

C4 IP Platform Architecture

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C4 IP is a single, integrated IP telephony service utilizing best-of-breed technologies and systems to leverage the flexibility of a next-generation VoIP platform while maintaining compatibility with legacy voice telephony platforms. Cypress Communications had the privileged opportunity to build a 'greenfield' platform, thus is unencumbered by outdated technology and patchwork integration, subsequently providing a time-to-market advantage for introducing new products or capabilities into the C4 IP portfolio.

The C4 IP platform architecture is divided into layers that deliver a sub-set of the overall C4 IP 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 C4 IP platform architecture is the IP transport layer. The IP transport layer (Figure 1) provides packet-based transport to all IP-based components and includes all underlying transport technologies necessary to enable packet-based transport.

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 markets at the time of this writing. 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 routers located throughout the domestic United States that are dedicated to only providing connectivity to multiple Internet service providers (ISPs). These routers connect to the various ISPs via Gigabit Ethernet (GE) circuits to ensure

sufficient bandwidth capacity to and from the Internet is always available.

These routers also implement version four of the Border Gateway Protocol (BGP-4) which is considered the defacto-standard protocol utilized to distribute IP reachability information to ISPs. With the distributed physical configuration and utilization of BGP-4, the failure of one or more external routers and/or GE circuits can be recovered by the remaining external 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 full-mesh of virtual circuits (VCs) provided by layer-2 MPLS VPN service from a national service provider. The VCs are delivered to each aggregation router via two GE circuits in a primary/backup configuration. The use of Ethernet-based circuit technology coupled with MPLS service enables Cypress Communications to easily scale the IP core network in response to customer growth while delivering predictable and unparalleled performance.

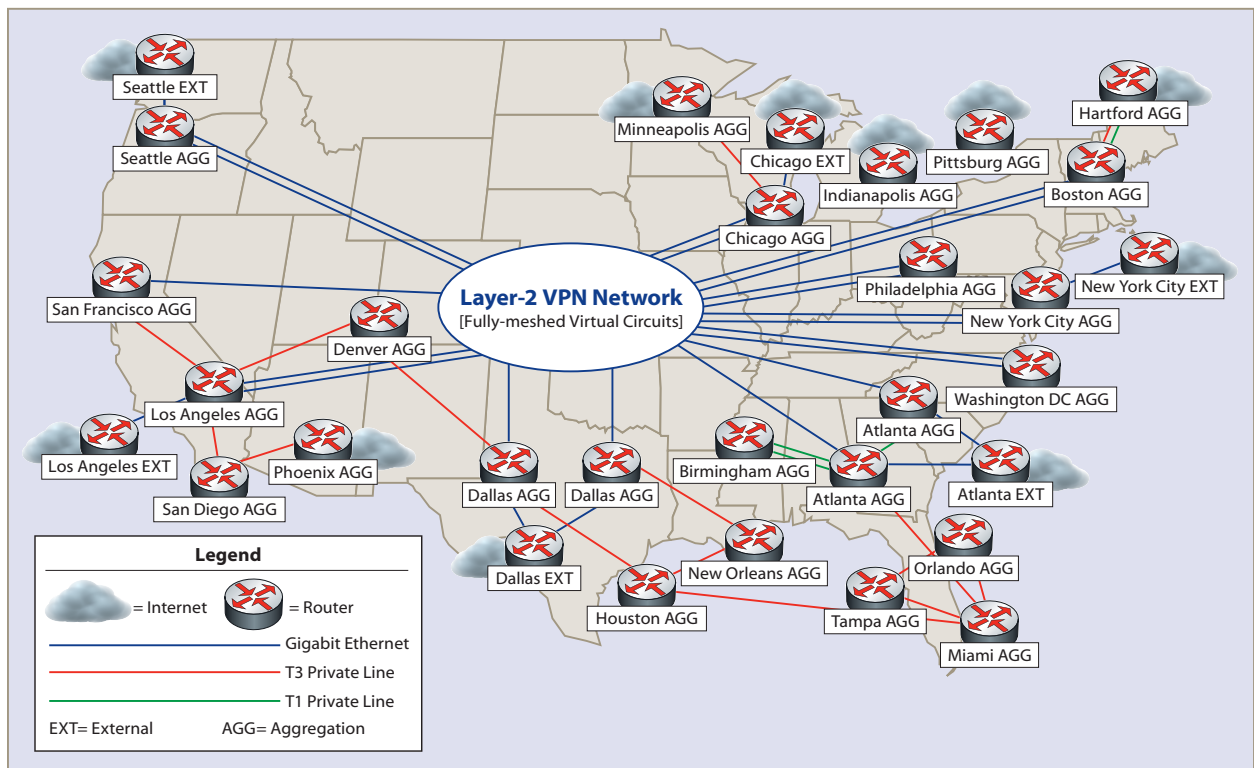


Figure 1: IP Transport Layer

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In smaller markets, the aggregation router may have multiple T3 circuits connecting it to aggregation routers in the larger markets until the layer-2 MPLS VPN service can be justified. In some smaller markets, the aggregation router has a single T3 circuit connecting to an aggregation router in a larger market. Since this presents a single point of failure, the smaller market aggregation router will have direct Internet connectivity as well for backup.

In two markets, Atlanta and Dallas respectively, the POPs were expanded to become Data Centers. The term Data Center is used to signify a significant Local Area Network (LAN) presence as compared to other POPs. 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 two Data Centers was chosen to provide geographic diversity for the LAN components.

- c.) The access layer of the network hierarchy is comprised of access routers that customers utilize to access the C4 IP platform. Details regarding this layer of the network hierarchy can be found in the Customer Premise 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 router within the IP transport layer is configured to differentiate traffic based on its class. VoIP transport and signaling packets 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.

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Voice/VoIP Transport Layer

The next layer in the C4 IP platform architecture is the Voice/VoIP transport layer (Figure 2). The VoIP transport layer consists of the VoIP transport components that provide the VoIP transport functionality necessary to the C4 IP service portfolio. Since the products within the C4 IP service 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.

The VoIP transport layer is comprised of media gateways (MGWs) and session border controllers (SBCs). These components provide connectivity to external Voice and/or 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.

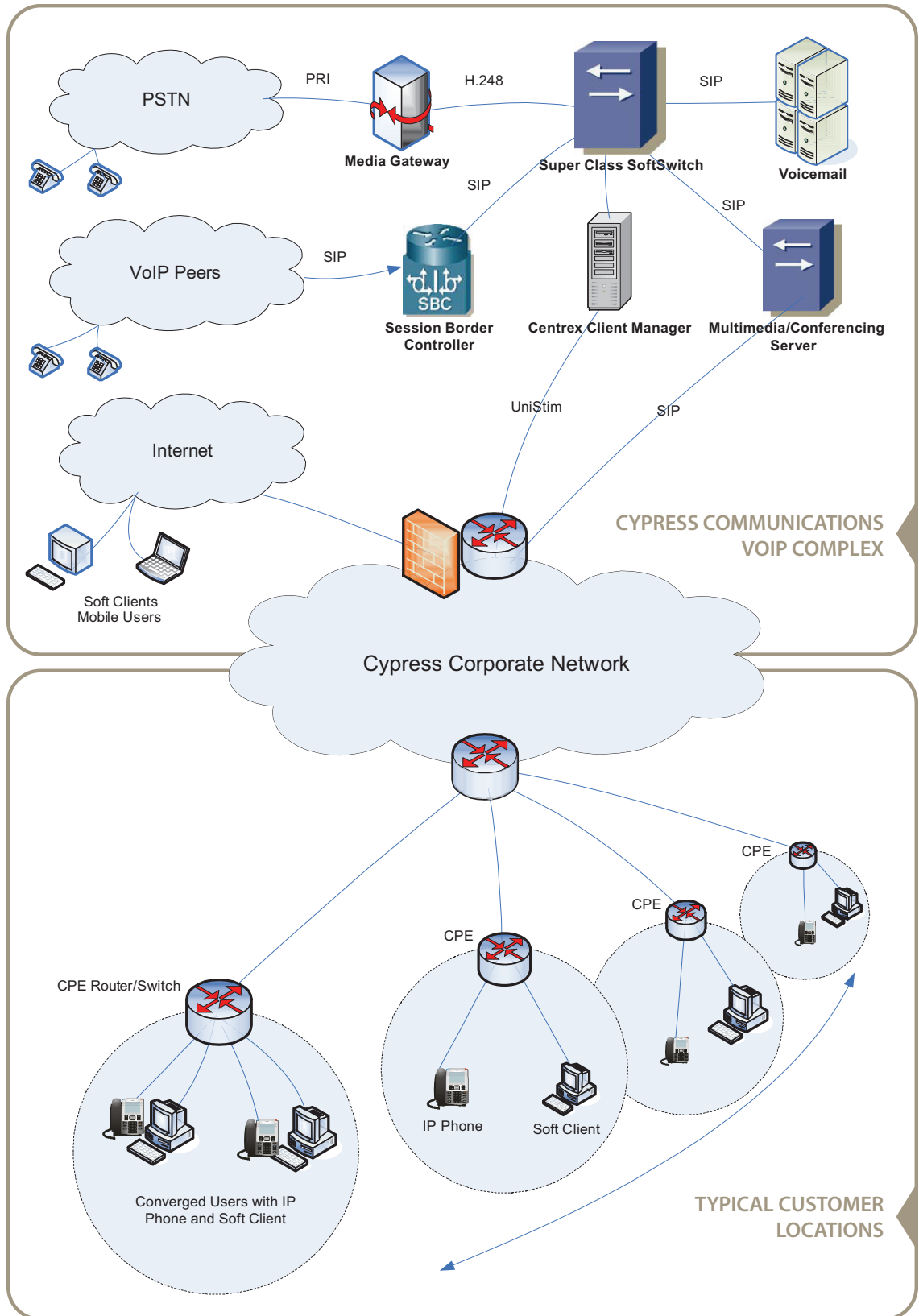


Figure 2: Voice/VoIP Transport and Signaling Layers

C4 IP Platform Architecture

The MGW converts voice transport traffic to VoIP transport traffic and vice-versa. Subsequently, the MGW provides 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 (VFW), blocking undesirable VoIP Transport traffic like IP firewalls block undesirable data IP transport traffic. Subsequently, the SBC provides connectivity to other providers who offer VoIP-based call termination and origination services.

Voice/VoIP Signaling Layer

The next layer in the C4 IP platform architecture is the Voice/VoIP signaling layer (Figure 2). The VoIP signaling layer consists of the VoIP signaling components necessary to establish, tear down established, and change the state of active VoIP calls. The VoIP signaling layer also includes the VoIP signaling components necessary to interface with VoIP knowledge bases and intelligent elements in private VoIP networks. There will always be at least one VoIP signaling component in every call.

The VoIP signaling layer is comprised of a Softswitch (SSW), a Multimedia Communication Server (MCS), 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. Not all SSWs provide class-5 or line-side features, however, those that do are typically termed 'feature servers'.

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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.

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 Communication Server (MCS). The MCS and Softswitch 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.

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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.

Customer Premise Layer

The top layer in the C4 IP platform architecture is the Customer Premise layer (Figure 3). Strictly speaking, the customer premise layer is not really a layer, but a domain. However, for the purposes of this whitepaper, its worthwhile to separate this function and model it as a layer.

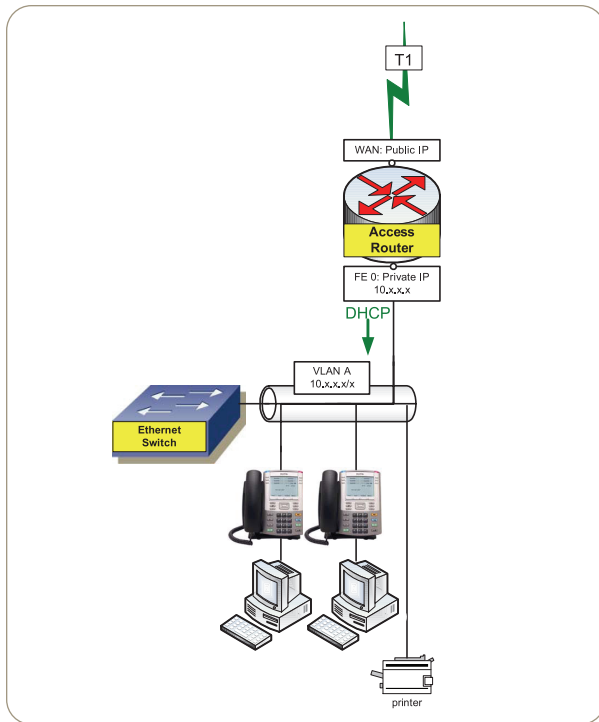


Figure 3: Customer Premise Layer

The customer premise layer is comprised of the components located at a customer's location that are necessary for accessing C4 IP services. The minimum configuration for the customer premise layer is an access router, Ethernet switch and multiple IP phones.

The access router is responsible for routing IP packets sourced from the IP phones and/or voice-enabled PCs to the Cypress Communications network and vice versa. The access router is connected to the Cypress Communications network via a single T1 circuit, multiple T1 circuits, a single T3 circuit or metro Ethernet circuit depending on the number of IP phones present at the customer premise. A single T1 circuit can support 16 talk paths. 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/or voice-enabled PCs are not dropped or delayed via the router, QoS mechanisms are utilized. Specifically, VoIP transport and signaling 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 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/or voice-enabled PCs. These IP addresses are distributed to the IP phones and/or voice-enabled PCs via the Dynamic Host Control Protocol (DHCP) by the access router. For PCs requiring Internet service, their 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 premise 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/or 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 into a standard power outlet. The POE Ethernet switch is utilized when each IP phone cannot be plugged into a standard power outlet and instead will be powered by the Ethernet switch itself.

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

Conclusion

The C4 IP platform architecture effectively utilizes best-of-breed technologies to provide a feature-rich product portfolio. The multimedia experience the C4 IP platform provides is unparalleled in the hosted-PBX industry today.

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



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Boasting a 20-year legacy and more than 6,500 customers coast-to-coast, Cypress is one of the nation's largest providers of end-to-end managed communication solutions for mid-sized businesses. Cypress provides advanced IP phones and voice over IP services with cutting-edge multimedia desktop applications like Microsoft Outlook integration; unified messaging; video calling; and audio, video and Web conferencing. As a Deloitte Fast 50 and Fast 500 award recipient, Cypress is also recognized as one of the fastest growing telecommunication companies in North America. Cypress is headquartered in Atlanta, GA. The company's Web address is www.cypresscom.net.

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