3GPP2 S.R0079-A
Version 1.0
Version Date: June 29, 2006

3RD GENERATION PARTNERSHIP PROJECT 2 "3GPP2"

Support for End-to-End QoS

Stage 1 Requirements

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VERSION HISTORY

VERSION HISTORY		
Ver. 1.0	*Final draft of S.P0079-A recommended for publication*	*June 29, 2006*

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1 INTRODUCTION AND SCOPE

This document describes the requirements necessary to support E2E (End-to-End) QoS in the cdma2000® wireless IP network. The requirements are based on leveraging, and extending where applicable, the standard IETF protocols for QoS. The proposed functionality described by these requirements include the use of int-serv, diff-serv, int-serv to diff-serv inter-working, network policy and subscriber profile, network provisioning and link layer to upper layer QoS adaptation. This document also specifies the requirements for the cdma2000 Radio Link QoS.

2 REFERENCES

The document references, which are applicable to this specification, include the following:

- *[1] Not Used.*
- *[2] S.R0037 All IP Network Architecture Model for cdma2000 Spread Spectrum Systems.*
- *[3] 3GPP TS 23.207 V5.5.0 (2001-02) 3G Partnership Project Technical Specification Group Services and System Aspects; End to End QoS Concept and Architecture.*
- *[4] Bernet Y., et al., "A Framework for Integrated Service Operation over Diffserv Networks", RFC2998, November 2000.*
- *[5] 3GPP2 C.S0001 Introduction to cdma2000 Spread Spectrum Systems.*
- *[6] 3GPP2 C.S0002 Physical Layer Standard for cdma2000 Spread Spectrum Systems.*
- *[7] 3GPP2 C.S0003 MAC Layer Standard for cdma2000 Spread Spectrum Systems.*
- *[8] 3GPP2 C.S0004 LAC Layer Standard for cdma2000 Spread Spectrum Systems.*
- *[9] 3GPP2 C.S0005 Upper Layer Signaling Standard for cdma2000 Spread Spectrum Systems.*
- *[10] 3GPP2 C.S0017 Data Service Options for cdma2000 Spread Spectrum Systems.*
- *[11] 3GPP2 C.S0024 cdma2000 High Rate Packet Data Air Interface Specification.*
- *[12] 3GPP2 X.S0011 cdma2000 Wireless IP Network standard:Quality of Service and Header Reduction*

3 DEFINITIONS AND ABBREVIATIONS

The terms and abbreviations, which are used within this specification, are defined as follows:

BR	Border Router
CN	Correspondent Node. A peer with which a mobile station is communicating. A correspondent node may be either mobile or stationary.
E2E QoS	End-to-End Quality of Service
HA	Home Agent
HAAA	Home AAA
HDB	Home Data Base
MS	Mobile Station
PDF	Policy Decision Function
PDSN/AGW	Packet Data Serving Node/ Access Gateway
IETF	Internet Engineering Task Force
SLA	Service Level Agreement
VAAA	Visited AAA
VDB	Visited Data Base
P-CSCF	Proxy-Call Session Control Function
S-CSCF	Serving-Call Session Control Function
RAN	Radio Access Network

Asymmetric Bearers: Bearers in opposite directions between the same two endpoints that have different QoS attributes.

Best Effort: The network does its best to forward IP packets but does not provide any guarantee on the delivery of the IP packets.

QoS Attribute: A QoS Attribute is one of several characteristics that can be assigned to a bearer. The QoS Attributes may include, but are not limited to:

- bandwidth
- delay

- jitter
- packet loss
- priority
- traffic class
- IP QoS Class

The quality of a bearer can be described by the attributes given above.

QoS Negotiation: The QoS Negotiation is the process followed by a QoS requestor and a QoS service provider for ultimately agreeing or disagreeing on a QoS attribute or set of attributes.

Subscriber's QoS Profile: The set of values or range of values of the QoS attributes authorized for the subscriber. The authorized QoS attributes are part of the subscriber's AAA profile. The Subscriber's QoS profile contains limits on the resources that can be authorized for use by a subscriber. These limits may include maximum allowed bandwidth, minimum delay, minimum packet loss rate etc. and may contain default values greater than best effort when no specific QoS request is signalled.

Main service instance: A packet data service instance that is set up during the initial establishment of a packet data service. This packet data service instance normally has default QoS characteristics that are based on subscriber's AAA profile and local policy.

Auxiliary service instance: A packet data service instance that is set up on-demand to support a required QoS greater than the default QoS characteristics that are configured for the Main service instance. This packet data service instance has QoS characteristics that are based on the request of the user, limited by the subscriber's QoS profile and local policy.

Differentiated-Services (diff-serv): A QoS architecture developed in the IETF that divides IP traffic into small number of classes and provides QoS to large aggregate of IP traffic.

Integrated-Services (int-serv): A QoS architecture developed in the IETF that uses signaling to establish E2E QoS for application flows.

Traffic Classes: Distinct QoS categories of application/service..

IP QoS Classes: A set of "best-practice" definitions for service classes based on different traffic characteristics and required performance of the applications/services. These classes provide the recommended corelation between the classes and their usage, with references to their corresponding recommended Differentiated Service Code Points (DSCP), traffic conditioners, Per-Hop Behaviors (PHB) and Active Queue Management (AQM) mechanisms.

4 GENERAL FEATURE DESCRIPTION

Requirements are defined to enable a cdma2000 wireless IP network to provide E2E QoS between a mobile station and a correspondent node. The E2E QoS network reference model involves several IP nodes. The two end points are the MS and the correspondent node (CN). The intervening networks span across a cdma2000 wireless IP network that includes the radio link, the intermediate IP network, and the Edge IP network of the correspondent node. The E2E reference model can be viewed as a set of consecutive networks. Figure-1 depicts an example of the E2E QoS architecture. (Note: Figure 1 is for reference purposes only. It does not imply that all network elements shown are necessarily involved with E2E QoS.) E2E QoS may be provided by explicit management of QoS on the consecutive networks, or by provisioning, or a combination of both.

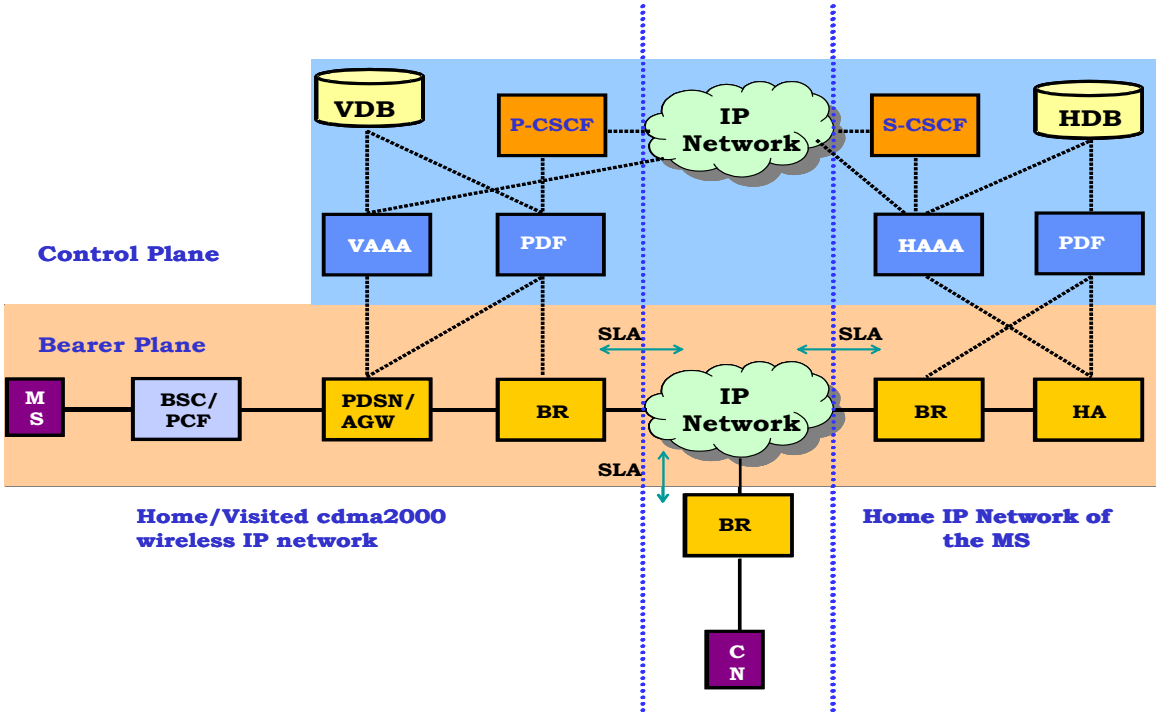

Figure 1. E2E QoS reference model

The availability of E2E QoS functionality in the cdma2000 wireless IP network provides the following benefits:

- E2E QoS would enable users to launch a variety of applications and experience their associated benefits in the wireless mobility context.
- E2E QoS would enable cdma2000 wireless IP network providers to provide a variety of services and benefit from their associated revenue streams.

The following provides an example of an approach to E2E QoS in the cdma2000 wireless IP network:

The E2E QoS support in the cdma2000 wireless IP network may be provided via one or more instances of a packet data service. The types of instances of a packet data service are identified as a main service instance or an auxiliary service instance. In the cdma2000 wireless IP network, the radio resources should be allocated per service instance.

In this context the purpose of a main service instance is used to provide resources in the cdma2000 wireless IP network to meet the QoS requirements for the applications that may only require Best-Effort QoS support. However, to meet the QoS demands of applications that require better than Best Effort QoS, an auxiliary service instance can be used. The resource allocation for an auxiliary service instance is selective and is based on a characterization of QoS requirements associated with an application. One or more auxiliary service instances may be established by the MS based on the number of applications in use for an MS each requiring different QoS.

4.1 The cdma2000 E2E QoS bearer services:

The E2E QoS support in the cdma2000 wireless IP network attempts to reserve the necessary resources to ensure that the requested QoS requirements for a user's application are satisfied. If the necessary resources are not available in the cdma2000 wireless IP network, an attempt should be made to negotiate a lower QoS. The following figure shows the different bearer services in a cdma2000 network to satisfy subscriber's E2E QoS requests.

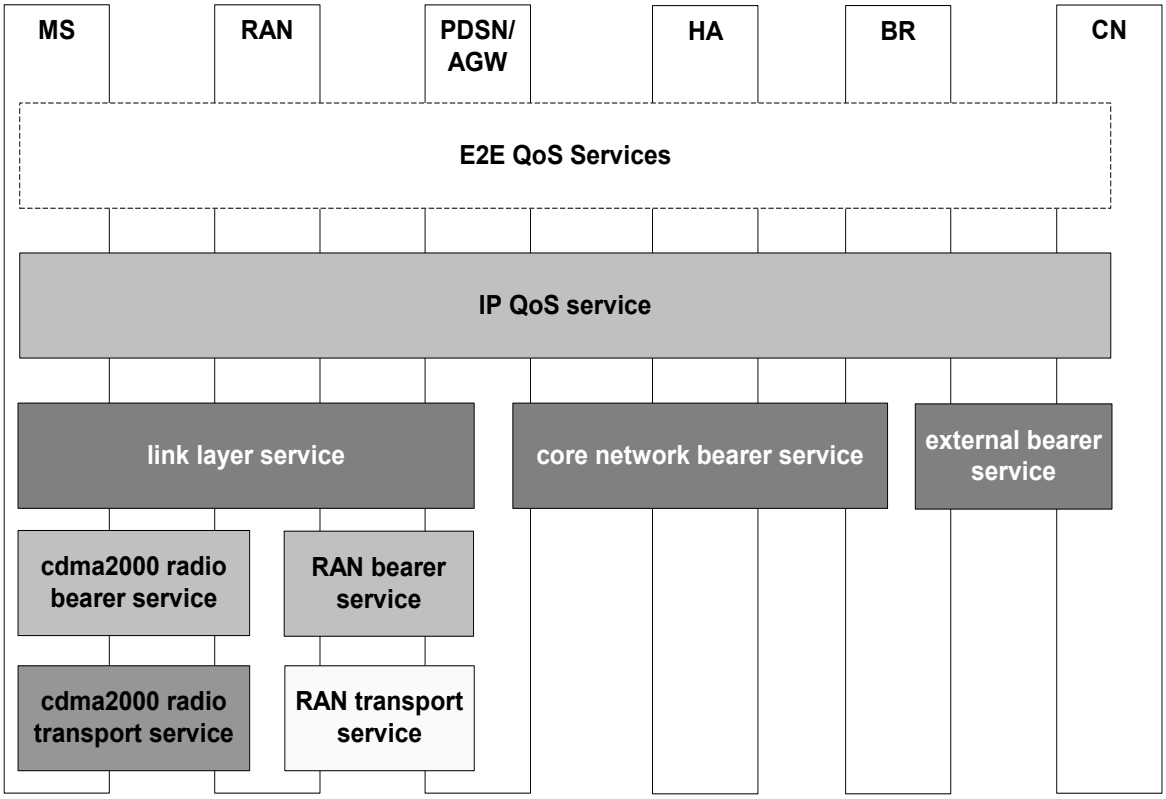

Figure 2. E2E QoS architecture

E2E QoS Service: The application layer QoS between the end hosts identifies the QoS requirements, for example via SIP/SDP signaling protocol. The QoS requirements from application layer are mapped down to create a network layer session. The mobile terminal then establishes a link layer connection suitable for support of the network layer session. The QoS parameters received from the application layer are mapped to the corresponding IP layer signaling parameters as well as the link layer parameters.

IP QoS Service: In the E2E scenario, the mobile terminal can use the IP QoS service to control the QoS at the local and remote access networks, and diff-serv to control the IP QoS through the backbone IP network. Any IETF defined IP QoS signaling protocol can be used for different services. The entities that are supporting the IP QoS signaling should act according to the IETF specifications for int-serv and int-serv/diff-serv interworking.

In addition to provision of E2E QoS Service and via IP QoS Service, QoS requirements may also be determined based on operator local policy/SLA.

Link Layer Service: The Link layer service currently does not provide any QoS capability. Support for QoS at the PPP layer (or any other link layer protocol that might be used in the future) is FFS.

External Bearer Service: The bearer services provided by the external network. e.g., the IP core network that is not owned and operated by the wireless service providers.

cdma2000 Radio Bearer Service: cdma2000 radio bearer services and their associated QoS parameters are defined in [10], [11]. This includes both the assured mode and non-assured mode QoS parameters. This service is enabled by the cdma2000 radio transport service.

RAN Bearer service: The RAN bearer service is concerned with the QoS guarantee for the following service scenario:

The bearer resources are allocated on the RAN interface in an attempt to meet the QoS requirements received from the mobile user as allowed by the network.

Core network bearer service: The core network in the cdma2000 wireless IP network provides this type of bearer service between PDSN/AGW and BR.

cdma2000 Radio Transport Service: This service is provided by the cdma2000 physical layer that is categorized by the QoS classes and parameters based on the stringent requirements of the physical channels (FCH, DCCH, SCH, etc). Note that the MAC/Multiplex sublayer has to map the radio bearer QoS parameters (logical channel) onto the physical channel QoS parameters. The radio transport layer service is concerned with the physical radio channel payload data units produced and consumed by the cdma2000 radio bearer service plus any signaling associated with those radio channels, e.g., common channel signaling, and call control messages and OAM. The radio transport service QoS should not be dependent on the definition of the radio bearer service QoS, or any higher-layer QoS definitions.

RAN Transport Service: The service provided by the RAN transport network to guarantee delivery of the RAN bearer services within their specified QoS limits.

5 DETAILED FUNCTIONALITY REQUIREMENTS

5.1 Detailed Feature Characteristics and Requirements

5.1.1 The Operational Requirements for the cdma2000 wireless IP network to support E2E QoS.

5.1.1.1 For QoS signaling, an open standard (IETF supported) E2E QoS signaling protocol shall be used in the cdma2000 wireless IP network.

5.1.1.2 The cdma2000 wireless IP network shall allow the MS to communicate with the Correspondent Node in order to request the reservation of the necessary resources to meet the E2E QoS required by an application. The cdma2000 wirelss IP network shall relay the E2E QoS signals to and from the MS and the Correspondent Node.

5.1.1.3 If the necessary resources are not available, the cdma2000 wireless IP network shall have the ability to negotiate a mutually acceptable E2E QoS with the Correspondent Node and the MS. The MS's request for QoS resources may be limited by the network provider's policy and the subscriber's QoS profile.

5.1.1.4 The visited cdma2000 wireless IP network's policy for E2E QoS shall have precedence over the subscriber's QoS profile.

5.1.1.5 The home IP network provider's policy for E2E QoS shall apply to any resource reservation in the home network.

5.1.1.6 The user's subscription profile for E2E QoS shall be stored in the home network in the Home Data Base (HDB) and may be cached in other network nodes.

5.1.1.7 A Service Level Agreement (SLA) should be established between the cdma2000 wireless IP network and the peer networks. The SLA shall be enforced at the Border Router (BR).

5.1.1.8 The policy and provisioning frameworks in the cdma2000 wireless IP network for E2E QoS should be based on IETF protocols.

5.1.1.9 E2E QoS shall support the capability for information exchange amongst network nodes for the purpose of resource allocation.

5.1.1.10 The cdma2000 wireless IP network bearer plane shall be able to support multiple and simultaneous packet data services (e.g., conversional, streaming, etc.) for users.

5.1.1.11 The granted E2E QoS values for a user's session shall be included in the appropriate accounting records.

5.1.1.12 The E2E QoS solution shall support both signaling based and local policy/SLA based QoS.

5.1.1.13 The E2E QoS solution shall provide support for applications that require E2E QoS but do not include air interface-specific information or procedures.

5.1.1.14 The state information stored during dormancy, for a service instance shall include granted Radio Link QoS attribute information.

5.1.1.15 E2E QoS of a particular class shall be authorized based on a subscriber's AAA profile and service provider's local policy. When the E2E QoS is no longer authorized, E2E QoS shall default to "Best Effort" class.

5.1.1.16 The E2E QoS architecture shall allow seamless delivery of negotiated QoS during handoff across cdma2000 air interface technologies.

5.1.1.17 The cdma2000 Wireless IP Network shall allow QoS on a per flow basis between the Mobile Station and the Correspondent Node.

5.1.2 The Operation Requirements for the cdma2000 radio link to support E2E QoS

5.1.2.1 Radio Link QoS shall be subject to radio network operator-defined policies and subscriber's QoS profile in the AAA.

5.1.2.2 A request for Radio Link QoS attributes for a new service instance or a request to modify the Radio Link QoS attributes of an existing service instance shall be supported.

5.1.2.3 The cdma2000 Radio Link QoS shall be defined in terms of the QoS Attributes.

5.1.2.4 The per subscriber Radio Link QoS authorization should be performed based on subscriber's QoS profile in the AAA.

5.1.2.5 The Radio Link QoS mechanism shall support a mapping between application requirements and cdma2000 Radio link layer QoS attributes.

5.1.2.6 When a service instance transitions from the dormant state to the active state, the Radio Link QoS attributes of the prior service instance should be requested/granted at the pre-dormancy values, if possible. If the pre-dormancy Radio Link QoS attribute values can not be granted, newly negotiated Radio Link QoS attribute values shall be established.

5.1.2.7 Radio Link QoS shall support an asymmetric bearer (i.e. the ability to support different Radio Link QoS attributes values associated with the forward and reverse airlinks.

5.1.2.8 When establishing Radio Link QoS attribute values for service instances, the Radio Link QoS mechanism shall allow the specification of value ranges rather than single values for Radio Link QoS attributes to accommodate the unpredictable nature of the wireless link.

5.1.2.9 The granted cdma2000 airlink QoS values for a user's session shall be included in the appropriate accounting records.

The system shall record call detail information as follows:

- the requested E2E QoS attributes
- the granted E2E QoS attributes
- the re-negotiated E2E QoS attributes, if applicable,
- the volume of data transferred and
- the duration of use.
- time of day of the start of the session

5.1.2.10 QoS traffic classes shall be defined with respect to the other QoS Attributes. The following table lists examples of traffic classes:

Class	Attributes of Traffic
Conversational	Two-way, low delay, low data loss rate, sensitive to delay variations.
Streaming	Same as conversational, one-way, less sensitive to delay. May require high bandwidth.
Interactive	Two-way, bursty, variable bandwidth requirements moderate delay, moderate data loss rate correctable in part.
Background	Highly tolerant to delay and data loss rate has variable bandwidth.

The service provider may also choose to specify the Per Hop Behavior (PHB) according to the subscriber's QoS profile.

5.1.2.11 If the requested level of QoS or traffic class is unspecified by the application or local policy/SLA, the system default level of QoS or traffic class shall be used.

5.1.2.12 If the required resources for a requested level of QoS or traffic class are not available, the system should attempt to negotiate an alternative to the requested QoS.

5.1.2.13 The QoS mechanism shall support a wide range of services and applications and allow the specification of traffic classes.

5.1.2.14 The Radio Link QoS information (both requested Radio Link QoS attributes and granted Radio Link QoS attributes) shall be included in accounting records

5.1.2.15 Consistent QoS shall be ensured among networks across an intersystem handoff.

5.1.2.16 If the E2E QoS cannot be honored on intersystem handoff, the QoS shall revert to local policy.

6 The Operational Recommendations for cdma2000 IP QoS Classes

The definition of IP QoS for cdma2000 remains the purview of the service provider. However, to improve both the interoperability between the network nodes and the consistency of the end-to-end application service performance, it is recommended that common configuration guidelines for QoS Traffic Classes be used. The following section provides a recommendation for the use of IP QoS Classes.

6.1 IP QoS Classes

The IP QoS Classes approach provides for an alignment of IP packet treatments at a QoS function with the presented load. The base set of cdma2000 IP QoS classes are defined as follows:

Network Control service class is intended to be used for routing and network control function.

OAM (Operations, Administration and Management) service class is suited for network configuration and management functions.

Telephony service class is best suited for applications that require very low delay variation and are of constant rate, such as IP telephony (VoIP) and circuit emulation over IP applications.

Signaling service class is best suited for peer-to-peer and client-server signaling and control functions using protocols such as SIP, SIP-T, H.323, H.248, MGCP, etc.

Multimedia Conferencing service class is best suited for applications that require very low delay, and have the ability to change encoding rate (rate adaptive), such as H.323/V2 and later video conferencing service.

Real-time Interactive service class is intended for interactive variable rate inelastic applications that require low jitter, loss and very low delay, such as interactive gaming applications that use RTP/UDP streams for game control commands, video conferencing applications that do not have the ability to change encoding rates or mark packets with different importance indications, etc.

Multimedia Streaming service class is best suited for variable rate elastic streaming media applications where a human is waiting for output and where the application has the capability to react to packet loss by reducing its transmission rate, such as streaming video and audio, web cast, etc.

Broadcast Video service class is best suited for inelastic streaming media applications that may be of constant or variable rate, requiring low jitter and very low packet loss, such as broadcast TV and live events, video surveillance and security.

Low Latency Data service class is best suited for data processing applications where a human is waiting for output, such as web-based ordering, Enterprise Resource Planning (ERP) application, etc.

High Throughput Data service class is best suited for store and forward applications such as FTP, billing record transfer, etc.

Standard service class is for traffic that has not been identified as requiring differentiated treatment and is normally referred as Best Effort.

Low Priority Data service class is intended for packet flows where bandwidth assurance is not required.

Two of the above classes, *viz*. "Network Control" and "OAM", are used for internal network traffic, while the rest support end-to-end user traffic. Additional IP QoS classes may be provided beyond those described above.

6.2 Mapping Between Traffic Classes and the IP QoS Classes

A possible mapping between the Traffic Classes and the IP QoS classes is shown below:

Traffic Class	IP QoS Class
Conversational	Telephony
	Multimedia Conferencing
	Signaling
Interactive	Real-time Interactive
Streaming	Multimedia Streaming
	Broadcast Video
Background	High Throughput Data
	Standard
	Low Latency Data
	Low Priority Data

Since "Network Control" and "OAM" service classes are not used for user-traffic, they are not mapped to any specific cdma2000 Traffic Class.