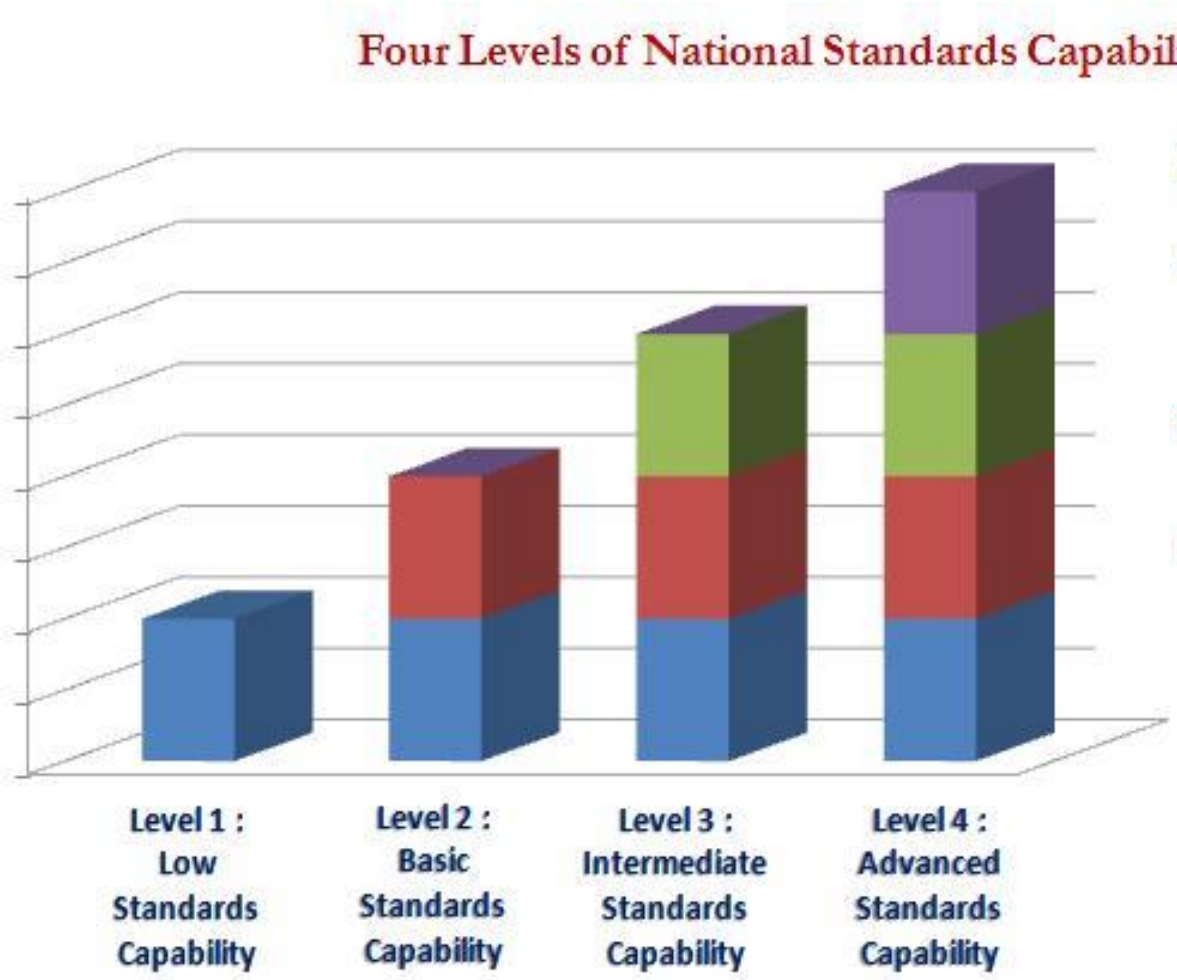



Strengthen Standard Making Capability

New Actions From WTSA-12

- Developing guidelines to assist developing countries in their involvement in ITU-T activities.
- Improving procedures and electronic tools for remote participation.
- Conducting consultancy projects designed to support developing countries in the development of standardization plans
- Studies on ICT innovations and standardization in developing countries

National Standards Capability



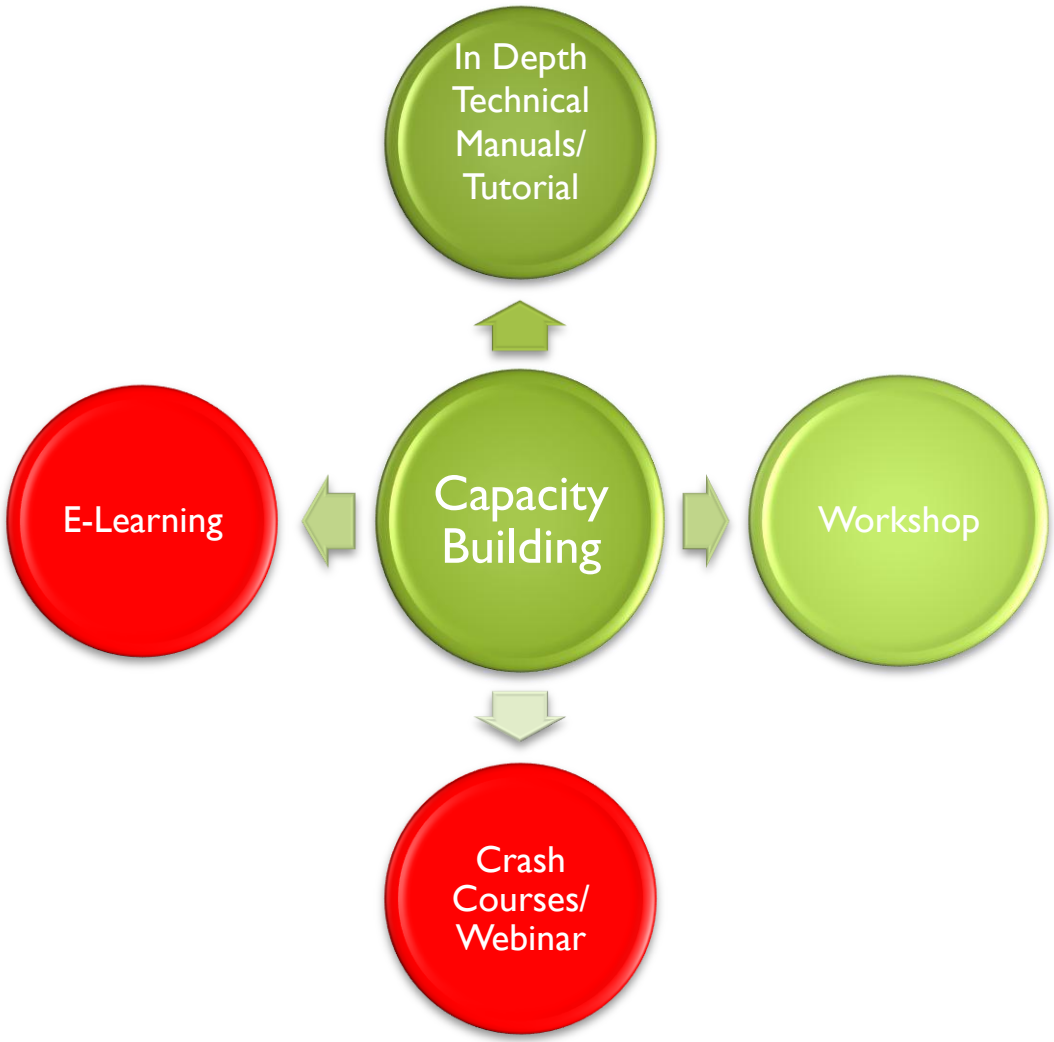
Develop Human Resources

- In-depth technical tutorials on ITU-T Recommendations
- Increase number of officials (Chairs / Rapporteurs) from developing countries in ITU-T Study Groups
- E-learning course on ITU-T Meeting Procedures (ITU-T A.1) NEW!
- New Actions From WTSA-12
  - Fellowships to be provided under TSB budget to eligible countries to attend relevant ITU-T meetings.
  - Encouraging secondment and short-term employment opportunities for developing countries experts in test laboratories of international standards development organizations (SDOs) and manufacturers, in particular in the area of conformance and interoperability testing





Develop Human Resources



Regional Groups

- SG2 Groups for Arab and East Africa Regions
- SG3 Groups for Asia and Oceania, Africa, Europe and Mediterranean, Latin America and Caribbean (Tariff and accounting principles)
- SG5 Groups for Arab, Africa, Latin America and Caribbean, Asia-Pacific (Feb 2013) (ICT and Climate Change)
- SG12 Group for Africa (Performance, QoS)





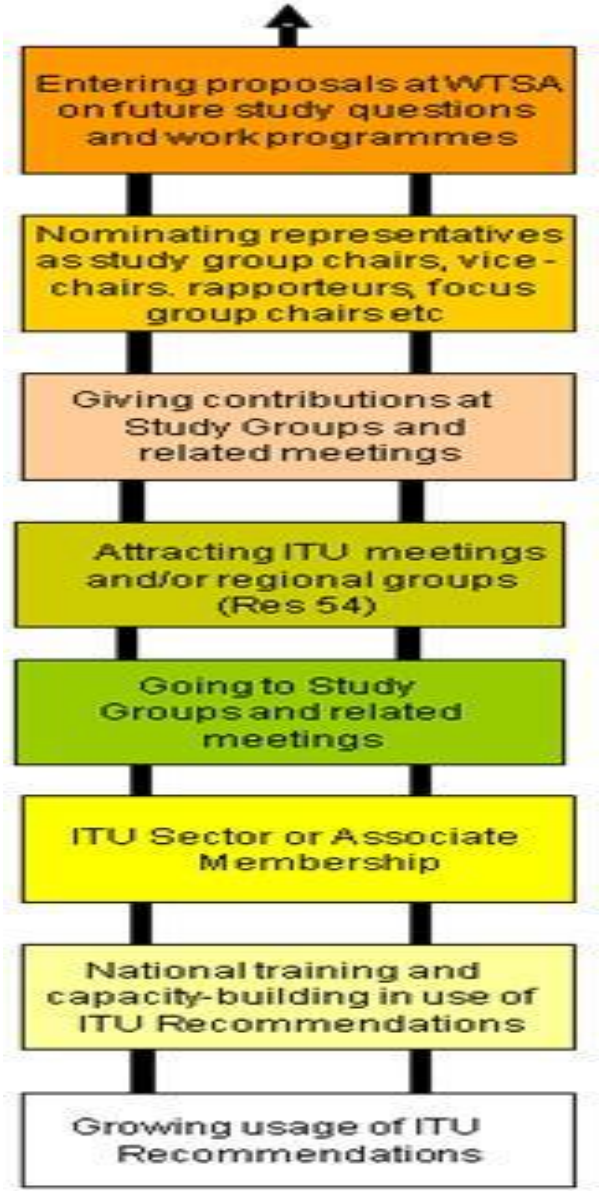



Regional Groups

- Regional Offices to collaborate closely with TSB
- Promote ITU-T Meetings and Regional Group events
- Assist TSB to coordinate standardization activities in the region
- Provide assistance to establish regional standardization bodies
- New Regional Groups established at WTSA-12
  - SG2 Group for Latin America
  - SG5 Group for Latin America
  - SG 13 Group for Africa

Approaching Standardization Development

Ladder of Standardization Development



The Standardization Ladder Concept

QoS Standards Development

ITU Study Groups

- Standardization work is done by the technical Study Groups (SGs)
- In the SGs, the representatives of the ITU-T membership develop Recommendations (standards) for the various fields of international telecommunications.
- SG2 - Operational aspects
- SG3 - Economic and policy issues
- SG5 - Environment and climate change
- SG9 - Broadband cable and TV
- SG11 - Protocols and test specifications
- SG12 - Performance, QoS and QoE
- SG13 - Future networks (& cloud)
- SG15- Transport, Access and Home
- SG16- Multimedia
- SG17 - Security





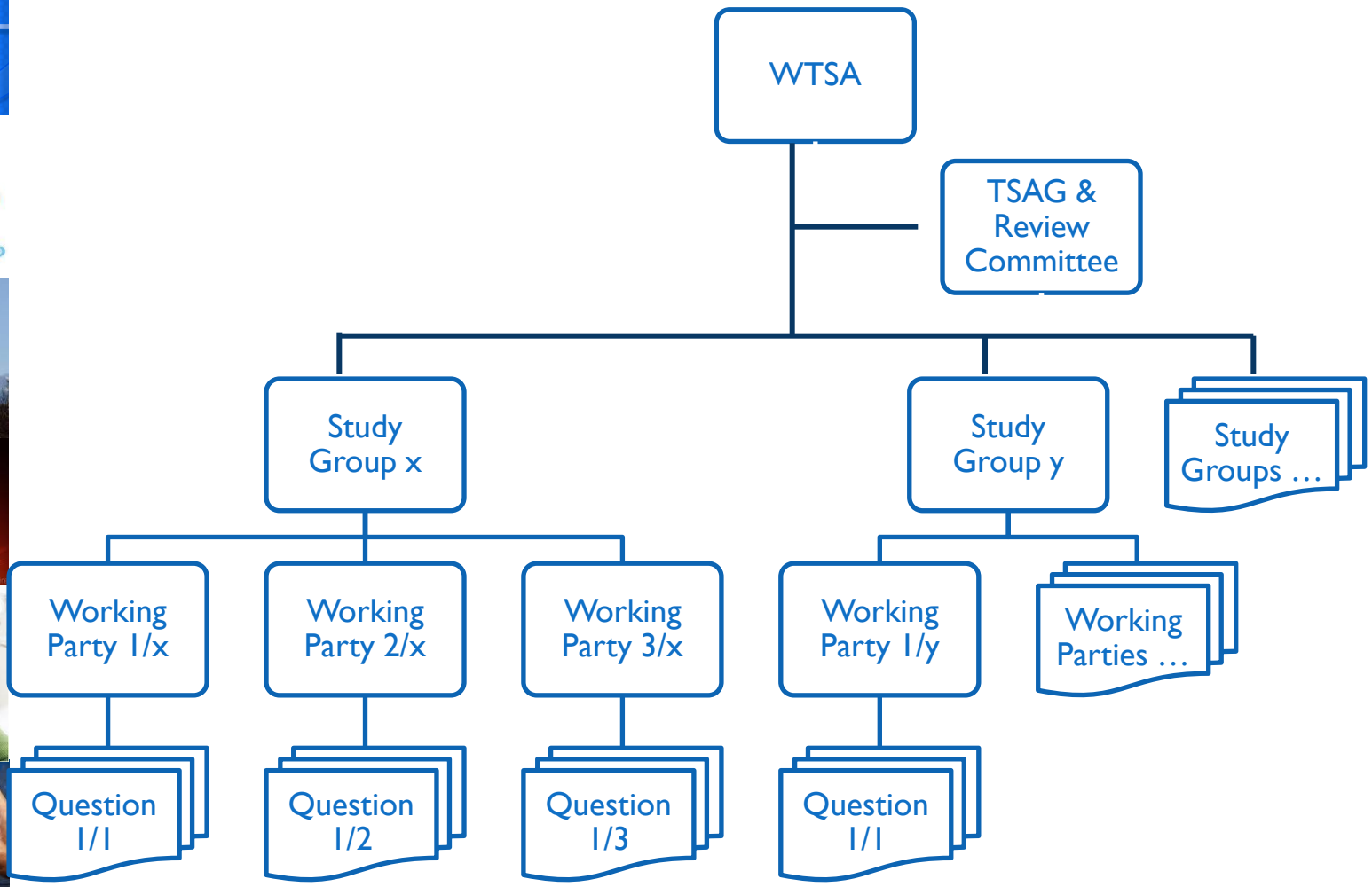
SG 12 Mandate

- SG 12 is the Lead SG on quality of service and quality of experience
- Recommendations on performance, QoS and QoE for
  - terminals, networks and services ranging from speech over fixed circuit-based networks to multimedia applications over networks that are mobile and packet base
  - operational aspects of performance, QoS and QoE
  - end-to-end quality aspects of interoperability development of multimedia quality assessment methodologies, both subjective and objective.
- http://www.itu.int/en/ITU-T/studygroups/2013-2016/12/Pages/default.aspx





Structure of ITU-T



Working Parties of SG 12

- **WP 1 Terminals and multimedia subjective assessment**





Q1/12	SG 12 work programme and QoS/QoE coordination in the ITU-T
Q2/12	Definitions, guides and frameworks related to QoS/QoE
Q3/12	Speech transmission characteristics of communication terminals for fixed circuit-switched, mobile and packet-switched (IP) networks
Q4/12	Hands-free communication and user interfaces in vehicles
Q5/12	Telephonometric methodologies for handset and headset terminals
Q6/12	Analysis methods using complex measurement signals including their application for speech enhancement techniques and hands-free telephony

Working Parties

- **WP 2 Objective models and tools for multimedia quality**

Q10/12	Conferencing and telemeeting assessment
Q7/12	Methods, tools and test plans for the subjective assessment of speech, audio and audiovisual quality interactions
Q8/12	E-Model extension in wideband transmission and future telecommunication and application scenarios
Q9/12	Perceptual-based objective methods for voice, audio and visual quality measurements in telecommunication services
Q14/12	Development of parametric models and tools for multimedia quality assessment
Q15/12	Objective assessment of speech and sound transmission performance quality in networks
Q16/12	Framework for diagnostic functions and their interaction with external objective models predicting media quality




Working Parties

- **WP 3: Multimedia QoS and QoE**

Q11/12	Performance interworking and traffic management for Next Generation Networks
Q12/12	Operational aspects of telecommunication network service quality
Q13/12	QoE, QoS and performance requirements and assessment methods for multimedia
Q17/12	Performance of packet-based networks and other networking technologies





SG 12 Recommendations

- E-Series: Overall Network Operation, telephone service, telephone operation and human factors
  - E.420-E.479, E.800-E.859
- G-Series: Transmission Systems and media, digital systems and networks
  - G.100-series, except G.160-, G.180- and G.190-series, G-1000 series
- I-Series: Integrated Services Digital Network
  - I.350-series (including Y.1501/G.820/I.351), I.371, I.378, I.381
- P-Series, except P.900-series: Terminals, subjective and objective test methods
- Y-series: Global Information infrastructure, Internet Protocol aspects and Next Generation Networks
  - Y.1220-, Y.1530-, Y.1540-, Y.1560-series





Recently approved Recommendations

- E. 803: "Quality of service parameters for supporting service aspects"
- E.804: "QoS Aspects for Popular Services in Mobile Networks"
- E.807: "Definitions and associated measurement methods of user-centric parameters for call handling in cellular mobile voice service".
- ITU-T Supplement.9 (E. Series): "Guidelines on Regulatory Aspects of QoS" and some best practices worldwide
- Y.1545: Roadmap for the quality of service of interconnected networks that use the Internet








End of Session 1

- Quality of Service Defined
- To understand the Bridging the Standardization Gap activities
- To understand the need for participation and contribution to Standards





Fundamentals of Quality of Service

Fundamentals of Quality of Service

- Justifications for quality of service regulation
- Parameters and targets
- Activities in quality of service regulation









Concept of Quality of Service

WHAT

- What is Quality?
- What is Service?
- What is Standard?

WHO

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




Concept of Quality

- Quality of service is the "collective effect of service performance, which determines the degree of satisfaction of a user of the service" ([ITU-T E.800]).
- Quality of service regulation is part of customer protection, however, customer protection is broader than quality of service regulation
- Customer protection covers, sales activities, complaint resolution procedures and disconnection policies, etc.
- Quality of service is not the same as network performance, which is concerned not with user experience but with standards for network design.

Parameter and Target

- The term "parameter“ describes the definitions of measurements to be made.
- A target is a potential value (or a range of values) for a parameter that must be met for quality to be satisfactory.
- Three classes of parameters determine user experience:
  - customer interface parameters,
  - network infrastructure parameters, and
  - service functionality parameters
- Parameters organized according to service type (such as voice, SMS, etc.) rather than by operator type (fixed wireless, wireline, mobile, etc.) to help with comparability between countries and consistency in the treatment of operators.





Parameters and Targets

- Parameters are named according to the same conventions irrespective of how they are named in different countries.
- As such:
  - Rate is the frequency of actions
  - Ratio is the proportion of actions that succeed, and;
  - "time" means the average time taken by actions that succeed.





Justification of QoS Regulations

Quality of service regulation aims at:

- helping customers to make informed choices;
- checking claims by operators;
- understanding the state of the market;
- maintaining or improving quality in the presence of competition;
- maintaining or improving quality in the absence of competition;
- helping operators to achieve fair competition;
- making interconnected networks work well together.





Guiding Principles for Parameters to be Monitored by the Regulator

- Parameters to be monitored should relate to the aspect of services that have the biggest impact on users;
- Parameters should be well defined and be cost-effective to operators.
- The measurement methods already in use by operators should be used as far as possible.
- The parameters should reflect differences in, for example, services and geographic areas but should be consistent between services.








Guiding Principles for Measurements to be Published

- Measurements to be published should relate to aspects of services that users experience directly (not the underlying technical cause).
- Publication of measurements needs to ensure that they reach beneficiaries, that they are easily understood without being misleading
- Publications should allow for comparison between operators.

Guiding Principles for Targets to be set

- Targets should relate to the quality users want.
- The targets to avoid limiting customer choices between quality and price.
- Target values to be determined through sufficient information such as:
  - earlier measurements by operators, used in other countries
  - proposed in international standards.





Variations of Standard Parameters

- To meet the specific situation in a country or sector.
- The measurements of a parameter might need to distinguish between:
  - Market segments: private consumers, small and large businesses, wholesale and retail offerings.
  - Reporting areas: rural or urban
  - Operators: number of customers
  - Services: specific of voice, text messages, internet, TV and Radio broadcasting, leased lines
- The list may be too long and it may not always be desirable or necessary to impose quality of service regulation on all areas.





QoS Regulations Activities

- Defining parameters
- Setting Targets
- Making Measurements
- Auditing Measurements
- Publishing Measurements
- Ensuring Compliance




Distinction among Quality Elements

- Quality of Service
- Network Performance
- Quality of Experience
- ☺ Customer Satisfaction









Quality

- The totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs.
- The characteristics should be observable and/or measurable.
- When define, the characteristics become parameters and are expressed by metrics
- A measure is a unit by which a parameter may be expressed.
- Stated needs the QoS requirements of the user/customer
- Implied needs of are the perceived QoS requirements.




QoS Concept Confusion

- QoS is frequently confused with elements of network performance (NP)
- Signalling functions inside the networks are sometimes referred to as "services“
- Internet Engineering Task Force (IETF) uses QoS to describe the performance of functional services in network layer models
- In order to avoid that confusion, QoS is often more precisely expressed as "end-to-end QoS"




QoS Parameter Confusion

- Another confusion to be avoided is when network counters and key performance indicators (KPIs) are brought into discussions about QoS.
- Network counters are vendor-specific Network Performance (NP) parameters which cannot be standardized due to specific applications.
- A majority of standardized KPIs describe NP parameters
- Avery limited number of such KPIs are truly related to end-to-end QoS.

QoS Interface Confusion

- The end-to-end QoS that is perceived at the user interface, basically summarises the characteristics of the underlying in-service media streams
- This should not be mistaken for the QoS of non-utilization stages of ICT services, which describes the (customer) "service" surrounding ICT services offered by service providers that are outside the actual usage of services that are of interest and concern to the users.





Customer QoS Requirements

- **QoS requirements of user/customer (QoSR)**
  - A statement of QoS requirements by a customer/user or segment/s of customer/user population with unique performance requirements or needs.
  - The customer/user needs may be expressed in descriptive terms (criteria) listed in the order of priority, with preferred performance value for each criterion.
  - The service provider translates performance vulues into parameters and metrics pertinent to the service (ITU-T E.802).





Customer Experienced/Perceived

- **QoS experienced/perceived by customer/user (QoE)**
  - A statement expressing the level of quality that customers/users believe they have experienced.
  - The level of QoE may be expressed by an opinion rating.




QoS Offered by service provider (QoSO)

- A statement of the level of quality planned and offered to the customer by the service provider.
- Level of QoS the service provider plans to achieve (and therefore offers) to the customer/user; expressed by target values (or range) for measures of parameters pertinent to a specified service.





QoS Delivered by Service Provider

- **QoS delivered/achieved by service provider (QoD)**
  - A statement of the level of QoS achieved or delivered to the customer.
  - The achieved or delivered QoS expressed by metrics for the pertinent parameters for a service.




Customer Experienced/Perceived QoSE

- **QoS experienced/perceived by customer/user (QoSE)**
  - A statement expressing the level of quality that customers/users believe they have experienced.
  - The level of QoSE may be expressed by an opinion rating.





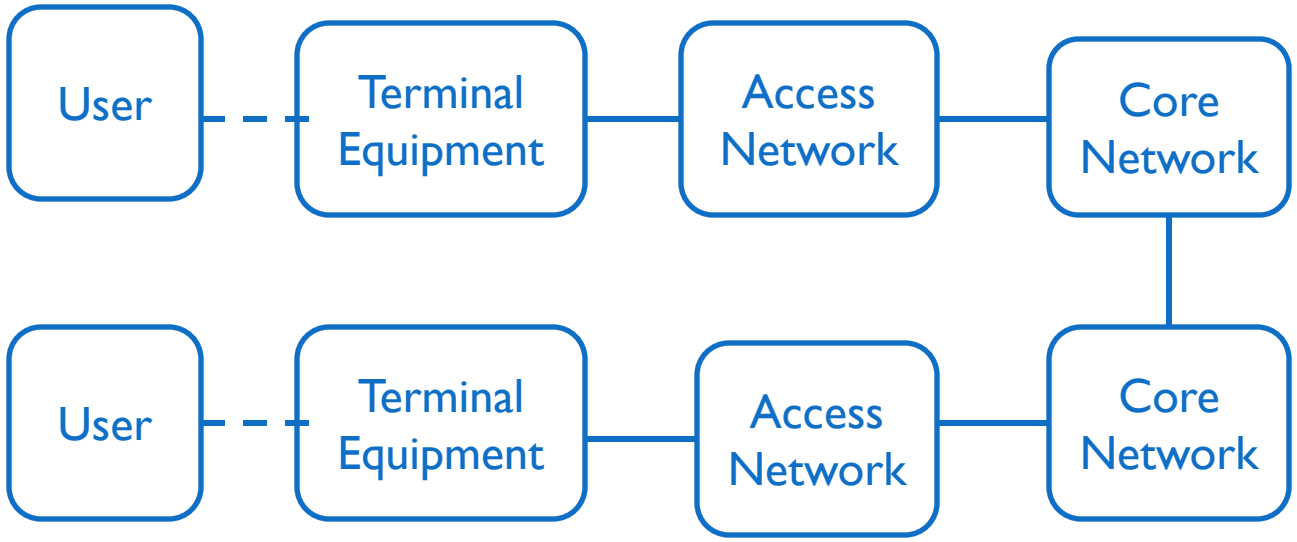
End-to-End QoS

- QoS covers the whole end-to-end view of a telecommunications service and can be subdivided into separate parts that all have an influence on the resulting QoS.
- The degree of QoS depends on the collective effect of all sub-parts.
- The sub-parts include: User Equipment-Access Network-Core Network-Access Network-User Equipment [ITU-T E.804 and ITU-T E.800].





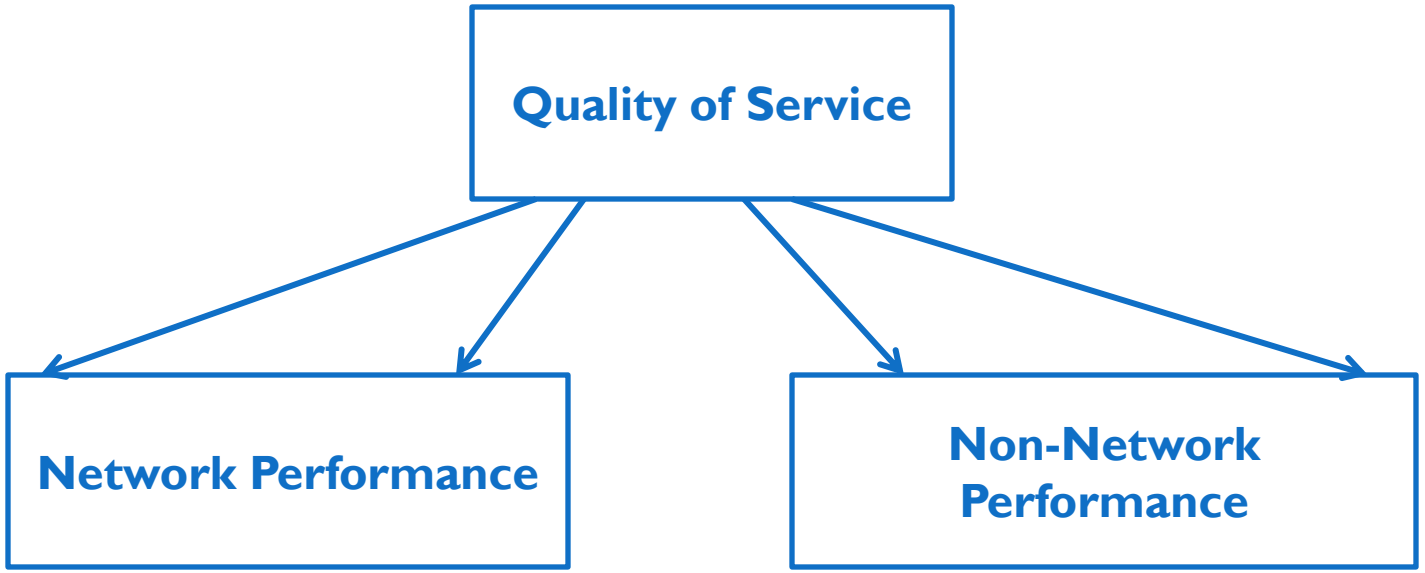
Fig. 1: Schematic End-to-End QoS



Source: ITU-T E. 800;

- The conventional service configuration with users at each end of a connection.
- The principle may apply to services by a service provider at one end and user/s at the other end.

Fig. 3 : Relationship between QoS and NP



***Source:* ITU-T E.800**

QoS comprises both network performance and non-network related performance

Network and Non-Network Performance

- Network Performance Measures
  - Bit error rate,
  - Latency, Etc
- Non-network performance measures:
  - Provision time
  - Time to repair
  - Range of tariffs
  - Complaints resolution time, Etc





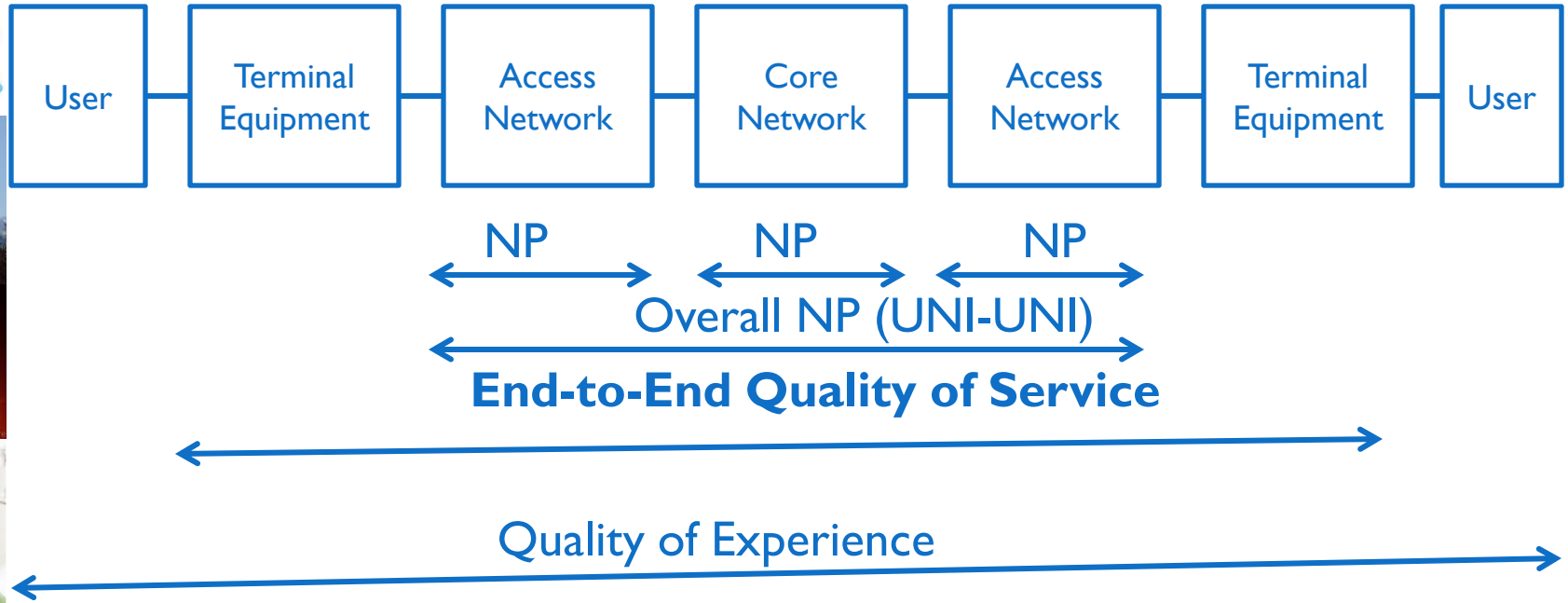
Network Performance

- Network performance is the ability of a network or a portion of a network to provide the functions related to communications between users [ITU-T E.800].
- Network performance applies to the network provider's planning, development, operations and maintenance activities
- Network performance is the detailed technical part of QoSO.





Fig. 2: End-to-End QoS



Source: ITU-T E. 804

End-to-End QoS

- **User:** An individual or organization using or requesting publicly available telecommunications services.
- **Terminal Equipment:** Variability of the performance of terminal equipment
- **Access Network:** Combination of access medium and technology used for a particular service (e.g. wireless, cable, ADSL)
- **Core Network:** Configurations of network components





End-to-End QoS

- **Single provider**:
  - National telecommunication services
- **Multiple providers:**
  - National services
  - International services
- **Technology used:**
  - digital multiplexing, IP, etc
- **Transmission media:**
  - Air:- terrestrial microwave radio radios, cellular mobile, Wi-Fi, WiMaX, satellite, etc
  - Cable: optical fibre, coaxial, twisted wireline





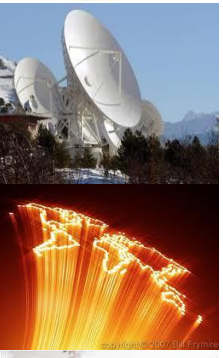



QoSE Components

- QoSE has two main man components:
  - quantitative and qualitative.
- **The quantitative component:** Influenced by the complete end-to-end system effects (network infrastructure).
- **The qualitative component:** Influenced by user expectations, ambient conditions, psychological factors, application context, etc.
- QoSE may also be considered as QoSD received and interpreted by a user with the pertinent qualitative factors influencing his/her perception of the service.

Network Performance (NP)

- The NP is assessed across a part of a network or a sub-network [Access Network or Core Network]
- Overall NP is from UNI to UNI: Access Network-Core Network-Access Network with several network sections considered as being one integral part of the network ("black box").
- Mostly, the NP is a technical way of assessing technical parameters which describe the performance a part of the network in the desired way (ITU-T E.804).
- NP parameters are meaningful to network providers and are quantifiable at the part of the network which they apply.

NP Versus QoS (ITU-T I.350)

Network Performance	Quality of Service
Provider Oriented	User Oriented
Connection Element Attribute	Service Attribute
Focus on planning, development(design), operations and maintenance	Focus on user observable effects
End to End or Network Connection Element capabilities	Between (at) Service access points




Quality of Experience (QoE)

- The QoE includes: User-User Equipment-Access Network-Core Network-Access Network-User Equipment-User (ITU-T E.804]
- The inclusion of the user to the overall quality in telecommunications extends the rather objective QoS to the highly subjective quality of experience (QoE).
- The QoE differs from user to user since it is influenced by personal experiences and expectations of the individual user.




QoE in QoP and QoS terms





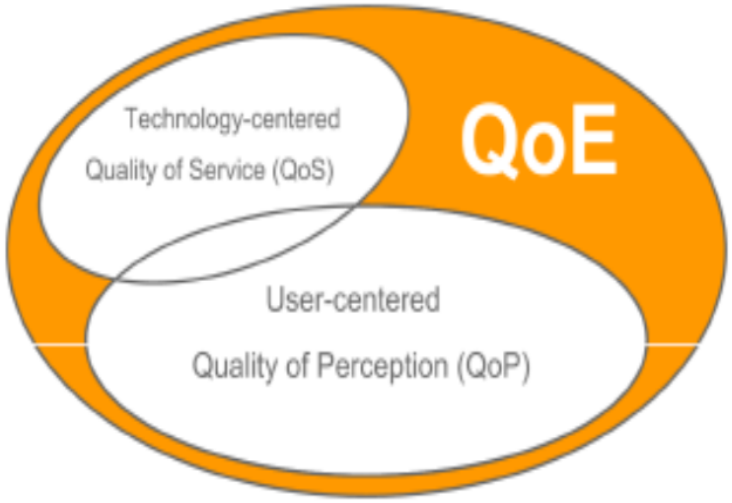
User-centered approach

- Quality of Perception (QoP)
- User-related parameters
  - Enjoyment, Satisfaction, Effectiveness, Efficiency, etc.

Technology-centered approach

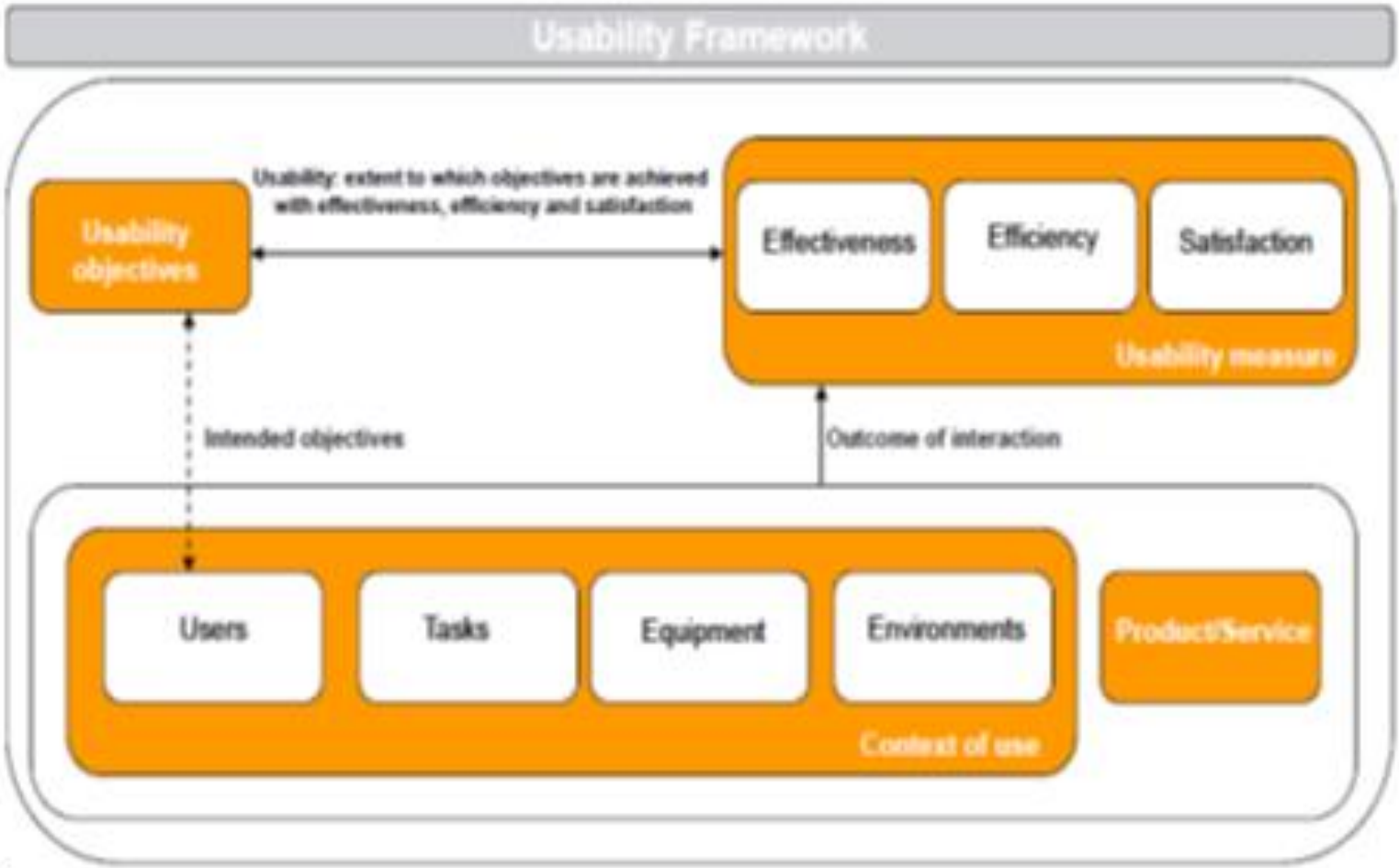
- Quality of Service (QoS)
- Network-related parameters
  - Delay, Jitter, Packet Loss, Frame Rate, Resolution, etc.

QoE/QoP/QoS Relationship



Higher QoS → Higher QoP
Higher QoP → Higher QoE

QoE: Usability



Non-Network Performance Measures

- **Complaint**
  - A statement by a user or customer expressing dissatisfaction due to a gap between the expected and the delivered benefits from the use of a service.
  - A complaint may be made in various forms, writing, electronic means, or in person.
- **Directory services**
  - A service to search and retrieve information from a catalogue of well-defined objects, which may contain information about certificates, telephone numbers, access conditions, addresses, etc.
  - An example is provided by a directory service conforming to ITU-T X.500, ITU-T X.843.







Customer Satisfaction

- **Customer:**
- The party that uses a telecommunication service(s) under a contractual agreement.
- A user who is responsible for payment for the services [ITU-T E.800].





Factors Influencing Customer Satisfaction

- Technical
  - Quality of the service delivered by the service provider
  - Billing Accuracy
  - After sale technical support
- Non-Technical
  - Point of Sale
  - Pricing
  - Complaint handing
  - Pricing

Factors influencing Customer Satisfaction

trends

advertising

tariffs, costs

customer expectation of QoS

customer satisfaction

QoS (technical)

QoS (non-technical)

Network Performance

Terminal Performance

Point of Sale

Customer Care

End of Session 3

- Clarifications among and the relationships among
  - Quality of Service
  - Network Performance
  - Quality of Experience
  - Customer Satisfaction