White Paper

# Cisco CDMA2000 Packet Data Services

As mobile wireless networks and the Internet connect in new and innovative ways, the opportunities for mobile operators to increase revenue, service offerings, and customer satisfaction grow as well. But mobile operators need access technology to keep pace with unprecedented demands. The technology must enable data-transfer rates that will make mobile Internet access both attractive and useful. To facilitate high-speed data access, international standards bodies are developing several new standards that provide the reliability, speed, and security required to offer mobile data services.

This paper describes Cisco® CDMA2000 Packet Data Services, a standards-based, cost-effective solution that allows mobile operators to deliver feature-rich packet data services in a Code Division Multiple Access (CDMA) environment. This solution includes the Cisco Packet Data Serving Node (PDSN); home agent and foreign agent functions; an authentication, authorization, and accounting (AAA) server (the Cisco CNS Access Registrar® server); and several security products and features.

A Cisco PDSN provides access to the Internet, intranets, and Wireless Application Protocol (WAP) servers for mobile stations that use a CDMA2000 Radio Access Network (RAN). CDMA is one of three key mobile communication technologies, the other two being time-division multiple access (TDMA) IS-136 and Global System for Mobile Communications (GSM). CDMA2000 is the third-generation (3G) CDMA technology that offers packet data. The largest CDMA technology networks are found in Korea, Japan, Malaysia, and North America.

The Cisco PDSN acts as an access gateway and provides simple IP and Mobile IP access, foreign agent support, and packet transport for VPNs. It acts as a client for the AAA servers, and also allows operators to enable prepaid billing services. Additionally, standalone Cisco PDSNs can be logically tied together under a clustering architecture to provide further benefits in terms of scalability, redundancy, load sharing, and more.

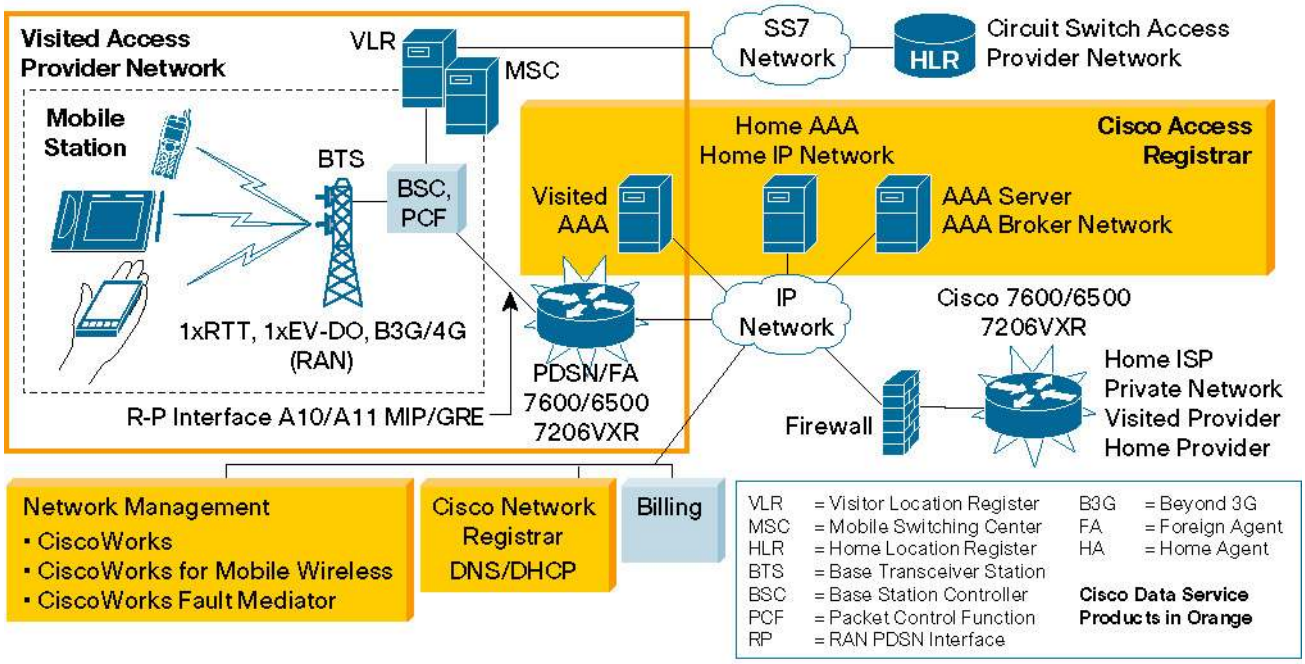
The home agent acts as an anchor point for mobile devices with Mobile IP or proxy Mobile IP services. Working with the Cisco PDSN with the foreign agent function (PDSN/FA), the home agent allows mobile clients with Mobile IP services to reach the Internet or corporate intranets by extending the coverage area of the existing PDSN/FA. Traffic is routed through the home agent, and the home agent also provides proxy Address Resolution Protocol (ARP) services. When reverse tunneling is used, traffic from the terminal is also routed through the tunnel to the home agent.

A Cisco PDSN network is similar to a traditional routed network. Mobile stations, which can be personal computers with wireless adapters, PDAs, or mobile handsets, are IP hosts. Like a default router in a traditional routing environment, the Cisco PDSN provides the gateway to the IP network for the mobile stations. What makes this different from a traditional routed network is mobility. Because the host in this case can move around, there must be a means to find the host so packets can be forwarded to it. The Cisco CDMA2000 Packet Data Services solution offers a secure means to provide packet data services to mobile stations.

## Architectural Overview

Figure 1 illustrates the components of a CDMA2000 network. The mobile station, which must support either simple IP or Mobile IP, connects to a radio tower and base transceiver station (BTS) that connects to a base station controller (BSC). The BSC communicates to the Cisco PDSN through a component called a packet control function (PCF), over a generic routing encapsulation (GRE) tunnel. The PCF and Cisco PDSN communicate with each other using a standard interface known as the RAN-to-PDSN interface, which has two components: the A11 interface, used for control messages, and the A10 interface, used for user data.

**Figure 1**
CDMA2000 Network Components




## How It Works

When a mobile station first makes a data service call, it establishes a Point-to-Point Protocol (PPP) session with the Cisco PDSN. The Cisco PDSN may authenticate the mobile station[1] by communicating with the AAA server in the visited IP network, which in turn may communicate to the AAA server in the home IP network (possibly through a AAA server in a broker network). The AAA server verifies that the user is a valid subscriber, determines what services are available for the user, and tracks usage for billing purposes. When the mobile station is authenticated, it may use the IP Control Protocol (IPCP) to request an IP address. In the case of simple IP routing, the mobile station is assigned an IP address by the local Cisco PDSN.[2] In the case of Mobile IP, the home agent assigns the IP address for the mobile node[3] during the Mobile IP registration process. A mobile node registers with a home agent when it determines that it is no longer in its home network.[4] This is necessary to receive datagrams because they would not otherwise be directed to the host at its current location. The mobile node communicates to the home agent through the foreign agent in the Cisco PDSN. This communication uses either IP-in-IP encapsulation (RFC 2003) or GRE (RFC 1701).

1 The Cisco PDSN solution also supports mobile station identifier (MSID)-based no-authentication access.

2 BTSs or BSCs. If, however, the mobile station moves beyond the area of the IP, addresses may also be statically defined. For simple IP virtual private dialup networks (VPDNs), the mobile station may get an address from its home AAA server.

3 Mobile node is the term used in the Mobile IP standards to refer to an IP host that supports Mobile IP. Mobile station is the terminology used in the PDSN standards. It is more generic and may include an IP host that supports only simple IP or multiple IP hosts sharing a common mobile access point. This document uses the term mobile node only when referring to a device that supports Mobile IP.

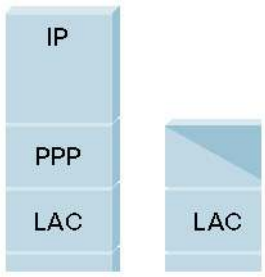
4 When a mobile station is trying to access a public network from its home access provider network, the home agent used is the home agent in the home access provider's network or home IP network. When the mobile station is roaming and trying to access a public network, it uses the foreign agent/PDSN in the visited access provider network and the home agent in the home access provider or visited access provider network, depending on the configuration in the visited network. When the mobile station is trying to access a private network or its home ISP network, the home agent resides in those networks.

When not in its home network, the mobile node will be associated with a care-of address (typically the address of the foreign agent). This address identifies the mobile node while the user visits other locations. As part of the registration process, the home agent puts a mobility binding into its binding table. This mobility binding associates the home address of a mobile node with its care-of address.

When the mobile node is authenticated, it can then communicate to any authorized IP device and through any authorized IP network.

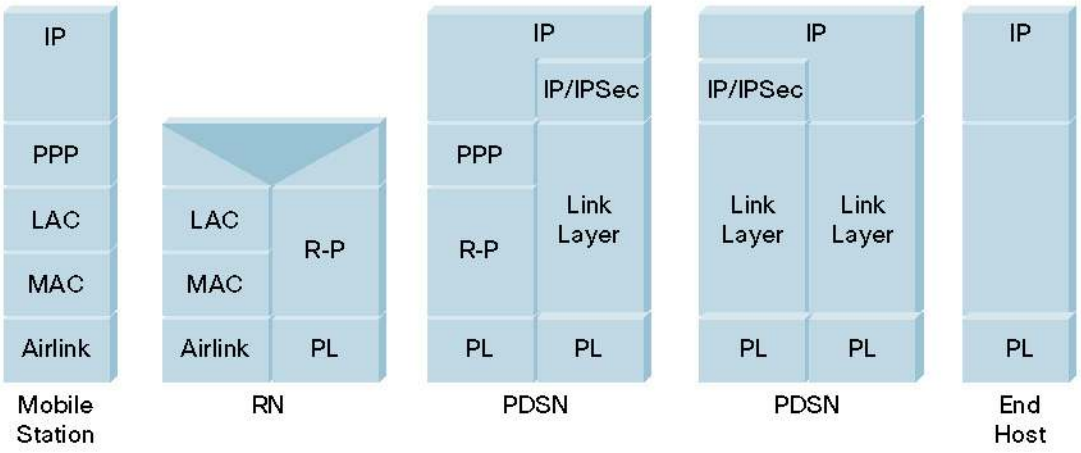
If the operator is offering VPN services, the mobile station can securely access private resources through a public Internet or dedicated links. The VPN tunnel extends from the Cisco PDSN to the home IP network (the IP network associated with the network address identifier; for example, the home IP network of xxx@ispxyz.com would be “cisco”).

**Figure 2**
Protocol Reference Model for Simple IP




So far, this is fairly straightforward IP networking applied to the mobile environment. When the mobile station becomes mobile and moves between different service areas, the scenario is more complicated. The mobile station can move to a different BTS or BSC. Because the PPP session exists between the Cisco PDSN and the mobile station, as shown in Figures 2 and 3, the Cisco PDSN maintains the PPP session while the mobile station is handed off between BTSs or BSCs. If, however, the mobile station moves beyond the area of the Cisco PDSN, then the session is handed off to a new PDSN and the PPP session is renegotiated. If the mobile station supports Mobile IP, the home agent maintains the IP address of the mobile station and its communication with any IP devices. If the mobile station supports only simple IP, it may be assigned a new IP address, and any application-level connections it has may be broken. This disruption can be avoided by using the Cisco proxy Mobile IP. The intelligent Cisco PDSN selection may also prevent a disruption. Both of these features are described later in this white paper.

**Figure 3**
Protocol Reference Model for Mobile IP User Data




## Solution Highlights

Providing mobile access to the Internet does not ensure success for mobile operators. The profitable companies will be those operators that offer the best services, the best customer experience, and the highest availability at the lowest cost. The Cisco PDSN solution is a cost-effective solution that is standards-compliant and offers many features to improve availability and scalability, tighten security, and enhance the customer experience.

## Features and Standards Compliance

The Cisco PDSN solution supports all required standards, including the Third Generation Partnership Project (3GPP2) TSG-X standard and Wireless IP Network Standard (also known as TIA/EIA/IS-835), which defines the overall structure of a CDMA2000 network. It includes features such as enhanced Mobile IP, carrier-class accounting, compression, security, and authentication. Cisco IOS® Software supports 3GPP2 TSG-A, Inter-Operability Specification (IOS) for CDMA2000 Access Network Interfaces, also known as TIA/EIA/IS-2001. The 3GPP2 TSG-A standard focuses on the radio side and the interfaces between radio components and the Cisco PDSN. Cisco supports 3GPP2 IOS 4.3 in Release 3.0 of the Cisco PDSN.

## Cisco Mobile Wireless Home Agent

The Cisco Mobile Wireless Home Agent feature serves as an anchor point for mobile subscribers. It maintains mobile user registrations and tunnels packets destined for the mobile client to the Cisco PDSN/FA with the home agent function. It supports reverse tunneling, and can securely tunnel packets to the Cisco PDSN using IP Security (IPSec). Broadcast packets are not tunneled. The home agent can also perform dynamic home address assignment for the mobile from address pools configured locally, through Dynamic Host Configuration Protocol (DHCP), or from the AAA server. The Cisco Mobile Wireless Home Agent supports Wireless IP Network Standard (TIA/EIA/IS-835-B) and the wireless IP network architecture based on IETF Protocols (TIA/EIA/TSB-115).

## Dynamic Home Agent Assignment

The Cisco Mobile Wireless Home Agent can be dynamically assigned by the Cisco CNS Access Registrar server for load-balancing purposes by distributing mobile clients among a pool of home agents. At the same time, the Cisco CNS Access Registrar server ensures that the same

home agent is always assigned to the same Mobile IP client for the same session. The selection procedure is performed by the Cisco CNS Access Registrar server and can use either a round robin or a hashing algorithm over user network access identifier (NAI) selection criteria.

## Home Agent Redundancy

Home agent redundancy takes advantage of the Cisco Hot Standby Router Protocol (HSRP) and allows for one or more home agents to back up each other in the event of a failure. The active home agent sends binding updates to the backup home agent every time a new registration is entered into the binding table, a scenario that keeps the binding tables synchronized. If a new home agent boots up on the LAN, it can have the entire binding table loaded into its memory so that it can be ready in case of any network failure.

## Proxy Mobile IP

Mobile devices are now starting to provide a Mobile IP client stack, which will make Mobile IP a reality, but a lot of end systems today still do not support Mobile IP. To enhance the customer experience, the Cisco PDSN Packet Data Services solution supports proxy Mobile IP, which enables non-Mobile IP clients to maintain IP connectivity while changing Cisco PDSNs. The IP address of the end system does not change, so any application sessions it has that are dependent on that IP address, remain active.

When a simple IP mobile station makes a data services call, the Cisco PDSN prompts it for a NAI and password. If the user is authenticated and authorized (through AAA) for proxy mobile node service, the Cisco PDSN/FA will initiate a proxy mobile registration to a home agent on behalf of the mobile station. The home agent authenticates the registration and assigns the mobile station an IP address, which it returns to the PDSN/FA. The mobile station receives the IP address during the IPCP phase of PPP session establishment. When the mobile station moves to another Cisco PDSN, the PPP session is renegotiated. Using this capability, end systems that do not support Mobile IP will have the same benefits as end systems with Mobile IP. The mobile stations maintain the same IP address regardless of where they attach to the network, and they do not lose application connectivity if they move. Thus, they can take advantage of Layer 3 VPN services with corporate networks. The only restrictions are that the mobile station must use Challenge Handshake Authentication Protocol (CHAP), and the mobile station can have only one single IP flow per PPP session.

## Mobile IP Flows

The Cisco PDSN Packet Data Services solution enables multiple IP access points from the same mobile station, as long as each IP flow registers individually (each IP flow requires a unique NAI). Each IP flow is assigned a unique IP address. This can be used, for example, when multiple IP hosts share the same device to communicate through the mobile network.

## PDSN Clustering

The Cisco PDSN clustering feature brings added value in domains such as availability, performance, scalability, load balancing, intelligent selection, and hand-off. It also enables additional Cisco PDSNs to be added nondisruptively to an existing network, and spreads the load intelligently across all the Cisco PDSNs. Cisco PDSN clustering includes configuring of numbers of Cisco PDSNs into groups that exchange session information about existing PPP sessions and workload. Cisco PDSN 3.0 uses a controller-member clustering architecture to provide reliability and capacity. The functions and benefits of this architecture include the following:

- Controller maintains load and session information for each member within the cluster and performs member selection and load balancing. A controller keeps track of the operational state of each member and detects member failure.
- Two controllers are grouped together within one HSRP group in order to provide redundancy and availability.
- Member is responsible for notifying the active controller about its load and session information and to provide control and bearer plane functionality

- The initial A11 registration request for a given session is sent from the PCF to the active cluster controller (in fact, the IP address of the HSRP group to which the controllers belong). Based on its members' load table and existing call registered by the same user, the active controller chooses a member in its list.
- The cluster controller then sends back to the PCF a registration reject with the reject code cause set to 0x88 (136 decimal) and the IP address of the selected member in the cluster. The PCF will then send a new registration request for that session to the indicated cluster member. This approach assures optimal performance, and provides a scalable approach to growing the network. As demand increases, additional Cisco PDSNs can be added to a cluster without disrupting service, while the load remains evenly distributed across all Cisco PDSNs.

## The Cisco PDSN/Home Agent Hardware Platform

The Cisco PDSN solution is supported on two platforms. The first is the Cisco 7206VXR Router with an NPE-400 Network Processing Engine. It requires a special software feature set based on Cisco IOS Software Release 12.3.14(YX) for Cisco PDSN Release 3.0 (http://www.cisco.com/en/US/products/sw/wirelssw/ps4341/index.html). Hardware assistance for IPSec requires the use of the Cisco VPN Acceleration Module 2+ card for scalable encryption acceleration. Fast Ethernet and Gigabit Ethernet on the Cisco 7206VXR are supported for the Cisco PDSN. For more information about the Cisco 7200VXR, refer to the product specifications at: http://www.cisco.com/en/US/products/hw/routers/ps341/index.html.

For deployments requiring a higher density, the Cisco PDSN also runs on the Cisco Multiprocessor WAN Application Module (MWAM) for the Cisco 7600 Series Router and Cisco Catalyst® 6500 Series Switch, where each MWAM runs either five PDSN/FA or Home Agent images as virtual routers. Hardware assistance for IPSec operations is available with the use of the Cisco 7600/Catalyst 6500 IPSec VPN Services Module. The physical interfaces supported on the Cisco 7600 Series and Cisco Catalyst 6500 Series for both the R-P and P-I interfaces can be Fast Ethernet, Gigabit Ethernet, FlexWAN (ATM, Frame Relay), and the new line of Cisco Shared Port Adapter (SPA) and SPA Interface Processor (SIP) line cards.

The Cisco PDSN and the Cisco Mobile Wireless Home Agent support the full set of Cisco IOS Software features. Both also have additional software that supports CDMA2000 packet data services and mobility. CDMA-specific software features are listed in the next section. For more information about the Cisco IOS feature set, go to: http://www.cisco.com/en/US/products/sw/iosswrel/products_ios_cisco_ios_software_category_home.html.

## Mobile IP

Mobile IP enables a host to be identified by a single IP address, even while the device physically moves its point of attachment from one network to another, and allows data packets to be transparently forwarded to a single address. This IETF-proposed standard maintains sessions, regardless of movement between locations on different networks, because there are no address changes. Movement from one point of attachment to another is transparently achieved without the intervention or the knowledge of the user. Therefore, Mobile IP provides ubiquitous connectivity for users whether they are within their enterprise networks or away from home.

The Cisco IOS Software implementation of Mobile IP has enhancements to help ensure scalability, resiliency, and security. Cisco IOS platforms can function as home agents or foreign agents. Because it is possible for large numbers of devices to be mobile, the number of keys needed to perform the authentication function could become very large. For this reason, Cisco IOS Software allows for the mobility keys to be stored on an AAA server that can be accessed through either TACACS+ or RADIUS. This allows for scalability to large numbers of potential mobile users, and provides a single place for maintenance.

For security, Cisco IOS Software can use registration filters to restrict who is allowed to register. This mechanism can be used on both the foreign agents and the home agent to prevent certain mobile nodes from registering, and to prevent registration through some mobility agents. This also provides the ability to restrict usage only to areas where administrators have trust relationships in place. The Cisco Mobile Wireless Home Agent feature offers additional built-in redundancy. Because the home agent specification has no "keep-alive" mechanism between the

home agent and registered mobile nodes, the failure of a home agent could interrupt data flow to the mobile node. If a home agent fails, the mobile node has no way of knowing if there is simply no traffic destined for it, if the home agent has failed, or if the binding table is lost. This situation is avoided with the implementation of home agent redundancy.

## Virtual Private Networks

VPNs deliver enterprise-scale connectivity deployed on a shared infrastructure with the same policies enjoyed in a private network. They are attractive to corporate customers and may be one of the most used applications for mobile data. The Cisco PDSN solution helps enable companies to offer VPNs to their corporate customers, while taking advantage of the Cisco IOS VPN features to enable world-class security, scalability, quality of service (QoS), and manageability.

## VPN Security

Many robust security measures such as data encryption, restricted access for authorized users only, user tracking after users are connected to the network, and real-time intrusion auditing are available from Cisco Systems® to keep information confidential.

## VPN Scalability

The Cisco Multiprotocol Label Switching (MPLS) technology fuses the intelligence of routing with the performance of switching to scale existing networks to meet future growth demands. With this technology, networks can manage more traffic, users, media-rich data, and bandwidth-intensive applications. In intranet and extranet VPNs based on Cisco MPLS, packets are forwarded using a unique route distinguisher. Route distinguishers are unknown to end users and uniquely assigned automatically when the VPN is provisioned. MPLS packets are forwarded using labels attached in front of the IP header. Because the MPLS network does not read IP addresses in the packet header, it allows the same IP address space to be shared among different customers, simplifying IP address management. Service providers can deliver fully managed MPLS-based VPNs with the same level of security that users are accustomed to in Frame Relay and ATM services, without the complex provisioning associated with manually establishing permanent virtual circuits (PVCs) and performing per-VPN customer premises equipment (CPE) router design.

## VPN Quality of Service

Cisco offers a range of solutions that provide greater granularity to individual applications for priority and bandwidth management so that providers can easily deliver incremental services. QoS affords an enormous opportunity to service providers to provision varying service levels (such as first class, business class, and economy class) and subsequently create differentiated pricing models. It is an essential ingredient of a VPN because it determines the ability of the network to assign resources to mission-critical or delay-sensitive applications. QoS mechanisms ensure that mission-critical applications receive priority over other traffic.

QoS is essential for intranet and extranet VPNs that support exciting services such as packet telephony, e-commerce, IP-based video, and other multimedia offerings. Cisco offers a comprehensive set of QoS capabilities that enable providers to prioritize service classes, allocate bandwidth, and avoid congestion. These capabilities include both link Layer 2 and Layer 3 QoS mechanisms. One of the best examples is committed access rate (CAR), which classifies packets by application and protocol, and specifies bandwidth allocation. Weighted Fair Queuing (WFQ), and class-based queuing techniques implement efficient bandwidth usage by always delivering mission-critical application traffic and deferring noncritical application traffic when necessary. Weighted Random Early Detection (WRED) provides congestion avoidance to slow transmission rates before congestion occurs and ensures predictable service for mission-critical applications that require specific delivery guarantees. Cisco also provides a robust set of Layer 3 traffic engineering tools that let service providers map traffic through specific routes. This lets them simply engineer backbone networks to deliver the total subscribed capacity to all intranet and extranet VPN customers more efficiently.

## VPN Manageability

As service providers build VPNs that include WAN switches, routers, firewalls, and Cisco IOS Software, they need to be able to easily manage these devices across the network infrastructure and provide service-level agreements to their customers. They also need to enable business customers to personalize their access to network services and applications. The Cisco Service Management System addresses these needs with a suite of service management solutions to enable service providers to effectively plan, provision, operate, and bill VPN services. The Cisco Service Management System provides an integrated set of products for service planning, provisioning, operations, and accounting and billing. Service planning products such as the Cisco Planning Center, Cisco Netsys, and Cisco WAN Service Administrator help service providers to optimize their resources, speed time-to-market with new differentiated services, and increase profitability. Similarly, service-provisioning solutions such as Cisco Provisioning Center and the Cisco User Control Point assist service providers in provisioning new services end to end and ensuring error-free deployment. For service operations, the Cisco Info Center offers tools that monitor performance and faults on existing services to improve quality; and for service accounting and billing, Cisco Accounting Center and data collectors process accounting information and present data records to billing.

## Cisco CNS Access Registrar

Cisco CNS Access Registrar is a RADIUS server designed to meet the demanding AAA requirements of service providers. Not merely an enhancement or port of public domain RADIUS “freeware,” Cisco CNS Access Registrar is designed to provide scalable performance and an extensible platform that can adapt and scale with ever-changing requirements. Based on a multithreaded architecture, Cisco CNS Access Registrar provides numerous extension points that allow additional logic to be added as required, and Lightweight Directory Access Protocol (LDAP) capabilities to allow integration with back-end directory systems. Running on a Solaris for SPARC server, the Cisco CNS Access Registrar executes hundreds of AAA transactions per second, reducing the number of servers needed to support a service infrastructure.

## Extension Points

Cisco CNS Access Registrar extension points support additions to its RADIUS server logic to customize or enhance its ready-to-use functionality. Extensions can be in the form of C or C++ shared libraries or Tool Command Language (TCL) scripts. This allows extensions to be quickly prototyped in TCL, and then coded with C or C++ for optimal performance. Extensions can be used to modify server behavior at more than 10 predefined points during packet processing. Specifically, extensions are allowed to modify the incoming or outgoing RADIUS packet, or modify Cisco CNS Access Registrar environment variables that control packet processing. An extension can be written, for example, to use a custom authentication service for a particular user or user community.

## Directory Integration

Directory systems are fast becoming an integration point for service management systems and the overall operations support system (OSS). Directories serve as a central repository for user information, service profiles, billing profiles, and other service information. Multi-master, replicated directories provide a means to rapidly distribute and allow access to this information from any location. Whether the directory is X.500, Microsoft’s Active Directory, or Novell’s NDS, a Cisco CNS Access Registrar can access this information using its LDAP capabilities.

Cisco CNS Access Registrar authenticates users against a Lightweight Directory Access Protocol (LDAP) directory and provides the flexibility to work with a variety of directory configurations. It can be configured to consult a single directory for all user authentication, or different directories (or directory branches) for particular communities of users. Cisco CNS Access Registrar performs an LDAP lookup to find the user record, and verifies the user password as stored in the directory. Cisco CNS Access Registrar can also map LDAP user record attributes to RADIUS attributes. Thus, a user’s RADIUS profile can be configured in the corresponding LDAP user record, allowing provisioning systems to use LDAP to directly configure users that will be authenticated and authorized by Cisco CNS Access Registrar.

## AAA Proxy

The growth of the Internet and the proliferation of service providers have naturally led to consolidation, partnerships, and other arrangements that require integration of AAA systems. For service providers offering corporate remote-access outsourcing, there is also a need to integrate with end-user customer AAA systems. Cisco CNS Access Registrar supports RADIUS proxy where, instead of directly authenticating and authorizing users against a directory, the server selectively proxies the AAA request to another service provider's RADIUS server, or to a customer RADIUS server that authenticates and authorizes users against another directory or database.

Cisco CNS Access Registrar allows the configuration of service filters that instruct the server to proxy RADIUS requests based on the dialed number identification string (DNIS) or realm contained in the request packet (for example, "isp_a" in "bill@isp_a.com"). Through extension points, Cisco CNS Access Registrar can also proxy based on any other information in the request packet.

## Address and Session Management

RADIUS servers are stateless servers that independently manage incoming requests as they are received. While this is sufficient for rudimentary AAA, the efficient operation and utilization of access networks today require "stateful" tasks such as IP pool management and address allocation, and the enforcement of session limits. Previously managed by each network access server (NAS), these tasks need to be centralized and managed in a vendor-independent manner. Cisco CNS Access Registrar provides resource managers that handle the dynamic allocation of IP or Internetwork Packet Exchange (IPX) addresses and enforce both user and group session limits across multiple network access servers. Here again, Cisco CNS Access Registrar extensions can be used to select or override default IP address pools or session managers. The Cisco CNS Concurrency Control Services application provides additional session-management scalability where required. It is a distributed Solaris application that can manage session limits across multiple Cisco CNS Access Registrar servers and remove single points of failure.

## Prepaid Data Services

The Cisco PDSN allows mobile operators to provide prepaid data services by taking full advantage of their existing architecture and AAA server as a mediation device for the billing server. After the user is identified as a prepaid user, quota information is retrieved from the billing server through the AAA server, and allows the Cisco PDSN to do real-time metering on different criteria.

## Conclusion

The Cisco CDMA Packet Data Services solution meets the needs of the mobile wireless industry as it drives toward new third-generation (3G) cellular data services and solutions. It is standards-compliant, yet offers additional features to address the most critical needs of mobile wireless operators. Cisco Systems brings a wealth of data experience into the mobile wireless arena – along with some of the first Mobile IP solutions and leading security solutions. And Cisco brings openness into an industry previously governed by vendor-proprietary solutions. Cisco also offers a cost-effective means to increase revenue today while building an infrastructure and migration roadmap to provide the best next-generation services in the future.

## References

Cisco CNS Access Registrar: http://www.cisco.com/en/US/products/sw/netmgtsw/ps411/index.html

VPNs: http://www.cisco.com/en/US/products/hw/vpndevc/index.html

Wireless and mobile solutions: http://www.cisco.com/en/US/netsol/ns523/networking_solutions_market_segment_solution.html

## For More Information

For more information about Cisco mobile wireless products and solutions, go to http://www.cisco.com/go/mobile.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