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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Multimedia Quality of Service and performance – Generic and user-related aspects

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Quality of service and quality of experience aspects of digital financial services

Recommendation ITU-T G.1033

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Recommendation ITU-T G.1033

Quality of service and quality of experience aspects of digital financial services

Summary

Recommendation ITU-T G.1033 highlights important aspects related to quality of service (QoS) and quality of experience (QoE) that require consideration in the context of digital financial services (DFSs).

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Keywords

Digital financial service, QoE, QoS

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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1 Scope

This Recommendation highlights important aspects related to quality of service (QoS) and quality of experience (QoE) which shall be considered in the context of digital financial services (DFSs).

NOTE – This Recommendation builds upon the discussions in the (now closed) DFS Focus Group and on [b-ITU-T DFS TR]. The continuation of work on QoS and QoE aspects is undertaken by the Financial Inclusion Global Initiative (FIGI) [b-FIGI 2019a], [b-FIGI 2019b], [b-FIGI 2019c].

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T E.811] Recommendation ITU-T E.811 (2017), *Quality measurement in major events.*

[ETSI TS 103 296] ETSI TS 103 296 V1.1.1 (2016), *Speech and multimedia transmission quality (STQ); Requirements for emotion detectors used for telecommunication measurement applications; Detectors for written text and spoken speech*.

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

2G second Generation

3G third Generation

CPU Central Processing Unit

DFS Digital Financial Service

DTMF Dual Tone Multi Frequency

E2E End-to-End

FEC Forward Error Correction

GSM Global System for Mobile communications

HLR Home Location Register

HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
IP	Internet Protocol
IPTV	IP Television
IVR	Interactive Voice Response
KPI	Key Performance Indicator
KQI	Key Quality Indicator
MMS	Multimedia Messaging Service
MOS	Mean Opinion Score
OTT	Over The Top
P2P	Person to Person
QoE	Quality of Experience
QoS	Quality of Service
QoSE	QoS Experienced
QoSP	QoS Perceived
RTP	Real-Time Protocol
SIP	Session Initiation Protocol
SLA	Service Level Agreement
SMS	Short Message Service
SMSC	Short Message Service Centre
SSL	Secure Sockets Layer
TCP	Transmission Control Protocol
TLS	Transport Layer Security
UMTS	Universal Mobile Telecommunications System
USSD	Unstructured Supplementary Service Data
VoIP	Voice over IP
VoLTE	Voice over Long-Term Evolution
WAP	Wireless Application Protocol
WML	Wireless Markup Language
XML	extensible Markup Language

5 Conventions

None.

6 Problem statements

QoS and QoE aspects depend in particular on the use case under consideration and related aspects like environment and detailed macro parameters.

6.1 Different use cases

Use cases of DFSs can be easily categorized and analysed when applying the hierarchy concept depicted in Figure 1.

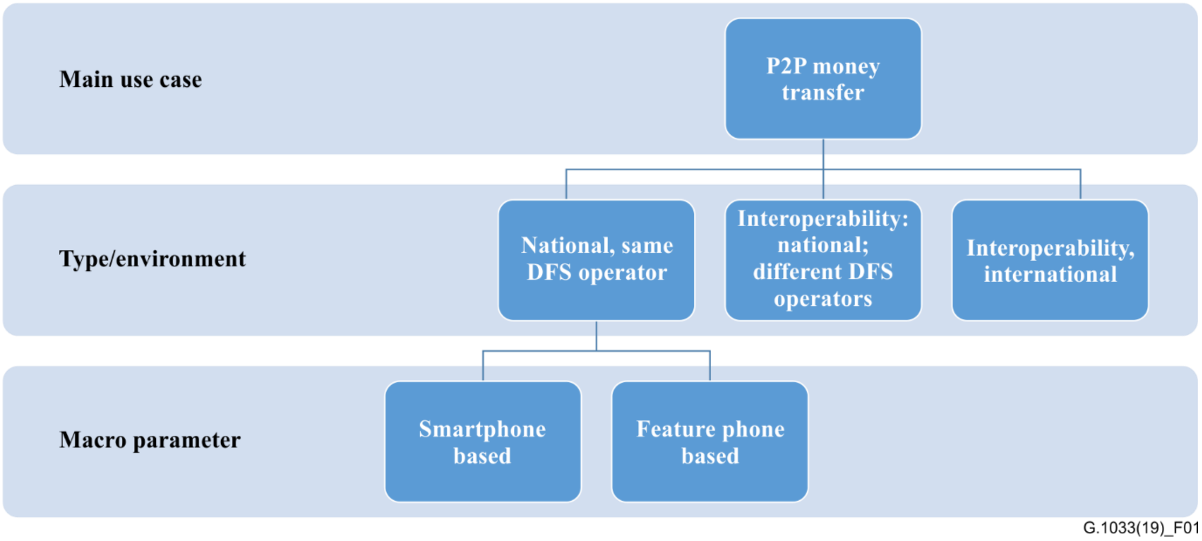

Figure 1 – Hierarchy of use cases, types, and macroscopic parameters

Other main use cases are, for example, transfers between a mobile device and a bank account, or bulk transfers such as payment of wages by an employer. The hierarchy also allows the introduction of higher-level classifications (transfer types), e.g., one-to-one, one-to-many, many-to-one

NOTE – The use case hierarchy shown in Figure 1 displays some variants that are for further study.

QoS aspects of DFSs need to be assessed for two different service categories that are, with reference to Figure 1, macroscopic parameters of a main use case, namely person to person (P2P) money transfers.

1) In service category 1, the targeted group of users is limited to the use of (cheap) basic feature phones. This excludes for example browser-based DFS solutions.

2) In service category 2, the additional QoS aspects are assessed when the minimum requirements to the phones used for DFSs are raised and basic smartphone functionality can be assumed.

6.2 Legal entities

It is important to accept that in reality the provision of a service offer ("service") is – as a general rule – independent of the physical operation of a telecommunication network.

Whereas for most service offers there is – beside the general legal framework – no specific regulation, DFS "services" are under the close control of banking sector regulators, whereas operators of telecommunication networks are under the control of telecom sector regulators.

Therefore, legal aspects (from a QoS perspective) need to assess two different legal cases:

1) in legal case A, the provider of a DFS "service" and the operator of a physical telecommunication network are two distinct and different legal entities;

2) in legal case B, the provider of a DFS "service" and the operator of a physical telecommunication network are the same and identical legal entity.

NOTE – This Recommendation is without prejudice regarding actual legal actions or situations or conclusions or any combination thereof.

6.3 Mobile network QoS affecting all services

Figure 2 (adapted from [b-ITU-T E.804] and [b-ETSI TS 102 250-2]) shows a model for QoS parameters. This model has four layers, each of which provides the necessary precondition for the next layer, i.e., that a property belonging to layer N needs the presence of the properties of layer $N-1$.

The first layer is network availability, which determines QoS from the viewpoint of the service provider than the service user. The second layer is network access. From the service user's point of view, this is the basic requirement for all the other QoS aspects and parameters. The third layer contains the other three QoS aspects: service access, service integrity and service retainability. The different services are located in the fourth layer; the performance of these services is characterized by service specific QoS key performance indicators (KPIs).

The first three layers (with green highlights) are common to all mobile services or applications.

They are characterized typically by the following parameters (KPIs):

- network availability;
- network accessibility;
- service accessibility;
- service integrity;
- service retainability.

In cases where the KPIs in layers 1, 2 and 3 are not maintained at a stable high level, it is useless to attempt to assess the QoS of any kind of service, because prerequisite conditions are not met and the relevance of QoS figures received will be close to zero.

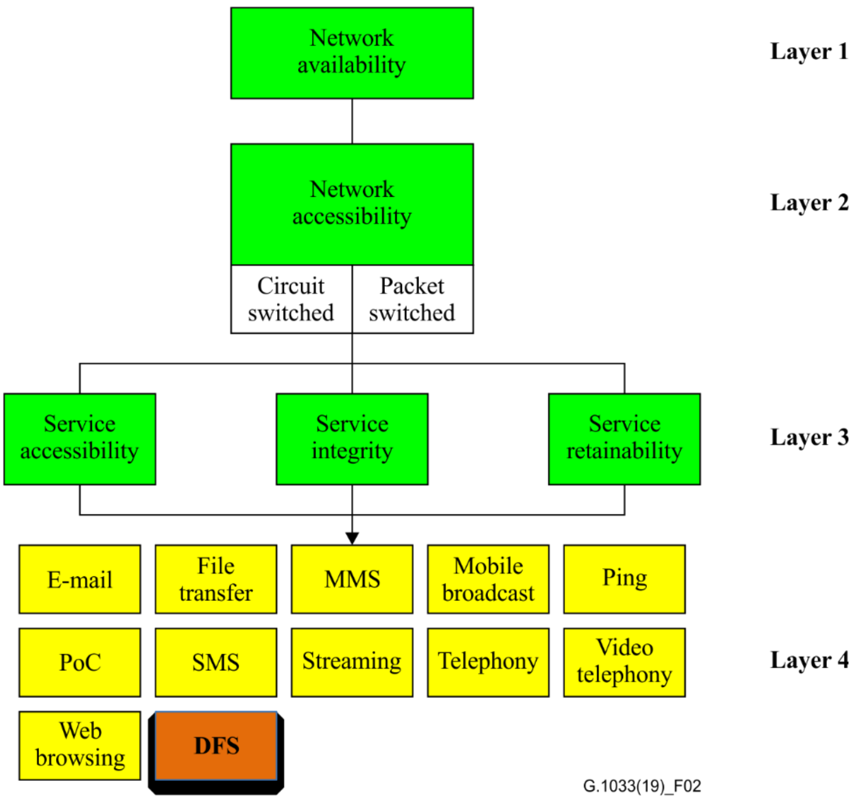

Figure 2 – Model for quality of service parameters

Persisting problems with the KPIs for layers 1, 2 and 3 of a mobile network need to be resolved by the stakeholder in the interest of any mobile service and are therefore clearly out of scope of QoS-for-DFS-considerations.

NOTE – Figure 2 requires an update. First of all, layers 1 to 3 describe actually a kind of "pyramid of needs", i.e., before starting to think about service integrity (e.g., call drop rate in telephony), the service needs to be accessible first. Also, the "service" picture needs an overhaul. The "circuit/packet switched" division is legacy from 2G or 3G. Some of the "services" in layer 4 actually depend on each other or belong to different groups. There are "carrier services" such as the basic Internet protocol (IP), and also combined services using one or more such carrier services, e.g., the multimedia messaging service (MMS) that relies on the short message service (SMS) (which is actually an end user-related service as well) for notification, and uses packet data to actually transfer data. A "service" with the same effect for end users, e.g., some kind of over the top (OTT) chat with attached files, uses only basic packet data. In any case, there is no longer any real "technology dependency". If an operator decides to suppress Skype, or prioritizes certain video streaming, this is not the result of some fundamental ability or inability, but just the effect of some "traffic shaping" elements.

6.4 Possible solutions

DFSs are realized through utilization of basic services provided by a network. Assuming that the reliability of DFSs has to be very high, there are two basic ways to ensure this reliability.

- Network centric: The QoS level for basic services provided by the network is sufficiently high to create the required reliability.
- User centric: Robust E2E protocols on UE- and DFS-related infrastructure ensure the reliability of the actual service, even in the presence of deficiencies in the underlying functionality.

Such robustness can be described by key criteria for DFSs. Topmost is, for each transaction, a clear indication whether it was successful, which needs to be consistent for both sides. Assume a transaction is composed of a number of steps, each step being the exchange of a data token. If the transfer of a data token has no clear "lost" criterion, but can take, in principle, indefinite time, a time-out needs to create a defined situation. The essential property of robustness is that, if a data token now arrives after its time-out, the protocol needs to ensure that this token is not causing any action any more.

With respect to practical aspects of DFS implementations, this poses some fundamental differences. When the main goal is to introduce DFSs in the near future, it needs to operate with the existing installed base of end user devices. This will automatically limit the spectrum of applicable methods to those which can be supported by those devices. A possible drawback of this approach is that if a technology has been deployed and is widely used, it will – as long as it is working without major problems – be difficult to replace, even if the new technology is superior. This may be less an issue with respect to end user devices as the penetration of smartphones continues to increase strongly due to their manifold advantages. It may be that these retaining factors are more on the side of infrastructure, as introduction of new technologies requires new investment that may, at least in the first years of usage, not be balanced by similar new opportunities to generate additional revenue.

7 Conclusions

The following conclusions are, with respect to clause 6, based on the assumption that necessary DFS performance is achieved by ensuring a sufficiently high performance of the basic services used to implement DFSs. The case of using a robust E2E protocol is not treated here.

7.1 Conclusions for service category 1

Four different techniques are discussed in Annex B, which might be used in conjunction with DFS offers for service category 1.

- SMS is a store and forward service. Even if the share of short transfer times may be high in typical cases, it cannot – without modifications – be used reliably for real-time transactions.
- Dual tone multi-frequency (DTMF) has limited transfer capabilities and will most probably only be used to complement one of the other techniques.
- Interactive voice response (IVR) typically requires reasonably high listening quality, which might pose a problem with feature phones in environments with higher levels of background noise.
- Unstructured supplementary service data (USSD) is a true real-time technique. However, the message transfers which could be used for DFSs are not standardized.

7.2 Conclusions for service category 2

Seven different techniques are discussed in Annex A, which might be used in conjunction with DFS offers for service category 2. As per availability on smartphones, solutions based on the hypertext transfer protocol secure (HTTPS) appear to be the optimal carrier technology for DFSs.

7.3 Conclusions related to digital financial services

It is of importance for any further work in the field of QoS/QoE for DFSs to get access to more detailed information, such as descriptions of the various DFS offers to see on a technical level, which underlying services in the network are used and which are the technical parameters associated with them, e.g., timer values, timeout events and number of interactions involved in a single financial transaction. Doing so carries potential for improving the quality of standards development and testing, which has been an on-going need.

Therefore, it is suggested that telecom regulators collect such information prior to the issue of licenses in order to make their own judgement of the quality of the planned DFS offering.

Such information should be submitted by regulators to ITU-T Study Group 12, where the experts could start categorizing the different approaches and provide comments and guidance on such implementations. If possible, the information on the DFSs should be summarized in a flowchart.

There are even more issues remaining currently open, which will need further discussion.

- Mobile operators have increasing problems with the huge amount of data traffic in their networks. Therefore, if high-speed fixed networks are available, there is a massive trend to use so-called "Wi-Fi offloading", where data traffic is redirected via Wi-Fi accesses to the internet backbone core. The consequences for DFSs seem to be quite unexplored, as yet.
- The text displayed in the course of DFS interactions or the accentuation in spoken dialogue systems may be loaded with emotion, which could affect the user experience of the service (QoE). Emotion detectors could be used to minimize any negative impact from this text and speech material. Currently, requirements for emotion detectors in telecommunications have been published in [ETSI TS 103 296].
- A serious problem (mostly for regulators) are effects that cannot easily be allocated to one of the stakeholders in the DFS process. A prominent example is so-called early timeouts in DFSs, which anyone outside the DFS provider would interpret as dropped- calls, i.e., blame the network or blame the terminal or blame the user – in reality it turns out just to be a badly designed flow-of-actions: users still reading instructions on their screens before initiating the next step of a transaction are hit by an invisible timer's timeout action.

8 Future considerations: Top-level view

This clause deals with an end-to-end (E2E) model of DFSs. It focuses on the essence for user-related functionality of DFSs by providing a top-level view of (selected) DFS use cases.

The term "transaction" is used to describe a single instance of a complete use case from a customer point of view, in accordance with the usage of this term in other fields of QoS standardization. It is noted that in this case, the term is also part of the common expression "financial transaction".

The use cases described serve as examples to explain the underlying framework. The underlying model can, however, be easily applied to other use cases that are identified to be relevant in the DFS context.

From the use cases, quality metrics are derived. The key point of the model is that it is, on its topmost level, "technology agnostic". The actual implementation may be in manifold ways, with specific technical characteristics, strengths and weaknesses; these come in at lower levels of the model. The technology agnostic top level makes sure that no "technology-related" allowances are made (such as "discounts" for known technical weaknesses of particular implementations). Also, the model makes sure that new technical developments in realizing DFSs do not disrupt existing QoS metrics.

The underlying general principle of the QoS metrics proposed is also to provide the smallest possible number of KPIs, with each KPI having a clearly defined relation to user perception. This shall avoid the situation, observed in some KPI sets, where individual KPIs overlap in meaning, which can lead to unclear or even contradictory results.

An actual DFS implementation uses different network- related "services" or functionality. The relevant clause shows how the use case related top-level view – and its KPIs – can be mapped to this technological level of currently existing "carrier services" with appropriate (mostly already existing) KPIs.

The principle of having a small number of strong KPIs does not exclude additional KPIs with diagnostic or administrative functions.

It is recognized that there are several stakeholders with different interests. The relevant clause – which is also to be seen as an expandable illustration of the underlying concept – describes this view in more detail.

The fact that different stakeholders have different interests also leads to the conclusion that not all KPIs are of equal importance to all stakeholders. This aspect can provide guidance when it comes to the provision of a legal or regulatory framework to enable or support emergence of DFSs.

Clause 8.4 considers how practical monitoring of DFS service performance could be implemented. It differentiates between test and measurement in the introduction phase, and continuous quality monitoring in the operational phase of DFSs.

8.1 Use cases and related top-level KPI

8.1.1 Transfer of money from A to B

Basic flow of activities:

Party A decides to transfer amount *X* from its account to the account of B. Key interests of this transfers are:

1) the transfer is made with a clear indication of success or failure on both sides within a reasonable time span;
2) the success rate of a money transfer needs to be high;
3) the duration of a transaction is reasonably short;
4) if the transaction fails, the situation needs to be completely reversed within a reasonably short time span (i.e., no money "lost in limbo");
5) the transaction leads to a stable and correct end state for all participants in a reasonably short time span (i.e., all accounts are "up to date" as fast as possible);

6) there are no losses or duplications of money during the transaction (i.e., money not deducted from A's account but appearing in B's account).

NOTE – Not all of these conditions are of equal importance to all stakeholders, e.g., the absence of "money duplications" may not be of interest to end users.

A further differentiation of the use case may come from the question whether some kind of proof for the transaction is created, and if yes, in which way. This may be a crucial element if money is paid to clear debts, e.g., an electricity bill. This may involve data transmission to a possible third party to send such a proof, or access to appropriate services to produce this.

From these requirements, the following E2E KPIs can be derived:

- money transfer completion rate;
- money transfer completion time;
- money transfer false positive rate;
- money transfer false negative rate;
- money transfer failed transaction resolution rate;
- money transfer account stabilization success rate;
- money transfer account stabilization time;
- money transfer loss rate;
- money transfer duplication rate.

NOTE – These KPIs and their technical basis are currently not standardized and therefore cannot be assessed in a comparative manner.

This list clearly contains elements that are not primarily related to mobile network behaviour or performance; they also relate to the performance of underlying banking processes and implementations. So, the list can probably be reduced to elements that are assumed to be primarily linked to mobile networks.

There is, however, a connection. If, for example, a connection loss occurs during a transaction consisting of a number of roundtrips estimated to complete a DFS transaction, this may have different results depending on a particular implementation of such banking processes. Therefore, it is assumed that the robustness and stability of such processes against failures which are typical to specific basic services of mobile networks will also have an effect on the overall QoS of DFSs.

8.1.2 Other use cases

This is for further study.

8.2 Technological components of DFSs

As outlined in other parts of this Recommendation, there are some services and functionalities within existing mobile networks that can be used – with a further selection by available features of mobile devices – to realize DFSs.

From the concept of a "pyramid of needs" and assessment of the E2E KPIs for DFSs, a clear hierarchy of quality requirements can be derived.

The topmost requirement will be the integrity of a transaction. Integrity in DFSs is the clear and reliable assessment, whether a transaction has been successful or not. This is seen as even more important than the overall success rate of an implementation. If a transaction is erroneously assessed as being successful or failed, the objective damage (e.g., to a person's financial condition) will be larger than a case where a transaction has to be repeated due to a detected failure. The same applies to a transaction that is erroneously assessed as unsuccessful, which would result in duplicate transfer due to a repetition of the process.

From a QoE point of view, the situation can be more complex. Assuming there are two implementations: one of them being stable and robust in the sense of low (ideally zero) probability of false positives or negatives, but slow; the other one faster, but more sensitive to such errors. Unless the false-assessment error is quite large, it is likely that in the customer perception, the latter will appear as the "better" one. It follows that in this area, consideration beyond mere competition according to market rules is needed.

An E2E approach needs to be taken because the overall robustness of a particular implementation depends on several factors.

Assume that there are two alternatives, one of them requiring a number, N_1, of roundtrips, each having a time duration of T_1, and a success rate per roundtrip of S_1; the other is characterized likewise by N_2, T_2 and S_2. Clearly, there are several interactions with typical network properties. For instance, if the transaction is performed while the actor is moving (e.g., in a public transport vehicle or as a passenger in a car), the change of network conditions during a transaction influences the overall success rate. This links the time scale of motion-related impairments to transaction characteristics. If the typical overall duration of a DFS transaction (T_1*N_1 and T_2*N_2) is above the typical time during which network properties show degradations, the probability of failure increases. In a more general view, the overall success rate of a DFS transaction can be expressed as S_1N_1 and S_2N_2. So even if an individual success rate per roundtrip of a specific implementation (where the motion profile can be factored in) is lower, the resulting E2E success rate may be higher if the number of roundtrips in this implementation is sufficiently smaller.

The same linkage between characteristics includes the times involved. For instance, if a transaction fails (in a "proper" way, i.e., with correct assessment of the result), the negative impact on QoE will presumably be smaller if this result is obtained in a shorter period of time, as a follow-up try can be started and completed faster.

8.3 Stakeholders

This clause is not meant to be a complete analysis of stakeholder structure and their requirements. The point is that different stakeholder types exist, and that their concerns and main interests differ. This will have an impact on the relative weighting of particular QoS metrics and therefore on definition of QoE.

End customers

The main interest of end customers will be to have access to DFSs at low cost (which also means without the need to spend more on new mobile devices) and with a high degree of reliability, as financial losses due to service failures will be felt relatively strongly, in particular in low-income segments. It is assumed that transaction speed considerations are (as long as transaction times are within certain reasonable limits) of less importance.

Businesses

Assuming the same basic need for reliable and affordable transactions, larger enterprises at least will have an interest in DFS technologies that allow for efficient processing of recurring or larger scale transfers. It is further assumed that there may be interest in technologies that can be deployed on fixed-network equipment (i.e., personal computers) without excessive cost. This will in turn affect market acceptance of solutions with different ways of interfacing. An example is access to certain gateways or other network-based functions like a short message service centre (SMSC).

Network operators

As network operators are, usually, subject to regulation, relevant factors actually can be separated into two categories. The first category contains general technical and commercial requirements, such as cost of operation of a particular technology in relation to profits that can be generated. The second category may include cost of non-compliance with legal or regulatory requirements, in terms of service level agreements (SLAs), or linkages between, for example, licenses and obligations to provide certain services or service properties.

DFS operators

Although DFS operators are not identical to network operators, they will basically be subject to similar conditions to them, with perhaps other governmental entities responsible for setting and enforcing the rules under which they operate. Commercially, their market power will probably be large enough to impose quality standards (SLAs) or other market forces to service providers (network operators).

Governments/Regulators

Assuming that the main objective of governments is economic development, their task is to find a balance between carrot and stick, i.e., a level of rules and regulations that enables technical evolution, while leaving DFS operators enough room to run a profitable service, and making sure that costs of DFS services are in an affordable range. For this stakeholder group, it is assumed that the main objectives are stable, reliable services in combination with a technology that gives the target segment of the population a sufficiently barrier-free access to DFSs.

Furthermore, there are different ways in which each of these stakeholder groups has influence on other stakeholders, for instance in rewarding or sanctioning market offerings or more general decisions. The crucial point to be made here is that beyond the directly visible first-order effects, second-order interactions exist that do not necessarily have to be weaker, but may work in a "cybernetic" way, i.e., with longer time constants, but with likewise or even stronger effects than first-order dependencies.

8.4 QoS monitoring

In order to secure the necessary quality level of DFSs, appropriate regulatory guidance and comprehensive performance targets need to be established. Basically, it would be possible to refer to basic performance measurements of respective carrier services (such as SMS, telephony (for DTMF or IVR) or packet data. Due to the nature of services implementation this will, however, be a surrogate with considerable risk of predicting actual DFS performance incorrectly.

It is therefore – owing to the importance of DFS – assumed that a better way of monitoring needs to be established. This monitoring should – while being fully aware of practical issues in definition and implementation – use actual use cases, i.e., actual money transfer.

The monitoring is proposed to have multiple forms that cover all stages of the technical life cycle of any DFS implementation.

Assessment and roll-out phase:

E2E performance measurements as professionally done by dedicated systems, e.g., under control of regulatory authorities.

Operational phase:

Regular E2E performance measurements as professionally done by dedicated systems, e.g., under control of regulatory authorities.

"Test panel" performance measurements, integrated into selected end user devices/apps:

For this kind of measurement, a group of end users, selected to be representative for the general usership, would be recruited and equipped with specially designed DFS clients. This group would, along with doing their "real life" DFS usage, also file additional reports. These reports would then allow responsible entities to constantly assess the performance of DFSs in the field.

"Crowd-sourced" performance measurements, integrated into end user devices/apps:

This would be a simple and non-intrusive way to obtain information on DFS performance on a broad scale. Professional systems used would be equipped with functionality to not only measure E2E performance, but also collect diagnostic information allowing to track root causes for poor performance or malfunction of services.

Using real use cases creates additional cost. This cost needs to be assessed against the benefits of obtaining real instead of surrogate data that only can estimate actual service performance. Moreover, it is possible, with a little additional effort in planning and implementation, to design processes that optimize additional cost, such as re-transferring money that has been moved by a DFS.

It is therefore proposed to add appropriate concepts to a DFS implementation strategy. To increase the effectiveness of such concepts, it is recommended that a pilot phase be designed to give insight into practical aspects and provide information to optimize respective operations.

Annex A

Underlying functionalities of DFS applications

(This annex forms an integral part of this Recommendation.)

A.1 Service category 1 (feature phone)

This clause focuses on DFS applications that can be run using simple mobile feature phones (low-end mobile phones that are limited in capabilities in contrast to modern smartphones, see clause 6.1). Therefore it is assumed in the following that financial services requiring file transfer protocol, hypertext transfer protocol (HTTP) or browser-based transactions can be safely excluded from the discussion in this clause.

Table A.1 – Summary of technologies for service category 1

Technique	Main features	Disadvantages	Advantages
SMS	Store-and-forward alphanumerical messages	Not real-time	Globally available Interconnection ok
IVR	Interaction with user by artificial or recorded voice, voice recognition or DTMF	Requires good speech quality transmission	Real-time
DTMF	Simple keypad operation	Limited character set	Real-time
USSD	Alphanumerical messages	Requires USSD Gateways	Real-time

A.1.1 Short message service

The SMS is used to send text messages to and from mobile phones, fax machines or IP addresses. The messages can typically be up to 160 characters in length, though some services use 5-bit mode, which supports 224 characters. SMS was originally created for phones that use the global system for mobile communications (GSM), but now all major mobile phone systems support it. Once a message is sent, it is received by an SMSC, which must then get it to the appropriate mobile device.

To do this, the SMSC sends an SMS request to the home location register (HLR) to find the roaming customer. Once the HLR receives the request, it will respond to the SMSC with the subscriber's status:

1) inactive or active;

2) where subscriber is roaming.

If the response is "inactive", then the SMSC will hold on to the message for a period of time. When the subscriber accesses his device, the HLR sends an SMS notification to the SMSC, and the SMSC will attempt delivery.

The SMSC transfers the message in a short message delivery point to point format to the serving system. The system pages the device, and if it responds, the message gets delivered.

The SMSC receives verification that the message was received by the end user, then categorizes the message as "sent" and will not attempt to send again.

SMS falls into the group of the so-called store-and-forward services and is normally being transported in the background class according to [b-ETSI TS 123 107]. As a consequence, parameters like SMS delivery time or SMS response time depend very much on the traffic load of the mobile network and cannot be guaranteed.

A.1.2 Interactive voice response

IVR is a technology that allows a computer to interact with human users through the use of voice and DTMF tone input via a keypad.

In telecommunications, IVR allows customers to interact with a company's host system via a telephone keypad or by speech recognition, after which they can service their own enquiries by following the IVR dialogue. IVR systems can respond with pre-recorded or dynamically generated audio to further direct users on how to proceed. IVR applications can be used to control almost any function where the interface can be broken down into a series of simple interactions.

A.1.3 Dual tone multi-frequency signalling

The DTMF system uses a set of eight audio frequencies transmitted in pairs to represent 16 signals, represented by the 10 digits, the letters A to D, and the symbols # and * as described in [b-ITU-T Q.23]. Detailed requirements for DTMF are specified in [b-ETSI ES 201 235-1], [b-ETSI ES 201 235-2], [b-ETSI ES 201 235-3] and [b-ETSI ES 201 235-4]. As the signals are audible tones in the voice frequency range, they can be transmitted like speech signals. Originally used to dial the number of the remote terminal, it became a common method to transmit small amounts of data.

In packet based networks, there are three common ways of sending DTMF:

- session initiation protocol (SIP) INFO packets as described in [b-IETF RFC 2976];
- as specially marked events in the real-time protocol (RTP) stream – as described in [b-IETF RFC 2833];
- inband as normal audio tones in the RTP stream with no special coding or markers.

For mobile networks [b-ETSI TS 123 014] describes how DTMF signals are supported. A message-based signalling system is used across the air interface. Inband transmission is not possible.

That means that in mobile communication, the originating mobile terminal directly creates relevant messages when the keys are pressed by the user during a call.

A.1.4 Unstructured supplementary service data – both push and pull services

USSD is a protocol used by mobile terminals to communicate with the network of the mobile operator.

USSD messages are up to 182 alphanumeric characters in length. USSD messages create a real-time connection during a USSD session. The connection remains open, allowing a two-way exchange of a sequence of data. This makes USSD more responsive than services that use SMS.

Messages sent over USSD are not standardized:

Normally, USSD is used in the format *nnn# as part of configuring the phone on the network. In order to transfer text messages via USSD to another mobile network, a special USSD gateway is required, which mobile operators do not normally provide.

USSD is sometimes used in conjunction with SMS. The user sends a request to the network via USSD, and the network replies within the same USSD session with an acknowledgement of receipt.

Subsequently, one or more mobile terminated SMS messages communicate the status or results of the initial request. In such cases, SMS is used to "push" a reply or updates to the handset when the network is ready to send them. In contrast, USSD is used for command-and-control only.

USSD is generally associated with real-time or instant messaging services. There is no store-and-forward capability, as is typical of other short-message protocols like SMS.

USSD is specified in [b-ETSI TS 100 625], [b-ETSI TS 100 549] and in [b-ETSI EN 300 957]. USSD modes are:

- mobile-initiated: USSD/ PULL or USSD/P2P.

When the user dials a code from mobile terminal

- network-initiated: USSD/ PUSH or USSD/A2P.

When the user receives a push message from the network:

USSD can be used, e.g., for prepaid call-back service, mobile-money services, location-based content services, menu-based information services and as part of configuring the phone on the network.

A.2 Service category 2 (smartphone)

In addition to service category 1, the underlying techniques listed in Table A.2 can be taken into account. Even basic smart phones (see clause 6.1) will provide services based on these techniques.

Table A.2 – Summary of technologies for service category 2

Technique	Main features	Disadvantages	Advantages
SMS	Store-and-forward alphanumerical messages	Not real-time	Globally available Interconnection ok
IVR	Interaction with user by artificial or recorded voice, voice recognition or DTMF	Requires good speech quality transmission	Real-time
DTMF	Simple keypad operation	Limited character set	Real-time
USSD	Alphanumerical messages	Requires USSD Gateways	Real-time
WAP	Simple web browser	Limited set of functions	Available on some phones even if they do not support HTTP
HTTP	Standard web browser	Unsecure	Internet-like access
HTTPS	Safe web browser	Complex	Encrypted, not even subject to traffic shaping

A.2.1 Wireless application protocol

TheWAP is a technical standard for accessing information over a mobile wireless network. A WAP browser is a web browser for mobile devices such as mobile phones that use the protocol.

WAPs that use displays and access the Internet run what are called micro browsers – browsers with small file sizes that can accommodate the low memory constraints of hand-held devices and the low-bandwidth constraints of a wireless hand-held network.

Although WAP supports hypertext markup language (HTML) and extensible markup language (XML), the wireless markup language (WML; an XML application) is specifically devised for small screens and one-hand navigation without a keyboard. WML is scalable from two- line text displays up through graphic screens found on items such as smart phones and communicators. WAP also supports WMLScript, which is similar to JavaScript, but makes minimal demands on memory and central processing unit (CPU) power, because it does not contain many of the functions found in other scripting languages that are unnecessary in this context.

A.2.2 Hypertext transfer protocol

The HTTP is an application protocol for distributed, collaborative, hypermedia information systems. HTTP is the foundation of data communication for the world wide web. Hypertext is structured text that uses logical links (hyperlinks) between nodes containing text. HTTP is the protocol to exchange or transfer hypertext.

HTTP functions as a request-response protocol in the client-server computing model. A web browser, for example, may be the client and an application running on a computer hosting a web site may be the server. The client submits an HTTP request message to the server. The server, which provides resources such as HTML files and other content or performs other functions on behalf of the client returns a response message to the client. The response contains completion status information about the request and may also contain requested content in its message body.

A.2.3 Hypertext transfer protocol secure

HTTPS (also called HTTP over transport layer security (TLS), HTTP over a secure sockets layer (SSL), and HTTP Secure) is a protocol for secure communication over a computer network that is widely used on the Internet. HTTPS consists of communication over HTTP within a connection encrypted by TLS or its predecessor, SSL. The main motivation for HTTPS is authentication of websites visited and protection of the privacy and integrity of the exchanged data.

In its popular deployment on the internet, HTTPS provides authentication of the website and associated web server with which the user is communicating, which protects against man-in-the-middle attacks. Additionally, it provides bidirectional encryption of communications between a client and server, which protects against eavesdropping and tampering with or forging the contents of the communication.

Appendix I

Considerations related to the fitness for DFSs

(This appendix does not form an integral part of this Recommendation.)

A successful introduction of DFSs via a mobile network requires fitness of the whole environment used, which is

– fitness of the mobile network, to provide a minimum level of availability and accessibility;
– fitness of the mobile network to provide the services required for realization of DFSs;
– fitness of mobile devices used, to support the basic services used to realize DFSs;
– fitness of the DFS service itself to provide useable interfaces;
– fitness of users to successfully use DFSs – this may include the necessary skills to operate DFSs on phones as well as basic understanding of properties of DFSs in general, to protect users against exploitation of insufficient knowledge, see [b-FIGI 2019c];
– fitness of the general society and the governmental institutions for DFSs.

Figures I.1 to I.5 are decision diagrams meant to facilitate discussion between stakeholders in different regions or countries. Figures I.1 to I.5 do not contain any numbers or specific target values. This is by intention, because target values acceptable for all stakeholders will vary from region to region and from country to country.

The term "major events" used in Figures I.1 to I.5 refers to [ITU-T E.811], aiming at QoS in mobile networks during major events, as for example, major sports events.

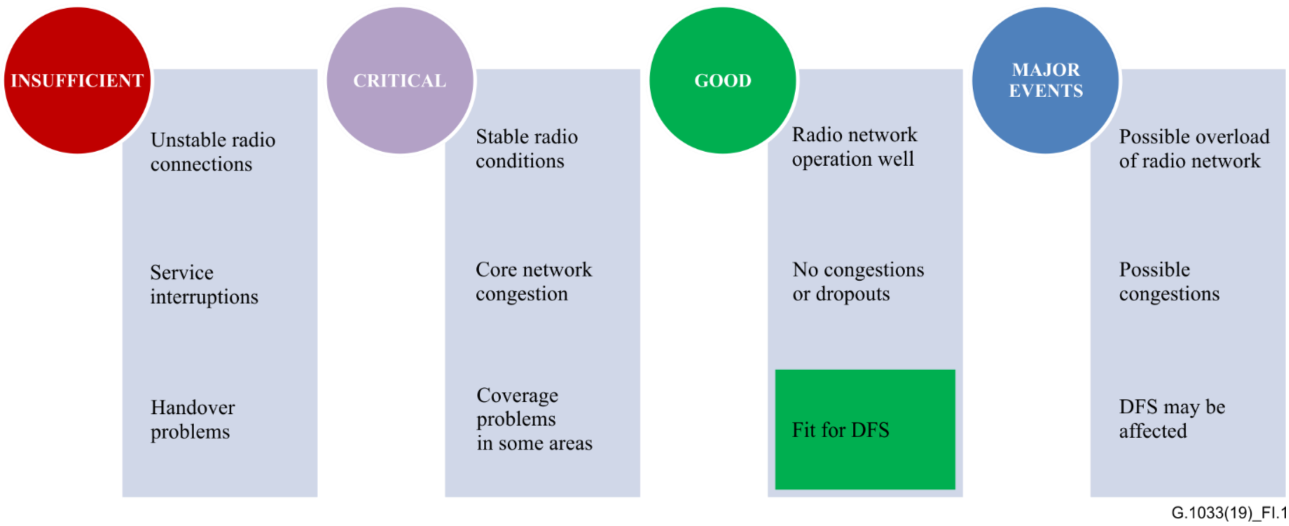

Figure I.1 – Decision diagram for fitness of a mobile network for DFSs

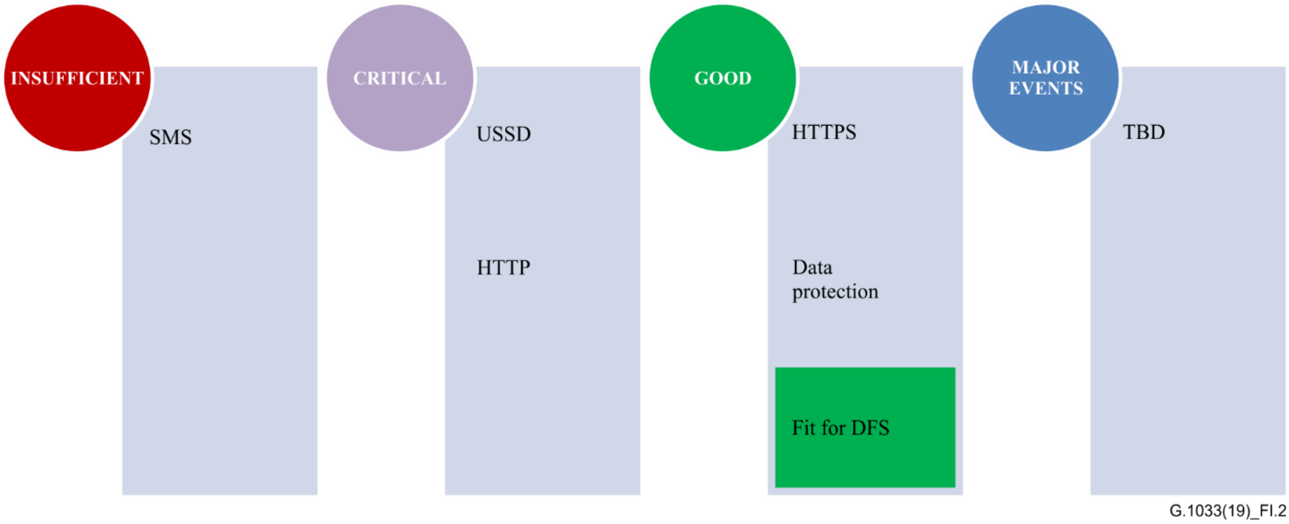

Figure I.2 – Decision diagram for fitness of mobile terminals for DFSs

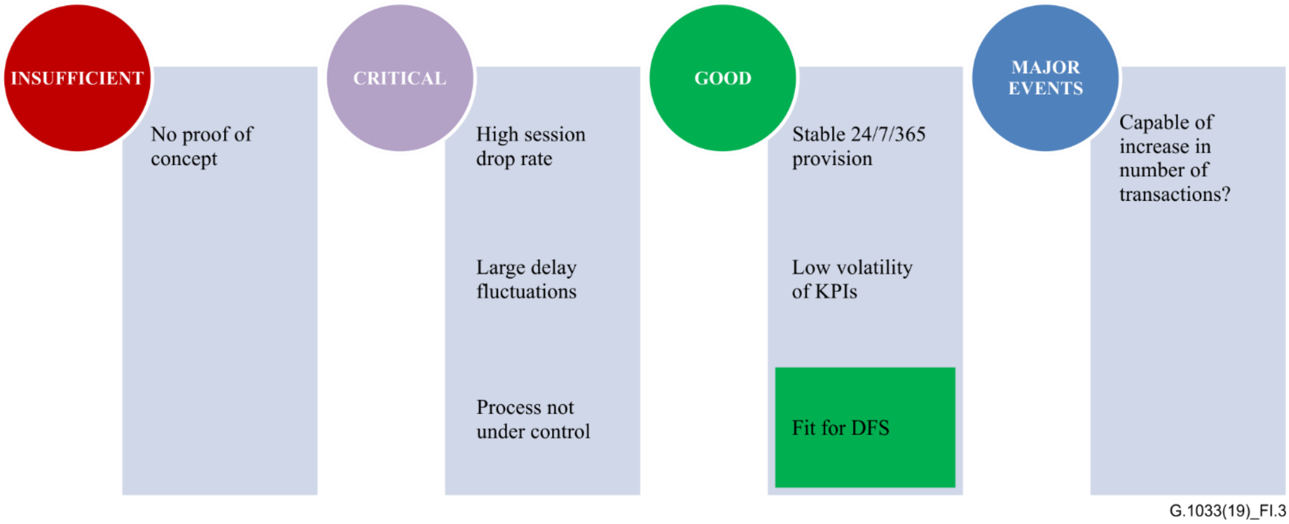

Figure I.3 – Decision diagram for fitness of mobile network services for DFSs

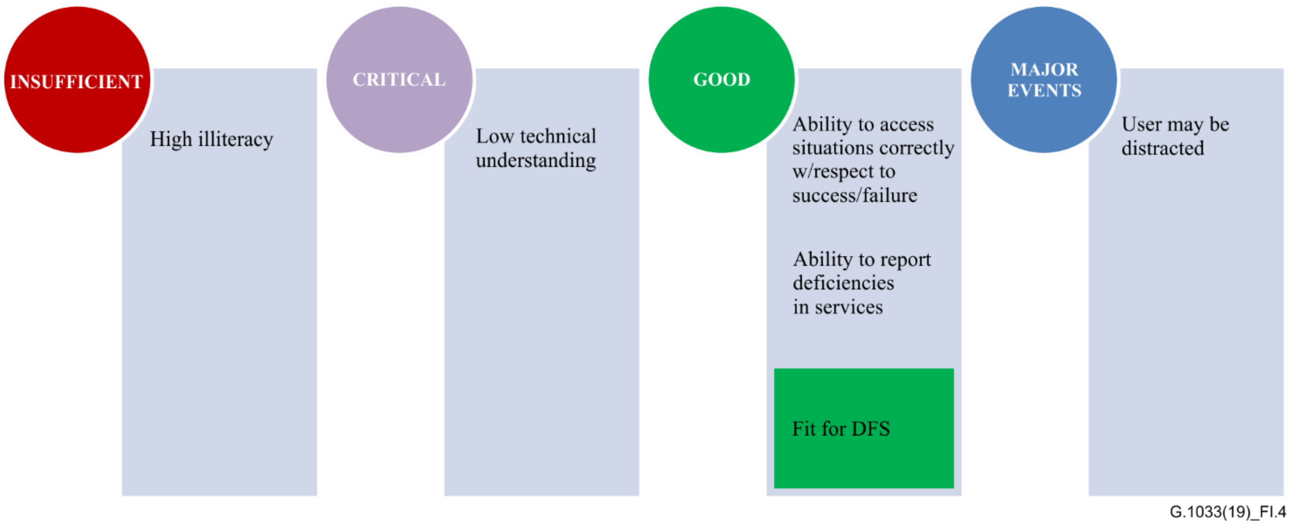

Figure I.4 – Decision diagram for fitness of mobile users for DFSs

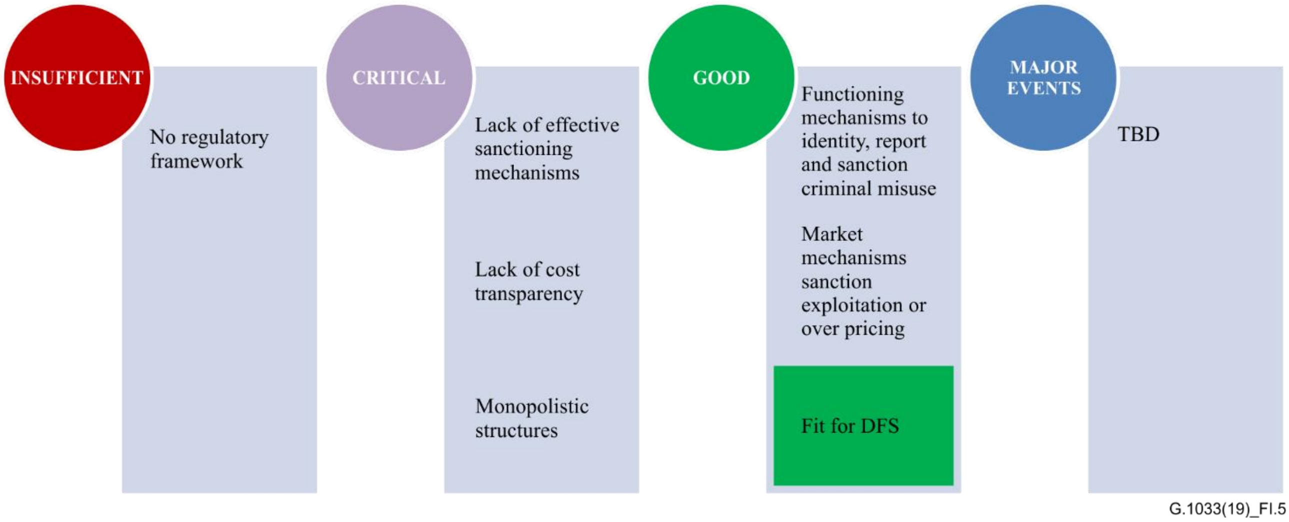

Figure I.5 – Decision diagram for fitness of a society/government for DFSs

It is important for any further work in the field of QoS/QoE for DFSs to get access to more detailed information, such as descriptions of the various DFS offers to see on a technical level, which underlying services in the network are used and which are the technical parameters associated with them, e.g., timer values, timeout events, number of interactions involved in a single financial transaction.

Therefore, it is suggested that telecom regulators collect such information prior to the issue of licences in order to make their own judgement of the quality of the planned DFS offering.

Such flowchart information should be submitted by regulators to ITU-T SG12, where the experts could start categorizing the different approaches, and provide comments and guidance on such implementations.

There are even more issues remaining currently open, which will need further discussions:

- Mobile operators have increasing problems with the huge amount of data traffic in their networks. Therefore, if high speed fixed networks are available, there is a massive trend to use so-called "WiFi offloading", where data traffic is redirected via Wi-Fi accesses to the internet backbone core. The consequences for DFS seem to be quite unexplored, as yet.
- The text displayed in the course of DFS interactions or the accentuation in spoken dialogue systems may be loaded with emotions, which could affect the users' experience of the service (QoE). Emotion detectors could be used to minimize any negative impact from this text and speech material. Requirements for emotion detectors in telecommunications are provided in [ETSI TS 103 296].
- A serious problem (mostly for regulators) are effects that cannot easily be allocated to one of the stakeholders in the DFS process. A prominent example is so-called early timeouts in DFSs, which anyone outside the DFS provider would interpret as dropped- calls, i.e., blame the network or blame the terminal or blame the user – in reality it turns out just to be a badly designed flow-of-actions: users still reading instructions on their screens before initiating the next step of a transaction are hit by an invisible timer's timeout action.

Because the field of DFSs and its related QoS and QoE aspects is both of high importance and quite complex, capacity building is essential.

Appendix II

Is DFS a "popular service"?

(This appendix does not form an integral part of this Recommendation.)

II.1 Relationship between QoS and QoE

In addition to the term QoS, the term QoE is often used nowadays to stress the purely subjective nature of quality assessments in telecommunications and their focus on the user's perspective of the overall value of the service provided.

The increased significance of the term QoE is related to the fact that in the past the term QoS was used mostly for only technical concepts focused on networks and network elements. The definition of QoS, however, does include the degree of satisfaction of a user with a service. Thus, non-technical aspects are included, like e.g., the user's environment, expectations, the nature of the content and its importance. However, most service providers used QoS only in relation to the actual user-service interaction to cross-check whether user requirements were met by the service implementation of a provider (as perceived by the user). Therefore, there was a strong focus on the actual network performance and its immediate influence on user perceivable aspects, while additional subjective and not directly related service aspects were omitted.

QoE is defined in [b-ITU-T P.10] as the degree of delight or annoyance of the user of an application or service. It includes the complete E2E system effects (client, terminal, network, services infrastructure, etc.) and may be influenced by user expectations and context. Hence, QoE is measured subjectively by the end user and may differ from one user to another. However, it is often estimated by a combination of objective measurements and metrics describing subjective elements.

NOTE – The definition of QoE and, in particular, the dividing line between QoS and QoE is, however, quite fuzzy, and up to today it does not appear that a globally accepted definition exists. For example, [b-ITU-T E.800] does not use the term QoE at all; instead, it uses a four-viewpoint model (similar to the one in [b-ITU-T G.1000]) with terminology, like QoS experienced (QoSE) or QoS perceived (QoSP).

For working purposes, preferably the use of QoS can be limited to things that can be measured by machines or technical means (including, for example, speech quality metrics, like [b-ITU-T P.863], which already contain some perceptual considerations), and QoE should be used for items further down a "processing chain" where some kind of assessment has been applied. This assessment can be, for instance, some kind of usually nonlinear (clipping) function expressing limits where service quality is either "unacceptable" anyway, or so good that a further improvement will not have any practical consequences. It is important to note that such limits will be strongly dependent on previous experience, i.e., will vary between regions or countries, and will also vary with time as people get accustomed to improvements. Therefore, the issue of "typical values" or "threshold values" is characteristic for the QoE domain.

Objective measurements deal with quantities that can usually be determined by technical measurements, such as information loss and delay. Subjective elements are components of human perception that may include emotions, linguistic background, attitude, motivation, etc., which determine the overall acceptability of the service by the end user. An important part of subjectivity is expectations that usually are formed by previous experience of users for the same or similar types of service.

Figure II.1 shows factors contributing to QoE. These factors are organized as those related to QoS and those that can be classified as human components. QoE for voice and video is often measured via carefully controlled subjective tests, where voice or video samples are played to viewers who are asked to rate them on a scale. The ratings assigned to each case are averaged together to yield the mean opinion score (MOS).

QoS is defined in [b-ITU-T E.800] as the totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service.. In general, QoS is measured in an objective way.

In telecommunications, QoS is usually a measure of performance of services delivered by networks. QoS mechanisms include any mechanism that contributes to improvement of the overall performance of the system and hence to improving the end user experience. QoS mechanisms can be implemented at different levels.

Example – At the network level, QoS mechanisms include traffic management mechanisms, such as buffering and scheduling employed to differentiate between traffic belonging to different applications. Other QoS mechanisms at levels other than transport include loss concealment, application forward error correction (FEC), etc.

QoS parameters are used to describe the QoS observed. Similar to the QoS mechanisms, QoS parameters can be defined at different layers. Figure II.1 shows the factors that have an influence on QoS and QoE.

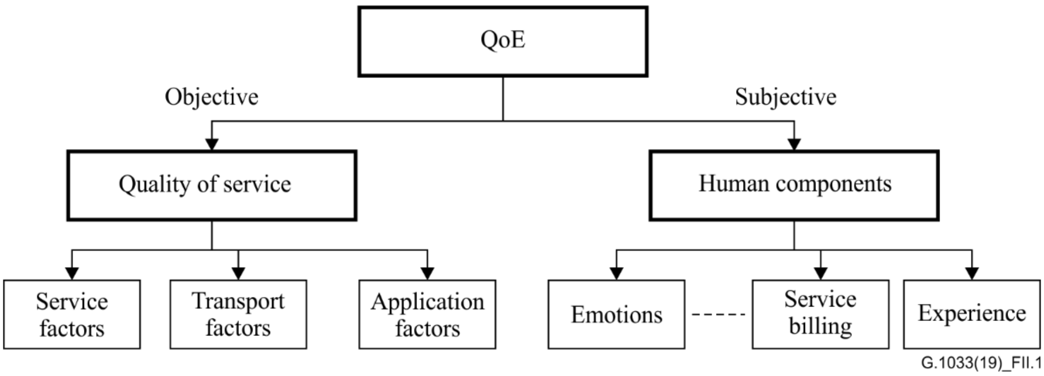

Figure II.1 – Factors that have an influence on QoS and QoE

In general, there is a correlation between the subjective QoE as measured by the MOS and various objective parameters of QoS.

Typically, there will be multiple service level performance (QoS) metrics that impact overall QoE.

The relation between QoE and service performance (QoS) metrics is typically derived empirically.

Having identified the QoE/QoS relationship, it can be used in two ways:

1) given a QoS measurement, the expected QoE for a user can be predicted;

2) given a target QoE, the net required service layer performance can be deduced.

– These prediction and deduction steps are built on assumptions and approximations.

Due to the complexity of services and the many factors that have an influence on QoS/QoE, there is no close one-to-one relationship that would allow statements like "If the bandwidth is increased by 200 kbit/s, then the rating by the user will rise by 0.5 points".

To ensure that the appropriate service quality is delivered, QoE targets should be established for each service and be included early on in system design and engineering processes where they are translated into objective service level performance metrics.

QoE is an important factor in services that are successful in the marketplace and is a key differentiator with respect to competing service offerings. Subscribers to network services do not care how service quality is achieved. What matters to them is how well a service meets their expectations (e.g., in terms of price, effectiveness, operability, availability, and ease of use).

II.2 Services, applications or "popular services"

Within the formal standardization community, the term "service" was always understood as a functionality for which all aspects are standardized (i.e., standardized service); the concept behind this was that globally all networks would (be able and willing to) offer exactly the same – fully interoperable, harmonized service.

However, over time the terminology got corrupted in a sense that service today stands for any application. For example, the Internet Engineering Task Force (IETF) refers to their standards which basically describe network functionalities as services.

Under end user aspects, "service" is used for any application offered in the networks; this makes it very difficult to standardize assessment methods and target values or requirements for related KPIs.

Therefore, if we speak about services, today, we can distinguish multiple dimensions:

a)	applications with global reach	vs.	b)	locally limited applications
c)	specifically named applications	vs.	d)	application class denominators

Typical examples for each dimension are:

a) Netflix or YouTube;

b) eGovernment application in country xyz;

c) Netflix or YouTube;

d) video streaming, IP television (IPTV).

Since services in all these dimensions are not standardized in their functionality *a priori*, the communities involved in assessing QoS and QoE for them have focused on what are called "popular services". The underlying concept is to provide assessment methods and targets for such services that are used frequently by a huge number of users.

- Looking first at dimension a) with the examples given above, these are truly "popular services" – however, the underlying technical aspects, such as carrier services, may change from time to time.
- For dimension b), the main obstacle is the limitation itself. It is highly probable that there will not be any international standard to measure the QoS or QoE of exactly one of those specific services.
- Dimension c) requires close cooperation between the stakeholder providing these services and standardization experts.
- Appropriate handling of dimension d) requires the standardization of new E2E mechanisms. Otherwise, existing carrier services will be confronted with more stringent targets for existing services.

II.3 Is a DFS a "popular service"?

A DFS is popular, yes – but DFS is only a class denominator.

NOTE 1 – At the time work on mobile QoS started (about 10 years ago), the experts considered "service" as something that has a direct impact on the customer's perception. Typical examples are telephony or web browsing. A "service" in this view is understood as something connected to an E2E use case. However, many E2E use cases relate to "carrier services", such as some types of packet data functionality having their own QoS metrics (KPIs).

In this context, a DFS can be considered as a classical example of such a user-related service, which can be realized in several ways, using "carrier services" such as SMS or packet data functionality of networks.

A DFS is not alone in this "top level service" view. Today's telephony is a prominent example. End users basically do not care if the function they are looking for (being able to orally communicate with another) is realized using legacy GSM or the universal mobile telecommunications system (UMTS), voice over long-term evolution (VoLTE) or some OTT voice over IP (VoIP) technology. Their quality assessment is based on universal metrics such as setup time, call drop rate or speech quality, which are exactly those metrics which are at the core of documents such as [b-ITU-T E.804] or [b-ETSI TS 102 250].

The sometimes very detailed KPI definitions in these documents arise due to a "diagnostic" approach, but this is by no means "the golden rule". Future developments will attempt to reveal true "end customer" related key quality indicators (KQIs).

An additional example for this may be web browsing using HTTPS instead of HTTP. For the user, nothing seems to have changed, so top-level QoS KPIs to assess user perception are the same – however, the networks are treating HTTPS and HTTP traffic in many cases differently, which will lead to a difference in usage of such KPIs for diagnostic purposes.

If a technical assessment is desired of the expected top-level QoS of a particular DFS offering using a carrier service point of view, knowledge is needed of the technical flow of data and signalization. This information is not normally available from service providers' websites or brochures.

NOTE 2 – Strictly speaking this is true for most other services offered by network operators. First of all, operators typically do not commit themselves (at least not towards end customers) to strict performance targets; in the case of mobile networks, this is perfectly understandable as the local conditions vary in a wide range (e.g., from rooftop to cellar of a house even in the same geographical spot). Then, with networks going even more towards "content sensitive" behaviour for the sake of resource optimization, the performance cannot safely be predicted from just some general "bit pipe" properties, measured using simple E2E services, such as web browsing. However, a DFS can be – as will be shown later – made subject to objective measurement quite easily.

Ideally, this must be dealt with when licences are negotiated between regulators and potential DFS service providers.

NOTE 3 – This is well known and understood for other services, e.g., video streaming:

When YouTube first became popular, it was based on transmission control protocol (TCP) streaming; with this information KPIs could be defined in standards, QoS could be assessed and QoE could be predicted. Today, for good reasons, the same service by the same entity is rendered as adaptive streaming using HTTPS. Consequently, new standards have been written with new KPIs in order to assess QoS for the "same service".

Strictly speaking, the KPIs with respect to video quality are still the same; only the methods have changed (or were forced to change). Most importantly, KPI definitions using "low level" technical events as those from the IP level no longer work if encrypted connections such as HTTPS are used.

If it is possible to identify categories of different DFS offerings, it can be concluded, which of such categories constitute "popular services" (i.e., which are widespread and used by many customers) and a more selective look into KPI definitions could be initiated.

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