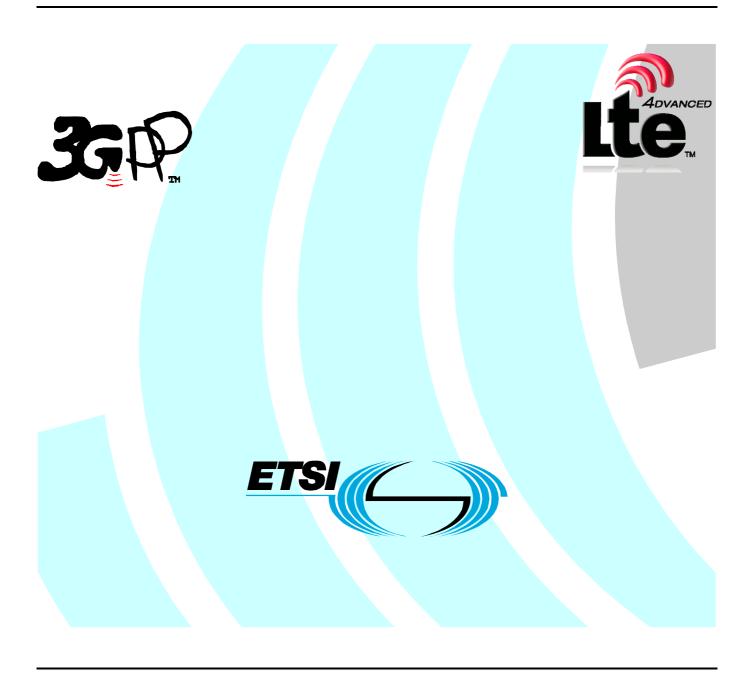# ETSI TR 122 987 V10.0.0 (2011-04)

Technical Report

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Foreword

This Technical Report (TR) has been produced by ETSI 3rd Generation Partnership Project (3GPP).

The present document may refer to technical specifications or reports using their 3GPP identities, UMTS identities or GSM identities. These should be interpreted as being references to the corresponding ETSI deliverables.

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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP) Secretariat on behalf of the 3GPP Technical Specification Groups (TSGs).

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The present document is based ISO/IEC Directives. Most clauses of the ISO/IEC document have been retained, while some clauses have been modified or deleted. Additional material has been inserted.

Items concerning word-processor specific layout and formatting matters when using the Microsoft Word for Windows$^{®}$ based skeleton documents and templates are shown with shaded background. Boiler plate text (i.e. text which shall be directly used in 3GPP specifications) is represented by *italic* characters.

1 Scope

This Technical Report aims to present use cases in telecommunication services that are developed by applying haptic technology. It also justifies accepting haptic technology in telecommunication services by investigating readiness for its use in the telecommunication system and the level of benefit for the user experience.

For such purpose this document investigates following questions:

- Provide the overview of current haptic technology which might be deployed in telecommunication

- Identify any adaption required for existing services enhanced by supporting the delivery of haptic sense

- Identify key aspects of new services built on capabilities provided by haptic technology

- Identify and specify general requirements for delivery of haptic sense in telecommunication networks

- Identify the scope and roles of 3GPP for mobile haptic services and consult with OMA to coordinate on the development of mobile haptic services

Note that this Technical Report considers all types of telecommunication networks within the scope of 3GPP, including mobile networks and IMS-based fixed networks, etc.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document.*

[1]   3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2]   3GPP TS 22.101: "Service Principles".

3 Definitions

For the purposes of the present document, the following terms and definitions apply.

Haptic (Haptic Sense): Haptic is a sense perceived by touching an object. It involves tactile senses, (from the Latin, *tangere*, to touch), which refers to the touching of surfaces, and kinaesthetic senses (from the Greek, *kinesis*, movement and aesthesis, perception), or the sensing of movement in the body.

Haptic Information: Haptic Information is signal that is delivered over telecommunication networks to generate Haptic Feedback in the UE. Haptic Information may contain sender and receiver addresses, data types, haptic feedback data, and others.

Haptic Feedback: Haptic Feedback is a haptic sense generated in the UE.

Haptic Service: A Haptic Service indicates any communication-related services that involve delivering haptic. The haptic can be initiated either by the network or the user.

Local Party (Sender): the local party is the entity that sends Haptic Information.

Remote Party (Receiver): the remote party is the entity to which Haptic Information is sent.

4 General description

4.1 Introduction

Telecommunication has evolved over time by expanding the variety of senses it can deliver. Originally supporting voice calls, the telecommunication system conveyed auditory sense stimulation. After SMS, and then MMS introduction, users were provided visual sense stimulation by conveying messages in a written and image/graphical form. Recent telecommunication systems have extended the visual stimulation by adding motion video capabilities. In spite of these service enhancements, telecommunication is yet to provide a full range of sensory expression and input, used in human face to face communication and activities.

One sense that has drawn attention rapidly is haptic. The word 'Haptic' originated from Greek *haptesthai*, which means "to touch." Haptic involves tactile senses, (from the Latin, *tangere*, to touch), which refers to the touching of surfaces, and kinaesthetic senses (from the Greek, *kinesis*, movement and aesthesis, perception), or the sensing of movement in the body.

Haptic has been one of major sources for human being to collect information in the external environment and has also been used in communication between people, such as expressing intimacy by touch. Recent development in haptic feedback devices made it possible to provide haptic feedback to users and has been applied in a wide range of fields. For example, game controllers such as joysticks and steering wheels are able to provide haptic feedback that simulates the tactile sense and/or kinaesthetic sense (i.e. force feedback) a player in the game might experience in the virtual environment.

Contrary to the examples above, in telecommunication systems, haptic has been neglected as the UEs are not ready for haptic services. Even though most mobile devices support vibration, it was not programmable, and thus its use is confined to playing silent ring tones. But recent devices are beginning to adopt a more advanced haptic feature that supports programmable vibrations varying in length, frequency and magnitude. Moreover, it is expected that in the near future mobile devices is expected to adopt various haptic feedback other than vibrotactile device enabling the delivery of temperature, texture or electronic stimulus more apparent. With the introduction of haptic enabled devices, it is now timely to evaluate the benefits of deploying haptic services in telecommunication networks, and evaluate the feasibility and efforts to implementing them.

4.2 Benefits

By supporting the delivery of haptic sense in telecommunication networks, network operators can provide a more enhanced way of communication in terms of information accessibility and receptiveness to subscribers.

From subscribers' point of view, haptic sense is an appropriate medium through which distinctive and intuitive messages can be conveyed. Alert messages in haptic sense can help reduce cognitive load and provide additional information compared to the messages transferred via sound. Also, it can also be used in distractive and loud environments. Moreover, when haptic sense combines with auditory or visual sense, the multimodal feedback is known to reinforce the receptiveness of messages. Such multimodal feedback can also help users with visual or hearing disabilities understand messages more clearly.

From network operators' viewpoint, the most obvious benefit is that it enables to provide new services built upon haptic sense, which has not been utilized in previous telecommunication services. Note that in addition to providing new services based solely on haptic sense, it is also possible to add haptic sense to existing supplementary services. For example, warning, alert or confirmation messages that have been delivered through audio channel can be delivered with a combination of sound and haptic sense. By introducing new services and/or extending existing services with haptic sense, operators can have additional source of revenue. In summary, the addition of haptic sense helps operators enrich existing services, as well as to develop new services.

4.3   Haptic technology

4.3.1   Overview

The prerequisite for providing mobile haptic service is that the UEs should be able to generate appropriate haptic sense based on the haptic information delivered through the network. To this end, three components should be prepared: 1) UEs that generate haptic senses, 2) haptic information format that both UEs and networks can understand, and 3) telecommunication networks that deliver haptic information for haptic senses.

4.3.2   User equipments

A number of UEs already support the generation of haptic feedback due to the rapid development of haptic components that are simple and small enough to be adopted in mobile devices. Until now the most of available haptic devices are those with high-fidelity vibration. Such devices usually include vibration actuators that provide high-fidelity vibration effects and a vibration player that controls the operation of the actuator. Moreover, given the trend of fast developing haptic feedback devices such as thermal display, electrostatic feedback device or tactile display, the number of UEs supporting haptic service and the variety of senses they support are likely to increase quickly.

4.3.3   Haptic information format

While more and more handsets supporting haptic senses are available, a standardized haptic information representation formats should be developed for haptic services. The absence of standardized haptic information representation formats has prevented possible applications from being developed in telecommunication networks. While there are some standardization activities outside 3GPP, efficient and clear representation for telecommunication services need to be defined. [1]

4.3.4   Telecommunication networks

Without the standardized haptic information format and the related protocols, telecommunication networks are not yet ready support haptic service. Therefore the haptic information representation formats and the protocols for their delivery through telecommunication networks should be the main focus of standardization.

4.4   Service Concept

Haptic service requires the delivery of haptic information from the sending party, either user or the network, to the receiving party(s). An application in the receiving party's UE converts haptic information to perceivable haptic feedback.

The kind of haptic sense is not limited, as long as the UE is able to generate the sense. Examples of haptic senses include, but are not limited to, vibrotactile sense, shear sense, thermal sense, and pneumatic sense.

As haptic can be combined with other senses or can even replace other senses that have been used in delivering messages, theoretically every service in telecommunication can incorporate haptic.

Below several categorizations of haptic services are introduced.

1. By the timing of haptic information delivery:

   - Asynchronous (alert message, SMS enriched with haptic information, …)

   - Synchronous (haptic information shared in real time during communication between two persons)

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[1]   For example, the International Organization for Standardization (ISO) Technical Committee on Ergonomics (TC159) has started to standardize haptic technology in Working Group 9 "Tactile and Haptic Interaction since 2005. A more detailed introduction can be found in this publication: http://www.springerlink.com/content/u25hw52p50488180/

2. By the entity that initiates the delivery of haptic information:

- Network-initiated services

- User-initiated services

3. By the stage of communication:

Table 1: Category of Haptic Service

Category	Description	Expected Needs	Examples
1. Idle Status	Status when a subscriber does not engage in any communication activity through telecommunication network	- Receive relevant, but not critical information, in not intrusive way	
2. Connecting Status	The status when a calling subscriber is establishing connection to a receiving subscriber,	- Express unique identity when calling or identify the caller without directly checking the screen or sound through speaker	- Customized alerting haptic service
3. Calling Status	The status when a subscriber is engaged in a communication activity through telecommunication network, such as voice call or SMS	- Express one's message and sentiment in a richer and more delicate way through haptic information - Receive important signals from the network during the call	- Haptic emoticon delivery service - Call waiting haptic service

5 Use Case

5.1 Haptic Emoticon Delivery Service

5.1.1 Description

The Haptic Emoticon Delivery Service is a service that delivers haptic information or 'haptic emoticon' during communication. According to the type of communication, the Haptic Emoticon Delivery Service can be divided into synchronous service and asynchronous service. An example of synchronous service is the Haptic Emoticon Delivery Service in a voice/video call, and that of asynchronous service is the Haptic Emoticon Delivery Service in messaging services, such as SMS, MMS, and IM service.

Firstly in a voice or video call, the Haptic Emoticon Delivery Service helps the sending party to express a certain feeling, emotion, or other information implicitly by the haptic feedback generated in the receiving party, while talking during the voice or video call. The example of such haptic feedback includes a heartbeat or laughter.

Secondly when a subscriber is communicating via SMS, MMS or IM service, the Haptic Emoticon Delivery Service allows the sending party to express a certain feeling, emotion, or other information implicitly by the haptic feedback generated in the receiving party when the receiving party checks the message. The example of such haptic feedback includes a heartbeat or laughter.

5.1.2 Procedure

For an illustrative purpose, suppose two subscribers, Joe and Sally, are engaged in a voice or video call.

- While talking, Joe wants to express his joy by generating haptic feedback that represents 'laughter' in Sally's UE.

- Joe initiates the intended Haptic Emoticon Delivery Service by shaking his UE vertically for example.

- An application in the Joe's UE recognizes the movement, and notifies the network that it should deliver haptic information that represents laughter to Sally's UE.

- The network delivers the haptic information to Sally's UE.

- When Sally's UE receives the incoming haptic information from the network, the application in the Sally's UE generates haptic feedback based on the haptic information.

- As a consequence, Sally receives the haptic feedback representing Joe's emotion while talking.

The service procedure in messaging is slightly different.

- While sending SMS or MMS or talking through the IM service, Joe wants to express his joy by generating haptic feedback that represents 'laughter' in Sally's UE when Sally checks the message.

- In order for the network to deliver to the Sally's UE the haptic information that represents 'laughter', Joe attaches the text string such as '/laughter/' within the message.

- The network delivers the haptic information to Sally's UE.

- When Sally checks the message, the application in the Sally's UE generates haptic feedback based on the incoming haptic information from the network.

- As a consequence, Sally receives the haptic feedback representing Joe's emotion while receiving SMS, MMS, or IM message.

5.1.3 Requirements

When the sending party attempts to send haptic information to the receiving party(s), for example by shaking the UE or mobile-initiated USSD operation, the network should support the delivery of the haptic information.

When the sending party wants the receiving party's UE to generate haptic feedback, the network should deliver the haptic information along with the original message.

5.1.4 Benefits

In a voice or video call, the Haptic Emoticon Delivery Service helps to express the sending party's feeling or emotion by the haptic feedback generated in the receiving party's UE. Such implicit way of expression supplements voice or visual call that they are engaged in, providing joyful experience while delivering the speaker's intention more effectively.

When sending a message, the Haptic Emoticon Delivery Service helps to express and deliver the sending party's feeling or emotion by the haptic feedback generated in the receiving party's UE. It supplements SMS, MMS, or IM message that the sending party is sending, by delivering the speaker's emotions more clearly.

5.2 Customized Alerting Haptic Service

5.2.1 Description

The Customized Alerting Haptic Service enables a subscriber to replace the default alerting ring back tone and customized alerting tone into customized alerting haptic feedback, a multimodal tone that combines haptic with sound, video and other senses altogether.

5.2.2 Procedure

The subscriber (either the called party or the calling party) subscribes and activates the Customized Alerting Haptic Service to change his or her active Customized Alerting Haptic feedback. Here it is assumed that the called party has a priority in playing Customized Alerting Haptic feedback, but it is the network operator's policy whether the called or the calling party has the priority.

When the calling party tries to establish a call channel to the called party, a Customized Alerting Haptic information is sent to the called party's UE, along with the notification about the incoming call.

The called party's UE receives the Customized Alerting Haptic information from the network and generates Customized Alerting Haptic feedback accordingly.

When the called party answers the call, the network stops sending Customized Alerting Haptic information and the conversation begins.

5.2.3 Requirements

The calling party's operator should be able to configure from which party the Customized Alerting Haptic should have the priority.

The Customized Alerting Haptic shall override the default set alerting tone towards the calling subscriber.

The operator should provide the Customized Alerting Haptic library in the home network to store subscriber's Customized Alerting Haptic information.

The Customized Alerting Haptic information that is sent to the calling party or the called party can be chosen from the Customized Alerting Haptic library according to the rules such as time, the identity and the location of each party.

The network should store the User Profile including UE capability. Based on the information, appropriate haptic information that the UE can interpret is sent.

The network should send Customized Alerting Haptic information to the called party's UE when the calling party tries to establish the call channel to the called party.

The service subscriber can activate and de-activate their Customized Alerting Haptic Service. For activation and de-activation, the service subscriber may employ USSD commands, SMS, IVR or other means.

5.2.4 Benefits

If the calling party has the priority, the benefit is as follows.

- While waiting for the called party to answer a call, the calling party can enjoy the Customized Alerting Haptic feedback that he/she chooses.

- The calling party can notice the exact moment when the call connection is made to the called party simply by holding the UE and perceiving that the haptic feedback stops generating. Such feature is useful for someone who is reluctant to put the UE into his/her ear closely because of the concern about the electronic wave, for example.

If the called party has the priority, the benefit is as follows.

- The called party can express their individual character by sending the haptic feedback to the calling party.

- The calling party can notice the exact moment when the call connection is made to the called party simply by holding the UE and perceiving that the haptic feedback stops generating. Such feature is useful for someone who is reluctant to put the UE into his/her ear closely because of the concern about the electronic wave, or because of the willingness to avoid annoying sound of ring back tone, for example.

5.3 Call Waiting Alerting Haptic Service

5.3.1 Description

The Call Waiting Alerting Haptic Service permits a subscriber to be notified of an incoming call by haptic feedback when the subscriber is engaged in an active or holding a call.

5.3.2 Procedure

For an illustrative purpose, let's suppose there are three subscribers: Joe, Sally and Tom.

- Joe is a subscriber who is provided by the network with the Call Waiting Alerting Haptic Service and who reacts to Call Waiting.

- Sally is a subscriber who originated a call to Joe which causes the Call Waiting Alerting Haptic Service to be initiated.

- Tom is a subscriber who is engaged in a call with Joe, either being the calling or the receiving party.

Joe is subscribed to the Call Waiting Alerting Haptic Service and his UE supports the play of haptic feedback

The normal flow for Call Waiting Alerting Haptic Service is as follows.

- Joe is engaged in a call with Tom.

- Sally calls Joe.

- Joe is notified by haptic feedback that someone has called him.

- If Joe responds to Sally's call, a new call between Joe and Sally is established.

5.3.3   Requirements

The network should store haptic information that can generate haptic feedback which notifies of an incoming call.

The network should store the User Profile including UE capability on whether the UE can interpret the appropriate haptic information or not.

The network should be able to send haptic information to the UE.

The network sends haptic information to the UE only if the UE can interpret the haptic information and generate haptic feedback accordingly.

The network should allow the subscribers to set different haptic information to each potential caller, so that the subscriber can identify the caller simply by holding the UE.

The service subscriber can activate and de-activate his Call Waiting Alerting Haptic Service. For activation and de-activation, the service subscriber may employ USSD commands, SMS, IVR or other means.

5.3.4   Benefits

  Joe can perceive the Call Waiting Haptic Feedback much easier compared to the current Call Waiting Service that relies on beeping, especially when Joe is located in a noisy environment. In addition, it will not interrupt the current conversation since the message does not include any sound. Therefore, the Call Waiting Haptic Feedback enables seamless communication during the call even when the network notifies that another call is waiting to answer.

Moreover, if it is supported that a subscriber can set a different form of haptic information to each potential caller, then the subscriber can identify the caller simply by holding the UE.

5.4   Accident or Health Crisis Haptic Service

5.4.1   Description

A UE may be dropped accidentally or the user may have a greater or lesser health crisis that results in the user falling. Acceleration profiles may be used to assess which of several possible scenarios have taken place and then initiate appropriate action to verify the situation and to bring help if needed.

5.4.2   Procedure

A user may elect to subscribe to a the "Accident or Health Crisis Haptic Service" in which case the user may choose to indicate in the subscription information on health conditions that may lead to a fall, and may also indicate who is to be called should a fall occur.

Independent of the above subscription, a UE may experience downward acceleration followed by sudden and possibly severe deceleration (the UE hits the floor) or lesser deceleration (the user falling cushions the UE from the more severe

impact of the UE hitting the floor directly.) To distinguish among possible alternative causes, the application in the UE assesses whether:

- the UE was dropped (there is an upward vertical acceleration soon afterwards (i.e., there is a "recovery" acceleration profile following the "dropped UE" acceleration profile); or

- the user had a lesser health crisis of some sort (the vertical deceleration was not as severe as in the "dropped" case and there is a "recovery" acceleration profile detected which may be delayed or slower or both compared to the "dropped UE" profile); or

- the user had a significant health crisis of some sort (possibly the vertical deceleration was not as severe as in the "dropped" case and there was no "recovery" acceleration detected.)

If the sequence of accelerations is clearly a "dropped UE" instance, do nothing. Alternatively, the UE may indicate to the user that it has detected a "dropped UE" instance and request verification that this is the case to avoid a "false positive" interpretation as a health crisis.

If the sequence of accelerations appears to be a lesser health crisis (a "recovery" is detected), alert the user with an appropriate indication and await a response. If there is no response, treat as a significant health crisis.

If the sequence of accelerations appears to be a significant health crisis (no "recovery" is detected), consult the subscriber's profile and connect the user to the appropriate response agency or authority indicating the reason for the call and providing geographic position information. Interaction between the user and the agency will determine whether help (e.g., an ambulance) is sent.

5.4.3   Requirements

The UE is fitted with accelerometers configured to detect sudden accelerations and an application that can assess the severity and direction as inputs to a decision process on the type of event that has occurred.[2] The application may be located in UE or the network. If in the network, appropriate data transfer to the network entity where the application resides would be required.

The network stores health crisis contact information for use when a health crisis event is detected. This information should be stored as part of or be associated with the user profile.

The subscriber should be able to cancel an instance of this haptic service based on a response to the UE indicating it has detected what may be an event that would cause it to alert appropriate assistance services.

5.4.4   Benefits

This service enables rapid response to a health crisis. It can initiate a response even if the user is incapacitated by the crisis. This is especially useful to individuals living alone as a health crisis might otherwise not be discovered for some time.

6   High level service requirements

6.1   General requirements

General requirements for haptic services are as follows:

- Either the user or the network may initiate haptic services.

- The network may store a set of haptic information, among which one will be chosen and delivered to the remote party.

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[2] This is envisaged as similar to the ability of modern laptop hard disk drives to detect whether they have been dropped and to park their heads to prevent damage before the device strikes the floor.

- The network should deliver such haptic information within existing communication services including both real time services (e.g. Multimedia Call/Conferences) and non real time services (e.g. SMS, MMS).

In addition, it shall be supported for subscribers to activate or deactivate the service.

- Both the local and the remote party shall be able to activate and deactivate the haptic service.

- When the local party deactivates haptic service, the network should not send haptic information.

- When the remote party deactivates haptic service, the haptic information should be ignored.

Finally, the haptic services shall not affect the service of other services.

- If the haptic information cannot be delivered to the remote party, or the haptic feedback cannot be generated in the remote party, the remaining services except haptic service shall be provided

- Even in case haptic service is unavailable for some reason (e.g. failure of delivery of the haptic information, wrong delivery of haptic information to the UE without haptic feedback capability, etc), the services other than haptic service shall be still provided.

6.2 Network requirements

This section describes the network requirements for haptic service. The scope of network includes both fixed and mobile networks.

- The network shall be able to send haptic information for haptic services.

- The network shall be able to decide the haptic service availability based on the UE capabilities of the remote party.

- The network shall deliver haptic information which the remote party supports.

- The network shall be able to generate haptic information based on a pre-defined set of haptic actions and user created haptic actions.

- The network shall not send haptic information if either the local party or the remote party deactivates the haptic service.

- The network shall generate and store data for charging. (e.g. CDR)

6.3 UE requirements

This section describes the UE requirements to provide haptic services.

- The UE shall be able to provide the network with its capability information such as what haptic sense it can send and receive.

- The UE shall be able to send haptic information via the network.

- The UE with haptic capability shall be able to generate haptic feedback according to haptic information.

- The UE may ignore the received haptic information when the haptic information is out of its capability.

6.4 Interworking requirements

In case haptic services are provided via interworking between different domains, (i.e. mobile networks, IMS mobile and fixed networks), the followings should be supported.

- UE capability should be exchanged between domains.

- Haptic information may be transcoded to be delivered between domains.

6.5   Data description requirements

The network and UE shall have a standardized way of data description for haptic information in common. This allows a standardized access and handling of the data. The specific representation of such data is out of the scope of 3GPP specifications. For illustration purpose, an example of the data description for haptic information is shown below.

   - Haptic Type (e.g. type of haptic sense such as vibration, thermal sense)

   - Haptic Feedback Data (parameters of haptic sense such as amplitude, length, cycles etc)

6.6   Charging requirements

Depending on the network operator's policy various charging models can be supported. Examples of charging models are presented in Table 2.

Table 2: Examples of charging models

Index	Charging models	Description
1	Flat rate	Fixed (for example monthly) sum is charged for the haptic service.The amount of usage may be limited by the quota.
2	Fee for purchasing predefined haptic information	A subscriber is charged by the system when he purchases a predefined set of haptic information.
3	Fee for sending haptic information	A subscriber is charged when he sends haptic information to the remote party.
4	Fee for changing service configuration	A subscriber may be charged when he changes or updates his setting.

The network should generate the charging-related data such invocation date and time, local and remote parties, haptic types, etc.

7   Relation to Open Mobile Allicance (OMA)

As mentioned above, a standardized representation of haptic information should be developed for haptic service. Even though a common platform for haptic services enables network operators and 3rd party service providers to deliver various haptic information, the absence of a standardized representation of haptic information   may prevent possible applications from being developed in telecommunication networks.

Therefore, 3GPP should work closely with OMA in order to define a standardized representation of haptic information. 3GPP should play a significant role in defining architecture, protocols, and other requirements from the viewpoint of network and service providers. But it should also work closely with OMA to define what data format works best for the representation of various types of input and outputs, and different UE capabilities.

8   Conclusion

This Technical Report aims to evaluate the benefits and the technical feasibility of haptic services in telecommunication networks. Broadening the type of human senses that telecommunications may bring in to play, haptic services have the potential to enrich user experience as identified in the use cases such as Haptic Emoticon Delivery Service and Haptic Customized Alerting Tone Service.

This Technical Report identifies the potential requirements to implement haptic services over telecommunication networks regarding network, UE, inter-working, data description, and charging perspectives. This Technical Report also

recommends the collaboration with other standardization bodies such as OMA or ISO TC 159, etc   in defining application level haptic information. To conclude, this study has identified potential requirements for haptic services and their implementation that may lead to other TS or CRs.

Annex A:
Change history

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History

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