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Requirements for WiMAX Peer-to-Peer (P2P) Services

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1 ***I*** **Introduction (Informative)**

2 This document is the first of a three-stage, end-to-end network system architecture specification for broadband
3 wireless networks based on WiMAX Forum Certified™ products. This document specifies requirements for such
4 networks from the perspective of network operators intending to deploy WiMAX networks. It describes business
5 and usage scenarios, deployment models, and functional requirements. Architectural details shall be specified in
6 stage-2 and stage-3 specifications based on the requirements outlined in this document.

7

8 Peer to Peer (P2P) service is a data communication between peers through a WiMAX access network.

9 Common characteristic of P2P applications may include:

10

- 11 • Large number of peers;
- 12 • Centralized peers
- 13 • Distributed peers

14

15 For P2P communication, two different modes of communication can be identified:

16

- 17 1. A peer communicates with another peer through a WiMAX access network,
- 18 2. A peer communicates with another peer directly.

19 Note: This second communication mode is outside the scope of this document; all communications between
20 peers using service provider owned spectrum will be under the service provider control.

21

2 Objective and Scope

The objective of this document is to define requirements to support Peer to Peer Service over WiMAX System in order to provide WiMAX operators with lower CAPEX and OPEX when deploying P2P service. Other requirements will also be defined to optimize network operation by configuring the best Peer-Peer data delivery path in distributed environment and managing large mobile peers. The work item targets Release 3.0 timeframe.

The scope of the work item is as follows:

- To define use cases for P2P services over WiMAX network
- To define the requirements of WiMAX network and devices for P2P services.
- To define the requirements of any new WiMAX network element in CSN for P2P services.
- To identify the network improvements and optimizations to support P2P service.
- To identify any potential impact on air interface for the support of P2P services.
- To identify any relevant roaming/inter-operation in P2P communication.

This feature does not support direct device to device communication. All communications using service provider owned spectrum will be under the service provider control.

3 Abbreviations, Definitions, and Conventions (*Informative*)

3.1 Conventions (*Informative*)

The key words “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” in this document are to be interpreted as described in Ref [3] RFC 2119.

3.2 Abbreviations and Acronyms (*Informative*)

AL-FEC	Application Layer – Forward Error Correction
ASN	Access Service Network
CSN	Connectivity Service Network
NAP	Network Access Provider
NSP	Network Service Provider
P2P	Peer to Peer

3.3 Definitions (*Informative*)

3.3.1 Peer

A Mobile Station (MS) that is capable of providing P2P service(s).

4 References

1 **5 Use Cases (Informative)**

2 **5.1 Use Case 1 - Content-on-Demand with Content Server**

3 5.1.1 Short Description

4 A subscriber of WiMAX Peer-to-Peer (P2P) operator MAX1, Asan viewed a latest movie with his
5 WiMAX device from the content provider that he has already subscribed. Bonnie wants to view the
6 movie that Asan already saw. Bonnie has been viewing the movie from the content server provided by
7 his content provider, but the movie has been paused and played repeatedly due to overload of the content
8 server – in that time a lot of subscribers were joined and served. In order to solve the problem, WiMAX
9 P2P operator MAX1 decide to inform the content provider that Asan had the movie and he could sent the
10 content to other subscribers. Now, Bonnie is viewing the movie better because he is provided the movie
11 from Asan as well as the Content Server. Also, Candace and David want to view the same movie, they
12 can watch the movie from Asan and Bonnie as well as the content server.
13

14 5.1.2 Actors

15 Asan – WiMAX Peer-to-Peer (P2P) operator MAX1 subscriber
16 Bonnie – WiMAX Peer-to-Peer (P2P) operator MAX1 subscriber
17 Candace – WiMAX Peer-to-Peer (P2P) operator MAX1 subscriber
18 David – WiMAX Peer-to-Peer (P2P) operator MAX1 subscriber
19

20 5.1.3 Pre-conditions

21 WiMAX P2P control functions know where the peers are located in and which content is stored in a peer.
22 MS as a WiMAX peer informs its content list and status(e.g., battery power, CPU, memory, etc.) to
23 WiMAX P2P control functions and is able to send/receive the content to/from other peers.
24

25 5.1.4 Post-conditions

26 As soon as a WiMAX peer finishes receiving the content, it has to send the information to WiMAX P2P
27 control functions to minimize BW usage for the other user.
28

29 5.1.5 Normal Flow

- 30 1. Asan starts his P2P application client and begins service registration process. After Asan finishes his
31 registration, the content provider (e.g. a portal site) delivers the content list to the P2P client. Asan
32 searches and selects a movie from the content list.
- 33 2. After receiving Asan's request, the content server starts to send the movie to Asan's MS.
- 34 3. While downloading the movie, Asan's device is able to play the movie and inform its downloading
35 status to WiMAX P2P control functions.
- 36 4. After Asan's device completes downloading the movie, it has to inform the WiMAX P2P control
37 functions of its result.

- 1 5. Afterwards, more users around Asan join the watching the movie and being served by the content
2 server. More users connect to watch the movie resulting congestion. As a consequence, quality of
3 experience for the end users deteriorates.
- 4 6. Fortunately, from step (4), the WiMAX P2P control functions know that the movie has been cached in
5 Asan's device and can serve some of the users. As a result, the workload of the content server is
6 relieved to some extent and can serve more users.
- 7 7. Afterwards, a lot more users join to view the movie, which has been cached in many peers. For
8 example, from step (5), David's device is able to receive the movie from Asan, Bonnie, Candace's
9 devices as well as the content server.
- 10 8. As a result, the workload of the content server is relieved to some extent and can serve more users.

11

12 5.1.6 Alternative Flow

13 The movie can be divided in some parts. So that it can be transmitted to a peer from multiple source
14 peers.
15

16 5.2 **Use Case 2 - Content delivery without Content Server**

17 5.2.1 Short Description

18 A subscriber of WiMAX Peer-to-Peer (P2P) operator MAX1, Asan has a content generated by himself in
19 his device. He wants to share his content without uploading it to any content server. He informs the
20 WiMAX P2P control functions only brief information. Bonnie wants to view the content generated by
21 Asan. Bonnie views the content from Asan's device. After Bonnie finishes viewing the content, Bonnie's
22 device informs the WiMAX P2P control functions that it has stored the content. Candace also wants to
23 view the content generated by Asan. Candace views the content from Asan's device, but the movie has
24 been paused and played repeatedly due to overload of the Asan's device – in that time a lot of subscribers
25 were joined and served. In order to solve the problem, WiMAX P2P operator MAX1 decide to change of
26 the content source from Asan's device to Bonnie's.
27 Now, Candace is viewing the movie better because of load balancing. Also, David want to view the same
28 content, she can view the content from Asan, Bonnie or Candace.
29

30 5.2.2 Actors

31 Asan – WiMAX Peer-to-Peer (P2P) operator MAX1 subscriber
32 Bonnie – WiMAX Peer-to-Peer (P2P) operator MAX1 subscriber
33 Candace – WiMAX Peer-to-Peer (P2P) operator MAX1 subscriber
34 David – WiMAX Peer-to-Peer (P2P) operator MAX1 subscriber
35

36 5.2.3 Pre-conditions

37 WiMAX P2P Control Functions know where the peers are located in and which content is stored in a
38 peer.
39 MS as a WiMAX peer informs its content list and status(e.g., battery power, CPU, memory, etc.) to
40 WiMAX P2P Control Functions and is able to send/receive the content to/from other peers
41

1 5.2.4 Post-conditions

2 As soon as a WiMAX peer finishes receiving the content, it peer send the result to WiMAX P2P control
3 functions.
4

5 5.2.5 Normal Flow

- 6 1. Asan starts his P2P application client and begins service registration process. After Asan finishes his
7 registration, the P2P Portal delivers the content list to the P2P client. Asan uploads his content information
8 (e.g., content name, type, genre, file size, running time, etc.) so that the P2P portal can distribute the
9 information.
- 10 2. Bonnie, a member of Asan's community receives the content information from the P2P portal. If Bonnie
11 wants to view the content, he starts his P2P application client and views the content.
- 12 3. After receiving Bonnie's request, the Asan's device starts sending the content to Bonnie's MS. While
13 downloading the content, Bonnie's device is able to play the content and inform its downloading status to
14 WiMAX P2P control functions.
- 15 4. After Bonnie's device finishes downloading the content, it has to inform the WiMAX P2P control functions
16 of its result.
- 17 5. Afterwards, more users view the content served by Asan's device. As viewer of the content increase, the
18 Asan's device becomes congested and quality of experience for end users deteriorates.
- 19 6. Fortunately, from step (4), the WiMAX P2P Control Functions know that the content has been cached in
20 Bonnie's device and can serve some of the users. As a result, the workload of the Asan's device is relieved
21 to some extent and can serve more users.
- 22 7. Afterwards, as content viewers increase, the content has been cached in lot of peers. For example, from step
23 (5), David's device is able to receive the content from Asan, Bonnie, and Candace's devices.
- 24 8. As a result, the workload of the content source is relieved to some extent and can serve more users.

25
26 5.2.6 Alternative Flow

- 27 1. Asan starts his P2P application client and begins service registration process. After Asan finishes his
28 registration, the P2P Portal delivers the content list to the P2P client. Asan uploads his content
29 information (e.g., content name, type, genre, file size, running time, etc.) so that the P2P Portal can
30 distribute the information.
- 31 2. Bonnie starts his P2P application client and begins service registration process. After Bonnie finishes
32 his registration, the P2P Portal delivers the content list to Bonnie's P2P client. Bonnie searches and
33 selects the content generated by Asan in the content list.
- 34 3. After receiving Bonnie's request, the Asan's device starts sending the content to Bonnie's MS. While
35 downloading the content, Bonnie's device is able to play the content and inform its downloading status
36 to WiMAX P2P control functions.
- 37 4. After Bonnie's device finishes downloading the content, it has to inform the WiMAX P2P control
38 functions of its result.
- 39 5. Afterwards, more viewers join into the content served by Asan's device resulting congestion on the
40 Asan's device. Quality of experience for the end users deteriorates.
- 41 6. Fortunately, from step (4), the WiMAX P2P control functions know that the content has been cached
42 in Bonnie's device and can serve some of the users. As a result, the workload of the Asan's device is
43 relieved to some extent and can serve more users.

- 1 7. Afterwards, a lot more users join to view the content which has been cached in a lot of peers. For
2 example, from step (5), David's device is able to receive the content from Asan, Bonnie, and Candace's
3 devices.
4 8. As a result, the workload of the content source is relieved to some extent and can serve more users.
5

6 5.3 Use Case 3 - Near live cast streaming

7 5.3.1 Short Description

8 A subscriber of WiMAX Peer-to-Peer (P2P) service, Asan, is viewing a live cast program with his
9 WiMAX device. Initially he is able to receive the content directly from the service provider MAX1, and is
10 requested to store a copy of the received content in his local storage system. A control function on the service
11 provider side keeps track that a new copy of the live cast content is on Asan device. Later on, when a new
12 subscriber Bonnie requests for the same program, the control function informs Bonnie's device that peer Asan
13 has the content and a decision is made for Bonnie's device to get part of the content from the server, and part
14 from a peer Asan. Bonnie, while receiving the content, is also asked to store a copy of the received content on
15 his local device and to notify the control function. As more and more peers (subscribers) request to join, the
16 same process goes on for each peer, except that there are more sources of the content for each peer to get the
17 streaming program from. As a result, each peer receives, and at the same time share, the program from/with
18 other peers as the live cast program is up on the network. This process ensures that the bandwidth usage among
19 the content server or any peer is optimized, avoiding the risk of shutting down any of the systems.
20
21

22 5.3.2 Actors

23 Asan – WiMAX Peer-to-Peer (P2P) operator MAX1 subscriber
24 Bonnie – WiMAX Peer-to-Peer (P2P) operator MAX1 subscriber
25 MAX1 – WiMAX Peer-to-Peer (P2P) service provider
26

27 5.3.3 Pre-conditions

28 WiMAX P2P control function knows where the peers are and what content is stored in each peer.
29 Each peer has to inform the control function of its content list and its device status (e.g. battery power,
30 CPU, memory, etc.).
31 Each peer is able to send/receive the content to/from other peers, and stores the content on his local device.
32

33 5.3.4 Post-conditions

34 None.
35

36 5.3.5 Normal Flow

- 37 1. Asan starts his P2P application client software and begins the service registration process. After Asan
38 finishes his registration, the service provider delivers the content list to Asan. Asan selects a live cast
39 program from the list.
40 2. The control function on the service provider side keeps a track record of each program, including the
41 program Asan requested. The record contains information about who has what parts of the content of the
42 program, as well as each peer's device status.

- 1 3. Since Asan is the first one to request for the content, the track record shows that only service provider has
- 2 the content. Therefore, after receiving Asan's request the control function on the service provider side
- 3 sends the content to Asan's device.
- 4 4. While receiving the program, Asan's device stores the received content on his local device, and at the same
- 5 time, reports the stored content list and device status back to the control function. And the control function
- 6 updates the track record for the program.
- 7 5. As Asan continues to receive the content of the program, another peer Bonnie joins and receives the track
- 8 information from the control function, knowing that Asan has a copy of the content.
- 9 6. A decision is made for Bonnie to get part of the content from the service provider and part from Asan.
- 10 Bonnie stores a copy of the content he receives and informs the control function of his stored content list
- 11 and device status. The control function updates its track record.
- 12 7. As more and more peers join and request for the same live cast program, they all receive track information
- 13 from the control function and perform the same process as that by Bonnie, only that there will be more
- 14 peers storing the content, and each peer can get different parts of content from different peers.
- 15 8. The process continues until the live cast program is finished.

16

17 5.3.6 Alternative Flow

18 None.

19

20 5.4 **Use Case 4 – P2P based on ASN Proxy**

21 5.4.1 Short Description

22 A subscriber of WiMAX Peer-to-Peer (P2P) operator MAX1, Asan viewed a latest movie with his

23 WiMAX device by P2P mechanism. The WiMAX ASN stored the movie while the data had transferred

24 to Asan's device. Bonnie wanted to view the movie that Asan already saw. Bonnie has been viewing the

25 movie from the WiMAX ASN storing it. It helps us to reduce end-to-end latency and uplink traffic load.

26

27 5.4.2 Actors

28 Asan – WiMAX Peer-to-Peer (P2P) operator MAX1 subscriber

29 Bonnie – WiMAX Peer-to-Peer (P2P) operator MAX1 subscriber

30 Candace – WiMAX Peer-to-Peer (P2P) operator MAX1 subscriber

31 David – WiMAX Peer-to-Peer (P2P) operator MAX1 subscriber

32

33 5.4.3 Pre-conditions

34 WiMAX P2P Control Functions know where the peers are located in and which content is stored in a

35 peer.

36 The WiMAX ASN shall be able to store P2P data while the data have been delivered.

37

38 5.4.4 Post-conditions

39 As soon as a WiMAX peer finishes receiving the content, the peer sends the result to WiMAX P2P

40 control functions.

41

1 5.4.5 Normal Flow

- 2 1. Asan starts his P2P application client and begins service registration process. After Asan finishes his
3 registration, the P2P service provider (e.g. a portal site) delivers the content list to the P2P client. Asan
4 searches and selects a movie from the content list.
- 5 2. After receiving Asan's request, a content server or other P2P clients start to send the movie to Asan's
6 device.
- 7 3. While downloading the movie, Asan's device is able to play the movie and inform its downloading
8 status to WiMAX P2P control functions.
- 9 4. After Asan's device completes downloading the movie, it has to inform the WiMAX P2P control
10 functions of its result.
- 11 5. The WiMAX ASN has stored the movie while the data had been transferred to Asan's device.
- 12 6. Afterwards, more users around Asan join to watch the movie. By step (5), Bonnie, Candace, and
13 David's devices can receive the movie from WiMAX ASN.
- 14 7. As a result, the WiMAX uplink resources and end-to-end latency are reduced to some extent.

15
16

17 5.5

18 **6 Requirements (Conditional Normative)**

19 **6.1 Service Requirements**

- 20 R-[01] The WiMAX Network supporting WiMAX P2P Control Functions SHALL support all applicable
21 requirements of WiMAX Network Release 1.6 or later.
- 22 R-[02] The WiMAX Network supporting P2P services SHALL provide data sharing between Peers.
- 23 R-[03] The WiMAX Network SHALL reuse existing interfaces between functional entities to support
24 WiMAX P2P services.
- 25 R-[04] The WiMAX P2P Control Functions SHALL maintain the location and the content list.
- 26 R-[05] The WiMAX P2P Control Functions SHOULD be able to configure P2P delivery path based on
27 distance, traffic load of BS, and capability of MS.
- 28 R-[06] The WiMAX P2P Control Functions SHALL provide user with means of controlling, e.g.,
29 transmitting, receiving and rejecting, his or her subscribed P2P client while on line.
- 30 R-[07] The WiMAX P2P Control Functions SHOULD support Multi-Source Download to reduce
31 workload of a Peer.

32
33

34 **6.2 Functional Requirements**

35 **6.2.1 System Requirements**

- 36 R-[08] The WiMAX network SHALL support content delivery function to distribute contents or content
37 segments from the content server to WiMAX peers.

- 1 R-[09] WiMAX System SHALL provide a mechanism for the MS to accept or reject download request
2 coming from another peer.
3 R-[10] The WiMAX system SHALL provide forward error handling mechanism (e.g. AL-FEC) during
4 near live cast streaming case.
5

6 6.3 Roaming Requirements

- 7 R-[11] The Visited WiMAX network, which supports P2P function, SHOULD inform the MS that the
8 P2P function can be supported upon request. This is done when requested by the MS.
9

10 6.4 Accounting and Management Requirements

- 11 R-[12] The WiMAX network MAY provide different charging schemes (e.g. reduced rate) for P2P data.
12 R-[13] WiMAX Networks SHOULD support a mechanism for network operators to charge content
13 providers for data usage of P2P service.
14 Note: 3rd party content providers MAY charge P2P service users on the contents used by subscribers.
15 R-[14] The WiMAX network SHALL support activation/deactivation of the P2P service.
16 R-[15] The WiMAX network SHALL support activation/deactivation of the P2P service per subscriber.
17 R-[16] The WiMAX network SHOULD support over the air activation/deactivation of the P2P service
18 per subscriber.
19 R-[17] The WiMAX Network SHOULD be able to prevent User Peers from distributing any illegal
20 contents to other users.
21 R-[18] WiMAX Networks SHOULD support a mechanism for network operators to charge users based
22 on the amount of actual time usage for the near live case streaming.
23

24 6.5 Security Requirements

- 25 R-[19] The WiMAX MS supporting WiMAX P2P services SHALL NOT be able to access contents
26 without authorization.
27 R-[20] WiMAX Systems supporting P2P services SHALL NOT impact the security mechanism defined in
28 previous WiMAX Releases.

29 6.6 Regulatory Requirements

- 30 R-[21] WiMAX P2P services SHALL abide local copyright regulations.
31