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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Infrastructure of audiovisual services – Quality of service architecture for audiovisual and multimedia services

A framework for adaptive end-to-end QoS control based on variable bit-rate codecs in wireless networks

Recommendation ITU-T H.362

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Recommendation ITU-T H.362

A framework for adaptive end-to-end QoS control based on variable bit-rate codecs in wireless networks

Summary

Recommendation ITU-T H.362 describes a framework for adaptive end-to-end quality of service (QoS) control using variable bit-rate codecs in wireless networks. Specifically, this Recommendation describes a reference network architecture, functional entities, references points, a terminal architecture, and signalling flows between functional entities. The framework in this Recommendation can be used for application level QoS support to control the multimedia service quality adaptively in wireless networks where the network status may change over time.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T H.362	2010-09-13	16

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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A framework for adaptive end-to-end QoS control based on variable bit-rate codecs in wireless networks

1 Scope

There are various wireless networks including 2G/3G/4G mobile networks, wireless LANs, and mobile WiMAX networks. On the other hand, there are various multi-rate codecs including ITU-T G.729.1, ITU-T G.722.2, and ITU-T H.264, which can provide variable bit rates and adaptability in the dynamic environment where the network status may change over time.

Networks are being evolved toward the converged network where heterogeneous wired/wireless access networks are converged using the IP-based core network. Fixed mobile convergence (FMC) and fixed mobile substitution (FMS) are some examples. In such an environment, many of the QoS control mechanisms are employed in the core/access networks to manage QoS resources efficiently. However, this type of QoS control may not be sufficient to meet the end users' expectation from the end-to-end QoS perspective because QoS control at the application level is not involved. To provide more complete end-to-end QoS, the application level QoS support can be useful. This is particularly important when the network is not able to support QoS. One of the possible application level QoS mechanisms is codec-based QoS control which adjusts encoding parameters such as codec bit rate or codec mode according to the network status, e.g., wireless channel status.

Various codec-based QoS mechanisms were proposed to control the codec bit rate and call capacity using the wireless channel information in diverse wireless networks. However, in the heterogeneous network environment, it is difficult to control QoS in a unified way and to achieve the desirable service quality. Therefore, it is useful to design a common framework to control the codec mode adaptively, according to the channel status in wireless networks and reflect the users' perceived quality. For achieving the objective, this Recommendation describes a framework for adaptive end-to-end QoS control using variable bit-rate codecs in wireless networks. Specifically, this Recommendation describes a reference network architecture, functional entities, references points, a terminal architecture, and signalling flows between functional entities. The stability of control loop and delayed feedback in the control path which may affect the service quality is important in such an adaptive QoS control; however, it is out of scope of this Recommendation.

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 G.711.1] Recommendation ITU-T G.711.1 (2008), *Wideband embedded extension for G.711 pulse code modulation*.

[ITU-T G.722.2] Recommendation ITU-T G.722.2 (2003), *Wideband coding of speech at around 16 kbit/s using Adaptive Multi-Rate Wideband (AMR-WB)*.

[ITU-T G.729.1] Recommendation ITU-T G.729.1 (2006), *G.729-based embedded variable bit-rate coder: An 8-32 kbit/s scalable wideband coder bitstream interoperable with G.729*.

[ITU-T H.245] Recommendation ITU-T H.245 (2008), *Control protocol for multimedia communication*.

[ITU-T H.264] Recommendation ITU-T H.264 (2009), *Advanced video coding for generic audiovisual services*.

[ITU-T H.323 v7] Recommendation ITU-T H.323 (2009), *Packet-based multimedia communications systems*.

[ITU-T M.2301] Recommendation ITU-T M.2301 (2002), *Performance objectives and procedures for provisioning and maintenance of IP-based networks.*

[ITU-T Y.1541] Recommendation ITU-T Y.1541 (2006), *Network performance objectives for IP-based services.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation does not use any particular terms defined elsewhere.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 base station (BS): A radio receiver/transmitter that serves as the hub of the wireless access network and connects the wireless stations (WSTAs) to the IP-based network.

3.2.2 codec mode (CM): A specific bit-rate of a variable bit-rate codec.

3.2.3 quality-of-service control function (QCF): A service quality control function capable of managing the codec mode to control the amount of traffic from/to WSTAs or packet transfer characteristics such as delay, loss, and jitter.

3.2.4 variable bit-rate codec (VBRC): A multi-mode codec which can support a set of variable bit rates, e.g., ITU-T G.711.1, ITU-T G.722.2, ITU-T G.729.1, and ITU-T H.264.

3.2.5 wireless station (WSTA): A terminal which provides wireless access to the end user and is equipped with one or more variable bit-rate codec(s).

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BS Base Station

CI Codec Information

CMC Channel Measurement Command

CMC_REQ Codec Mode Change Request

CMC_RESP Codec Mode Change Response

CMCM Codec Mode Control Module

COCM Codec Operation Control Module

CQ Channel Quality

CSMMF Channel Status Measurement and Management Function

MDP Multimedia Decoding Parameters

MEP Multimedia Encoding Parameters

OSS	Operations Support System
PCF	Policy Control Function
PEM	Packet Evaluation Module
PMC	Packet Measurement Command
PMP	Packet Measurement Parameters
QCF	QoS Control Function
QoS	Quality of Service
QSF	QoS Signalling Function
RSSI	Received Signal Strength Indicator
RTP	Real-time Transport Protocol
RTSP	Real-time Streaming Protocol
RxCMCR	Received Codec Mode Change Request
SIP	Session Initiation Protocol
SIR	Signal-to-Interference Ratio
SQ	Service Quality
SQCF	Service Quality Control Function
SQMM	Service Quality Measurement Module
TxCMCR	Transmitting Codec Mode Change Request
VBRC	Variable Bit-Rate Codec
WAI	Wireless Access Interface
WCMM	Wireless Channel Measurement Module
WSTA	Wireless Station

5 Adaptive QoS control framework for wireless networks

5.1 Reference network architecture

Figure 1 shows a reference network architecture for adaptive QoS control using variable bit-rate codecs, which consists of wireless stations (WSTAs), base stations (BSs), QoS control functions (QCFs), wireless access networks, and an IP-based core network.

Variable bit-rate codecs, such as ITU-T G.711.1, ITU-T G.722.2, ITU-T G.729.1, and ITU-T H.264, can be employed at each WSTA for multimedia services and used for adaptive QoS control when the network experiences QoS degradation due to poor wireless channel quality or packet transfer performance, e.g., high packet loss, delay, and jitter. When a WSTA detects the quality of the wireless channel, it can communicate with a QCF in the local site where the WSTA is located and its counterpart WSTA in the remote site to control the codec mode. QCFs in the local and remote sites can communicate with each other to exchange the codec mode information of the WSTAs.

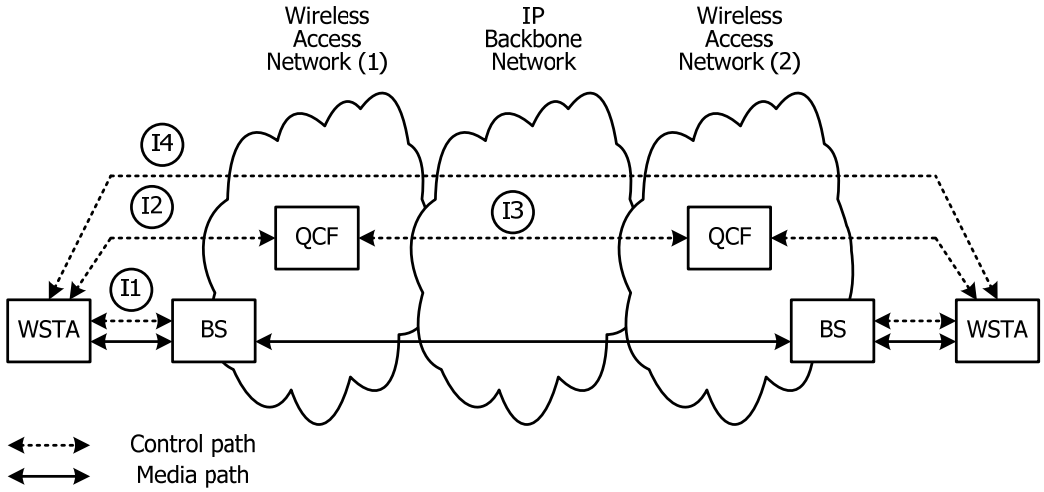


Figure 1 – Conceptual reference network architecture for adaptive QoS control using variable bit-rate codecs

5.2 Functional entities

5.2.1 Wireless station

A wireless station (WSTA) is a terminal which provides wireless access to the end user and is equipped with one or more variable bit-rate codecs. The WSTA monitors the signal strength of the downlink channel and measures key performance parameters such as signal-to-interference ratio (SIR). The WSTA also measures perceived service quality by examining received packets and utilizing an objective quality measurement method. Based on the measurement result, the WSTA determines if the codec mode needs to be changed. If it is necessary to change the codec mode for QoS control, the WSTA sends a codec mode change request to the QCF in the local site where the WSTA is associated. It is also possible for the WSTA to have a service quality control function (SQCF) that can control the codec mode, according to the measured wireless channel quality and packet transfer performance and to communicate with the SQCF in the remote WSTA.

5.2.2 Base station

A base station (BS) is a radio receiver/transmitter that serves as the hub of the wireless access network, which communicates with the WSTA. The BS monitors the signal strength of the uplink channel and measures key performance parameters such as SIR. After measuring the uplink channel quality, the BS calculates the adequate signal power for uplink transmission and commands the WSTA to control the uplink signal power, if necessary. If there is any request from the WSTA to change the downlink signal power, the BS adjusts the downlink signal power for packet transmission.

5.2.3 QoS control function

A QoS control function (QCF) is a service quality control function which manages the codec mode to control the amount of traffic from/to the WSTA or packet transfer performance such as delay, loss, and jitter, etc. If there is a codec mode change request in the direction of downlink, the QCF communicates with the remote QCF that is located near the remote WSTA to check whether the codec mode change is possible. If it is possible, the remote QCF instructs the remote WSTA to change the codec mode. A SQCF has a similar function to the QCF but it exists in the WSTA. The SQCF can communicate with the QCF in the network or with the SQCF in the remote WSTA to directly control the codec mode.

5.2.4 Variable bit-rate codec (VBRC)

A variable bit-rate codec (VBRC) provides variable bit-rates to support multimedia services in the network where the available amount of network resources may vary. Examples include ITU-T G.711.1, ITU-T G.722.2, ITU-T G.729.1, and ITU-T H.264.

5.3 Interfaces between functional entities

5.3.1 I1

I1 is the reference point between a WSTA and a BS. Using the I1, the WSTA and the BS measure the quality of the wireless channel and examine received packets to see if there is any need to change the codec mode.

5.3.2 I2

I2 is the reference point between a WSTA and a QCF. The WSTA exchanges the codec mode control messages with the QCF for QoS control through the I2.

5.3.3 I3

I3 is the reference point between QCFs which are located in the different wireless access networks. QCFs negotiate the codec mode for packet transmission between WSTAs through the I3.

5.3.4 I4

I4 is the reference point between WSTAs which are located in the different wireless access networks. The SQCF of the WSTA is used to negotiate the codec mode with the SQCF of the remote WSTA through the I4.

5.4 Terminal architecture for codec mode control

5.4.1 Terminal architecture and components

As depicted in Figure 2, a WSTA is comprised of wireless access interfaces, codec mode control functions for controlling multimedia service quality, and multimedia terminal components for processing multimedia data. A call server may contain a call processing unit and a policy control function.

The codec mode control functions in the WSTA include the channel status measurement and management function (CSMMF), the service quality control function (SQCF), and the QoS signalling function (QSF). The policy control function (PCF) in the call server can also be used for codec mode control according to the policy.

The CSMMF is subdivided into the wireless channel measurement module (WCMM) and the packet evaluation module (PEM). The SQCF is subdivided into the service quality measurement module (SQMM), the codec mode control module (CMCM), and the codec operation control module (COCM).

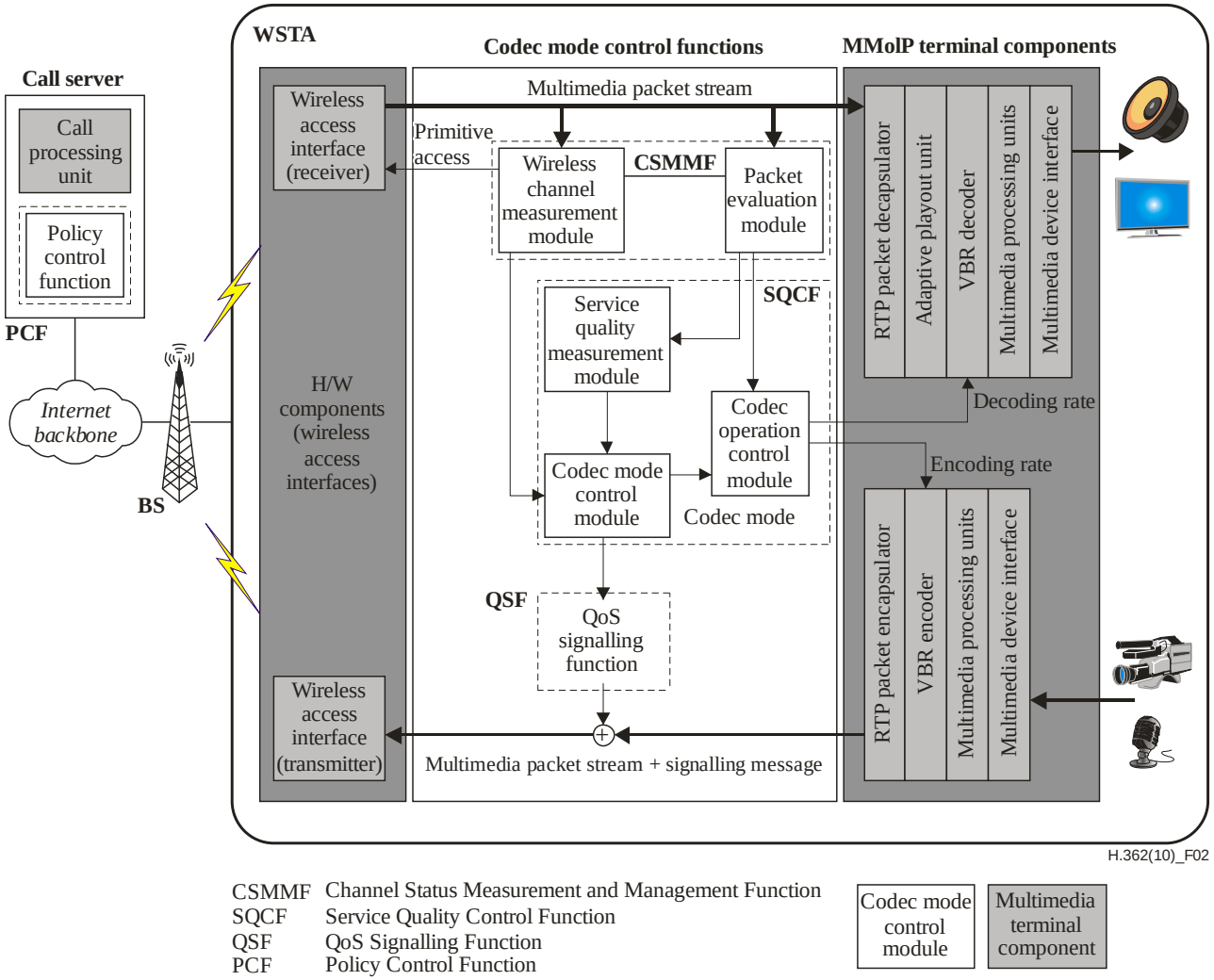


Figure 2 – Terminal architecture for codec mode control

5.4.2 Functional procedure for codec mode control

When a call or session set-up is requested by a WSTA, the call server decides admission of the call based on the resource availability and/or the admission policy. After the call is accepted, the WCMM of the WSTA measures the wireless channel quality through the physical interface within the WSTA, and delivers the measurement results to the CMCM.

The PEM assesses the transfer performance of the received multimedia packets and control packets sent by the remote WSTA, and it delivers the assessment results to the SQMM. Then the SQMM evaluates the quality of the received packets during the call or session, using an objective quality measurement method.

After receiving the quality assessment results, the CMCM determines the appropriate codec mode of the VBRC using the information on the wireless channel quality received from the WCMM and the service quality assessed by the SQMM. When it is necessary to change the codec mode, the CMCM instructs the QSF to change the codec mode of the remote WSTA. Then, the QSF generates a signalling message which carries the codec mode information.

When the signalling message is transferred through the configured networks and arrived at the remote WSTA, the PEM of the WSTA delivers the newly received codec mode to the COCM. The COCM finally changes the codec mode of the VBR codec for the multimedia content source.

5.5 Functional descriptions

5.5.1 Channel status measurement and management function (CSMMF)

The CSMMF measures the wireless channel quality through a wireless interface (PHY/MAC) within a WSTA. It also evaluates the packet transfer performance including delay, jitter, and loss by examining the multimedia packets transmitted by a remote WSTA. The information on the wireless channel quality and the packet transfer performance is delivered to the SQCF to control the codec mode of the remote WSTA during a call or session.

The CSMMF consists of WCMM and PEM, as shown in Figure 3.

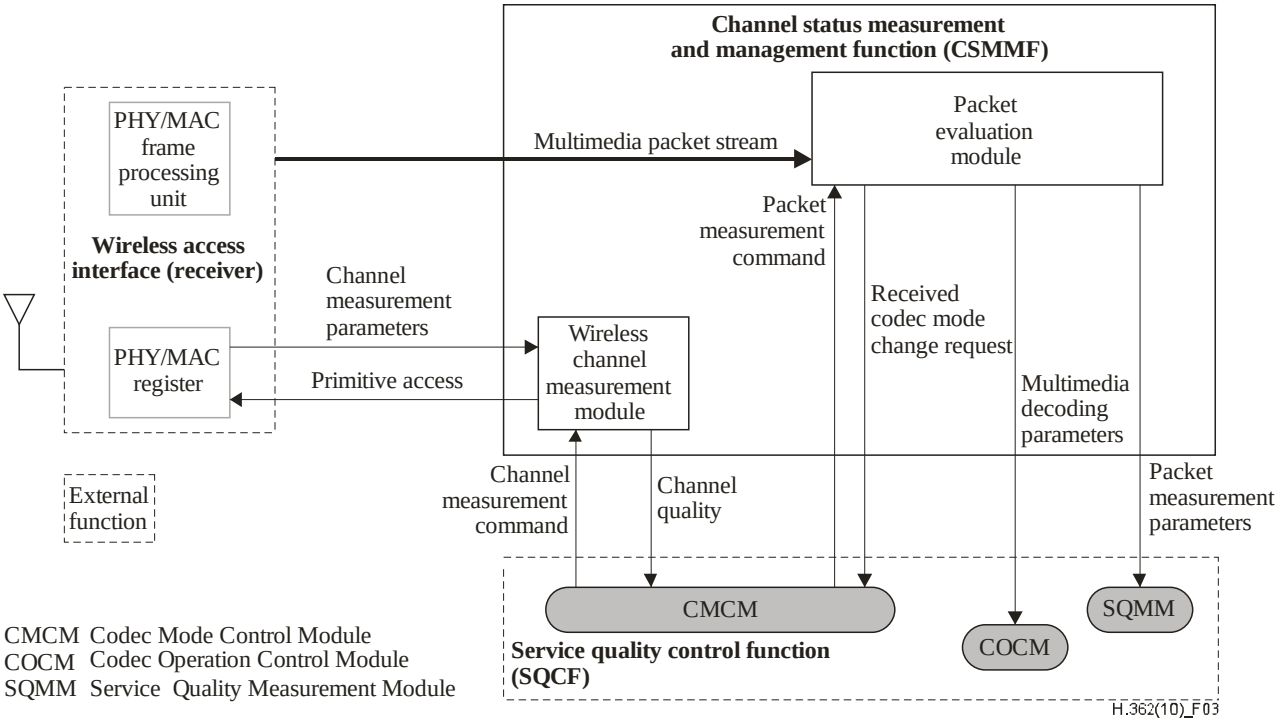


Figure 3 – Channel status measurement and management function (CSMMF)

5.5.1.1 Wireless channel measurement module (WCMM)

The WCMM evaluates the wireless channel quality by examining packets which are received via the air interface and contain the information on various characteristics, including signal strength and transmission rates. The WCMM delivers the quality evaluation results obtained during a communication session to the SQCF to control the codec mode.

When a WSTA completes a call set-up procedure and before transmitting the media packets to its remote WSTA, the SQCF of the WSTA instructs the WCMM to collect the wireless channel information with a channel measurement command (CMC). If the WCMM receives the CMC from the CMCM of the SQCF, the WCMM instructs the wireless access interface (WAI) to measure the wireless channel status using a primitive access command. After receiving the primitive access command, the WAI measures the wireless channel quality and reports the measured channel measurement parameters (CMPs) to the WCMM. The WCMM gathers the wireless CMPs such as the SIR of the received frame, frame transmission rate and frame loss ratio through the wireless interface within the WSTA. The WCMM evaluates the channel quality (CQ) using the CMPs and delivers the CQ to the CMCM in the SQCF.

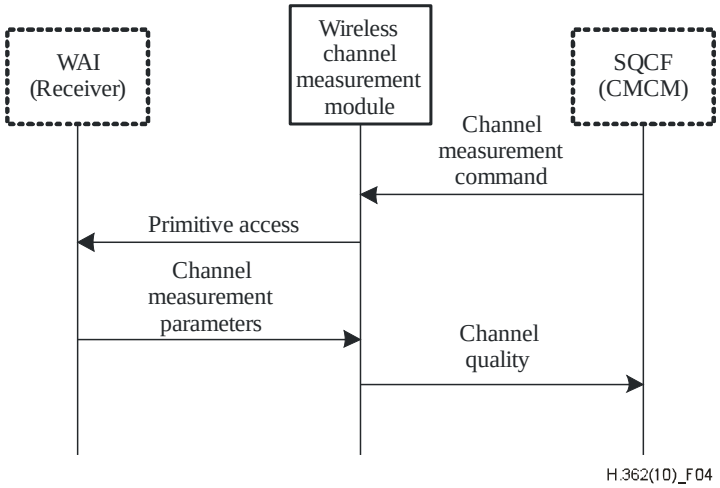


Figure 4 – Signalling flow for the wireless channel measurement module (WCMM)

5.5.1.2 Packet evaluation module (PEM)

The PEM assesses the packet transfer performance such as delay, jitter, and loss by examining multimedia packets and control packets sent by a remote WSTA. Additionally, the PEM extracts parameters for variable bit-rate codec operation from the received packets to utilize them for service quality control.

After starting a media session with a remote WSTA, the CMCM of the SQCF in the current WSTA sends the packet measurement command (PMC) to the PEM. When the PEM receives the PMC, the PEM evaluates the packet transfer performance by examining the received multimedia packets through the WAI. As a result, packet measurement parameters (PMPs) such as delay, jitter, and loss are assessed. Then the measured PMPs are delivered to the SQMM of the SQCF and used to measure the multimedia service quality.

The PEM also extracts the multimedia decoding parameters (MDPs) from the received multimedia packets and delivers them to the COCM of the SQCF. The COCM uses the MDPs to select a sampling rate of the multimedia decoder, a type of media (e.g., mono/stereo), a decoding rate, a compatible mode, and other parameters.

Another function of the PEM is to capture a codec mode change request (CMC_REQ) message transmitted from the remote WSTA. When the PEM receives the CMC_REQ message, it extracts the codec mode control parameters such as a sampling rate, a type of media (e.g., mono/stereo), a coding rate, a compatibility mode, from the CMC_REQ message, indicates the reception of the CMC_REQ to the CMCM of the SQCF with the received codec mode change request (RxCMCR) command and delivers the parameters to the CMCM which will decide a proper codec mode for the WSTA.

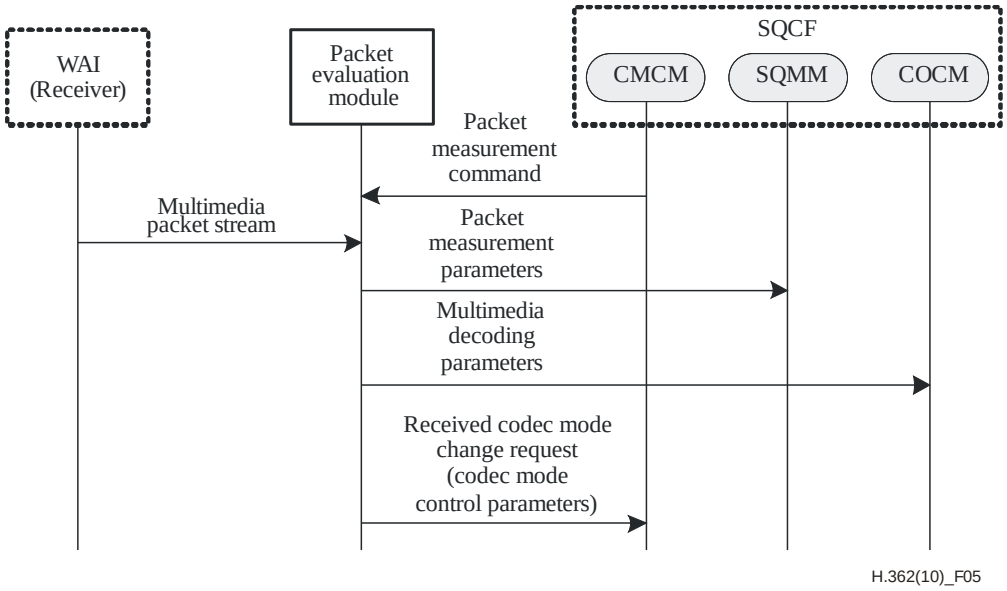


Figure 5 – Signalling flow for the packet evaluation module (PEM)

5.5.2 Service quality control function (SQCF)

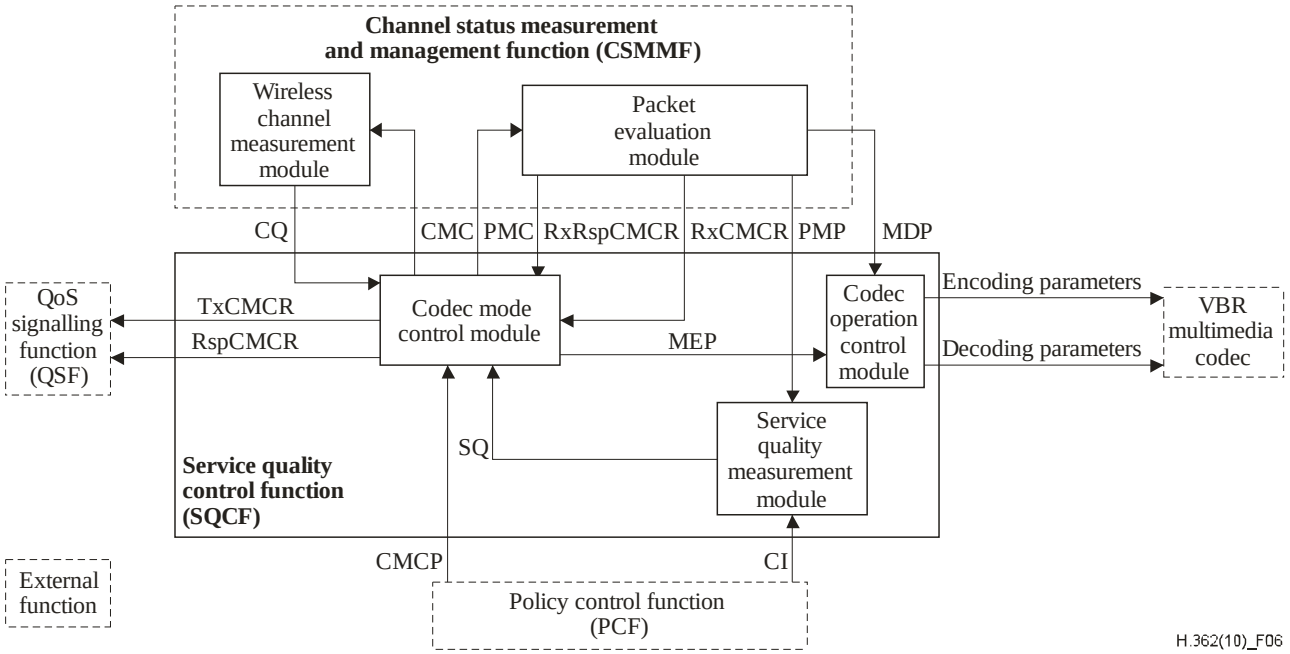
The SQCF receives the wireless channel quality information, the packet transfer performance, and the codec-related information from the CSMMF, and then it measures the service quality based on the received quality information and controls the codec mode of the remote WSTA according to the measured service quality.

When the WSTA determines that it is necessary to change the codec mode of the remote WSTA, the SQCF in the WSTA requests the QSF to transmit a CMC_REQ message with the transmitting codec mode change request (TxCMCR) command to the remote WSTA in order to change the codec mode of the remote WSTA. When the WSTA receives a CMC_REQ message, the SQCF instructs the QSF to respond to the remote WSTA with the Response-to-the-CMC_REQ (RspCMCR) command.

The SQCF calculates the service quality (SQ) based on the PMPs and CI and reports the quality to the CMCM. The CMCM controls the codec mode of the remote WSTA based on the SQ and the received codec mode control parameters (CMCPs) from the PCF.

In addition, the SQCF controls the VBR decoder with the MDPs extracted from the received packets during a call or session. The SQCF also applies the codec mode control parameters in the RxCMCR command from the remote WSTA to the VBR encoder.

The SQCF consists of SQMM, COCM and CMCM, as shown in Figure 6.



CI	Codec Information
CMC	Channel Measurement Command
CMCP	Codec Mode Control Parameters
CQ	Channel Quality
PMC	Packet Measurement Command
PMP	Packet Measurement Parameters
MDP	Multimedia Decoding Parameters
MEP	Multimedia Encoding Parameters
SQ	Service Quality
RxCMCR	Received Codec Mode Change Request
TxCMCR	Transmitting Codec Mode Change Request
RspCMCR	Response to the Codec Mode Change Request
RxRspCMCR	Received RspCMCR

Figure 6 – Service quality control function (SQCF)

5.5.2.1 Service quality measurement module (SQMM)

During a call or session, the SQMM evaluates the service quality using the information on the packet transfer performance and codec information (CI) delivered from the PCF. The quality evaluation occurs in the WSTA using an objective quality measurement method. The assessed service quality information is delivered to the CMCM for the codec mode control, see Figure 7.

Before measuring the multimedia service quality, the CMCM instructs the PEM of the CSMMF to measure the packet transfer performance with the PMC. When the PEM receives the PMC, it measures the packet transfer performance and reports the PMPs to the SQMM. The SQMM evaluates the service quality by using the PMPs such as delay, jitter, and loss received from the PEM and the CI of the remote WSTA received from the PCF. Then the SQMM delivers the evaluated SQ to the CMCM, and the CMCM utilizes the evaluated quality to control the codec mode of the remote WSTA.

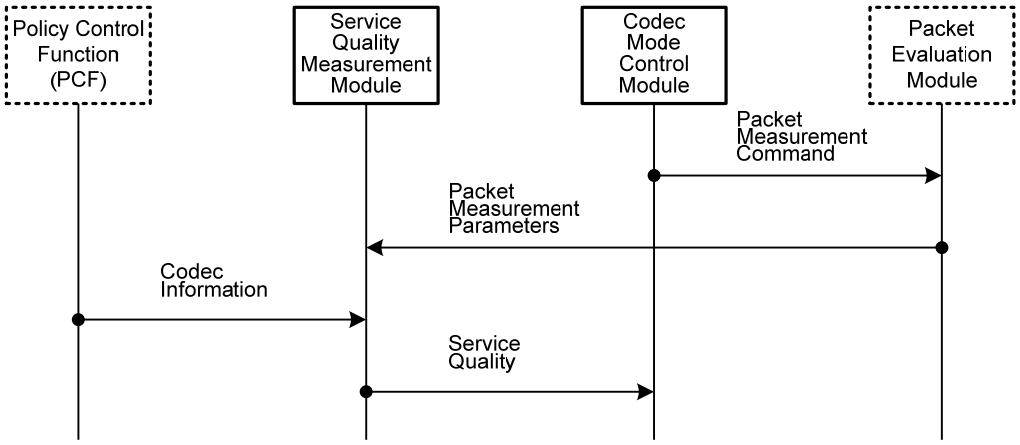


Figure 7 – Signalling flow to measure the service quality

5.5.2.2 Codec mode control module (CMCM)

The CMCM determines the codec mode of the VBRC of the remote WSTA based on the information on the wireless channel quality received from the CSMMF and the service quality assessed by the SQMM.

Case I: Changing the codec mode of the remote WSTA

The CMCM sends the CMC to the WCMM in order to measure the wireless channel quality, and dispatches the PMC to the PEM in order to evaluate the packet transfer performance. The CMC and PMC have information on a predetermined interval for which the WCMM and PEM measure the wireless channel quality and packet transfer performance periodically. Upon receiving the CMC, the WCMM extracts information on the measurement interval, and it measures the wireless channel quality during the interval. After finishing the measurement during the interval, the WCMM reports the CQ, which is the result of channel measurement, to the CMCM. This is illustrated in Figure 8.

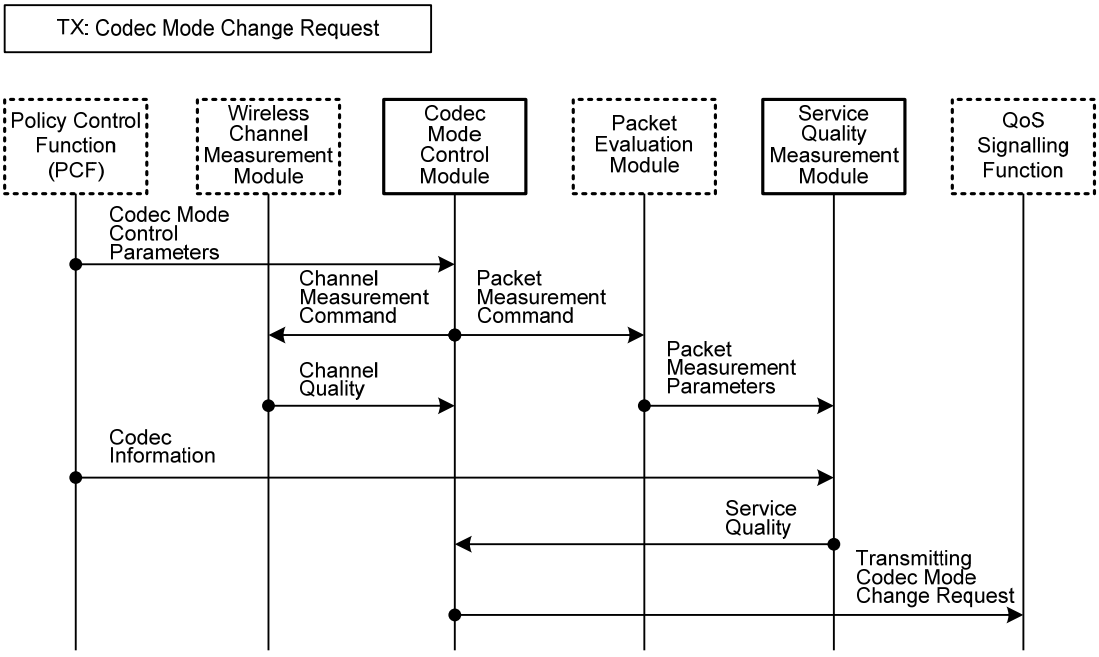


Figure 8 – Signalling flow to change the codec mode of the remote WSTA

The PEM assesses the packet transfer performance from the received media packets after receiving the PMC, and conveys the performance evaluation result using the PMPs to the SQMM. The SQMM calculates the SQ based on the PMPs and CI, and reports the SQ to the CMCM. The CMCM controls the codec mode of the remote WSTA based on the CQ from the WCMM, the SQ from the SQMM and the received CMCPs from the PCF. The CMCPs may include a service level and supported codec modes that are available for the remote WSTA. If there is a need to change the codec mode of the remote WSTA, the CMCM requests the QSF to transmit a CMC_REQ message with the TxCMCR command to a remote WSTA to change the codec mode of the remote WSTA.

Case II: Applying the codec mode change request from the remote WSTA

When the PEM receives the CMC_REQ message from the remote WSTA, the PEM extracts the codec mode control parameters from the CMC_REQ. Then the PEM delivers the RxCMCR command including the codec mode control parameters to the CMCM of the SQCF. Upon receiving the codec mode control parameters, the CMCM conveys the multimedia encoding parameters (MEPs) extracted from the codec mode control parameters to the COCM. The COCM applies the MEPs to the multimedia encoder. See Figure 9.

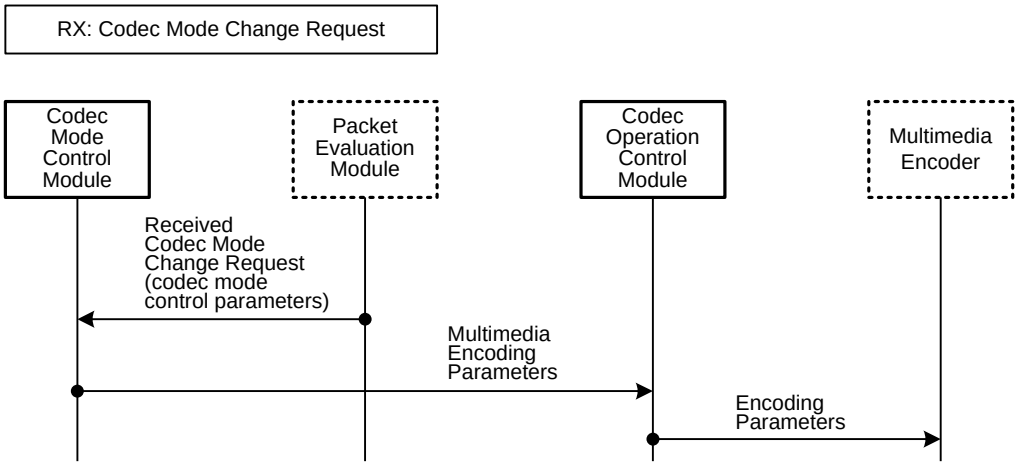


Figure 9 – Signalling flow to apply the received codec mode change request

5.5.2.3 Codec operation control module (COCM)

The COCM applies the parameters such as sampling rates, types of media (e.g., mono/stereo), coding rates, and compatibility modes delivered from the PEM and CMCM to the VBRC for encoding and decoding the multimedia content source.

Case I: Media decoding

Upon receiving a multimedia packet such as an RTP packet from a remote WSTA, the PEM extracts information for media decoding such as a sampling rate, a type of media (e.g., mono/stereo), a decoding rate, a compatibility mode, etc. This decoding information is encapsulated in the MDPs and delivered to the COCM. The COCM which receives the MDPs applies the decoding parameters to the media decoder. This is illustrated in Figure 10.

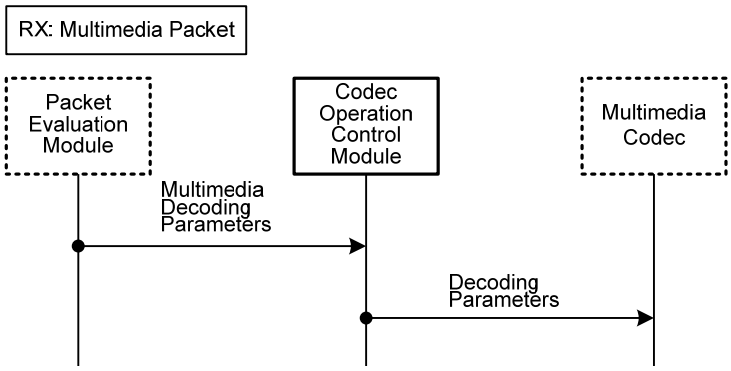


Figure 10 – Signalling flow to apply the multimedia decoding parameters

Case II: Media encoding (at the call set-up stage)

When a call is set up, the COCM instructs the encoder to operate with the MEPs that include a sampling rate, a type of media (e.g., mono/stereo), an encoding rate, and a compatibility mode, which are decided at the call set-up stage.

Case III: Media encoding (when receiving the codec mode change request message)

When the PEM receives the CMC_REQ message from the remote WSTA, it extracts the codec mode control parameters from the CMC_REQ, indicates the reception of the CMC_REQ with the RxCMCR command, and delivers the parameters to the CMCM. Upon receiving the RxCMCR command including the codec mode control parameters, the CMCM determines whether it should apply the received codec mode. If the CMCM decides to change the codec mode, the MEPs are delivered to the COCM to change the codec mode of the involved WSTA. The COCM which receives the MEPs applies the encoding parameters based on the received codec mode to the media encoder. This is illustrated in Figure 11.

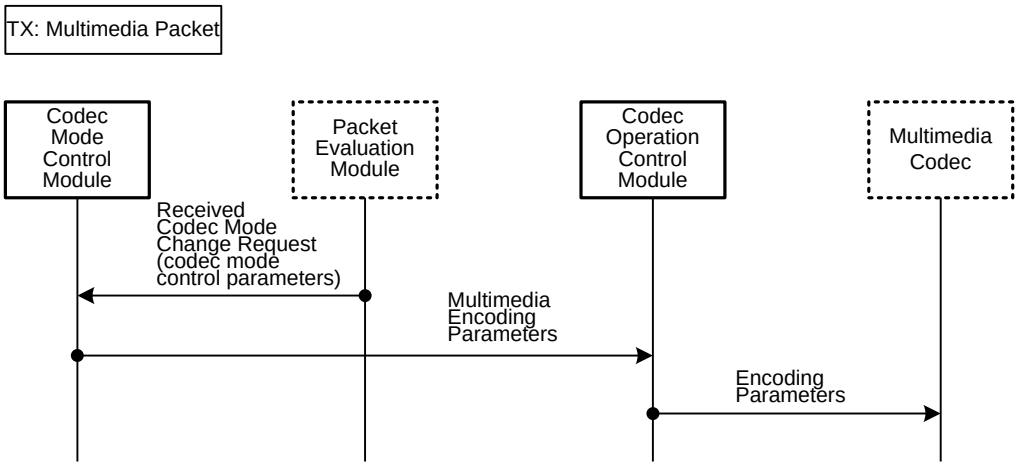
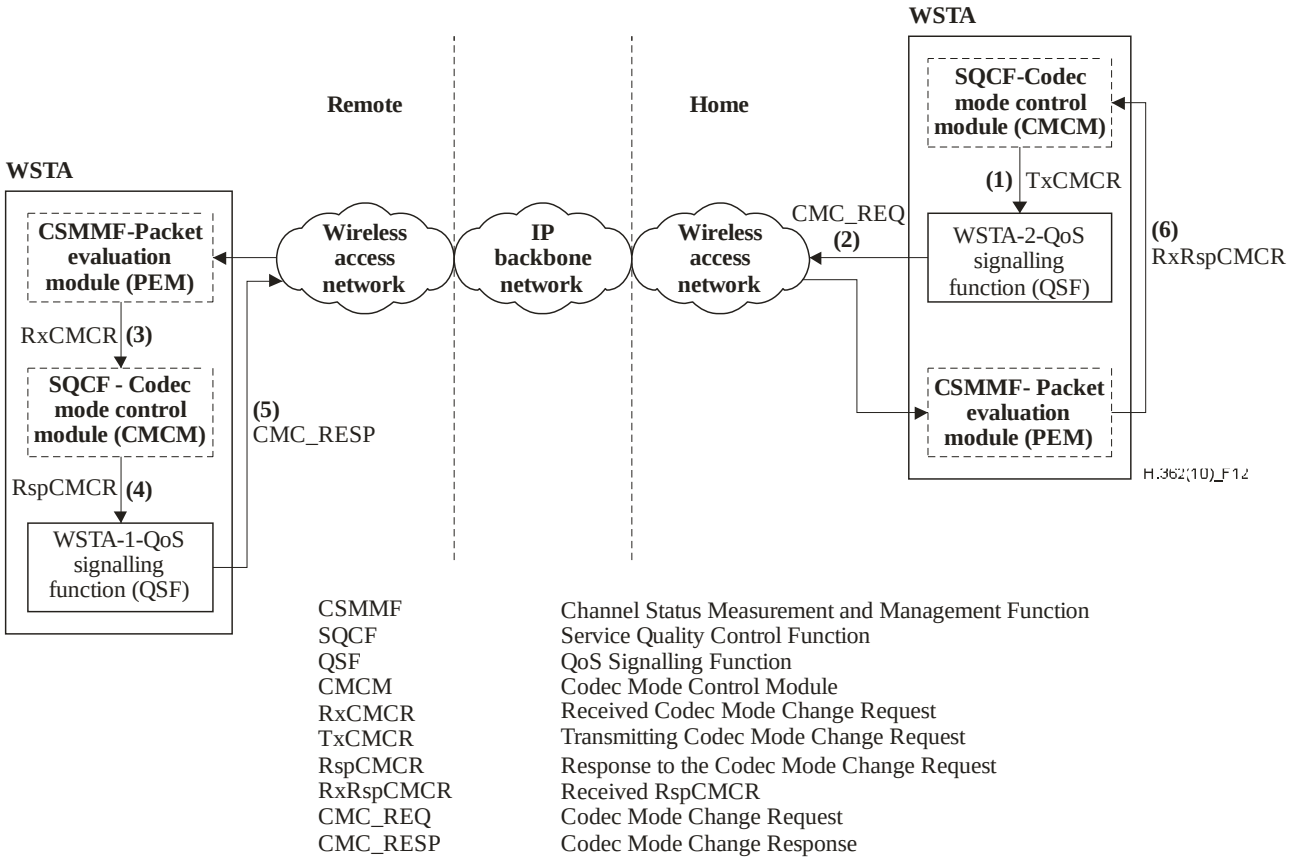


Figure 11 – Signalling flow to apply the multimedia encoding parameters

5.5.3 QoS signalling function (QSF)

As illustrated in Figure 12, after the QSF of a WSTA receives the codec mode change request command, TxCMCR, from the SQCF, the QSF generates a signalling message, CMC_REQ, which includes the codec mode control parameters to change the codec mode of a remote WSTA. The CMC_REQ message is transferred to the remote WSTA through the configured networks. At the remote site, the PEM of the remote WSTA receiving the CMC_REQ message, which is equally considered as the RxCMCR in the receiver, extracts the codec mode control parameters from the RxCMCR and delivers the extracted parameters to the CMCM.

When the CMCM of the WSTA in the remote site receives the CMC_REQ message, the CMCM requests the QSF of the WSTA with the RspCMCR command to respond to the CMC_REQ message. As a result, the QSF of the WSTA transfers a response message, CMC_RESP, including the current codec mode to the CMC_REQ message to the WSTA in the local site. Upon receiving the CMC_RESP message, the WSTA checks the Received-RspCMCR (RxRspCMCR) and whether the codec mode contained in the CMC_REQ has been adjusted appropriately at the remote WSTA or not.



CSMMF	Channel Status Measurement and Management Function
SQCF	Service Quality Control Function
QSF	QoS Signalling Function
CMCM	Codec Mode Control Module
RxCMCR	Received Codec Mode Change Request
TxCMCR	Transmitting Codec Mode Change Request
RspCMCR	Response to the Codec Mode Change Request
RxRspCMCR	Received RspCMCR
CMC_REQ	Codec Mode Change Request
CMC_RESP	Codec Mode Change Response

Figure 12 – QoS signalling function (QSF)

The procedure for QoS signalling message exchange is as follows and is illustrated in Figure 13. It is assumed that WSTA-1 and WSTA-2 are associated with AP-1 and AP-2, respectively, and connected to the IP backbone network through the wireless access network.

(1) If the WSTA-1 is ready to communicate with the WSTA-2, the WSTA-1 asks a call server to connect itself to the WSTA-2 that is located in the remote site by using a call signalling protocol such as ITU-T H.323, session initiation protocol (SIP).

(2) If the call server allows the requested call connection, multimedia packets will be transferred using real-time transport protocol (RTP) or real-time streaming protocol (RTSP) between the WSTA-1 and the WSTA-2.

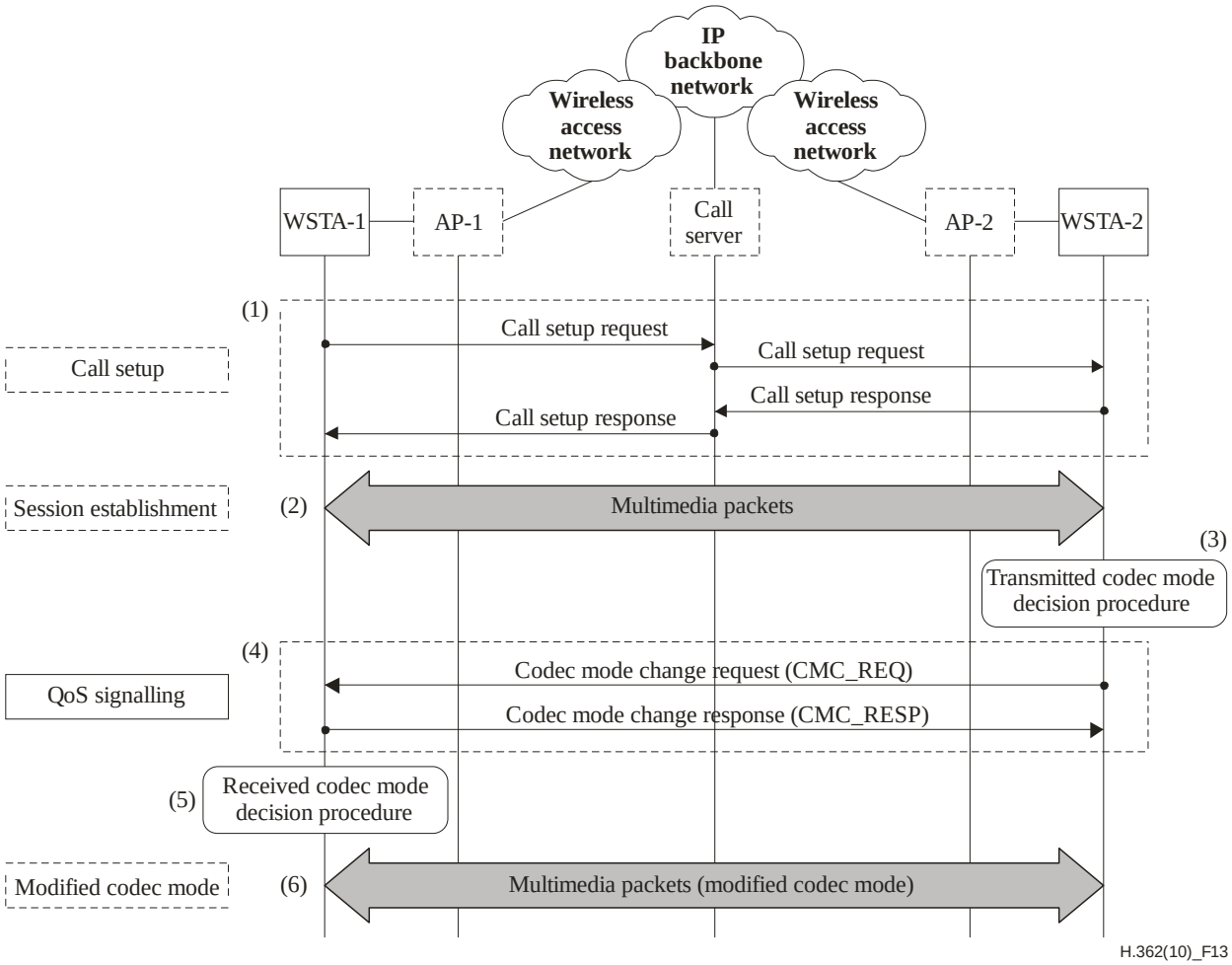


Figure 13 – Procedure for QoS signalling message exchange

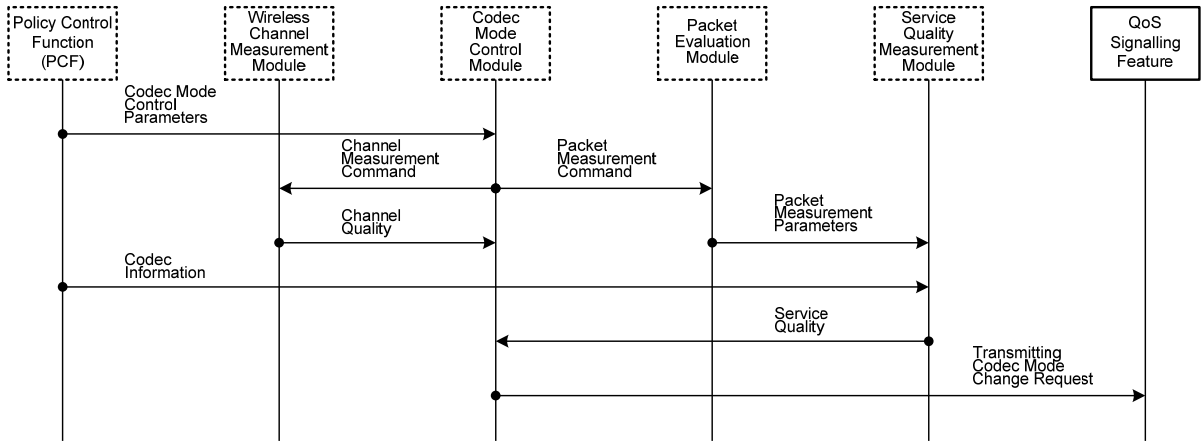


Figure 14 – Detailed message exchange sequences for the transmitted codec mode decision procedure

(3) After commencing the call, the WSTA-2 controls the codec mode of the remote WSTA-1 through the transmitted codec mode decision procedure which is described as follows (see also Figure 14).

The CMCM instructs the WCMM and the PEM to collect information about the wireless channel quality and packet transfer performance, which is used to control multimedia service quality by sending the CMC and the PMC to the WCMM and the PEM, respectively.

Upon receiving the CMC, the WCMM measures the wireless channel quality and reports the CQ to the CMCM. In the case of the PEM, upon receiving the PMC, the PEM evaluates the packet transfer performance and delivers the PMPs to the SQMM. The SQMM evaluates the SQ based on the PMPs and the CI from the PCF, and reports the SQ to the CMCM. Then, the CMCM controls the codec mode of the remote WSTA based on the SQ and the CMCPs from the PCF.

If a WSTA determines to change the codec mode of a remote WSTA, the CMCM sends the TxCMCR to the QSF in order to instruct the QSF to request for the change of the current codec mode of the remote WSTA.

(4) After the WSTA-2 decides to change the codec mode of the remote WSTA, the WSTA-1, through the transmitted codec mode decision procedure, the WSTA-2 transmits the CMC_REQ message to the remote WSTA-1. Upon receiving the CMC_REQ message, the WSTA-1 decides whether to change the codec mode and transmits the response message to the CMC_REQ, CMC_RESP, reporting the current codec mode of the WSTA-1 to the remote WSTA-2. When the WSTA-2 receives the CMC_RESP, the WSTA-2 checks whether the CMC_REQ has been adjusted to the WSTA-1 or not.

(5) The WSTA-1, which receives the CMC_REQ message, changes the codec mode through the following procedure.

Upon receiving the CMC_REQ message from the remote WSTA, the WSTA-2, the PEM extracts the codec mode control parameters contained in the CMC_REQ message and delivers the parameters to the CMCM. The CMCM, which receives the codec mode control parameters from the PEM, transmits the MEPs to the COCM. The COCM changes the current codec mode according to the MEPs. The COCM, which receives the MEPs, applies the encoding parameters to the media encoder.

(6) After completing the codec mode change, the WSTA-1 and the WSTA-2 communicate with the RTP/RTSP stream which is encoded using an altered codec mode.

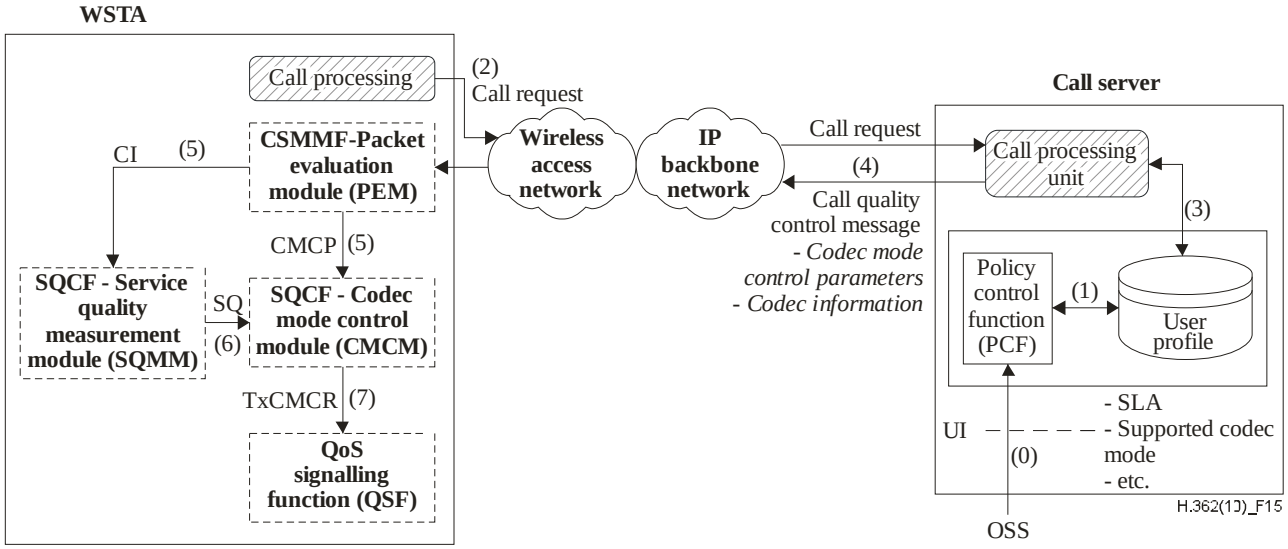
5.5.4 Policy control function (PCF)

The PCF receives the call control policy information such as a user's service level agreement (SLA), supported codec mode, and codec information through the operations support system (OSS) interface, manages the policy information in the user profile database, and uses it for call admission, modification and rejection. This is described below (see also Figure 15).

(0) Through an operations support system (OSS), a call server receives the information on a terminal and a subscriber such as a service level agreement and a supported codec mode.

(1) The PCF stores the information on the terminal and the subscriber which is received from the OSS into the user profile managed by the call control function.

(2) A terminal, WSTA, initiates a call set-up request to the call server. For call set-up, an existing signalling protocol, e.g., SIP, ITU-T H.323, can be used.



CSMMF	Channel Status Measurement and Management Function
SQCF	Service Quality Control Function
QSF	QoS Signalling Function
PCF	Policy Control Function
CMCM	Codec Mode Control Module
PEM	Packet Evaluation Module
SQMM	Service Quality Measurement Module
CMCP	Codec Mode Control Parameters
CI	Codec Information
SQ	Service Quality
TxCMCR	Transmitting Codec Mode Change Request
OSS	Operations Support System

Figure 15 – Policy control function (PCF)

(3) Upon receiving the call request message, the call processing unit decides whether it allows the call request or not, according to the service level agreement and available codec mode which are acquired from the user profile database.

(4) After accepting the call request, the call processing unit transmits the call quality control message, which includes codec mode control parameters and codec information, to the remote WSTA. The codec mode control parameters also include the service level and supported codec mode for the remote WSTA.

(5) The PEM of the CSMMF, which receives the channel quality control message from the PCF, delivers the codec mode control parameters to the CMCM of the SQCF and transfers the CI to the SQMM of the SQCF.

(6) The SQMM, which receives the CI, evaluates the SQ and reports the performance to the CMCM.

(7) The CMCM, which receives the SQ, decides the codec mode of the remote WSTA according to the service control algorithm. If there is a need to change a codec mode, the CMCM instructs the QSF with TxCMCR to change the codec mode of the remote WSTA.

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