

The Convergence of WLAN and CDMA 2000 1x Networks

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The global mobile communication networks currently in operation are mainly based on GSM and CDMA technologies.

The two types of networks enable mobile users to access packet-switched networks through general packet radio service (GPRS) and packet data service system (PDSS). Many operators and manufacturers are concerned about how to converge WLAN with GPRS or PDSS networks so as to offer more convenient services to their mobile users. This article takes PDSS network as an example, and discusses in detail how to converge WLAN with CDMA 2000 1x PDSS networks.

The WLAN and CDMA 2000 1x network are mutually complementary. WLAN offers high-speed packet data access services, while the CDMA 2000 1x network offers low speed, continuous and roaming-enabled packet data access services. Therefore, WLAN can be used as a supplementary access to CDMA networks to bring new development chances for CDMA networks.

As the two systems differ from each other in architecture, consequently in authentication and access methods, technical obstacles are inevitable in converging the two networks. However, two integration solutions can be recommended: loose coupling and close coupling.

1 Adopting the Loose Coupling Technology

The loose-coupling solution means the access server in WLAN (such as a narrow band access server) and the access server in CDMA

Abstract:

The technical solutions to the convergence of WLAN and CDMA 2000 1x are presented and compared. Problems brought on by network convergence are analyzed, and solutions to problems such as the coexistence of packet data service nodes (PDSNs), user identification, roaming, and handoff are discussed in detail.

2000 1x (such as a packet data service node) are completely independent of each other.

In the case of a fixed wired network, the subscribers' authentication, authorization and accounting are all performed in one AAA (authentication, authorization and accounting) server. The WLAN and CDMA 1x networks work independently without any interference with each other. The construction and development of one network do not have any impact on the other one.

2 Adopting the Close Coupling Technology

The close coupling solution is relative to the loose coupling solution. It means that the two networks maximally share the same fixed wired packet network resources. The two systems are independent of each other only when applied in wireless networks. The packet data service node (PDSN) is the access gateway to CDMA 2000 1x networks, while mobile terminals obtain access to packet-switched networks through PDSN.

Generally speaking, the existing PDSN merely offers packet-switched network access services for CDMA 2000 1x users. But in the

close coupling solution, GDSN supports WLAN user access services through general data service nodes (GDSN). Therefore, GDSN can support both CDMA 2000 1x and WLAN user access services, while PDSN can only provide access services for CDMA 2000 1x users.

In the close coupling scheme for WLAN and CDMA 2000 1X, main network nodes include access terminals, access points, access point gateways, GDSN, home agents, and AAA servers.

(1) Access Terminals

The access terminal (AT) can be a handset or a personal digital assistance (PDA) which can access to both WLAN and CDMA 2000 1x networks; it can also be a portable PC installed with a WLAN network card, and a CDMA 2000 1x network card, or a dual-mode interface card. An access terminal can even be any kind of wireless terminal providing access to a WLAN system.

(2) Access Points

An access point (AP) is usually a device used to connect the WLAN terminal to the fixed wired packet-switched network, providing users with wireless access services and data access services as well. An AP comprises a wireless processing module and an Ethernet interface module, performing wireless user management, wireless channel dynamic allocation, and protocol translation from 802.11b to 802.3.

(3) Access Point Gateways

The access point gateway (APGW) performs tunnel operation. It encapsulates media streams coming from wireless terminals so that the media streams can cross over IP networks and reach GDSN through the tunnel.

(4) GDSN

As GDSN and the access point gateway are identical to each other in their interfaces, the PPPoE session from the WLAN terminal is very much like the PPP over HDLC session from the CDMA 2000 1x terminal, only slight modifications on PDSN will enable WLAN users for access services.

(5) Home Agent

When an AT uses a mobile IP for access, a binding relationship established between the maintenance mobile console IP address and

the forwarding address will forward a message consisting of data IP with AT as the destination address to the forward address via the tunnel. At this point, GDSN takes over tasks from the foreign agent (FA) in mobile IP.

(6) AAA Servers

The AAA server provides authorization, authentication and accounting services for both WLAN and CDMA 2000 1x terminals.

3 A Comparison Between Loose Coupling and Close Coupling

The comparison between loose coupling and close coupling shows the advantages and disadvantages of the two solutions.

(1) Advantages of Loose Coupling:

- WLAN and CDMA 2000 1x technologies exist independently without any interference with each other.

- Low threshold for technical integration, with multiple mature products already available.

(2) Disadvantages of Loose Coupling:

- The network is difficult to construct and manage. Each single service point (where services are implemented) needs at least one NAS attached with routing capability as its access server. But no router should exist between AP and NAS; otherwise, the WLAN will fail to access the network.

- Since service zones are independent of each other, they cannot share the NASs in different service zones. In this case, when the networks in different service zones are overloaded, different networks can't help each other share the load.

- When the end user employs simple IP technology to access the networks with different servers, handoff between WLAN and CDMA 2000 1x will be disabled. When mobile IP technology is deployed, this will overload both the HA and the network. As a result, the handoff remains inconvenient.

- Loose coupling enables only simple convergence of WLAN and CDMA 2000 1x, because they share one AAA server. Hence, this solution does not appear really effective. Instead, it can only be taken as a transitional one, even when dual-mode terminals come out in the near future.

(3) Advantages of Close Coupling:

- Conforms to CDMA 2000 standards. Both WLAN and CDMA 2000 1x network have similar network architectures and clear network topologies.

- Unified access servers offer access services for both WLAN users and CDMA 2000 1x users to enable new services (prepaid packet services) allocated into the two networks very conveniently.

- Fast handoff across networks for terminal users.

- Low operating cost and easy maintenance. Only one APGW is required for all of the service zones. But the unbalanced network load problem mentioned above will never occur. The access equipment is efficiently utilized.

- Standard R-P interface is applied to realize the aggregation of PDSNs with different access functions. Those PDSNs with no access to WLANs are dedicated to CDMA 2001x terminal users. The GDSNs that support both types of access services, can serve both WLAN users and dual mode users (WLAN plus CDMA 2000 1x) simultaneously. Therefore, PDSNs with different functions can coexist in the network.

(4) Disadvantages of Close Coupling:

- To enable the existing PDSNs to support WLAN services, the software on PDSN must be updated.

- Its implementation is more difficult than that of loose coupling. In some cases, the existing network device renovations are needed.

4 Solution for Technical Integration

Technically compared with loose coupling technology, the close coupling solution is more advanced, more scientific, so it has been accepted by more and more organizations and institutions.

4.1 Coexistence of PDSN and GDSN

Since the WLAN works as a supplementary access method to CDMA 2000 1x, and normally the CDMA 2000 1x network is constructed before WLAN, how to combine WLAN with CDMA 2000 1x is possibly not planned when building CDMA 2000 1x networks. As a result, the proper solution to the coexistence of PDSN and PDSN-W becomes the only way to protect

the operators' advance investment. Concerning the coexistence of PDSN and GDSN, considerations as follows should be taken in designing a WLAN network:

(1) The previously constructed PDSN will continue serving pure CDMA 2000 1x subscribers.

(2) GDSN serves both WLAN users and dual-mode system users (WLAN plus CDMA 2000 1x).

(3) WLAN and CDMA 2000 1x access getways need to be integrated. This not only helps provide users with characteristic packet data services like handoff, but also leaves room for the expansion of CDMA 2000 1x network in the future.

(4) As a supplementary to CDMA 2000 1x, the WLAN network should take WLAN users' demands into account in network planning.

For the secure coexistence of GDSN with PDSN and to prevent the operation of CDMA 2000 1x system from the impact of the construction of WLAN, the standard R-P interface signaling can be used to help subscribers select intelligent options between PDSN and GDSN.

In a network where PDSN and GDSN coexist, the access pre-select machine (APM) software plays a very important role.

APM is a software that functions over every normal PDSN. The final access servers selected by either WLAN or CDMA 2000 1x users are all determined via APM. For WLAN subscribers, APM will choose GDSN that can support WLAN access. For sheer CDMA 2000 1x subscribers, APM will choose PDSN, and for dual-mode subscribers, GDSN will be selected.

4.2 User Identification

At present, there are two types of authentication modes for mobile subscribers:

The first type refers to the HLR authentication based on the existing CDMA voice service. This mode requires a subscriber identification module (SIM) to be installed on the WLAN interface card. When a mobile subscriber accesses WLAN, he first needs his ID to be authenticated by HLR in the CDMA network according to the international mobile subscriber identification (IMSI) on the SIM

card. A mobile terminal user cannot use WLAN network resources until his ID is authenticated. The advantage of the first mode is that the existing identification authentication mechanism of CDMA can be fully utilized. However, this solution greatly restricts the terminals since common WLAN network cards do not have this function. Furthermore, this solution conflicts with the development of CDMA, because HLR will eventually be replaced by RADIUS in the future.

The second solution refers to the user based RADIUS authentication mechanism. It is already implemented in the CDMA packet network service. Before a mobile terminal user can access WLAN or CDMA packet networks, his user ID needs to be authenticated first. In this solution, both WLAN users and CDMA packet network users share the same authentication mechanism. The reliable security mechanism provided by the CDMA packet networks is fully exploited without adding extra investment.

4.3 Roaming

The CDMA network uses IMSI as the only way to identify subscribers. So the system can perform such services as accounting, authorization and authentication for terminal users by simply following IMSI, even when a user roams to another cell. However, things become relatively complicated when WLAN subscribers roam into other cells. They are identified by their user names in two ways as follows:

(1)The first one refers to the mobile phone number plus password. The visitor AAA server analyzes this phone number and finds out its corresponding subscriber.

(2)The second refers to the SIM card number plus password or user name plus password. If merely user name or card number is used to identify subscribers, subscribers from different home locations may encounter the problem of homonymy. Besides, a normal user name or card number usually doesn't include home information. In this case, when a subscriber roams to another home location, a home domain name should be added to the user name or the card number. The AAA server can figure out the subscriber's home location by the

added suffixal domain name.

4.4 Handoff

How to guarantee mobile users' free and smooth handoff between networks is very important to the convergence of networks.

The most common solution is to install a dual-mode network card on the mobile terminal and integrate functions of WLAN and CDMA network cards. The dual-mode network card will decide whether to use WLAN or CDMA according to its current location. At the same time, mobile users can manually select the network for access.

Apart from dual-mode network card, relevant software is also needed. For example, a network card driver should be installed to a portable PC, so that the upper layer service applications will not be influenced by any changes occurred at the lower layer access network, and during the process of handoff, the IP address of the mobile terminal will keep unchanged, which is a key factor in realizing seamless handoff.

The WLAN and CDMA 2000 1x dual-mode terminal technology has not been put into commercial use yet, because multiple network elements are involved in the handoff between dual-mode terminals across networks, such as terminals, wireless networks and GDSN. The seamless handoff is still impossible for the time being.

According to the current status of terminals, auto-dialup plus manual solution may be applied as a substitute. That is to say, the terminal prefers to choose WLAN to connect to. It will only be connected to CDMA 2000 1x when there is no access to WLAN.

When a subscriber moves out from WLAN network access the CDMA 2000 1x network, the terminal dialing process will enable him to access to CDMA 2000 via auto dial-up. However, when a subscriber moves from CDMA 2000 1x to WLAN, manual operation will be needed because the WLAN-covered location is also covered by the CDMA 2000 1x network and the subscriber can not be automatically connected to WLAN.

Seamless handoff can also be achieved by the mobile IP technology. Both WLAN sub-

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