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3RD GENERATION  
PARTNERSHIP  
PROJECT 2  
"3GPP2"

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## ***3GPP2 Vision for 2009 and Beyond***

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4 **Revision History**

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## Scope

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1

## 1 **1 INTRODUCTION**

2 This document contains the 3GPP2 vision for the time frame 2009 and beyond.

3 It describes:

- 4 • New and enhanced services and applications
- 5 • Network and user equipment capabilities that meet the new and  
6 enhanced services and applications
- 7 • Candidate radio technologies and networks on which such capabilities  
8 are desired
- 9 • Roadmap(s) and time-lines of the new services and applications.

10 The key element of the 3GPP2 vision is to provide connectivity and support for  
11 access to open Internet services and applications.

12 The content of this document aligns with the views expressed by the 3GPP2  
13 Future Directions and IMT Advanced Workshop held in Osaka, Japan in May  
14 2008.

15 Ongoing updates to specifications are not included in this document.

16

1 **2 HIGH LEVEL VISION**

2 3GPP2 will strive to develop specifications that deliver the best voice and data  
3 communication services as measured by performance, network and air  
4 interface efficiency, and complexity.

5 The vision for 3GPP2 in the 3-5 year period from 2009 and beyond is:

- 6 1. Enable highly efficient wireless communication technologies of the  
7 cdma2000® family by evolving the technologies to maximize use of  
8 existing deployments of cdma2000-1X and HRPD;
- 9 2. Deliver with cdma2000 1x-Enhanced the highest voice capacity per MHz  
10 of spectrum among any known systems, with the goal of more than  
11 tripling that capacity relative to the currently deployed cdma2000-1X;
- 12 3. Deliver with HRPD- Enhanced the most spectrally efficient wide area  
13 wireless mobile packet data system;
- 14 4. Position 1X- Enhanced and HRPD-Enhanced as critical long-term  
15 components of evolving wireless technology platforms worldwide.

16

17 These goals are consistent with the often-expressed vision of operators,  
18 including CDG ([www.cdg.org](http://www.cdg.org)) and NGMN Alliance ([www.ngmn.org](http://www.ngmn.org)). Annex 1  
19 codifies the CDG “Operator Priorities for cdma2000 1x and HRPD  
20 Enhancements”. NGMN Alliance is an international group of operators that  
21 states “... existing systems, including planned enhancements such as HSPA  
22 and EVDO Rev. A [...] are expected to keep [these] platforms competitive for  
23 some time to come.”

24



1 **3 ACRONYMS, ABBREVIATIONS, AND TERMINOLOGY**

| TERMINOLOGY                              | ACRONYM & ABBREVIATION | DEFINITION   |
|--|------------------------|--|
| CDMA Developers Group                    | CDG                    |  |
| Computer and Communication               | C&C                    |  |
| Network Address Transliteration          | NAT                    |  |
| Next Generation Mobile Networks          | NGMN                   |  |
| Packet Switched Video Telephony          | PSVT                   |  |
| Supervisory Control and Data Acquisition | SCADA                  | A computer system for gathering and analyzing real time data.  |
| Voice over Data                          | VoD                    |  |
| Voice over IP                            | VoIP                   |  |
| Web-2.0                                  | n/a                    | A term for describing changing trends in the use of World Wide Web technology and web design that aims to enhance creativity, secure information sharing, collaboration and functionality of the web, by proliferation of interconnectivity and interactive web-delivered content. |

2

3

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12 EVDO", Version 3.0.

13

## 1 **5 TRENDS AND DIRECTIONS**

### 2 5.1 Technology Trends

3 Currently, the wireless industry is characterized with some general trends,  
4 which are outlined as follows.

5 Volume of traffic carried in wireless networks is increasing, even in developed  
6 markets with a high degree of penetration (percentage of populace that  
7 subscribes to wireless services). There are several reasons for this, the  
8 principal one being that affordability of services continues to improve, in  
9 particular for voice service.

10 In developing countries, this improved affordability allows more people to  
11 become qualified for wireless service subscription. Penetration is rapidly  
12 increasing for wireless systems, as wireless is seen as the fastest and most  
13 effective technology to improve communication infrastructure in those  
14 countries. Subscription growth is driven primarily by those developing  
15 markets. The historical trends and projections are for steady increases.

16 In developed cellular networks, the number of subscriptions may not be  
17 increasing as rapidly as in the past several years since penetration is  
18 approaching saturation levels in many countries. Though customer rate of  
19 increase may be tapering off, minutes of use per subscriber are growing.

20 In summary, there is an increase in volume of traffic per user, as well as overall  
21 traffic volume.

22 The number and variety of devices that have wireless connectivity continues to  
23 increase. There is an increased competition among device manufacturers at all  
24 tiers. At the high end, as wireless data services become more popular, new  
25 competition is arising from manufacturers which traditionally come from  
26 information technology and computers/software industry segments. At the low  
27 end, global competition is increasingly at play, as manufacturers from an ever-  
28 increasing number of countries introduce their wireless products.

29 End-user device capability continues to improve, in particular in terms of  
30 multimedia support (voice, audio, video, etc.). Devices are more capable in  
31 other aspects, including human-machine interface, display, camera, location,  
32 sensing capability (e.g. accelerometer support), increased storage capability for  
33 multimedia, e-mail, etc.

34 The share of Internet traffic being carried by wireless networks is increasing.  
35 This growth parallels increased traffic volumes for voice services described  
36 above, but it's even more pronounced. These trends will likely encompass  
37 newer multimedia services (e.g., video), as their user acceptance increases. The

1 rapid growth of data services is competing for the network capacity currently  
2 used for voice service.

3 The traditional methodology for expansion of network capacity (e.g. cell  
4 splitting) remains challenging for operators, as cell site acquisition in many  
5 communities becomes ever more difficult. Complexity of other associated  
6 activities such as power, backhaul, etc. is also a factor. Network expansion for  
7 growth must deal with these constraining circumstances as trends such as  
8 unlimited minutes of use (data is already unlimited in many markets) drive the  
9 need for efficiency and increased network capacity.

10 It is essential to maintain and enhance cdma2000 spectrum efficiency and  
11 network capacity, so that operators can cope with the trends outlined above,  
12 and remain capable of serving customers and growing subscribers.

### 13 5.2 Industry Trends

14 The global wireless industry is increasingly cooperating in many aspects of  
15 standardization and technology, as well as on the operational aspects. This is  
16 helping create a large wireless eco-system required for the industry to move  
17 forward.

18 Packet-data communication is a common foundation for the industry going  
19 forward. Internet protocols defined by IETF ensure convergence of various  
20 forms of access, including wireless, and compatibility of applications.

21 Fixed-Mobile Convergence is occurring partially as a result of the prevalence of  
22 the Internet as the underlying technological building block. The advent of  
23 femto cell systems is an example of the result of such developments. The use  
24 of femto cells has a potential to expand considerably, and be an element in  
25 assisting operators to manage traffic growth.

26 Another important industry trend is network openness to developers of end-  
27 user devices and applications, promising to accelerate innovative uses of  
28 wireless systems. Regulators may recognize that network openness and  
29 technology neutrality might serve to bolster the basic mission of regulatory  
30 bodies, which is to assist the populace in times of emergency, and to allow  
31 wireless networks to play an unimpeded role in advent of an increasing array of  
32 every-day activities of users.

### 33 5.3 General Direction of 3GPP2 Specifications Developments

34 The high level vision of 3GPP2 technology developments can be summarized as  
35 follows:

- 36 • System capacity improvements that allow operators to cope with  
37 increased demand for voice services.

- 1 • Efficiency of voice services is critical as growth of demand for data  
2 services accelerates and occupies an ever-increasing percentage of radio  
3 transmission resources.
  
- 4 • Data transmission efficiency is likewise increasingly important in order  
5 to lessen the impact of traffic growth.
  
- 6 • Network capacity, robustness, and resilience will be continually improved  
7 to handle such substantial increases in traffic during calamitous events.  
8 This is driven by public safety and security concerns which are of  
9 increasing importance for wireless network use. Regulators and the  
10 public are getting accustomed to relying on omnipresence of wireless  
11 communication in assisting at times of crises, and in everyday public  
12 safety.
  
- 13 • Femto cells may become increasingly important in providing an  
14 alternative to traditional network build-out, and offering increased  
15 network robustness. Femto cells, micro cells, pico cells and repeaters  
16 must work seamlessly with the macro network.
  
- 17 • The operator requirements for efficient network management and  
18 operation amplify the need for Self-Organizing Network (SON).
  
19

## 1 **6 SERVICES, APPLICATIONS AND NETWORK ENABLERS**

2 Connectivity in a user's every-day activities is essential, and something many  
3 consumers have come to expect. Increasingly, wireless communication devices  
4 are becoming central tools enabling constant connectivity, or an indispensable  
5 capability for other types of devices whose primary purpose is not necessarily  
6 voice communications, e.g. music players.

7 Younger consumers are probably most innovative among wireless  
8 communication users. They appreciate connectivity on-the-go, as social  
9 networking enters every-day lexicon, thanks to these young trendsetters.

10 Alluding to the version-numbers that commonly designate software upgrades,  
11 the phrase "Web-2.0" hints at an improved form of the World Wide Web, though  
12 in reality the fundamental Internet technology is unchanged. "Network as  
13 platform" mantra of computing in Web-2.0, allows users to run software-  
14 applications entirely through a browser, which enables applications to evolve  
15 on the web, with little or no need to change client software.

16 Collaborative Web-2.0 is perhaps not yet in every-day use, however, its  
17 development indicates that there is an on-going evolution of the  
18 communication service platforms, which will play an increasing role for  
19 wireless. Web-2.0 includes many convergent components of networking,  
20 including collective knowledge and sharing (e.g. Wikipedia), podcasting and  
21 media sharing, blogging, e-commerce, web-based messaging and archiving, etc.  
22 A general observation can be made that all these web-based services are  
23 increasingly interactive, with ever-higher demand for low round-trip delay. For  
24 example, a web based e-mail service demands user experience that is akin to a  
25 PC-based (local) e-mail application to be competitive in terms of user  
26 experience. Thus, the underlying wireless technology must have extremely low  
27 round-trip latency to make it all possible. This is one of the key requirements  
28 for enhancements for HRPD-Enhanced.

29 HRPD and cdma2000-1x can be envisioned to be embedded in many devices,  
30 not just cell phones. This trend has already started with convergence of  
31 computers (laptop is migrating toward palm-top) and communication, and will  
32 be amplified with the modern trends with applications and services such as  
33 those using Web-2.0 as a platform.

### 34 6.1 Service Vision

35 The mobile communication service has been developed with the purpose of  
36 providing communication between users and getting basic information in a  
37 mobile environment at a level that can replace existing wired phone service.  
38 However, as user demands for diverse multimedia services increase, and as  
39 technologies to provide these services rapidly develop, high quality service

1 infiltrates every aspect of our lives and provides convenience, stability and  
2 variety of contents, in addition to rapidly changing human lifestyles.

3 The next generation mobile communication system will provide not only the  
4 existing communication services, but also a variety of services in a mobile  
5 environment that extends over all areas of everyday life. They include:

- 6 • Business and commerce related services (banking, shopping)
- 7 • Health related services (telemedicine, health checkup)
- 8 • Safety related services (emergency communication, public safety, disaster  
9 management)
- 10 • Leisure and entertainment related service (video, music, game)
- 11 • Education related services (remote training)
- 12 • Location and transportation related services (LBS, travel)
- 13 • Lifestyle related services (personal assistant).

## 14 6.2 Service Requirements

15 The following is a summary of the characteristics of next generation services  
16 expected by the user:

- 17 • High-speed and Delivery: In the past, services such as video telephony,  
18 streaming, and VoD, were only possible through a wired network because  
19 of the difficulty for existing mobile communication to provide enough  
20 transmission bandwidth. These services are now also enabled in wireless  
21 mobile environments, wherein high speed data transmission will be  
22 provided through high quality multimedia and voice call service.
- 23 • Context Awareness and Adaptation: Smart units with Computer and  
24 Communication (C&C) abilities can support circumstantial recognition  
25 functions. These functions detect dynamic environmental changes and  
26 provide the user with services relevant to the specific circumstances.  
27 These functions operate by going through a recognition and deduction  
28 process, followed by a collection and exchange of circumstantial data  
29 (including data of the user and surroundings that can be used at the  
30 time of user interaction). This function is subject to user privacy  
31 constraints.
- 32 • Seamless Service Continuity: Based on the development of a variety of  
33 wireless communication technologies, the next generation mobile  
34 communication systems will provide:

- 1           • Service continuity using different devices
- 2           • Service mobility between different networks
- 3           • Service mobility between applications on a single device.
- 4           • Interworking and Convergence: The rapid development of Internet and
- 5           data communication technologies together with the integration of wired
- 6           and wireless communication systems enables the convergence of the
- 7           following:
- 8           • A variety of communication networks
- 9           • A variety of digital equipment
- 10          • A variety of application services

11          Examples of such services consist of a variety of usage scenarios,  
12          including:

- 13          • Communication and finance
- 14          • Communication and distribution
- 15          • Data communication and electronic appliance
- 16          • Personalization: Lifestyle enhancing services that are adaptable to the
- 17          individual needs within diverse societies are expected to be customized,
- 18          based on individual profiles and preferences.
- 19          • Always-best Connection: In a wireless environment where a variety of
- 20          communication technologies coexist and service domains overlap, end-
- 21          to-end connections can vary dramatically. The system should provide the
- 22          optimal connection for peripheral networks, equipment and services with
- 23          regards to the terminal location, transmission environment, QoS
- 24          requirement, and subscriber preference.
- 25          • Security and Privacy: The system should ensure communication security
- 26          and user privacy in any location for a variety of applications.

### 27   6.3 Service Classification

28   The classification of services into voice, data and broadcasting is inadequate for  
29   the next generation of mobile communication services. The following six  
30   service categories are defined based on service usage:

- 31          • Point-to-point Communication Services



- 1       • Personalized Infotainment Services
- 2       • Enterprise/Business Services
- 3       • Education Services:
- 4       • Public Services, including Safety and Disaster
- 5       • Health Care Services

6 These service categories are defined as follows:

- 7       • Point-to-point Communication Services: Traditional voice communication  
8       service has been used for direct communication between users (user-to-  
9       user communication). This service has expanded to text messaging and  
10       other non-voice services (e.g. PSVT). Such services will be further  
11       enhanced by additional information, such as mobile positioning that  
12       serves to enhance application capability. Furthermore, the point-to-  
13       point category includes basic communication to support all other service  
14       categories.
- 15       • Personalized Infotainment Services: These individual information  
16       activities include news, movies, feature stories on leisure and hobby  
17       activities, travel information, etc.
- 18       • Enterprise/Business Services: Information services tailored to the  
19       business community.
- 20       • Education Services: Information services tailored to the education and  
21       training.
- 22       • Public Services, including Safety and Disaster Recovery: This category  
23       includes all services provided by national, regional or local government,  
24       including disaster management and public safety services.
- 25       • Health Care Services: The number of such services will expand as more  
26       attention is focused on health and wellness.

## 27 6.4 Service Enhancements

### 28 6.4.1 Voice Enhancements

29 The two primary areas of voice service enhancements are capacity and voice  
30 quality. In addition to that, VoIP transition is a major development, which  
31 should be executed well by the cdma2000 community.

1 3GPP2 has developed a solid voice platform in the EVRC vocoder, including its  
2 wideband component. EVRC is flexible, with features such as rate control in  
3 Revision B and later, and superior MOS performance. However, it is the  
4 deployment of these Revisions of EVRC, which will result in increased network  
5 capacity and/or improved voice quality. Deployment of VoIP, which will enable  
6 wideband codec in commercial use, will be a market-changing event. 3GPP2  
7 should be fully engaged in these deployment events, and ensure that any  
8 standardization support goes hand-in-hand with these deployment, if needed.

9 An important goal for the organization is to support improved end-to-end voice  
10 quality. To that end, proliferation of broadband EVRC over VoIP, with these  
11 same technologies gaining penetration in fixed networks, should be supported  
12 by concrete efforts in 3GPP2.

13 Additional aspects of voice quality include minimizing call setup delay, and  
14 availability of supplementary features, among others. For VoIP, call set-up  
15 delay performance goal should be the same or better than for CS calls. With  
16 the Common IMS initiative, 3GPP2 must ensure that IMS supports VoIP over  
17 HRPD well.

#### 18 6.4.2 Packet Data Enhancements

19 The key performance enhancements for packet data support are further  
20 reductions in the latency of packet transport across cdma2000 radio access  
21 and core network, and the assurance of low signaling delays, so that call setup  
22 and handoff times are minimized.

23 In terms of feature support, expansion of efficient roaming support is also an  
24 important objective. The other areas of enhancements can be grouped into  
25 gateway and core network enhancements:

26 Gateway network enhancements include:

- 27 • QoS management
- 28 • Low-latency signaling for session and handoff management
- 29 • Minimized and flexible signaling hierarchy architecture
- 30 • Support for multimedia services
- 31 • Multicast capabilities across Radio Access Technologies (RATs)
- 32 • Policy enhancements to support heterogeneous RATs
- 33 • Firewall requirements
- 34 • Support for a variety of access security capabilities

- 1 • Femto system enhancements (see section 6.4)

2 Inter-Technology Inter-working Enhancements (see section 5.9):

- 3 • Protocol enhancements for seamless mobility
- 4 • Context transfer schemes for handoff optimization

5 Core network enhancements include:

- 6 • Policy management across a variety of access technologies and domains
- 7 • User profile driven service discovery support
- 8 • Enhancements for PSTN emulation and simulation (e.g., adaptation to
- 9 all-IP followed by native all-IP)
- 10 • Accounting enhancements for different access technologies and charging
- 11 metrics
- 12 • OSA enhancements for third-party applications
- 13 • Security enhancements
- 14 • Codec negotiation support
- 15 • Seamless mobility across core networks
- 16 • Common IMS

17 One of the objectives of packet data architectural enhancements in the  
 18 upcoming period should be to develop solutions which will offer universal  
 19 mobility between a variety of access networks, making it simple for an operator  
 20 to introduce a new access network and to migrate from one access network to  
 21 another. One possible approach is to design the packet data architecture in  
 22 such a way that no changes in the core are needed in case an operator  
 23 introduces a new access in the network.

24 A major stride forward is being made in this respect with the definition of the  
 25 Evolved Packet Core (EPC) by 3GPP. Using a dual gateway approach, the  
 26 ability is provided to have a common core and to attach multiple access  
 27 networks, including both wireline and wireless access technologies. The  
 28 cooperative work between 3GPP2 and 3GPP to attach the eHRPD access  
 29 network to EPC is representative of this advancement. Network evolution from  
 30 tightly coupled with HRPD rev A, to tightly coupled with HRPD rev B, to dual  
 31 gateway (see Figure 1) with eHRPD rev B may be an attractive path for some  
 32 operators.

1 The current mobility solutions were designed with an objective to allow mobile  
2 terminal movement from one base station to another, i.e. the fundamental  
3 assumptions are:

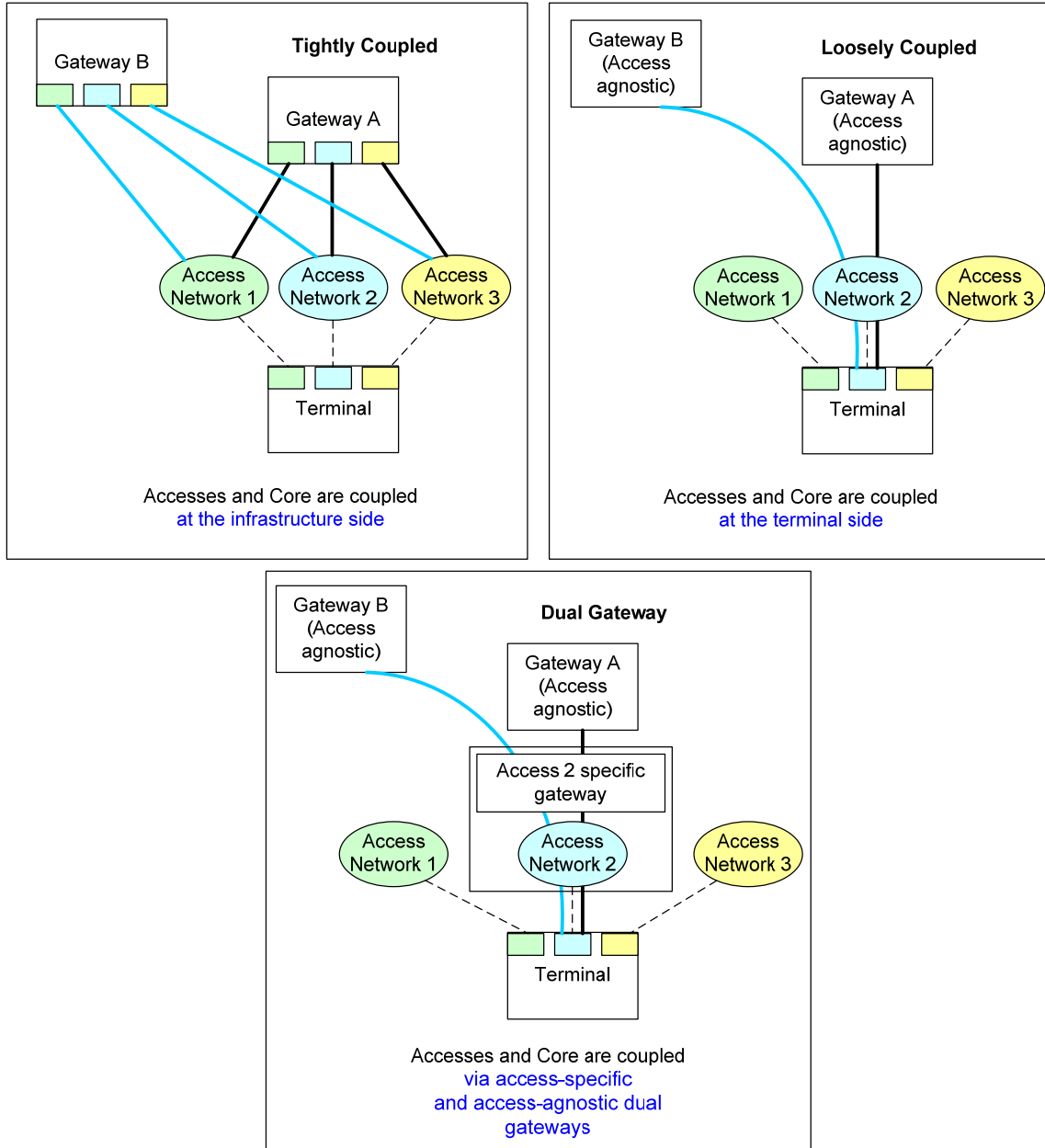
- 4 • Unchanged access technology
- 5 • The main service used by the subscriber is voice

6 Inter-technology mobility solutions that were subsequently developed built  
7 upon that basic concept, defined since the second generation network design.  
8 However, the scenario of mobile networks is much more complex now, with a  
9 plethora of different accesses, each with its own different characteristics, and  
10 with terminals capable of running many different applications, each with its  
11 own requirements.

12 Based on this consideration, the future mobility architecture should have as an  
13 objective the possibility for the terminal to be connected to any type of access,  
14 even simultaneously, and to move packet flows between connections,  
15 depending on radio conditions, user's preferences, operator's policies and  
16 application characteristics, be it on the same access technology, or between  
17 different ones. This type of mobility is referred to as universal mobility. One  
18 option is for the terminal to trigger this universal mobility, based upon the  
19 connectivity options available to it at any given time, and in accordance with its  
20 preferences, subject to controls imposed by the operator. An example of  
21 simultaneous multi-technology access is voice service on HRPD Rev. A and web  
22 browsing on WLAN.

23 The three mobility architecture options are illustrated in Figure 1.

24



1  
2  
3  
4

**Figure 1: Mobility Architecture Options**

5 In the tightly coupled architecture, the packet data core network gateway (GW)  
 6 must be coupled to each of the supported access network varieties individually.  
 7 The gateway is not access agnostic. The introduction of a new access implies  
 8 changes, in order to be adapted to the core, and possibly changes to the core,  
 9 in order to handle access-specific procedures and protocols.

1 A dual gateway architecture provides an answer to this issue by creating an  
2 access agnostic gateway and an access specific gateway to handle the details of  
3 specific access networks. This separation of the network agnostic and network  
4 specific functions into two gateways provides flexibility supporting multiple  
5 business models, multiple access networks, both home and local services, and  
6 controllable billing, e.g., for prepaid users.

7 In the loosely coupled architecture, every mobile is handled exactly the same  
8 way, be it a roamer or a local subscriber. In contrast to that, with the tightly  
9 coupled approach, if a roaming mobile needs to access its home gateway, that  
10 home GW must be connected to the local access network, and the access  
11 network must be able to handle the logic of connecting the mobile to the  
12 correct gateway.

13 The objective of the loosely coupled architecture is to make the gateway access  
14 technology agnostic. This can be achieved by limiting the access-specific  
15 coupling to the lower protocol layers between the terminal and each of the  
16 access technologies it supports, and building an access agnostic overlay that  
17 spans directly between the terminal and the gateway. This effectively achieves  
18 the binding of the terminal with the core independently from the accesses. The  
19 result is a simplified access system, having moved some complexities to the  
20 overlay, and each access variety simply providing an efficient local IP  
21 connectivity. This separation of core and access systems is achieved by a  
22 client-based mobility protocol.

23 The loosely coupled approach provides arbitrary connection of serving access  
24 network to core network which creates additional flexibility and more complex  
25 business models.

26 There are a number of benefits of the tightly coupled approach:

- 27 • An operator has tight control over which networks the mobile device is  
28 allowed to attach to.
- 29 • Inter-access technology mobility can be provided in a controlled manner.
- 30 • All backhaul is under the control of the operator.

31

32 The benefits of the dual-gateway approach are:

- 33 • A single core network architecture supports Common IMS and  
34 attachment of multiple access network technologies.
- 35 • Both wireless and wireline technologies are supported.
- 36 • There is a single way for operators to control Policy and Charging across  
37 roaming situations.

- 1 • Service limits, e.g., for prepaid subscribers, can be uniformly enforced  
2 across access networks.
- 3 • Inter-technology mobility can be supported.
- 4 • The ability of a misbehaving mobile to disrupt both access and core  
5 network operations is minimized.
- 6 • It is feasible for the terminal to operate on multiple accesses  
7 simultaneously, and to have mobility services between them.
- 8 • Core network evolution can proceed independently from access network  
9 evolution and vice versa, enabling each to develop at its own speed.
- 10 • Mobility between fixed/nomadic and truly mobile accesses are uniformly  
11 handled.
- 12 • An operator can offer services from any access network with which the  
13 operator has a business relationship.
- 14 • Offloading traffic to less precious accesses can be more easily  
15 implemented.  
16

17 There are a number of benefits of the loosely coupled approach:

- 18 • Applications can be decoupled from specific accesses by the uniform  
19 overlay.
- 20 • It is feasible for the terminal to operate on multiple accesses  
21 simultaneously, and to have mobility services between them.
- 22 • Core network evolution can proceed independently from access network  
23 evolution and vice versa, enabling each to develop at its own speed.  
24 Thus, it is not necessary for access systems to directly link with the core  
25 GW and with each other. There is no need to deploy a new core network  
26 when a new access type is introduced, and vice versa.
- 27 • Access systems can be simplified, as some key functions are moved to  
28 the overlay.
- 29 • Mobility between fixed/nomadic and truly mobile accesses would become  
30 more prominent.
- 31 • An operator can offer services from any access, even if not under its  
32 control.
- 33 • Offloading traffic to less precious accesses can be easier implemented.

- 1 • Enabling deployment of multiple access systems with lesser mutual  
2 dependency.

### 3 6.4.3 Mobile Broadcasting Services

4 The following Mobile Broadcast Services should be considered:

- 5 • Mobile broadcasting presents an opportunity for substantial future  
6 innovations in wireless services, in addition to its use as a tool for  
7 emergency management in such applications as wireless alerts in cases  
8 of potential natural disasters.
- 9 • In regards to emergency broadcast enhancements, the standard should  
10 allow good battery standby time once these services are put in operation.
- 11 • For multimedia Broadcast and Multicast Service (BCMCS), clip-casting  
12 security should be studied, to allow subscription-based service. Clip-  
13 casting is broadcasting of multimedia contents, usually of short  
14 duration, e.g. songs, music videos, news items, etc., for storing on the  
15 target mobile device, with the intent of later playback.
- 16 • Multicast messaging and group paging can be used for the purpose of  
17 addressing emergency response teams in the context of priority service  
18 support. They are an efficient way to distribute messages to a user  
19 group, as opposed to individual message to each member of the group.  
20 3GPP2 should enhance existing HRPD mechanisms with a cost efficient  
21 method to enable broadcast/multicast messaging applications.

### 22 6.4.4 Video Telephony and IPTV Services

23 PSVT has already been standardized in 3GPP2. However, the following should  
24 also be considered:

- 25 • Multimedia streaming, including video and audio (music), is a  
26 client/server web application that runs well over existing HRPD  
27 networks. 3GPP2 should investigate any required performance  
28 enhancements or supplemental web services for future applications in  
29 this area.
- 30 • IPTV is very similar to multimedia streaming. The principal distinction is  
31 multimedia codec formats (e.g. support of HDTV or Blue Ray format), and  
32 the associated accounting model. Authorization and charging may need  
33 to be addressed.
- 34 • As in the case of PSVT, femto cell deployments have the potential to  
35 enable IPTV, using femto cells as multimedia hubs in households. With  
36 femto cells, IPTV offers the potential for innovative and disruptive  
37 services for wireless operators. In its standardization work, 3GPP2



1 should account for such potential development, though this is not  
2 expected to affect the work plan in a direct sense.

### 3 6.4.5 Location Based Services Enhancements

4 Geographic location capability of cdma2000 is very strong in comparison to  
5 competitive location technologies in wireless devices. Further enhancements  
6 may be considered in the following areas:

- 7 • In addition to Assisted GPS (A-GPS), owing to synchronized network  
8 operation, cdma2000 has at its disposal Enhanced Forward Link  
9 Trilateration (E-FLT) techniques. Augmenting A-GPS in indoor and  
10 urban canyon environments when GPS satellite visibility is limited; this  
11 technique helps make cdma2000 location sensing extremely accurate  
12 and reliable. This robust basic solution and the technological lead it  
13 provides in the marketplace must be maintained and further improved.
- 14 • Emergency location (e.g. E-911 in North America) has proven to be a  
15 valuable public assistance capability, so much so that regulatory  
16 agencies are recognizing its value, and are aiming to further improve it  
17 by tightening accuracy requirements. Whereas previous accuracy  
18 requirements were on an aggregate statistical basis (throughout the  
19 operator's network), regulatory trend is to further improve accuracy  
20 requirements, and to make them applicable on a more granular basis,  
21 e.g. down to county average, and furthermore to municipality, postal  
22 code, even possibly city block in the future. The value of FLT techniques  
23 is thus becoming obvious, since the greatest accuracy challenge is in  
24 dense urban environments, where many users are in urban canyons or  
25 indoors in high-rise buildings with poor penetration of GPS signal.  
26 3GPP2 should strive to further improve these techniques, taking  
27 advantage of technological developments such as Highly Detectable  
28 Pilots, and broadband sampling capability trends in mobile terminals,  
29 which allow improved PN phase resolution, harmonic interference  
30 reduction, triangulation efficiency enhancements, etc.
- 31 • Femto cells are also important components of future, more accurate  
32 location service capabilities. High quality femto cell location standards  
33 must be developed in 3GPP2, so that femto cells meet Emergency Calling  
34 accuracy requirements, and their deployment positively contributes to  
35 the pending accuracy requirements on a more granular basis, where it  
36 counts most – indoors. Additionally, future femto cells are expected to  
37 have altimeter built in, so that vertical position can also be provided to  
38 emergency personnel.
- 39 • As VoIP deployments approach, Emergency Location native to HRPD  
40 must be enabled, as opposed to relying on cdma2000 1x.

- 1 • Making location services work with minimum impact on battery life is of  
2 paramount importance to commercialized location based services. Any  
3 standards impediments to that underlying standing requirement should  
4 be addressed. As mobile terminals become more capable, commercial  
5 location services will increase in appeal. For example, trends such as  
6 improved display technologies, increased memory for storing maps, faster  
7 data rate capabilities to download maps and current traffic data,  
8 additional sensors (e.g., odometer, accelerometer), etc., all have the  
9 capacity to supplement service offerings for location services.
- 10 • Network openness to run any application on a terminal will help to  
11 enhance location based services. With web-based maps that are easy to  
12 use and integrate into applications, communication services with the  
13 location component are potentially on the verge of mass market take-up.

#### 14 6.4.6 End-to-End Priority Services Enhancements

15 Wireless Priority Services (WPS) have been developed and they are already  
16 deployed for circuit-switched voice service on cdma2000 1x. For the future:

- 17 • In the next phase, aimed at VoIP, video, and packet data, the intent is to  
18 extend and broaden this capability, as well as to refine and enhance it  
19 relative to its predecessor. 3GPP2 has started work on this project by  
20 developing requirements for Multimedia Priority Services (MMPS). In the  
21 upcoming period, 3GPP2 should continue to support this effort.

22 The project envisions five (5) levels of priority, from the executive branch  
23 down to disaster recovery respondents. Privileged access and use of  
24 network resources is granted to priority users at times when ordinary  
25 users are blocked from accessing the network due to congestion or  
26 incapacitation of resources.

27 To work under all conceivable scenarios, MMPS with its associated  
28 priority capabilities must be supported throughout the network and at  
29 any and all potential blocking points. Thus numerous mechanisms must  
30 be developed, for example capability to queue up the users' MMPS  
31 invocation requests for network resource, rather than blocking them in  
32 case of congestion.

33 Strong security measures must exist to ensure that MMPS is not abused  
34 by fraudulent users.

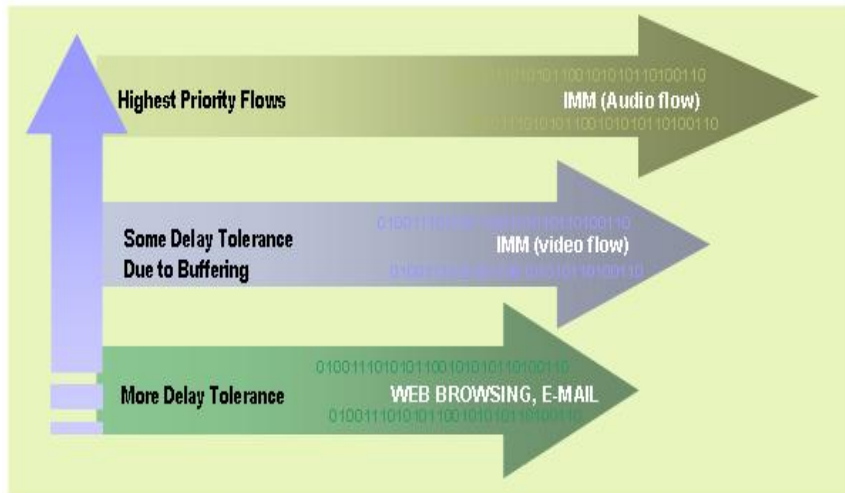
- 35 • Once developed and supported in the networks, this capability can be  
36 extended to the business and private sector, without jeopardizing its  
37 intended purpose. It would allow definition of premium service for high-  
38 end business users. These users would have preferential treatment by  
39 the network, with differentiated Grade of Service (GoS). High-end users

1 would experience low blocking rate during busy hour, and better data  
 2 traffic performance (e.g., low packet drop rate, queuing for resources,  
 3 etc.), while low-end users would have opposite experience. Off busy  
 4 hours, such differentiation is inconsequential.

- 5 • User differentiation by GoS will become one of possible tools to further  
 6 manage network growth. GoS offers ways to differentiate users by  
 7 blocking rates they experience. This approach may be appealing in some  
 8 markets, but care must be taken that consumer reception is well  
 9 understood before launching such capabilities, perhaps combining it  
 10 with minute buckets.
- 11 • GoS differentiation is related, but different than QoS. This is illustrated  
 12 in the following two figures.

13 Figure 2 is a pictorial illustration of flow-based QoS. Flows belonging to  
 14 different applications with different delay tolerance are differentiated in  
 15 their QoS treatment. The primary objective of flow-based QoS is to  
 16 efficiently allocate network resources for each application, commensurate  
 17 with that application delay tolerance, thus maximizing network  
 18 throughput. At any given time, network resources are equally shared by  
 19 two users each running an application with same QoS requirements.

20



21

22

**Figure 2: Flow-based QoS Differentiation**

23

24

25

26

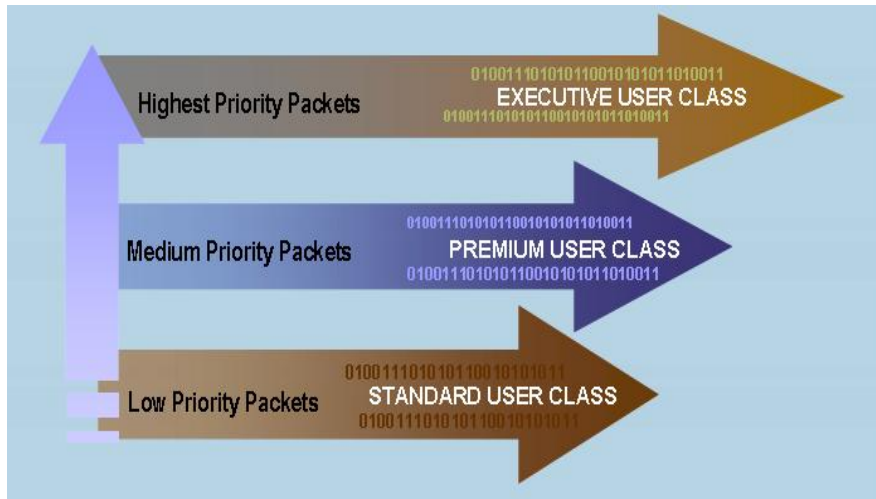
27

28

In contrast to that, GoS differentiation can occur among two users running the exact same application. When network resources are reaching the limit, the user with lower priority may experience dropped packets and more sluggish performance compared to a user with higher priority. This is illustrated in Figure 3. The differentiation is based on the user’s subscription level (Executive, Premium, Standard), where user

1 subscription profile determines transmission resource allocation, while  
 2 trying to keep them within general constraints of delay tolerance for a  
 3 given application, until resource exhaustion. Admission differentiation is  
 4 also applicable.

5



6

7

**Figure 3: Grade of Service Differentiation**

8 6.4.7 Advanced Network and Services Management (Self-Organizing Networks)

9 One of the most important trends in the wireless communication industry is  
 10 advancements in network management, and the accompanying management of  
 11 services. The goal of these advancements is to make network configuration as  
 12 automated as possible, ultimately to have the networks self-configure. Thus  
 13 the term Self-Organizing Networks (SON) entered the lexicon.

14 Nowhere is the goal of SON more important than in the case of femto cell  
 15 systems. There are two principal reasons for that.

- 16 • Activation of a femto cell must be simple for a typical customer, including  
 17 those who do not possess much technical know-how, and those who  
 18 expect ease of use of a consumer product such as femto cell.
- 19 • Hundreds of thousands of femto cells are expected to be deployed on a  
 20 large operator's network, often with a rapid pace of activation. It is  
 21 operationally less efficient for the operator to dedicate human resources  
 22 in their operations divisions to support this by way of a manual process.

23 Thus from the operator's perspective, the process should be "no-touch", with  
 24 rare cases of manual intervention and trouble-shooting.

25 Upon acquiring the femto cell by the customer, and exchanging basic  
 26 information with operator customer representative, which should be no more

1 extensive than cellular phone activation, the rest should be largely automated.  
2 Femto cell activation should be an easy set of steps of connecting the femto cell  
3 hardware to the fixed broadband outlet, applying power, and having the femto  
4 cell operate within a few minutes thereafter. This is sometimes referred as  
5 “plug-and-play”.

6 For this vision to become reality, supporting standards must be developed for  
7 the accompanying OAM&P systems, which will do the work for the operator  
8 with minimum manual intervention and oversight. The NGMN White Paper on  
9 Next Generation Mobile Networks puts it well in stating the overall goal as  
10 follows: “O&M systems should be an integral part of the network and not be  
11 designed and deployed as an afterthought”.

12 Some of the important steps in activating a femto cell automatically include:

- 13 • Initial discovery by the femto cell of the operator’s femto network gateway  
14 over the fixed broadband connection;
- 15 • Authentication and establishment of secure connection to the gateway  
16 based on the unique identity of the femto cell that is presented to the  
17 gateway;
- 18 • Automatic determination of the femto location, based either on GPS, and  
19 if in a local that does not have good GPS reception, with assistance from  
20 the surrounding macro network, and position location intelligence in the  
21 operator’s core network;
- 22 • Automatic determination of the neighbor list, based on the  
23 measurements conducted by the femto cell when first installed;  
24 Likewise, being able to automatically cope with any macro cell network  
25 changes such as cell splits;
- 26 • Automatic determination and configuration of other radio parameters,  
27 such as band class and frequency of operation, transmit power, Pilot PN  
28 Offset, etc., without resorting to manual cell planning;

29 Once femto cell is in operation, its performance should be monitored  
30 automatically by the system and self-optimized in many of the aspects of  
31 operation. For example, the system can monitor hand-in and hand-out  
32 success rate. The aggregate (for all femto cells) success rate can be used to  
33 evaluate algorithms for radio self-configuration, and refine those algorithms,  
34 e.g. the algorithm for PN Offset planning.

35 Femto cell systems are the best application of SON, but OAM&P automation  
36 efforts should extend to macro cellular components of the network planning,

1 management and maintenance, provisioning of network resources,  
2 subscriptions, and application management.

### 3 6.4.8 Cognitive Networks

4 Statistics show that there are inefficiencies in spectrum allocations and in the  
5 actual use of allocated spectrum. This is partly a result of variation of user  
6 densities, but also difficulties in managing more granular allocations.  
7 Spectrum licenses, by their nature, must be assigned for a relatively long  
8 period of time to make them economically viable for licensees. Yet  
9 technological changes are ever more rapid. Hence the appeal of cognitive radio  
10 networks, wherein communication systems “adapt” to and use available  
11 spectrum in a given locale, if not actually occupied by a licensee, or if in a  
12 license-free band.

13 Cognitive networks present a potential paradigm shift in spectrum  
14 managements. Regulatory agencies are adapting to a more flexible rules of  
15 use, by allowing secondary use, e.g. in unoccupied TV spectrum. The current  
16 licensed occupants have priority, but systems with cognitive network  
17 capabilities can use this spectrum otherwise. One potential use of cognitive  
18 networks is in peer-to-peer communication, and using relays, which allows ad-  
19 hoc networking to be established. The key technological capability is ability of  
20 communication devices to sense presence of available spectrum, which can be  
21 put to such use.

22 One of the side benefits of this technology is improved robustness in cases of  
23 widespread calamity, which is appealing to regulatory and government  
24 agencies, whose charters are to enable effective public assistance in such  
25 situations.

26 Cognitive networks could be one of the distinguishing areas of development  
27 opportunity for 3GPP2.

### 28 6.4.9 Machine-to-Machine Communication Applications

29 Cellular networks have the advantage of longer range and mobility support,  
30 which are lacking in other M2M standards.

31 Optimizing support for Machine-to-Machine (M2M) communications in 3GPP2  
32 networks will allow operators to penetrate and establish a strong position in  
33 this emerging and potentially large market [3]. Enhancements to current  
34 cdma2000 1x and HRPD air-interface protocols for optimized M2M support will  
35 allow operators to leverage existing network deployments in the near term.  
36 This market spans a wide range of applications such as telematics, vending,  
37 POS applications, automation manufacturing and control, telemedicine, etc.

38 The desirable features to optimize support for M2M communications are  
39 outlined below, from both air-interface and network perspectives. These

1 features and functionality to enhance support for M2M applications are  
2 suggested based on [3], [4], and [5].

### 3 6.4.9.1 Subscription Management

4 The system should be able to support the following subscription management  
5 capabilities:

- 6 • Subscription management for a large number of terminals
- 7 • Activation of a large number of terminals simultaneously, as opposed to  
8 one at a time
- 9 • Assignment of terminals to a service provider without human  
10 intervention, in today's cellular network, activation is cumbersome  
11 process that involves in-store or by-phone contact followed by over-the-  
12 air (OTA) activation
- 13 • Ability for remote subscription change for a large number of devices in  
14 the field. For example, a chain of photo-copier stores (the photo-copiers  
15 have embedded cellular network connectivity) wishes to change their  
16 service provider. It should not be required that the device(s) be brought  
17 back to the service provider outlet
- 18 • Dynamic provisioning should be supported for M2M devices.

### 19 6.4.9.2 Security Management

20 The credentials of these M2M devices should be managed securely, including  
21 the following:

- 22 • Appropriate security mechanisms may include a combination of physical  
23 and network based methods
- 24 • The device should not be required to be placed in a physically secure  
25 location or even physically locked

26 Network-based challenge response mechanisms need to be explored. This may  
27 pose a significant challenge when coupled with other desirable features  
28 described later.

### 29 6.4.9.3 Charging and Accounting Management

30 Generation of charge records should be possible for a wide variety of  
31 applications that include bulk message transfers, high bit rate video  
32 monitoring from a few locations, communications from a very large number of  
33 very small payload sessions etc. Representative session frequencies and data

1 payloads per session for a large number of M2M applications are indicated in  
 2 Table 1:

| Application                                    | Examples  | Access Frequency (sessions/unit time) | Number of Payload bytes/session  |
|--|---|---------------------------------------|----------------------------------|
| Vending  | Initially for high value items such as phone cards, cigarettes for inventory management                       | <5 times/day                          | small (10s of bytes)             |
| Machine monitoring/SCADA                       | Photocopiers, elevators, industrial machines, game machines where no access to local LAN for security reasons | <5 times/day                          | small                            |
| Automated meter reading                        | Electricity, gas meter reading  | <5 times/day                          | small                            |
| Smart metering                                 | Providing prices to end users for demand response, per appliance metering, parking meters etc                 | ~ 50 times/day                        | small                            |
| Home security                                  | As a backup to phone line or broadband  | rarely                                | small                            |
| Environmental Sensing                          | temperature, humidity, strain, road etc.  | varied                                | small(if not aggregated), medium |
| Vehicle Tracking                               | Occasional need to locate vehicle (theft, lost in parking lot etc.)   | rarely                                | small                            |
| Point of sale                                  | gas stations, rental returns  | ~100 times/day                        | medium ((1000s to 10K byte)      |
| Displays and Billboards                        | Traffic information on roads, dynamically changing advertisements, bus arrival times                          | 1~100 times/day, ~1000 times/day      | small to several mbytes          |
| Remote Video Surveillance                      | Toll/speed cameras, remote entrances to buildings, oil pipe lines etc   | continuous; rare if event triggered   | Mbytes/sec                       |
| Fleet Management                               | car rental, taxis, trucks, staff scheduling   | ~10-100 times/day                     | small to Mbytes                  |
| Driver/Vehicle Performance Monitoring          | Vehicle diagnostics(send back information on condition of car travel speed, etc)                              | ~10-100 times/day                     | ~1000 bytes                      |
| VehicleTraffic Information/Routin g/Navigation | Provide real-time traffic and routing   | continuous                            | Bytes/sec                        |
| Telemedicine                                   | Heart rate/auscultation rate  | continuous when triggered             | Kbytes/sec to Mbytes/sec         |

3  
 4 **Table 1: Some M2M Applications and Their Requirements**  
 5



1 In addition:

- 2 • Aggregate charging mechanisms that minimize network load and do not
- 3 cause scaling problems with current network architectures should be
- 4 considered
- 5 • Aggregate accounting across a number of devices should be supported

6 New roaming and mobility models for charging will be required. Alternate  
7 charging should be supported for stationary use. The stationary mode may  
8 need to be detected.

#### 9 6.4.9.4 Network Management

10 M2M Network management should include direct device management (as  
11 opposed to user-mediated), activity detection and monitoring of devices to  
12 prevent fraudulent use. It may be necessary to provide device behavior  
13 information to the network for fraud detection and remedial action.

#### 14 6.4.9.5 Address Management

15 Several challenges must be overcome to support deployment of large numbers  
16 of M2M devices and services are to be successfully deployed. These include:

- 17 • Mechanisms to overcome device ID (MEIDs, IMSIs) depletion
- 18 • Multiple subscriptions should be possible for a single M2M device each
- 19 applied in its distinct subscription domain
- 20 • IP address management for static IP and dynamic IP assignment
- 21 environments
- 22 • Group and per-operator addressing. It is expected that this will facilitate
- 23 device management and subscription change and management

#### 24 6.4.9.6 Data Management

25 Multiple communication paths should be supported for complete coverage.  
26 Different networks (cellular/WiFi) may be used at different times and data may  
27 come in from these different networks at different times. The system should be  
28 designed to have the ability to collate data from the same M2M device arriving  
29 through multiple interfaces.

#### 30 6.4.9.7 New M2M Device Class

31 New terminal classes targeting M2M modules should be specified. M2M  
32 terminals need not have all of the functionalities of a full-fledged voice  
33 terminal. They can support fewer features such as reduced set of coding and  
34 modulation rates, hybrid ARQ modes, etc. For this reason, it is beneficial to

1 have a separate class for such terminals with their own set of minimum  
2 requirements for testing.

### 3 6.4.9.8 Extended Battery and Low Power Operation

4 Battery life for M2M devices should be extended over current devices taking  
5 advantage of low power operation. A class of M2M applications, for example  
6 remote environmental sensing, is likely to be battery operated. Long battery life  
7 for such sensors is critical to the success of the application. Establishing the  
8 communication link with lower transmission powers will open up the cellular  
9 interface for a number of new applications, thereby increasing the number of  
10 devices using cellular networks. Operation at low powers is feasible because  
11 low data rate transmission is sufficient for many such applications.

12 Even when devices are not battery operated, limiting the transmit power can  
13 result in lower terminal complexity. Low power operation could reduce the  
14 filtering requirements since adjacent carrier interference will be reduced. It is  
15 beneficial to have a requirement for low power operation, e.g., to provide 95%  
16 coverage with 15 to 20 dB lower transmit power at a suitable transmission  
17 rate, which could be as low as 1 Kbps. Under low transmit power operating  
18 conditions, increased transmission range is not expected.

### 19 6.4.9.9 Extended Range Operation

20 Complementary to the low power requirement, extended range operation  
21 should be supported to take advantage of the low data rate. Since some of the  
22 M2M devices could be inside buildings it would be beneficial to extend the  
23 coverage for low data rates specifically meant for M2M communication.

### 24 6.4.9.10 Device Complexity Reduction

25 For low transmit power terminals, the possibility of relaxing the filtering  
26 requirements and still meeting the spectral mask/adjacent channel  
27 transmission power leakage limits should be investigated. Relaxed filtering  
28 requirements can potentially reduce the cost of the terminals.

29 Multi-code transmission increases the peak-to-average power ratio thus  
30 requiring a higher back-off and thereby limiting the range. Techniques to work  
31 around the need for multi-code transmissions should be investigated.

32 M2M applications generally do not require make before break seamless  
33 handoffs. This offers an opportunity to simplify the base band significantly by  
34 tracking only a single sector pilot at a given time. This can reduce pilot search  
35 requirements obviating the need for multiple searchers.

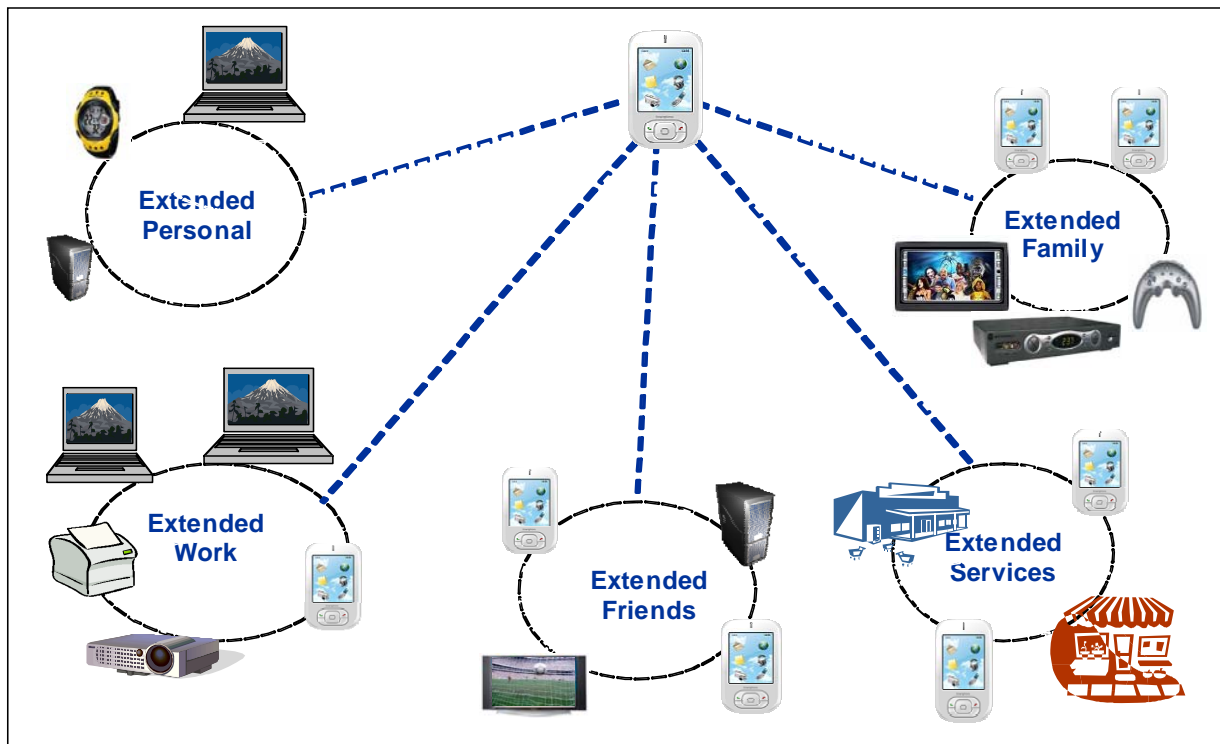
### 36 6.4.9.11 Scalability

37 Based on the low duty cycle, low throughput, and data transfer requirements of  
38 some of the applications, from an air-interface capacity point of view it would

1 be possible to support a very large number of devices. However, it is necessary  
 2 to ensure that other system aspects can handle a large number of devices that  
 3 may be in the dormant state.

#### 4 6.4.9.12 Peer-to-Peer Communication Applications

5 The objective of user-to-user communication applications (see illustration in  
 6 Figure 4) is to enable heterogeneous devices (e.g., mobile phones, consumer  
 7 electronic devices, PCs, etc.) to form overlay peer-to-peer networks to  
 8 communicate with each other in a distributed fashion (see illustration in Figure  
 9 4). Networks are expected to help enable application deployment without  
 10 significant costs other than the application development itself. They are also  
 11 expected to drive addition of services without significant effect on  
 12 infrastructure costs. An example use case is an extended personal network  
 13 created using an affinity among devices.



14

15

16

**Figure 4: Peer-to-Peer Overlay Networks**

1 This involves investigation and development of peer-to-peer network and  
2 service discovery, network formation and maintenance mechanisms and secure  
3 communications. This includes aspects such as Network Address Translation  
4 (NAT) and firewall traversal, service descriptions and discovery framework, and  
5 group communication. The idea is to develop common functionality to enable  
6 application development over peer-to-peer networks. A hybrid architecture  
7 composed of enrollment servers, accounting infrastructure and logging devices  
8 need to be part of the system.

9 6.4.10 Device Assisted Service Offerings (Cooperative Communications)

10 Cooperative communications occur between and among end-user Terminals (T)  
11 and the Network (N) where:

- 12 • Variants include N to T, N to N, and T to T
- 13 • Cooperative use of scarce resources such as battery, power, bandwidth,  
14 backhaul etc.
- 15 • Offer services through various combinations of Relays, MIMO, distributed  
16 antennas, etc.

17

1 **7 NETWORK AND END-USER EQUIPMENT CAPABILITIES**

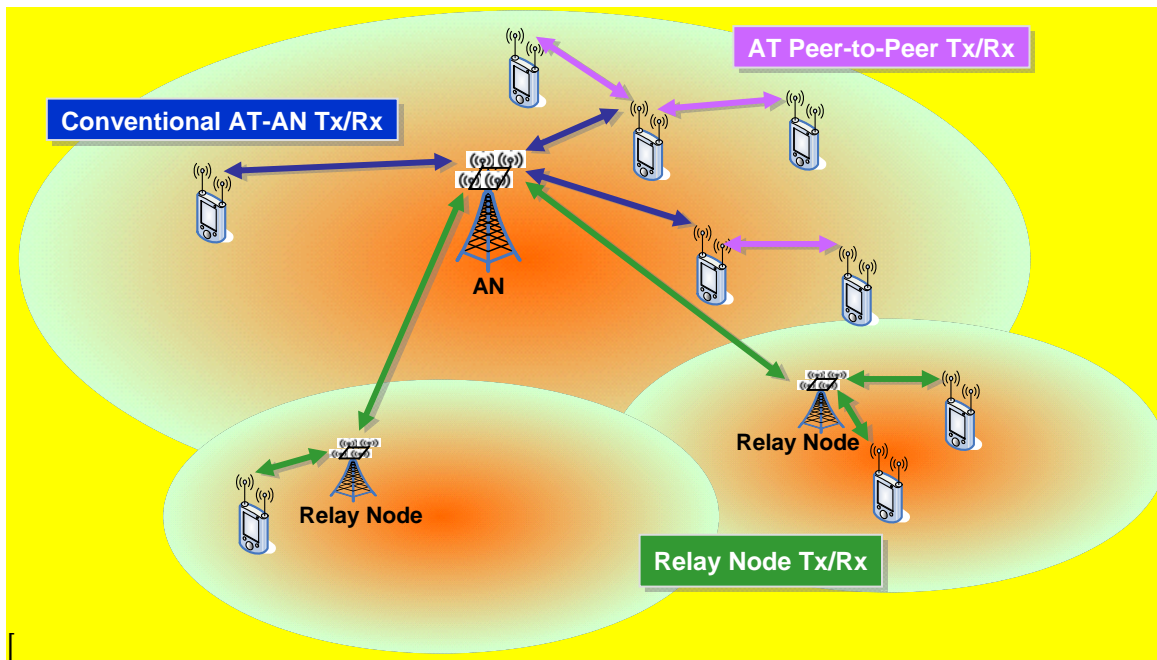
2 7.1 Relays, Multi-hop

3 Wireless relays have existed as a concept for some time, but their commercial  
 4 viability is improving as high data rate technologies and applications using  
 5 them grow. The key benefits of wireless relays:

- 6 • Reduction in path loss, thus improving coverage (relay amplifies a signal  
 7 before transmission)
- 8 • As a result of lower path loss, improved signal/noise ratio, allowing  
 9 higher data rate transmission
- 10 • Less complex deployment

11 Relays can be used in certain situations to improve backhaul efficiency for  
 12 operators, and they also enable a novel deployment model. In a newly deployed  
 13 network, for example, relays can be put in place first, until traffic grows to  
 14 warrant the full-fledged BS, which is more expensive than a relay. One can see  
 15 that relays go hand-in-hand with femto cells. Relays enable more rapid  
 16 deployment for coverage, until capacity growth occurs in an area.

17 Concept of relays is shown on Figure 5, which illustrates two basic variants of  
 18 relay networks – Peer-to-peer AT Transmit/Receive, and Remote Relay Node.



19 [ **Figure 5: Illustration of Relays and Multi-hop Connections**

1 Relays are not without drawbacks, and they have yet to be proven in an actual  
2 deployment scenario. The main drawbacks are complexity and increased  
3 signaling overhead. Multi-hop relays provide further potential benefits, but  
4 complexity is increased. However, solutions must include that option to allow  
5 migration from single to multi-hops.

6 In peer-to-peer relays, ATs cooperate by lending each other reception and  
7 transmission resources, i.e. an AT can act as a relay for another AT. In a  
8 multi-hop scenario, interference can be reduced, increasing overall efficiency,  
9 and likelihood of connectivity. This is particularly useful for emergency  
10 communication, under severe coverage conditions due to outages of traditional  
11 fixed infrastructure resources.

12 Mesh networking is closely related to relays. It's a concept of decentralizing  
13 network controls and scheduling. It's a way of taking multi-hop relays a step  
14 further. Relay and mesh networking can be helpful in certain situations, such  
15 as when there is clustering of mobiles (e.g. on a train).

## 16 7.2 Multimode System Selection

17 When system operators either own networks with non-cdma2000 air interfaces  
18 or have affiliates with non-cdma2000 air interface networks, multimode  
19 terminals will be required to allow the user to access service wherever it may be  
20 operating and on whatever compatible air interface is available. These  
21 multimode terminals will require a more flexible system selection mechanism to  
22 access those air interfaces based on geographic conditions and home operator  
23 priorities.

24 System selection is a reference to access management for a terminal that  
25 supports multiple radio access technologies. As multi-mode devices proliferate  
26 and technologies are intermingled, with co-existence of several varieties of 2G,  
27 3G, and in the future 4G networks, WLANs, etc., this issue is gaining in  
28 prominence. 3GPP2 should cooperate with other standards bodies to develop  
29 standards support for comprehensive system selection that is technologically  
30 sound, and meets a variety of business interests of operators and needs of  
31 subscriber.

32 As a guiding principle, the end user and its device are in the best position to  
33 observe what technologies are available at a given locale, how user experience  
34 shapes selection, etc. This should be done with the oversight and consent of  
35 the operator.

36 Any operator policy constraints should be pushed to the terminal, so that the  
37 terminal and user can, given those constraints, make the selection in a way  
38 that is user friendly, largely automatic, and preferably based on customary  
39 usage model of a given user, which however is flexible to allow migration of  
40 such usage model. The solution should have the flexibility to address various

1 business and situational cases. Low power consumption and minimal time to  
 2 acquire service are major requirements for a multimode system selection  
 3 mechanism.

#### 4 7.3 Terminal Battery and Power Consumption Improvements

5 New device technologies or services may cause increases in terminal power  
 6 consumption. Lowering power consumption and extending battery life are  
 7 required to maximize the user experience.

8 In addition to battery life considerations for user terminals, power consumption  
 9 by infrastructure functional elements should also be of concern in the current  
 10 era of worldwide attention given to global warming and the drive toward cleaner  
 11 and more efficient products and technologies. 3GPP2 should do its part to  
 12 address these issues by developing and refining standards such that they are  
 13 conducive to green technologies in broader sense. The following examples are  
 14 meant to illustrate some potential efforts.

- 15 • Wireless traffic volumes go down at night, when users are less active.  
 16 Base stations supporting multiple carrier frequencies could potentially  
 17 handle the lower night-time traffic with fewer carriers, by moving users  
 18 to a reduced set of carriers and temporarily turning off transmission of  
 19 unused ones.
- 20 • With the deployment of femto cells, their owners will have an incentive to  
 21 turn them off when not in use, in order to save power (e.g. while  
 22 members of the household are all at work or in school during the day, or  
 23 at night). Equally significantly, the macro system will benefit from  
 24 reduced interference by elimination of radio transmission from unused  
 25 femto base stations. It is feasible to standardize a system with mobile  
 26 assisted power on/off control of femto cells, which will make this process  
 27 seamless, not requiring any conscious action by users. A mobile can  
 28 automatically generate commands transmitted over the macro cellular  
 29 system, based on the mobile's proximity to its home femto cell. A  
 30 command signifying mobile's entrance into its home zone can be used to  
 31 turn the femto cell on. In the converse case, mobile's departure away  
 32 from its home zone can be used to turn the femto cell off. Mobile's  
 33 location need not be precise, e.g. such operation should not require GPS  
 34 precision, or any close tracking of mobile's location, which could be too  
 35 costly in terms of mobile's own power consumption. Such a system will  
 36 have to have an override capability, allowing the operator to keep femto  
 37 cells on, for the purpose of responding to a general emergency, e.g. in the  
 38 case of natural disaster. Under those circumstances, the added capacity  
 39 and robustness of the femto system becomes priority. Similarly, if an  
 40 open access femto is serving a mobile who is not the owner of the femto

1 cell, the feature should be temporarily disabled, or it should take effect  
2 upon first moving the user to the macro cellular system.

### 3 7.4 Inter-Technology Interworking

4 At present, the wireless industry is characterized by the following  
5 developments, driven by trends discussed in the beginning of this document.

- 6 • Proliferation of multimode devices
- 7 • On-going technology migration
- 8 • Imperative for global interoperability, as wireless operators operate  
9 internationally and strive to support roaming in a comprehensive fashion

10 3GPP2 should be committed to supporting inter-technology interworking. This  
11 allows operators to be more flexible in their migration plans, to introduce  
12 innovative solutions gradually and without risk of negative impact on existing  
13 subscribers. As stated in the opening parts of this Vision Document, the  
14 industry is firmly on the path of global cooperation on technological front, as  
15 well as on the business front.

16 Technology interworking has multiple facets including:

- 17 • Multi-mode system selection (see Section 5.6)
- 18 • Roaming and network support for multi-mode terminals
- 19 • Network and subscription policy issues
- 20 • Security

21 Interworking culminates in mobility from one access technology to another,  
22 with each technology possibly being defined by a different standards  
23 organization. Inter-organizational standards cooperation is critical. 3GPP2  
24 has a strong track record of addressing inter-technology issues in a prudent  
25 fashion, and should continue a sustained effort in the same vane.

26 3GPP2 is developing inter-working solutions between 3GPP2 technologies  
27 (HRPD and 1x) and 3GPP LTE and WiMAX®.

28

29

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32 Certified,” and “WiMAX Forum Certified” are trademarks of the WiMAX Forum.



1 The eHRPD network is an extension of the HRPD access network which enables  
2 single-radio and multi-radio terminals to attach to the EPC (evolved packet  
3 core) of 3GPP. Additionally, eHRPD support seamless handoffs between E-  
4 UTRAN and HRPD with single-radio terminals. Voice call continuity with and  
5 fallback to cdma2000 1x for voice service is also supported.

6 The interworking of HRPD with WiMAX enables seamless handoffs between  
7 WiMAX and HRPD systems for single-radio terminals. A dual-radio  
8 interworking solution between HRPD and WiMAX has also been developed  
9 by the WiMAX Forum®.

10 It can thus be seen that 3GPP2 has a strong track record of addressing inter-  
11 technology issues in a prudent fashion, and should continue a sustained effort  
12 in the same vane.

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1 **8 CANDIDATE RADIO TECHNOLOGIES**

2 It is imperative for cdma2000 family operators to maintain technology  
3 competitiveness of cdma2000-1x and HRPD. cdma2000 family is the best and  
4 most economical proven platform for voice and packet data communication.

5 3GPP2 should continue to update band classes and sub-classes, so as to  
6 broaden the market reach of cdma2000.

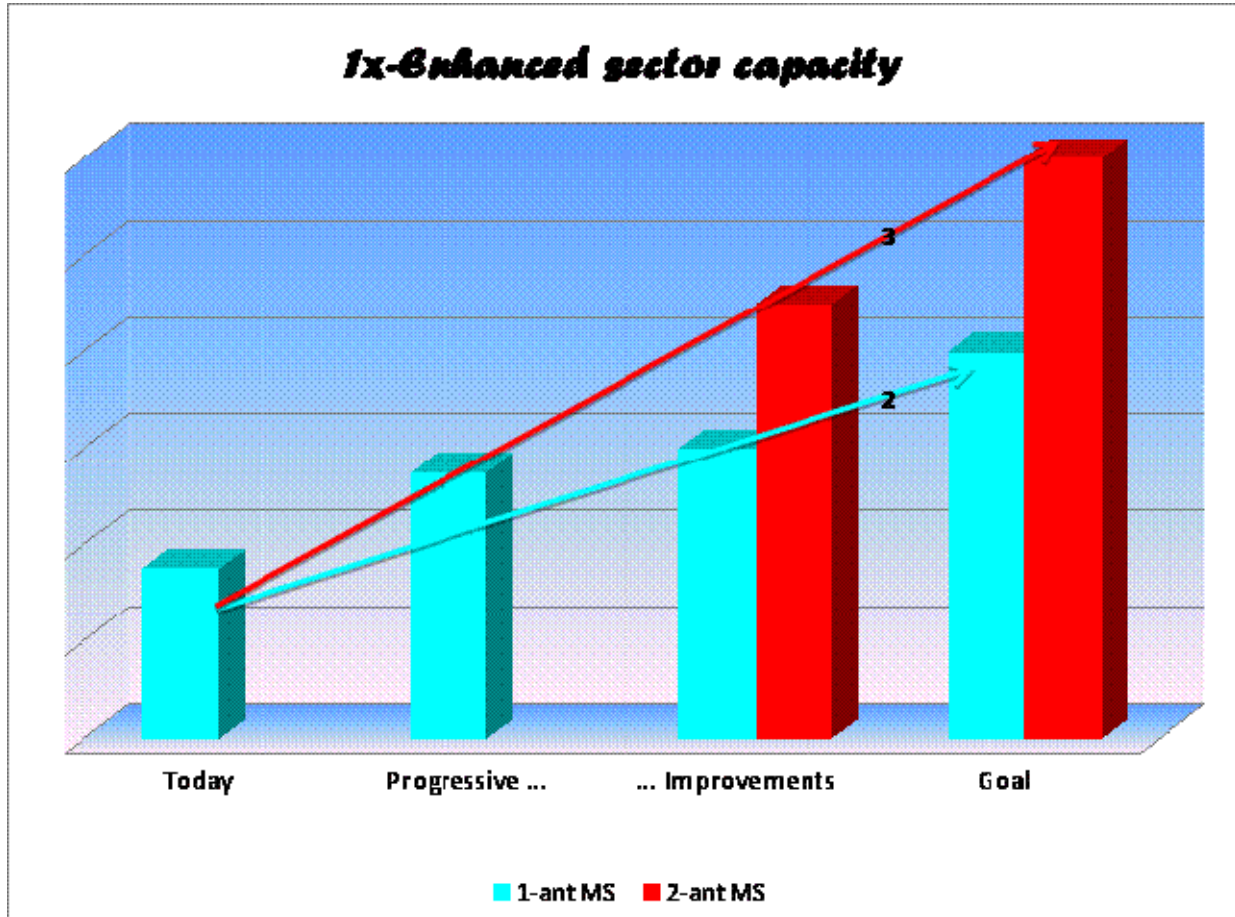
7 In addition to aggressive and industry-distinguishing performance  
8 improvements in 1x and HRPD, 3GPP2 should explore additional technical  
9 areas of leadership in wireless industry, possibly cognitive radio.

10 8.1 Capacity Improvements

11 Further VoIP and CS voice capacity enhancements, i.e. further spectrum  
12 efficiency improvements, are universally shared and enduring goals for 3GPP2.  
13 VoIP-ready HRPD systems are expected to lead the market in wireless  
14 deployments.

15

1



2

3 **Figure 6: Capacity Improvement Goals of 1x-Enhanced**

4 Note: Capacity estimates are based on a combination of simulations and  
 5 analysis of proposed changes performed by Qualcomm. Performance figures  
 6 are provided to illustrate goals, and subject to change.

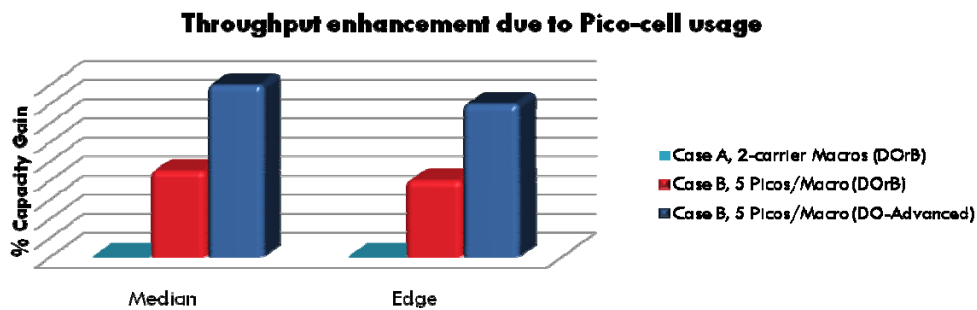
7 Techniques to be considered for this improved capacity include but are not  
 8 limited to:

- 9
- Interference Cancellation for Forward and Reverse Link (FLIC and RLIC)
  - 10 • Hybrid Automatic Repeat request (HARQ)
  - 11 • Power Control Optimization
  - 12 • Smart Blanking

13 The following must also be considered:

- 1 • Note that operators may choose to deploy in increments, or to leap-frog  
2 any intermediate steps, some of which are independent of each other  
3 (e.g., FLIC is a mobile feature, RLIC is a base station feature, and are  
4 independent from one another).
- 5 • Lower rate and rate controls on EVRC can be used to deal with capacity  
6 at times of peak traffic, but care should be taken that voice quality not be  
7 compromised, so as not to adversely affect customer satisfaction.
- 8 • With these capacity improvement measures, cdma2000 1x-Enhanced  
9 should be considerably ahead in voice spectral efficiency in comparison  
10 to foreseeable advancements in competing technologies.
- 11 • Regarding HRPD-Enhanced, support of heterogeneous networks (pico  
12 cells and femto cells) will enhance the performance and allow deployment  
13 flexibility.

14



15

**Figure 7: Illustration of HRPD-Enhanced Capacity Improvements**

16

*(Source: QUALCOMM)*

17  
18 Figure 7 illustrates performance gains achievable by heterogeneous  
19 network deployments and other advancements being studied for HRPD-  
20 Enhanced. The figure illustrates two deployment options on top of an  
21 already deployed macro carrier:

22

Case A: 2nd macro carrier deployed in all cell-sites

23

Case B: Deploying dual-carrier pico-cells wherever needed

24

Comparative performance of HRPD Revision B and HRPD-Enhanced is shown for Case B.

25

26 This serves to illustrate deployment flexibility and the overall advantage  
27 that a narrower band system can have with heterogeneous networks,  
28 when hot-spot coverage is required.

29

- 1 • Reduced transmission latency is an important performance

2 characteristic for real-world applications, such as http. In HRPD-

3 Enhanced, radio interface component of the round-trip packet delay can

4 be improved with load adaptive reverse link latency target methodology.
- 5 • Simultaneous circuit-switched voice over cdma2000 1x and packet-

6 switched data over HRPD is feasible using a multi-carrier capable

7 terminal. Modern chips contain a fast A/D converter (around 100 MHz

8 and soon higher) and other RF, analog, and DSP components enabling

9 these broadband capable terminals. When a cdma2000 1x and an HRPD

10 carrier are within terminal bandwidth capability, both can be received

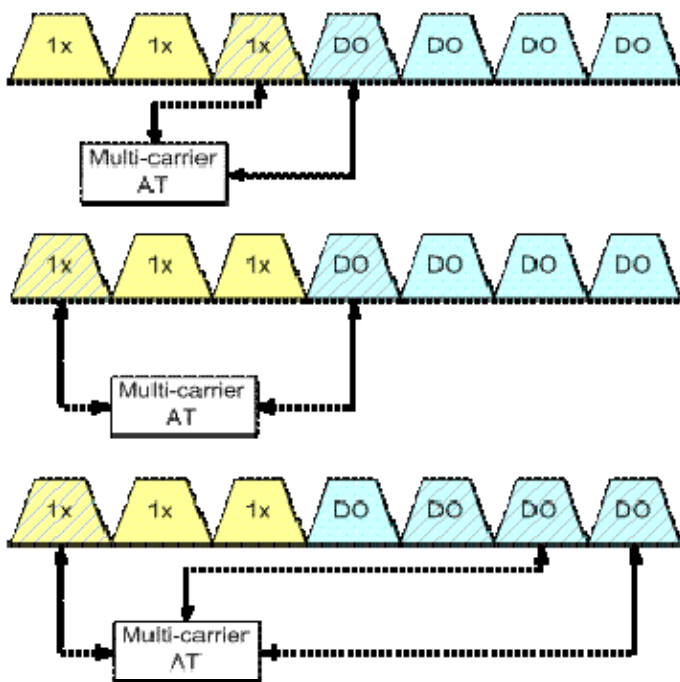
11 simultaneously. On the transmit side, the two signals can be combined.

12 This is independent of the HRPD radio interface revision. This is

13 illustrated in Figure 8, which shows possible options in combining 2 or 3

14 multi-carriers with spacing of up to 6 carriers total.

15



16  
17

18 **Figure 8: Combined cdma2000-1x and HRPD Multicarrier Placement**

19 Each cdma2000 1x and HRPD can operate independently, e.g., an application

20 on one can start independently of what is happening with another.

21 Specifications need to be developed regarding handling MS capability

22 limitations (e.g. allowed carrier separation, relative priority between voice on

23 cdma2000-1X and data on HRPD, etc.)

1 Simultaneous cdma2000 1x and HRPD entails multiple simultaneous Tx/Rx  
2 processes (bandwidth aggregation).

### 3 8.2 Femto Cell Support

4 The advent of femto cells is an artifact of one of the significant trends in the  
5 telecommunication industry known as fixed-mobile convergence (FMC), which  
6 encompasses multiple radio technologies including cdma2000 1x, HRPD, GSM,  
7 WCDMA/HSDPA, WLAN, etc. Both cdma2000 1x and HRPD are well  
8 positioned in this trend, and the goal of 3GPP2 should be to maintain and  
9 advance that position with successful evolution of femto cell systems for these  
10 technologies. Femto cells deployed in the licensed spectrum with smooth  
11 interworking and integration with the macro cellular system is the truest kind  
12 of FMC, since allows existing mobile devices to instantly attain FMC capability.

13 There are favorable drivers for femto cell growth including:

- 14 • Improvements in wireless coverage for weak or dead spots in the macro  
15 network or for areas outside the macro network coverage area
- 16 • Coverage improvements to resolve in-building penetration problems
- 17 • cdma2000 1x and HRPD “hot spot” coverage areas
- 18 • Coverage improvements to achieve higher data rates than may be  
19 achievable in light of lower SINR conditions, multipath, and other fading  
20 problems in the macro network
- 21 • Increased customer loyalty
- 22 • Economical deployment vis-à-vis macro cell deployment and operation  
23 complexities

24 Femto cells can significantly contribute to the overall network growth in a  
25 friendly and economical fashion. Femto cells can also become home network  
26 platforms and media hubs.

27 The initial focus of 3GPP2 specification activities for femto cell support is being  
28 driven as a phased effort as defined in S.R0126-0 v1.0 System Requirements  
29 for Femto Cell Systems as follows:

30 “Phase 1: Development of basic femto cell functionality intended for  
31 residential use, for support of legacy mobiles and limited femto-macro  
32 mobility when both macro and femto operate the same radio interface  
33 (e.g., both are cdma2000-1x).

34 Phase 2: Enhancements for more comprehensive mobility, including  
35 femto-femto handoffs, mobility between dissimilar radio interfaces, etc.

1 Phase 2 may additionally include enhancements that can facilitate  
2 denser femto cell deployments.”  
3

4 Phase 1 primarily focused on supporting a CLOSED access system – that is a  
5 system where access to the femto cell is limited to a fixed number of  
6 subscribers who have been specifically authorized to use that system. A closed  
7 access system will provide the basic platform for a residential or SOHO network  
8 intended to achieve the following objectives:

- 9 • Provide improved coverage for weak or dead spots in the macro network  
10 or for areas outside the macro network coverage area
- 11 • Provide improved coverage to resolve in-building penetration problems
- 12 • Provide improved coverage to achieve higher data rates than may be  
13 achievable in light of lower SINR conditions, multipath, and other fading  
14 problems in the macro network

15 However, the potential benefits to an operator’s network cannot be achieved  
16 until OPEN access femto cells are supported. The target benefits include full  
17 integration into the macro network to support load balancing, interference  
18 mitigation, and network controlled capacity management strategies.

19 The key technical issues that should be addressed for support of open access  
20 femto cell systems include:

- 21 • Full femto-macro mobility including femto hand in and femto hand out
- 22 • Full femto-femto mobility for areas that need to be covered by multiple  
23 femto cell access points
- 24 • Enhanced femto-macro and femto-femto interference cancellation  
25 support including both band splitting and shared frequency  
26 deployments. These strategies are required to support denser femto cell  
27 deployments. These interference cancellation schemes may include, but  
28 are not limited to, the following:
  - 29 • Directional antennas
  - 30 • MIMO/beamforming femto cell access points
  - 31 • Frequency and time hopping algorithms
  - 32 • Adaptive power control algorithms

- 1 • Hysteresis algorithms to prevent femto-macro and femto-femto “ping  
2 pong” accesses
- 3 • Algorithms to reserve femto bandwidth for primary users (e.g., users who  
4 are logged into the femto cell access point vs. those users redirected for  
5 improved network performance)

6 Critical for femto cell systems success will be ease of installation at customer  
7 premises, without extensive hands-on support by operator. This plug-and-play  
8 and no-touch aspects of OAM&P for femto cells is broadly known as Self-  
9 Organizing Networks (SON), and is discussed at some detail in Section 4.10.  
10 Femto cell systems are ideal candidates for proving out SON concepts. SON  
11 aspects of femto cells are key to their success, and will be subject of  
12 standardization in the upcoming period.

13 Generally speaking, open access to femto cells is the current direction of the  
14 market. This does not seem likely to change in the next 3-5 years. This should  
15 be the ongoing assumption in 3GPP2. Open access removes much uncertainty  
16 concerning interference, which is the most critical issue with femto cells,  
17 especially for legacy mobiles. At the same time, it is critical to specify robust  
18 handoff procedures from femto to macro system, to cope with situations such  
19 as exhaustion of femto channel resources.

20 Enterprise access may be the next wave of interest for femto cells, allowing  
21 deployment of a grid of femto cells in close proximity of each other, intended to  
22 provide carpet coverage within an enterprise campus. Business motivation for  
23 such deployments is similar to WLAN access, but could be amplified due to  
24 voice services capability. For this application, inter-femto handoffs should be  
25 fully standardized.

26 In conjunction with the enterprise applications, 3GPP2 should also explore the  
27 possibility of inter-femto soft handoff, and in the longer run, macro-femto soft  
28 handoff. At present, macro-femto handoffs are not studied extensively due to  
29 the fact that considerably tighter integration of the macro system and femto  
30 system would be necessary.

31 To prove out the femto business case, operators are initially reluctant to make  
32 major changes to the macro system in order to support the nascent femto  
33 market. However, this situation will change as femto cells get proven out in the  
34 market place, and as their advantages in capacity growth upkeep become more  
35 apparent.

36 Current market interest for femto cells is primarily focused on cdma2000 1x.  
37 Over time, addition of HRPD capability will occur. Eventually, HRPD-only  
38 femto cells may become popular for PC access, but in the longer term also for  
39 VoIP. 3GPP2 should anticipate such developments and be ready with



1 standards, so that products may address market demand in a timely fashion,  
2 once it materializes.

3 In conjunction with that, native use of IMS signaling from HRPD femto cells  
4 has the potential to substantially simplify the femto system architecture. This  
5 would facilitate support of VoIP and packet-switched video telephony using  
6 femto cells, and may stimulate the market for video communication. The  
7 economy for PSVT is more appealing than on the macro system, also from the  
8 man-machine interface perspective, video is more realistic from fixed or semi-  
9 fixed location.

10 One interesting potential application of femto and pico cells is venue-casts -  
11 BCMCS application over a temporarily deployed set of femto cells or pico cells  
12 in a conference or sports event venue. In addition to venue-casting, such  
13 deployment may be used by operator as a tool to relieve traffic from the macro  
14 system in a locale with a large concentration of users.

15 Another application that is similar in nature is AdHoc femtos, small personal or  
16 small group networks. Starting with emergency applications as market  
17 motivator, this application of femtos can grow into commercial realm, such as  
18 student groups at school.

19 On the technology front, advance MIMO antenna configuration can be  
20 attractive to enable higher data rates on HRPD femtos. This will allow HRPD  
21 femtos to fare favorably against competing technologies.

22 An additional technological opportunity is interference cancellation (IC) at  
23 femto receivers, which may prove important in dense deployments of femtos,  
24 such as the ones in enterprise locations. Using signaling capabilities required  
25 for handoffs, IC can improve spectrum efficiency performance, and can be an  
26 additional tool in interference management, critical for the long terms success  
27 of femto systems.

28 Further potential for integration exists in inclusion of fixed broadband modems  
29 into the femto cell. Though this is not subject to standardization, 3GPP2  
30 should ensure that standards specifications allow such product developments.

31 On the handset side, enhancements for femto-aware mobiles are already taking  
32 shape in 3GPP2, with system selection using advanced concept known as PUZL  
33 (Preferred User Zone Location), which individually in each mobile device  
34 contains a database of descriptors and pointers to femto cells for that device,  
35 allowing it to find them with minimum search effort. Further advancements  
36 using PUZL concept should be pursued, allowing autonomous configuration  
37 system selection for femto-aware mobiles, with good battery performance and  
38 taking maximum advantage of the deployed femto cell system.

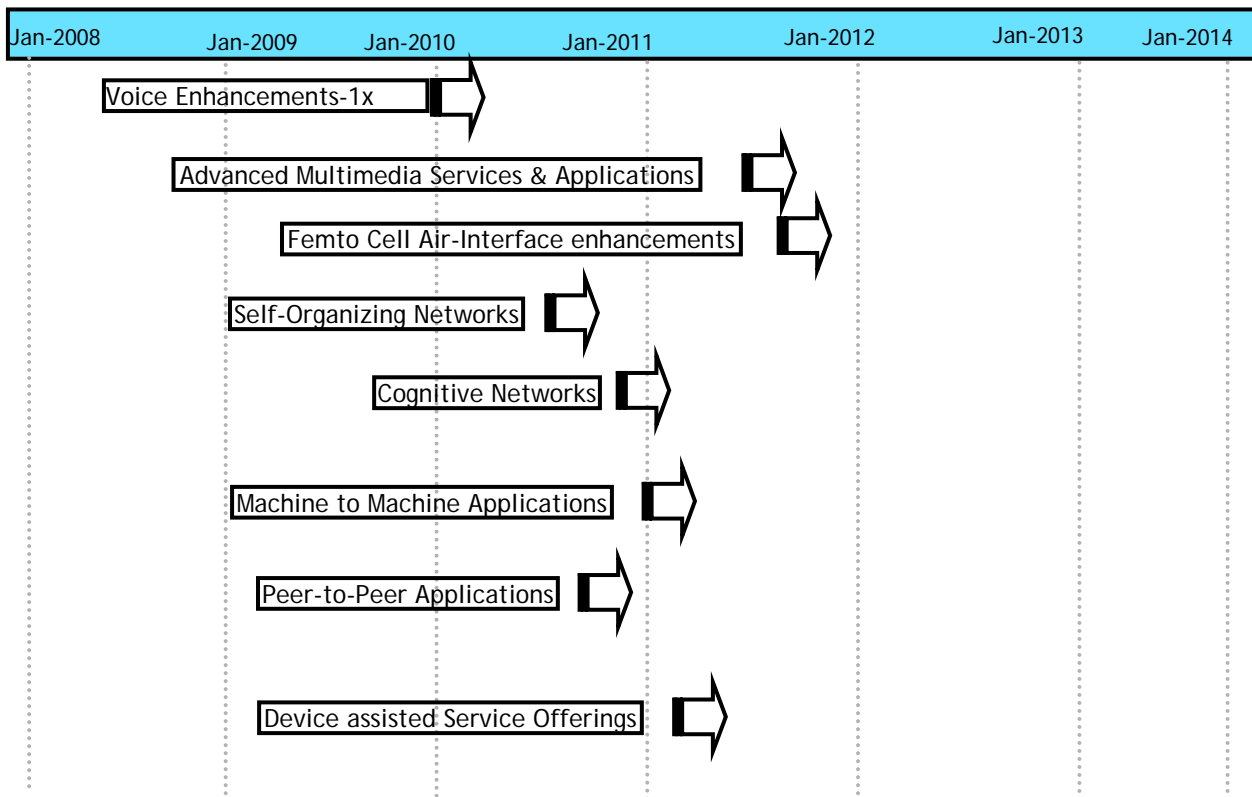
1 To reduce MS complexity for mobility between dissimilar radio interfaces  
2 (FDD/TDD, cdma2000/non-cdma2000 air interfaces, etc.) the capability  
3 should be specified so that the MS is not required to transmit simultaneously  
4 on both radio interfaces (i.e., specifications for single radio devices design  
5 should be supported).

6

1 **9 SERVICES AND APPLICATIONS ROADMAP**

2 This section provides a roadmap with service development time-lines. Figure 9  
 3 provides a high level roadmap for various applications and services previously  
 4 described in this document. Temporal dependencies and interactions between  
 5 some services may exist due to some common enabling functions and building  
 6 blocks. These temporal and feature interactions are not captured in this time-  
 7 line primarily to keep the figure simple and provide a high level view.

8 In Figure 9, the start of the arrow depicts either on-going efforts at the time of  
 9 this document being written or the view of anticipated activities in the coming  
 10 years. The arrow end-points only reflect anticipated completion of some simple  
 11 ideas currently being discussed in 3GPP2. As research in many of these  
 12 complex technology areas are currently underway, we anticipate new ideas will  
 13 emerge leading to continuing enhancements. Only broad categories are  
 14 highlighted. Many of these categories may be broken down into several  
 15 components, if desired.



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**Figure 9: Services and Applications Time-line (Anticipated)**

1 Annex 1 – Operator Priorities for cdma2000 1x and HRPD  
2 Enhancements

---

3 **HRPD Enhancements**

4 Interworking with Non-3GPP2 Systems

- 5 • Link Layer Interworking
- 6 • Network Layer Interworking

7 Enhanced Capacity

- 8 • Interference Cancellation Forward Link
- 9 • Interference Cancellation Reverse Link
- 10 • Multiple Antennas (MIMO, SDMA, OSTMA, etc.)
- 11 • Femto Cell Interference Management

12 **cdma2000 1x Enhancements**

13 Interworking with Non-3GPP2 Systems

- 14 • Link Layer Interworking
- 15 • Network Layer Interworking

16 Air Interface Modifications for Femto

17 Enhanced Voice Capacity

- 18 • New Radio Configuration (Eight rate blanking, slower power control, early  
19 decoding of frames)
- 20 • Quasi-Orthogonal Functions
- 21 • Power Control Changes (ZTE, Qualcomm or Motorola method)
- 22 • Forward Link Interference Cancellation (Qualcomm Linear Interference  
23 Cancellation)
- 24 • Reverse Link Interference Cancellation

25 **Other Related Enhancements**

26 MIMO on 1x and HRPD

- 1 Enhancements in Throughput on 1x and HRPD Using the Same Spectrum
- 2 Bandwidth
- 3 Co-existence of Multiple Vendors in the Same Area/Business District
- 4 Simultaneous 1x and HRPD
- 5 Seamless 1x/HRPD Integration