



# Service Platform Architecture

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## Introduction

Cypress Communications is a managed service provider that offers enterprise-class, hosted unified communications and managed data services. Services are delivered via an innovative platform that is comprised of best-of-breed technologies and systems. Cypress Communications had the privileged opportunity to build a “greenfield” service platform using technologies and systems designed specifically for IP, thus is unencumbered by outdated technology and patchwork integration, subsequently providing a time-to-market advantage for introducing new products or capabilities into the product portfolio.

The service platform architecture is divided into layers that deliver a subset of the overall service platform functionality. The use of layering is a common abstraction that provides a clear demarcation between discreet network functions.

## IP Transport Layer

The bottom layer in the service platform architecture is the IP transport layer. The IP transport layer provides packet-based transport to all IP components and includes all underlying transport technologies necessary to enable packet-based transport.

Figure 1 provides an illustration of the IP Transport Layer Topology:

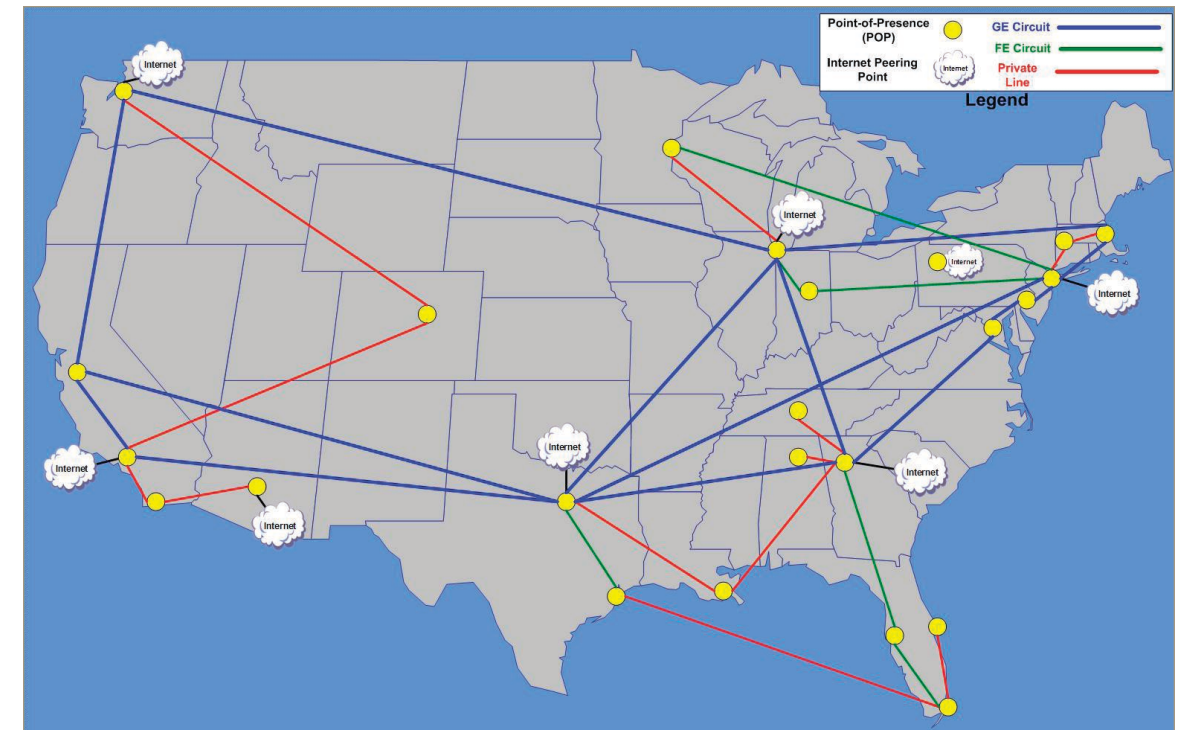


Figure 1: IP Transport Layer Topology

The Cypress Communications IP transport network is national in scope, thus includes Points of Presence (POPs) located throughout the domestic United States. Specifically, Cypress Communications has presence in twenty-nine major metropolitan areas, serving 38 states in the continental United States at the time of this writing. However, Cypress offers remote worker and remote office technology that makes it possible to provide service virtually anywhere in the world.

The Cypress Communications IP transport network implements a three-layer hierarchy, referred to generically as the: a) external, b) aggregation and c) access layers.

- a. The external layer of the network hierarchy is comprised of numerous IP routers located throughout the domestic U.S. that are dedicated to providing connectivity to multiple Internet Service Providers (ISPs). These IP routers connect to the various ISPs via Gigabit Ethernet (GE) circuits to ensure that sufficient bandwidth capacity to and from the Internet is always available.

## MULTIPROTOCOL LABEL SWITCHING (MPLS)

Multiprotocol Label Switching (MPLS) is a highly scalable, protocol agnostic, data-carrying mechanism that facilitates “virtual links” between distant nodes. MPLS allows network operators a great deal of flexibility and control in routing traffic across the network, improving traffic management with better reliability and increased performance.

In an MPLS network, data packets are assigned labels. Packet-forwarding decisions are made solely on the contents of this label, without the need to examine the packet itself. Thus, end-to-end circuits can be created across any type of transport medium, using any protocol. Network traffic can also be prioritized according to label contents and routed via the shortest path with available bandwidth.

These IP routers also implement version four of the Border Gateway Protocol (BGP-4) which is considered the defacto standard protocol to distribute IP reachability information to ISPs. With the distributed physical configuration and utilization of BGP-4, the failure of one or more external IP routers and/or GE circuits can be recovered by the remaining external IP routers and/or GE circuits. Subsequently, a customer’s Internet service will not be affected by first order or second order network failures at the external layer.

- b. The aggregation layer of the network hierarchy is interconnected via a partial mesh (i.e., redundant interconnections) of point-to-point GE circuit. The use of Ethernet-based circuit technology enables Cypress Communications to easily scale the IP core network in response to customer growth while delivering predictable and unparalleled performance.

In smaller markets, the aggregation router may have multiple private-line (T-3 or OC-n) circuits connecting it to aggregation routers in the larger markets until point-to-point GE circuits can be justified. In some smaller markets, the aggregation router has a single private-line circuit connecting to an aggregation router in a larger market. Since this represents a single point-of-failure, the smaller market aggregation router will also have direct Internet connectivity for backup.

In three markets—Atlanta, Chicago and Dallas—the POPs were expanded to become Data Centers. The term Data Center is used to identify the POP as also having a significant Local Area Network (LAN) presence. The significant LAN infrastructure is required in these locations to support the Voice/VoIP transport and signaling components. Thus, a minimum of two aggregation routers with redundant LAN cards is present in each Data Center. To take advantage of the redundant aggregation routers, redundancy protocols such as the Virtual Routing Redundancy Protocol (VRRP) are utilized. The implementation of three Data Centers was chosen to provide geographic diversity for the LAN components.

Finally, Multiprotocol Label Switching (MPLS) has been enabled within the aggregation layer of the network to provide enhanced data services, such as Layer-3 Virtual Private Networks (L3VPNs). MPLS is a standards-based framework that provides for the efficient designation, routing, forwarding and switching of network traffic flows through the network. MPLS is independent of Layer 2 (Data Link) and Layer 3 (Network) protocols and is often referred to as Layer 2.5. In other words, MPLS creates its own virtual layer. The Label Distribution Protocol (LDP) is utilized to create virtual paths between all aggregation routers, thereby creating a logical full-mesh topology. Subsequently, all network traffic traversing the aggregation portion of the network will be encapsulated in a MPLS packet and switched across the network.

- c. The access layer of the network hierarchy is comprised of access routers that customers utilize to access the service platform. Details regarding this layer of the network hierarchy can be found in the Customer Premises Layer section below.

Since Cypress Communications has the advantage of maintaining its own national IP network, private IP addressing, as specified by IETF RFC 1918, is utilized for a majority of the Cypress Communications IP transport network components. Public IP addressing is also utilized where necessary to facilitate connectivity to the external layer of the network hierarchy: the Internet or external partners (e.g., SIP peers).

To ensure packets sourced from VoIP transport and/or signaling components are not dropped or delayed via an intervening IP router, Quality of Service (QoS) mechanisms are utilized. Specifically, the Cypress Communications IP transport network adheres to the Differentiated Services (DS) model as specified by the Internet Engineering Task Force (IETF). DS is a class-based mechanism for traffic management where each IP packet is placed into a limited number of traffic classes: highest priority, lower priority and lowest priority in this case.

Subsequently, each IP router within the IP transport layer is configured to differentiate traffic based on its class. Please note that even though the aggregation layer of the network is MPLS-enabled, the DS value is maintained by copying it from the IP header to the MPLS header. High-priority packets (e.g., VoIP transport, signaling and interactive video) are classified and marked to be in the high-priority class. Each traffic class is managed differently, ensuring preferential treatment for higher-priority traffic on the network. Basically, the use of DS enables Cypress Communications to bound latency and latency variation (i.e. jitter) which are critical to delivering toll-quality voice service.

To secure the IP transport layer components, a mix of stateful and non-stateful firewalls are utilized. The non-stateful firewalls are implemented on the IP components themselves, thereby limiting access to these devices from trusted sources. The stateful firewalls are used to secure the LAN portion of the Data Centers, which contain numerous application servers.

The use of Differentiated Services (DS) enables Cypress Communications to bound latency and latency variation (i.e. jitter) which are critical to delivering toll-quality voice service.

### Voice/VoIP Transport Layer

The next layer in the service platform architecture is the Voice/VoIP transport layer. It consists of the VoIP transport components that provide the VoIP transport functionality necessary to the services portfolio. Since many of the products within the services portfolio are VoIP products, this transport layer is critical for the delivery of VoIP traffic from the end user to the Cypress Communications network, and potentially to one or more upstream providers. Subsequently, there will always be at least two Voice/VoIP transport components in every call.

Figure 2 provides an illustration of the Voice/VoIP Transport and Signaling Layers:

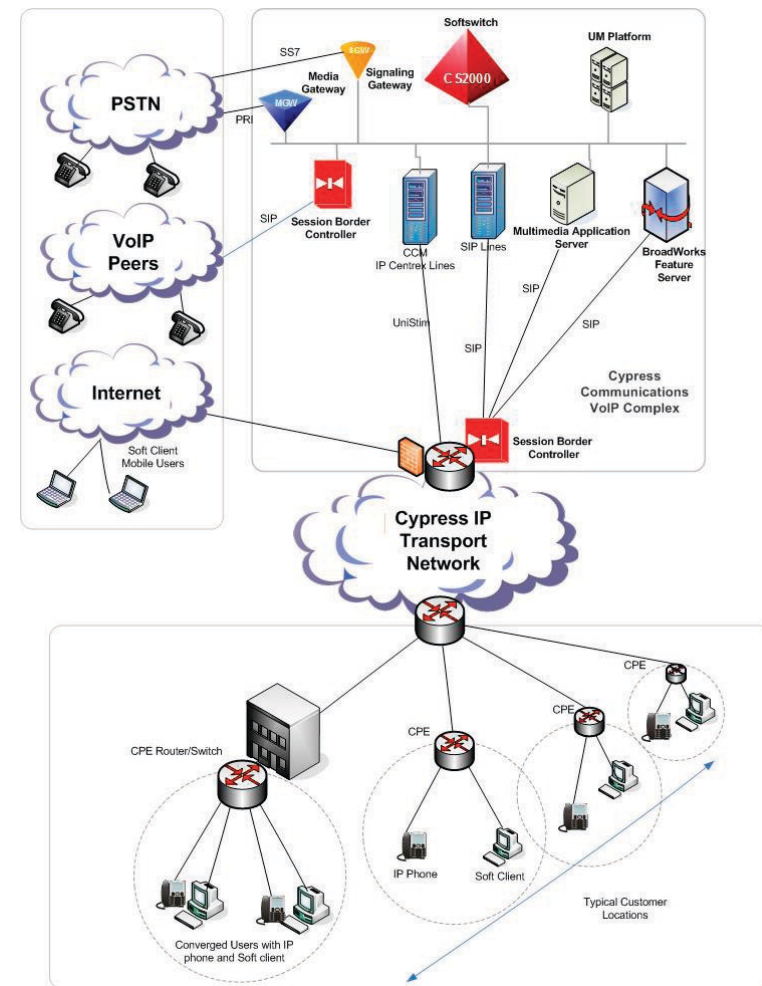


Figure 2: Voice/VoIP Transport and Signaling Layers

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The VoIP transport layer is comprised of media gateways (MGWs) and session border controllers (SBCs). These components provide connectivity to external Voice and VoIP networks, so phone calls can be received from and made to parties outside the Cypress Communications network. All VoIP transport components are located in the geographically diverse Data Centers to provide redundancy and high availability.

All VoIP transport components are located in the geographically diverse Data Centers to provide redundancy and high availability.

Figure 3 provides an illustration of the IP Transport Network with the VoIP transport and signaling component locations:

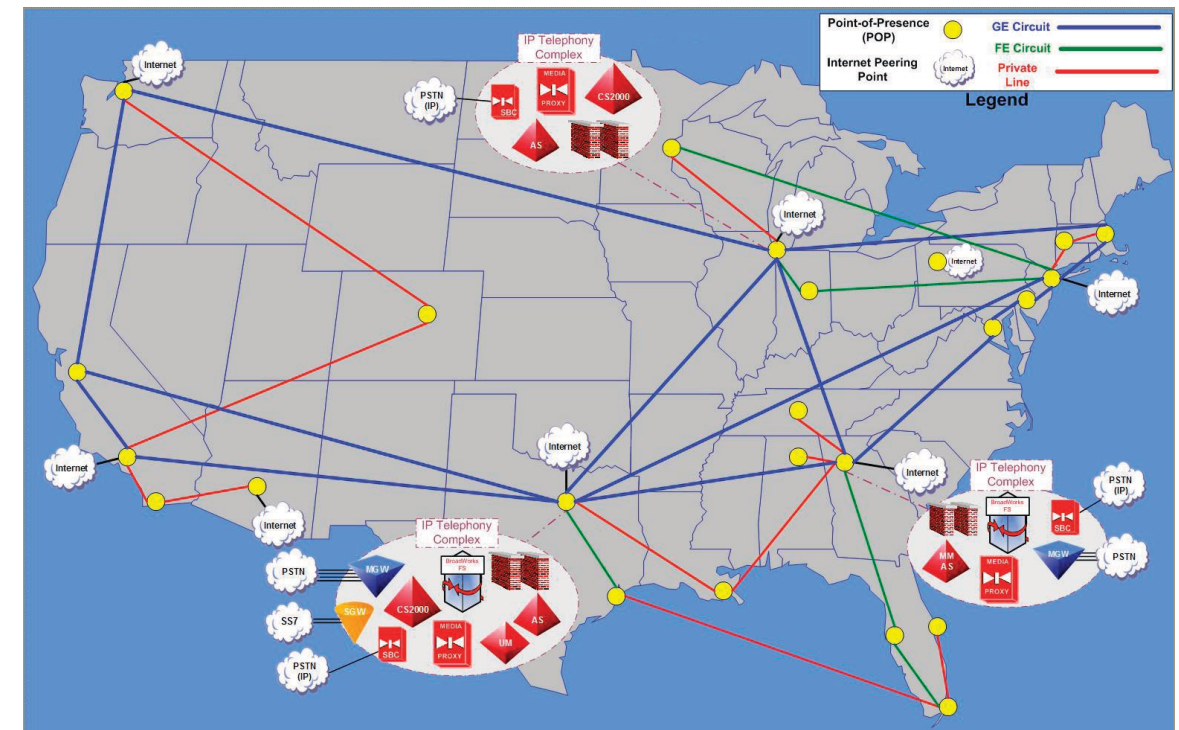


Figure 3: IP Transport Layer Topology with VoIP Components

The MGWs convert voice transport traffic to VoIP transport traffic and vice-versa. Subsequently, the MGWs provide connectivity to the Public Switched Telephone Network (PSTN). The MGWs comprising the VoIP transport layer are equipped with echo cancellers to reduce end-to-end echo as much as possible. Moreover, the MGWs are configured to utilize the G.711 variant of codec, which is widely considered the best codec type available for delivering toll-quality voice service.

The SBC protects other VoIP transport components by acting as a Voice Firewall, blocking undesirable VoIP transport traffic like IP firewalls block undesirable data IP transport traffic. Subsequently, the SBC permits connectivity to other providers who offer VoIP-based call termination and origination services.

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Multimedia features such as soft client functionality, presence services, network-based call logs, instant messaging, video calls and conferencing services are delivered by the Multimedia Application Server (MAS). The MAS and Softswitch (SSW) are closely integrated utilizing the SIP protocol to deliver a converged experience to the end-user.

## Voice/VoIP Signaling Layer

The next layer in the service platform architecture is the Voice/VoIP signaling layer. The Voice/VoIP signaling layer consists of the VoIP signaling components necessary to establish, change the state of and tear down active VoIP calls. The VoIP signaling layer also includes the VoIP signaling components necessary to interface with the VoIP knowledge bases and intelligent elements in private VoIP networks. There will always be at least one VoIP signaling component in every call.

Please refer to figure 2 for an illustration of the Voice/VoIP signaling layer.

The VoIP signaling layer is comprised of a Softswitch (SSW), a Feature Server (FS) a Multimedia Application Server (MAS), Centrex Client Manager (CCM) and signaling gateway (SGW). These components leverage the predominant VoIP signaling protocols including SIP, H.248 and Media Gateway Control Protocol (MGCP). All VoIP signaling components are located in the geographically diverse Data Centers to provide redundancy and high availability.

The Softswitch (SSW) serves as the main switching component for the VoIP signaling layer. The SSW delivers class-4 and class-5 features, including numerous traditional PBX features. Class-4 features include interLATA, Long Distance (LD) and International Long Distance (ILD) call routing. Class-4 switches also interface with the SS7 network to provide Intelligent Network (IN) services such as Calling Name (CNAM) display. Class-5 features are user-focused and include dial tone, call blocking, 3-way calling, automatic callback, paging and hunt groups – to name a few. Not all SSWs provide class-5 or call-related features; however, those that do typically have an embedded Feature Server.

The Feature Server (FS) is a switching component that offers class-5 call-related features. The FS can be one component comprising a SSW or it can be a standalone entity. In the case of the Cypress Communications VoIP transport layer, the FS is a standalone entity that can serve customers independently.

The Centrex Client Manager (CCM) manages the IP phones and functions as the gateway to the VoIP signaling layer. Moreover, the CCM provides call admission control, ensuring that a mass calling event won't affect voice quality. Today, the signaling between the CCM and the IP phones is facilitated via the UNISTIM protocol (i.e., proprietary SIP variant).

Multimedia features such as soft client functionality, presence services, network-based call logs, instant messaging, video calls and conferencing services are delivered by the Multimedia Application Server (MAS). The MAS and SSW are closely integrated utilizing the SIP protocol to deliver a converged experience to the end-user. The term converged is utilized to identify an experience that brings call logs, directory and personal call agent to the desktop and integrates it with multimedia features including video conferencing, presence, instant messaging and Web collaboration.

The signaling gateway (SGW) functions as a gateway between the VoIP and Voice signaling, translating VoIP signaling into voice signaling and vice-versa. The SGW offloads the voice signaling protocols from the SSW, allowing the SSW to function as a VoIP-only signaling component. The SGW also provides access to intelligent database components, such as calling name directories, etc.

## Application Layer

The next layer in the service platform architecture is the application layer. The application layer consists of all the hardware and software required to support application-intensive service offerings such as hosted email, call recording and C4 Office (Hosted Microsoft OCS) – to name a few.

From a hardware perspective, the application layer is comprised of numerous physical and logical servers distributed among the aforementioned Data Centers. Physical servers are tangible computing devices that may support one or more applications per device. Logical servers are a management abstraction that optimize server provisioning so that applications are no longer tied to specific physical servers. As a result, Cypress has the ability to adjust network resources based on workload or location, dynamically meeting the needs of our customers. Virtualization allows Cypress customers to leverage the Cypress network, gaining economies of scale that would be difficult, if not impossible, to achieve on their own.

From a software perspective, the application layer is comprised of the specific applications needed to offer the various services. Most services require numerous applications to function. For example, the call recording service requires six different primary applications to function. Beyond the primary applications themselves, supporting applications such as database services, authentication services and Web services may also be required.

Because servers and their corresponding applications are vulnerable to security attacks, Cypress utilizes stateful firewalls with integrated intrusion detection. Intelligent inspection engines provide robust network and application security by enforcing access-control policies, performing deep packet inspection and intrusion detection while continually tracking the state of all network communications.

Since Cypress Communications offers hosted services, it is imperative that the applications and their supporting data are always available. Moreover, some of the data may need to be available for a long period of time. For example, a financial services firm may need to store recorded telephone calls for weeks, months or even years in order to be in compliance with industry regulations. Subsequently, the Cypress IP network requires an integrated storage solution.

The two primary types of storage solutions utilized are Network Attached Storage (NAS) and Storage Area Network (SAN). NAS is a self-contained computing device that is connected to a network with the sole purpose of supplying file-based storage services.

A SAN is the favored storage solution and is utilized for most applications. This approach enables servers to attach to remote storage devices (e.g., disk arrays and tape libraries) via an intervening packet network. Cypress Communications has implemented a sizable SAN in the Dallas Data Center and will implement SANs in the other Data Centers in the future.

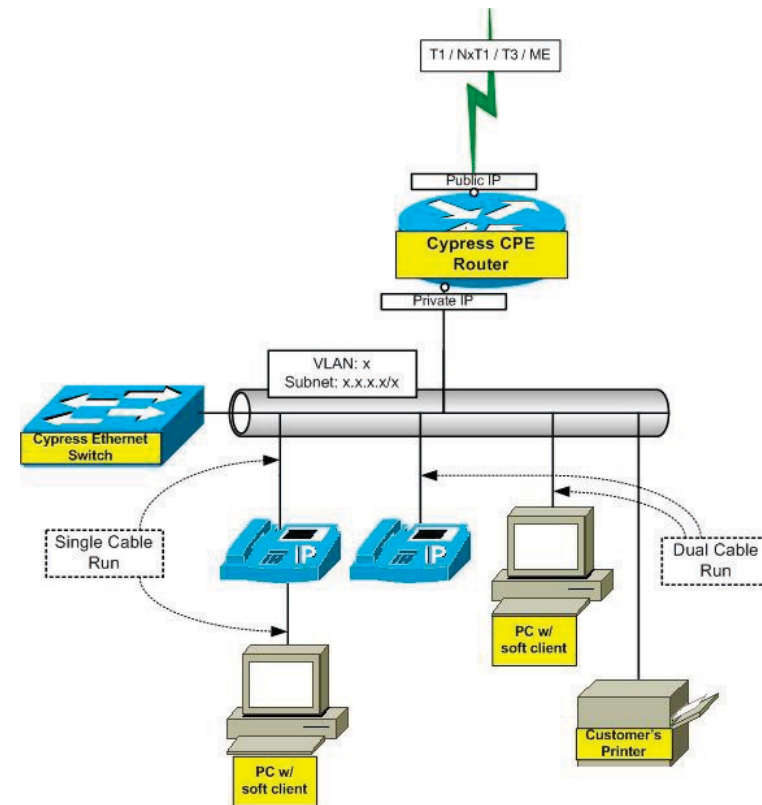
NAS is utilized for applications that do not support SAN. NAS is also used in cases where it was part of the overall solution from the original equipment manufacturer.

Either way, the result is that all applications and their corresponding data are stored and backed up via a NAS or SAN.

## Customer Premises Layer

The top layer in the service platform architecture is the customer premise layer. Strictly speaking, the customer premises layer is not really a layer. However, for the purposes of this whitepaper, its worthwhile to separate this function and model it as a layer.

Figure 4 provides an illustration of the Customer Premises Layer:



The customer premises layer is comprised of the components located at a customer's location that are necessary for accessing Cypress Communications services. The minimum configuration for the customer premises layer is a managed CPE router (access router), Ethernet switch and multiple IP phones.

The access router is responsible for routing IP packets sourced from the IP phones and voice-enabled PCs to the Cypress Communications network and vice-versa. The access router is connected to the Cypress Communications IP Transport Network via a single T1 circuit, multiple T1 circuits, a single T3 circuit or Metro Ethernet circuit depending on the bandwidth required. As a general rule, a single T1 circuit can support approximately 16 talk paths and 32 seats. A talk path is defined by an active phone conversation. Thus, a single T1 can accommodate 16 simultaneous calls with little to no data being transmitted in parallel.

To ensure packets sourced from the IP phones and voice-enabled PCs are not dropped or delayed via the router, Quality of Service (QoS) mechanisms are utilized. Specifically, high-priority packets are classified and marked as belonging to the high-priority class. Subsequently, the access router then prioritizes these IP packets by offering low-loss and low-latency forwarding treatments. This is part of the Differentiated Services (DS) model that is observed in the IP transport layer as well.

Since Cypress Communications has the advantage of maintaining their own national IP network, private IP addressing as defined by IETF RFC 1918 is utilized for the IP phones and voice-enabled PCs. These IP addresses are distributed by the access router to the IP phones and voice-enabled PCs using the Dynamic Host Control Protocol (DHCP). If a PC requires Internet service, the PC's private IP address is translated to a public IP address via Network Address Translation (NAT) at the access router.

The access router also incorporates a built-in stateful firewall that is used to secure the customer from internal or external attacks. While the components within the customer premises layer utilize private IP addressing, there is still risk of attacks from other customers (internal). When voice-enabled PCs also utilize Internet service, there is also risk of attacks from the Internet (external).

The Ethernet switch is used to interconnect the IP phones and voice-enabled PCs to the access router which has a limited number of Ethernet ports. The Ethernet switch comes in two different variations; standard and Power over Ethernet (POE). The standard Ethernet switch is utilized when the customer intends to power each IP phone by plugging in to a standard power outlet. The POE Ethernet switch is utilized when each IP phone will not be plugged into a standard power outlet but will instead be powered by the Ethernet switch itself.

Since each customer network is unique, multiple customer premises-layer topology standards were created. Subsequently, Cypress Communications' sales engineers will work closely with customers' technical resources to ensure a standards-compliant solution is created for each customer.

## Conclusion

The Cypress Communications service platform architecture effectively utilizes best-of-breed technologies to provide a feature-rich product portfolio. The multimedia experience and the breadth of platform choices that the service platform provides are unparalleled in the hosted-PBX and unified communications industries today.

The Cypress purpose-built network was architected to be reliable, secure, high-performing and scalable. This translates to a superior service that businesses can rely on.



Boasting a 25-year legacy and more than 6,000 customers coast-to-coast, Cypress Communications provides Unified Communications as a Service (UCaaS) to small- and mid-sized enterprises. UCaaS goes beyond traditional VoIP offerings by delivering a fully hosted VoIP and unified communications solution. Comprehensive and flexible, the UCaaS solution from Cypress includes integrated voice and data access, desktop phones, soft phones, local and long-distance voice services, voicemail, advanced collaboration tools and remote office functionality. From their computers, users can take advantage of productivity-enhancing applications such as real-time presence, desktop video, unified messaging, chat, file sharing, and Outlook integration. As a Deloitte Fast 50 and Fast 500 award recipient, Cypress Communications is also recognized as one of the fastest growing telecommunication companies in North America. Cypress is headquartered in Atlanta, GA.

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