AVAYA

Avaya IP Office Technology Backgrounder

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White Paper

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December 2001

Converged Voice and Data Networks

Customer Relationship Management

Unified Communication

Supported by: Avaya Labs and Services

Communication without boundaries

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1 Introduction

The purpose of this document is to introduce IP Office technology designed to deliver a single communication solution that satisfies the requirements for cost, convenience, and performance optimized for small and mid-size businesses.

Small and medium sized businesses have a greater need than ever before to improve performance, remain competitive and deliver profits. There is no doubt that world class communication solutions are a key tool to achieve these goals. But these solutions have to be right for them. As the Gartner group has said: "Networking for small and midsize enterprises is not simply scaled-down large enterprise networking. SMEs have new and unique opportunities to help them meet the challenges they face as voice and data solutions converge".

These needs include:

- Convenience of an all-in-one solution with or without IP
- Exploiting the economies of convergence
- Low cost of ownership
- Investment protection migration path from current systems
- Full array of integrated applications
- Leveraging existing LAN/WAN infrastructure
- Easy to install and use and maintain.

IP Office fills the gap between yesterday's circuit switched PBXs and Key Systems and the IP-only solutions of tomorrow by meeting the total office communications needs of small-to-medium sized businesses. IP Office has been designed for those organizations wishing to support voice and data networking, either on one or more sites. It supports PBX and key system telephony, IP telephony, voicemail, call center, high-speed Internet access, Computer Telephony Integration, and remote network access.

Rich functionality combined with ease of use can only be achieved when all components have been designed as a fully integrated system. This document describes the technology and architecture of IP Office, which has been designed into a unique integrated solution to deliver these benefits.

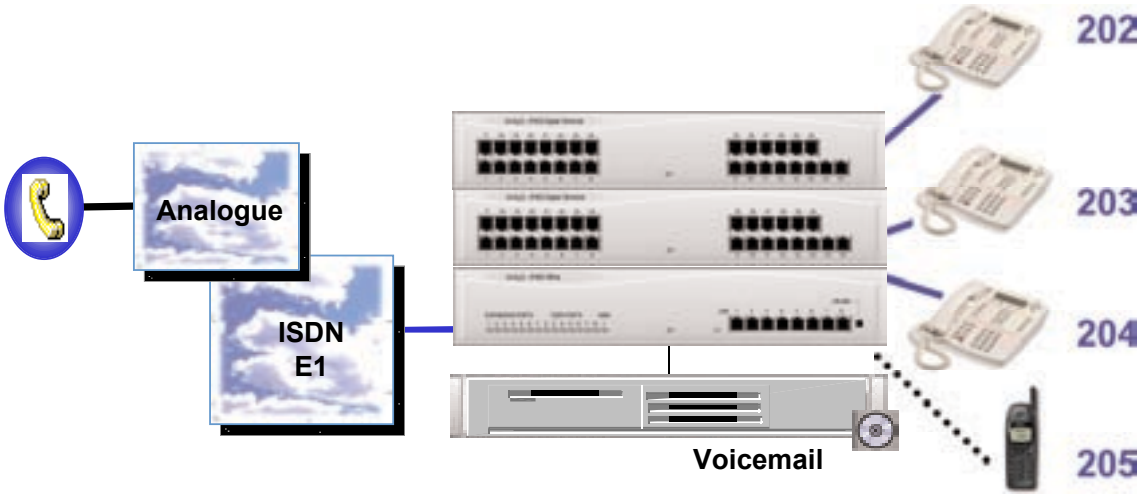
2 Functional Overview

2.1 Voice communication solutions

IP Office provides all of the functionality required for small and medium enterprise voice communications:

- Full PBX with key system features
- E1, T1, PRI,
- 2- 180 Extensions
- IP Telephony, Caller Display or Digital Handsets
- Voicemail & auto Attendant
- Hunt Groups
- Advanced Call Distribution
- Alternate Call Routing
- Q.Sig Networking

IP Office provides a comprehensive set of telephony features.



Features such as Caller Display and alpha tagging allow employees to see who is calling and why before they pick the handset up. Client information can be 'popped-up' on the user's PC.

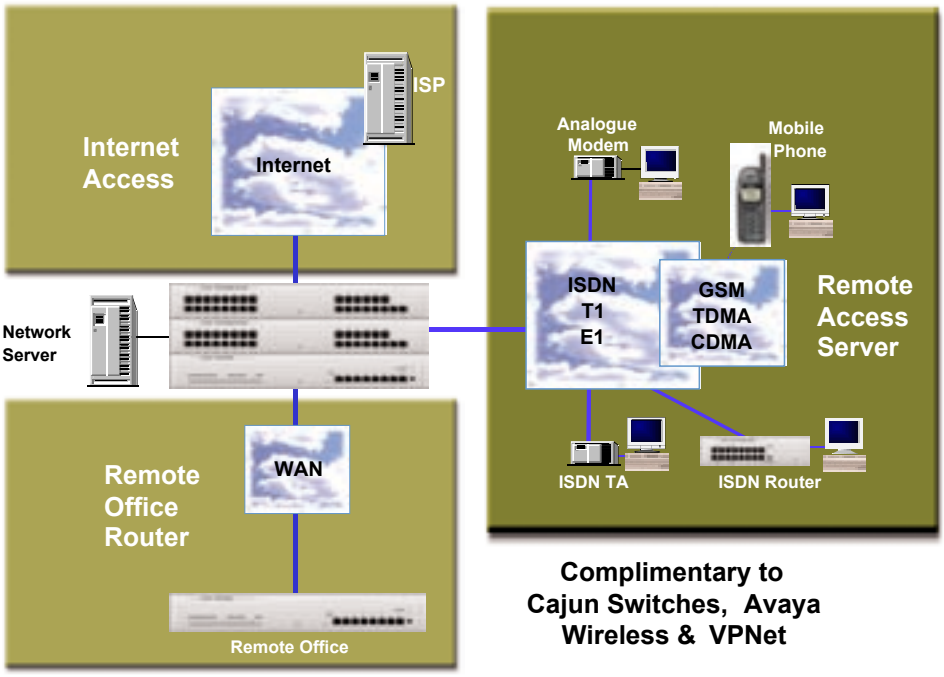
For those who aren't tied to a desk, cordless handsets offer mobility around the office. For those on the road or working from home, comprehensive and easy to use call forwarding and following facilities and remote access server software allow them to remain in telephone contact and provide access to centralized resources at all times.

Incoming calls can be efficiently handled by Direct Dialing, or with one or more dedicated operators. For out of hours calls or whenever you just can't take calls, Voicemail, and auto attendant services can all be effectively deployed.

2.2 Data communication solutions

IP Office provides integrated standards-based support for all of the data networking requirements of small and medium enterprises. These are discussed in detail in section 4.

- Routing
- NAT
- Firewall
- RAS & Dial-Up
- Fax over IP



2.3 Integrated Applications

IP Office provides a broad range of built in and value added applications to meet the demands of any small business. These applications are all fully integrated into IP Office, and they work together as an integrated suite.

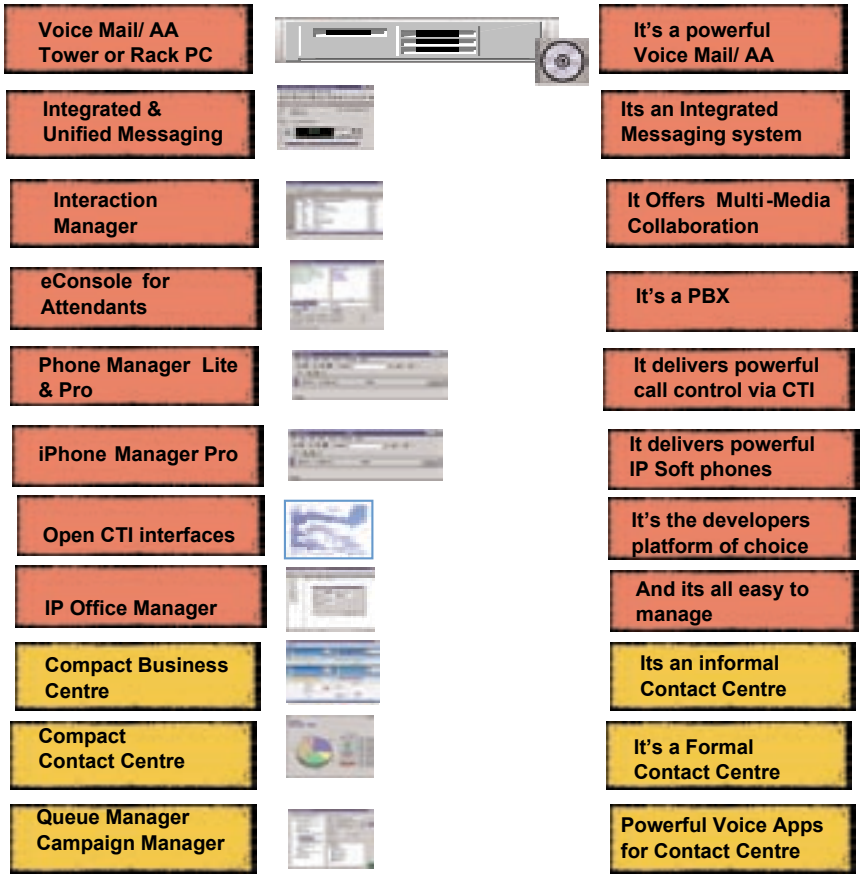
For example, Voice Mail Pro is a value priced, almost zero install time solution delivered on a CD for use with an external PC. It offers Voice mail and Auto Attendant as well as contact center support such as Queue monitoring and agent recording. Only a network connection is required, no voice processing cards are needed.

Unified Messaging is offered in three levels of functionality, ranging from simple notification through to full synchronization with Microsoft Exchange™, or actual use of exchange as the message store through integration with the Unified Messenger for Exchange™.

Compact Contact Centre offers formal and informal real time agent, group and system management and historical reporting, as well as reporting integration with Voice mail Pro.

Interaction Manager is a customer contact solution that enables companies and departments to manage multi-media contacts into and out of the organization. It supports inbound and outbound telephony, Web call back, e-Mail routing, and Chat.

IP Office is an Application Platform



3 Data Services

3.1 LAN/WAN Services

Computers in an office communicate via the LAN (Local Area Network), which may be a length of coax cable connecting all the computers, or twisted pair cables going into a central hub unit. The smaller IP Office platforms incorporate an integral dual speed Ethernet hub (10/100 Base-T) thereby allowing all users to easily leverage the data networking capabilities of IP Office.

Offices are connected together using router boxes. The routers may be connected together using WAN (Wide Area Network) links which could be 56k/64k T1/E1 leased lines, managed IP or Frame Relay networks or ISDN dial up. IP Office platforms support all these types of network connections.

The main unit has a Wide Area Network (WAN) port that can be connected to a digital leased line service using either X.21 or V.24 or V.35 interface at speeds up to 2048kbps. Point-to-Point protocol (PPP) is used over this link. The data within the

ISDN call uses the Point-to-Point Protocol (PPP) which is used by the vast majority of manufacturers for linking routers, particularly where different manufacturers routers are used at each end of the link.

ISDN links can also be used in the event of failure of the WAN link to provide alternate or top up bandwidth on demand. The link can use CHAP (encrypted passwords) to verify the end users (preferred) or PAP, which does not use encryption.

The computers communicate by putting data into packets and labeling them with the source and destination IP addresses. IP Office can act as a DHCP server and assign IP addresses automatically thereby simplifying the IP address allocation process.

All IP Office platforms have an integrated router with support for bandwidth on demand – proprietary Bandwidth Allocation Control Protocol (BACP). BACP is a protocol specification for PPP that allows Multilink PPP (MLPPP) routers to negotiate extra bandwidth dynamically over time.

By supporting BACP and MLPPP, IP Office initiates extra calls between sites only when there is data to be sent or sufficient data to warrant additional channels, then drops the extra channels when they are no longer needed. The calls are made automatically without the users being aware of when calls begin or end. Using T1 or ISDN it is possible to establish a data call and pass data without the user being aware. The rules for making calls, how long to keep calls up, etc are configurable within IP Office.

It is possible to have several different routing destinations active at any time. The unit can handle multiple simultaneous active data routes dependent on the number of data calls supported by the individual IP Office systems.

3.1.1 DTE Port

DTE ports are provided on all IP Office systems. This DTE port (25-pin D-type connector) has an AT command interface. Certain AT commands may be sent to the serial port so that it will run an X.25 TPAD interface. The T1/PRI/E1 link between the main unit and the transaction Authenticator is Digital. The Authenticator requires no modem. A credit card “swipe” terminal can utilise the PRI (B channel) trunks via this DTE port and allows for faster transactions than provided by conventional modem connectivity where supported. This port also allows IP Office to be used as a terminal Adaptor (TA).

3.2 Internet Access and Security

While the telephone is still the primary business communication tool, Internet access is becoming increasingly important for all forms of communications. The ability to send and receive email is now considered mandatory when dealing with many suppliers and customers, while access to the World Wide Web for e-commerce applications and information is also becoming vital.

With the exception of IP412, all IP Office systems employ an integral 10/100 Mbps Hub to network PCs and servers to provide shared, secure, high-speed access to the Internet via external T1/PRI or digital leased line services.

Internet security concerns are addressed through the provision of an integrated Firewall. This removes the need for an expensive, standalone, software solution tying up another PC where basic Firewall is needed. The Firewall can be configured to cater for a variety of situations and will allow customers to control who can access external resources, and when. This isolates your private networks from the Internet thereby ensuring that your network remains beyond the reach of hackers while configurable service quotas can be set against the service to ensure that it is not abused.

The integrated Firewall will also perform Network Address Translation (NAT) allowing access to the Internet using a single pre-configured or dynamically assigned IP address, yet still allow all your users PCs and workstations simultaneous access as and when required. The largest system, the IP412, employs dual segment LAN ports with a Firewall break so that internal and external networks can be physically separated.

The Firewall can filter a variety of IP protocols including file transfers (FTP), internet browsing (HTTP), voice over IP (H.323). Each protocol passing through the Firewall can be restricted/allowed access in four different ways:

Drop No sessions via this protocol will be allowed through the wall

In An incoming session can "punch a hole" in the wall to allow traffic in both directions

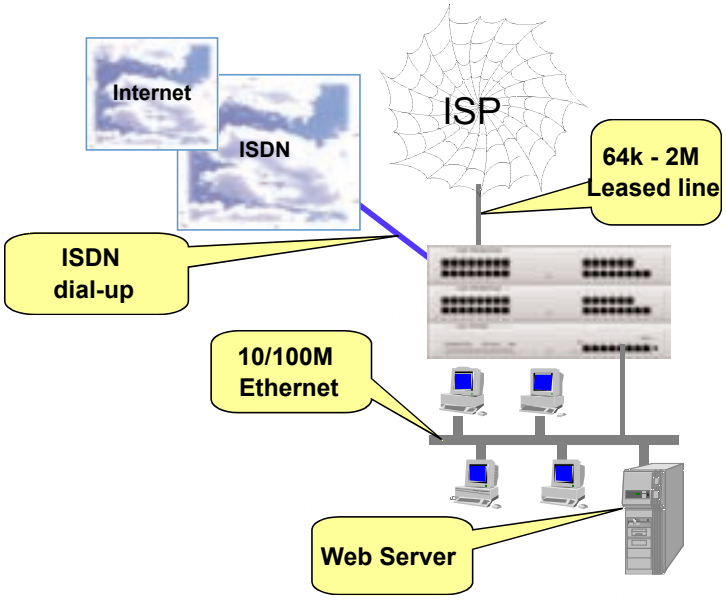
Out An outgoing session can "punch a hole" in the wall to allow traffic in both directions

Bothway Incoming or outgoing sessions can "punch a hole" in the wall to allow traffic in both directions

Service Quotas place a time limit on outgoing calls to a particular IP Service. This avoids excessive call charges either because of user abuse e.g. excessive surfing or when something changes on your network and call frequency increases unintentionally.

A Fallback Service can provide an alternative route while a service is in fallback. For example, you may wish to connect to your ISP during working hours and at other times take advantage of varying call charges from an alternative ISP. You could therefore set up one Service to connect during peak times and another to act as fallback during the cheaper period.

Internet Access



3.3 Remote Access Features and Security

IP Office's integral Firewall, service quotas and time bands all apply to remote access calls. Remote access security is supplemented by CHAP or PAP to verify user access. Time bands can control the hours within which the remote access service is available.

A "trusted location" can be set. This allows either data access, e.g. a user dialing in from home, or access to Voicemail without a Voicemail code for a user collecting his Voicemail messages from a mobile. The trusted location is also the location the Voicemail Server will call to inform the user of a new message.

Conversely a "specified location" can be set that restricts remote access from only that location. This specified location can also be a designated dial back number thereby minimizing the threat of unauthorized remote access.

IP Office systems can also incorporate remote access dial back services so that if a user always remotely accesses the office from a single location e.g. their home, then after logon verification the system will disconnect their call and dial them back. In addition to the added level of security dial back provides, it can also be an excellent method of consolidating remote access charges onto the central office telephone bill instead of employing expensive freephone services.

An optional dual V.90 56Kbps modem module can be added to provide dial-in/dial-out to/from users equipped with analog modems. Where T1/PRI is supported, remote access is also available through Terminal Adapters.

4 Voice over IP

Convergence is recognized as the future of voice communications and all IP Office systems are Voice over IP (VoIP) enabled. VoIP trunks (VoIP Networking) are supported to facilitate the convergence of voice and data on the WAN and allow customers to deploy this latest voice technology while still utilizing the IP Office as a traditional business telephone system with analog and digital handsets. The IP Office also supports IP extensions (IP telephony) allowing a customer to deploy an IP-only solution.

IP Office fills the gap between circuit switched PBXs and Key Systems and the IP-only solutions of tomorrow. This facilitates the migration to VoIP and IP Telephony as and when it's right for each customer's business, managing the migration from traditional telephony to their needs and resources. The result is true investment protection for their business.

4.1 IP Telephony - The Benefits

A key benefit of IP Telephony is the ability to deliver enterprise voice and data using a single infrastructure. Use of a single wire to the desktop reduces installation cost, and a single point of management reduces Total Cost of Ownership.

But it's the integration of IP Telephony with IP applications that unlock the real value. Information that can be used for messaging, e-business and Customer Relationship Management (CRM) will be easier to obtain, more flexible in it's use and likely to be more cost effective than yesterday's solutions.

4.2 H.323 Gateways and Gatekeepers

A Gateway allows IP Telephone calls to be converted into traditional voice calls and vise versa. This allows a call made from an IP Telephone to be received across the Public Switched Telephone Network (PSTN) by traditional telephones. The Gateway is controlled by the Gatekeeper, which knows who is where (and how to get to them) in an end-to-end IP Telephony system. This Gatekeeper is typically an internal device in a small to medium sized system (as with IP Office), or an external, stand-alone facility in very large networks.

Whereas traditional telephone systems are proprietary in their design, the design of IP Telephony systems has been driven with open standards. Well-designed IP Phones, Gateways & Gatekeepers all should support the H.323 standard and this allows devices from different manufacturers to work together. IP Office contains an integral Gateway and Gatekeeper so there is no need for expensive or complicated adjuncts. In addition it complies with H.323 standard to enable multi-vendor connectivity.

4.2.1 Supplementary Services within IP Networks

Supplementary services provide for a range of features beyond simply making a call. The industry standard for providing these services under H.323 is H.450. IP Office provides the same rich services as enjoyed within a traditional network environment. Our standards-based approach allows interoperability within mixed vendor networks.

Features supported by H.450 are:

- Basic call set up (voice)
- Call Hold
- Call Transfer

There are additional telephony features when using Avaya IP sets with IP Office.

4.3 IP Networking

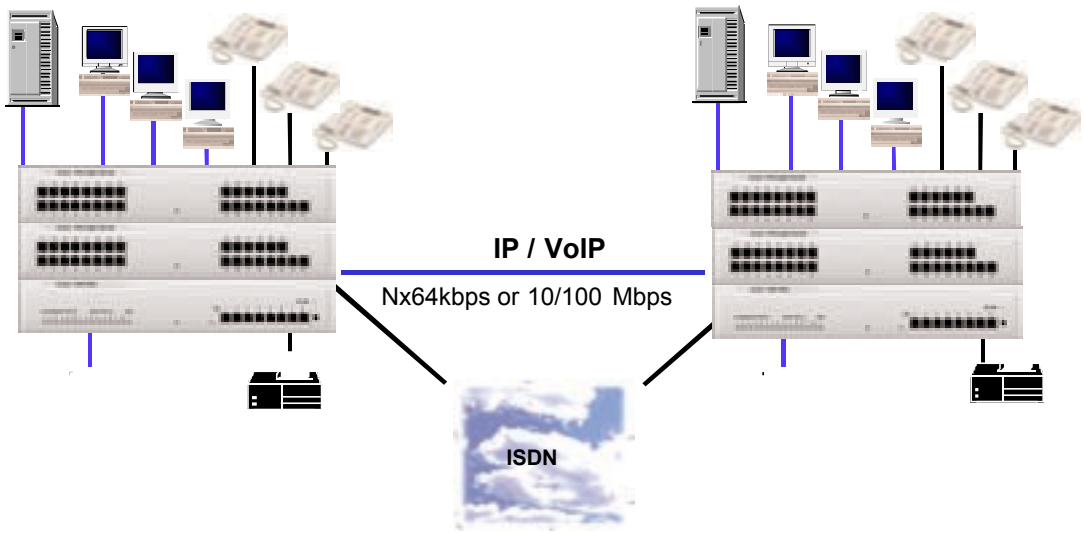
IP Office supports a wide variety of voice and data networking options from traditional circuit switched networks such as the ISDN and structured leased circuits to a multitude of packetized voice solutions. IP Office can operate as a traditional circuit switched telephone system utilizing both standard analog and digital handsets or IP Hardphones and Softphones.

4.3.1 Voice networking across packet networks

In addition to circuit switched telephony over the PSTN/ISDN or suitable leased circuits as described in section 5, Voice networking between IP Office sites can be achieved in many other ways using structured or unstructured networks:

- VoIP over T1/PRI/BRI
- VoIP over an unstructured private circuit
- VoIP over a managed IP VPN
- VoIP over a managed Frame Relay network
- VoIP across the LAN

VoIP networking across IP network or WAN



4.3.2 VoIP over a private data circuit

Private voice networks can be constructed using available unstructured data circuits (X21, V35 or V24/V28) at speeds of up to 2 M/bits.

These data circuits are accessed via IP Office's WAN port and combined with IP Office's Voice over IP Gateway and Voice Compression Module (VCM) allow up to 60 compressed VoIP calls to be interleaved with data on a leased circuit.

This approach can realize significant savings by allowing compressed VoIP calls to be interleaved with data on any leased circuit with spare bandwidth.

Where multiple sites exist, the addition of the WAN 3 Module(s) allows larger networks to be deployed.

4.3.3 VoIP over a managed Frame Relay network

Frame Relay is a high-speed, packet switching WAN protocol that enables the interconnection of geographically dispersed LANs. Frame Relay is a connection-oriented protocol, which means that it relies on an existing end-to-end path between devices connected across the network. It implements these connections using Permanent Virtual Circuits (PVCs).

Like a leased circuit, a PVC is a logical path that connects two devices. This path between the source and destination point is a dedicated connection, so the PVC is always available to the connected devices. However, unlike a leased circuit, many PVCs can coexist on a single access bearer which allows devices to share the bandwidth of a given transmission line.

Voice over a managed Frame Relay network is similar to Voice over a managed IP network except that the access interface is usually a unstructured leased circuit via IP Office's WAN port. IP Office employs a Frame Relay Assembler Disassembler (FRAD) to allow voice and data traffic to be formatted and framed for a Frame Relay network.

4.3.4 VoIP over IP VPN

The inclusion of an integrated Voice over IP (VoIP) Gateway in IP Office allows significant cost savings to be realized by converging voice and data onto a single managed IP VPN.

An IP VPN is a private network of routers managed and partitioned by a single network service provider who assigns IP addresses and manages the network. Because of this the network service provider can guarantee throughput levels, minimize latency and ensure transmission speeds to give greater quality of service supported by a contracted service level agreement.

This is different from creating a private network by using IP tunneling techniques such as Microsoft's PPTP or Cisco's L2TP to create a VPN over a public IP network such as the internet, which uses multiple non-specified IP backbone infrastructures where end-to-end quality of service cannot be controlled. PPTP and L2TP are not supported natively IP Office, but Virtual private networks can be

supported with IP Office using the Avaya **VPNet** product range.

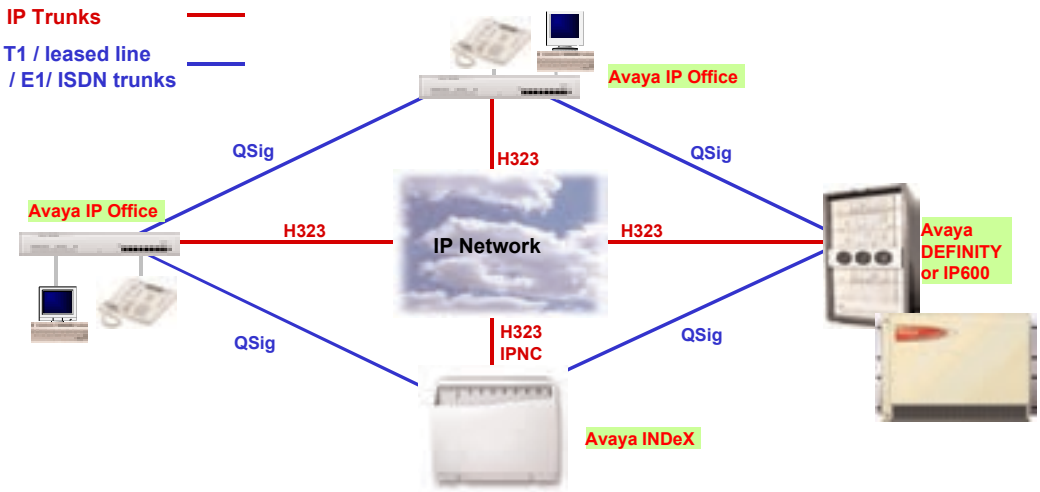
IP VPNs have some distinct advantages over Frame Relay networks: access bandwidth need not be pre-allocated between sites like Frame Relay's PVCs, they are generally cheaper and their global reach is normally greater. Access to the IP VPN is via one of IP Office's LAN ports.

4.3.5 VoIP across the LAN

In a factory or campus environment, voice calls can also be linked utilizing 10/100 Mbps LAN connections, which can be copper or fiber. This is again facilitated by the optional Voice Compression Module (VCM).

In order to avoid bandwidth issues, VoIP across the LAN will require some form of bandwidth management. Avaya's Cajun switches are the recommended option for this.

VoIP networking across the LAN



4.3.6 Voice Compression

VoIP solutions require coding and decoding of voice packets. In IP Office this is performed using Voice Compression Modules (VCM) to packetize voice into VoIP packets. The VCM is available in a number of variants depending upon the number of required simultaneous compressed calls – 5, 10, or 20 channels.

The Voice Compression Module (VCM) is H.323 compliant and can packetize and compress voice down to 32K (G.726/ADPCM), 8K (G.729/Netcoder) or even 6k (G.723). It enables IP Office to efficiently deliver high bandwidth communications, reducing congestion and expense.

Echo cancellation is built in to help with high latency circuits. The choice of voice compression algorithm selected is a trade off between call quality and the bandwidth requirements but, as a rule, the greater the compression the greater the latency i.e. the delay between what's being said and when it is heard.

4.3.7 Silence Suppression

Like voice compression, silence suppression is a technique used to make best use of available bandwidth. Silence suppression works by lending voice bandwidth to data traffic when there are pauses in the conversation.

Because absolute silence is unnatural during a conversation, IP Office generates an artificial background noise during these gaps in the conversation and this provides a more natural experience for the conversation participants.

4.3.8 RTP Stream Redirection ("shuffling" and "hairpinning")

This functionality ensures that IP Office media processing resources are used efficiently. Its role is to connect resources such as Codecs (compressor/decompressor) and tone generators only when they are required, and remove them from the media stream so they can be utilized on other calls when they are not required. For example, when an IP phone is picked up to make a call, it is connected to the IP Office resources to generate dial tone and progress the call. However, when the call is connected, these resources are no longer required so the media stream can be connected directly between the endpoints.

"Hairpinning"

Sometimes IP endpoints do not support compatible audio codecs, or an endpoint does not support "shuffling" (see above). In this case, IP Office converges the audio using its media processing using a technique called "hairpinning".

4.4 Quality of Service

When transporting voice over low speed links (WANs) it is possible that normal data packets can prevent or delay the voice data from getting across the link. This can cause a very unacceptable speech quality. Thus, it is vital that the routers in the network that carry voice have some form of Quality of Service mechanism (QoS).

IP Office supports DiffServ (RFC 2474) Quality of Service mechanisms (QoS); this is based upon the Type of Service (ToS) field in the IP header. The

software will prioritize voice, fragment large packets and provide VoIP header compression to minimize the overhead required for VoIP addressing, using Industry standards.

IP Office Header compression and fragmentation is based upon the following standards:

- RFC 2507 (IP)
- RFC 2508 (RTP)
- RFC 2686 (Multi-Class Extension to Multi-Link)

When used with data switches such as the Cajun range, DiffServ tags can be used for 802.1p marking. The Cajun range also supports 802.1q for VLAN prioritization. QoS routers are also required to ensure low speech latency and to maintain sufficient audible quality.

4.5 Voice over IP Standards Supported

IP Office supports industry standards because interworking with other products will be increasingly important as more companies introduce VoIP products. Avaya is actively participating in the definition and evolution of the H.323 and the emerging SIP (Session Initiation Protocol) standards.

The IP Office supports the following protocols and standards:

- H.323 (V2)(1998), Packet-based multimedia communications systems
- Q.931, ISDN user-network interface layer 3 specification for basic call control
- H.225.0 (1998), Call signaling protocols and media stream packetization for packet-based multimedia communication systems
- H.245 (1998), Control protocol for multimedia communication
- T.38 Real time Fax over IP support is planned for a future release

Audio CODECs:

- G.711 A-law/U-law
- G.723.1 MP-MLQ
- G.729 Annex A – CS-ACELP
- G.726 ADPCM
- Silence Suppression
- Fax Relay
- Local End Echo Cancellation 25ms
- Out of band DTMF
- Jitter buffer, 5 frames of jitter buffer

Internet Standards/Specification (in addition to TCP/UDP/IP)

- RFC 1889 – RTP/RTCP, Real Time and Real Time Control protocol
- RFC 2507,2508,2509 – Header Compression
- RFC 2474 – DiffServ, Type of Service field set to DSCP 6

5 Branch and Remote Working

The IP Office WAN3 module is the mainstay of IP Office's branch office solution. Situated at the main office the IP Office WAN3 can be utilized in a central position to act as the hub of a voice and data network between three other IP Office systems. With the central IP Office platform supporting up to six IP Office WAN3 modules, it can provide WAN connections of up to 2Mbps to a maximum of 19 IP Office branch offices (including the on-board interface).

5.1 Telecommuting & Remote working

The IP401 Compact Office 8/16 provides the ideal solution for the very small office and home worker/telecommuter who requires all the voice and data capabilities of his office based counterpart, whether using conventional telephony or VoIP. With the optional WAN port, IP401 Compact Office 8/16 provides the same level of flexible networking via both the PSTN and data networks as the larger systems. IP Office employs remote access security and ISDN terminal adapters to facilitate remote working.

5.2 Networking the Branch Office and Telecommuter

Branch offices and Telecommuters remotely connect to the main office via a variety of TDM and IP methods previously described within the 'Voice Networking' and the 'Convergence & IP Telephony' sections. The options include:

- VoIP over the T1/E1
- VoIP over an unstructured private circuit
- VoIP over a managed IP VPN
- VoIP over a managed Frame relay network

Typically branch offices will also require a local telephone number, local DID ranges and outgoing calls, so a local PSTN connection is necessary and this is facilitated by IP Office's BRI , PRI and T1 interfaces.

6 Unified Management

A key requirement of any successful solution is its ability to be easy to configure and manage. This section gives an overview of the management applications, common to all IP Office platforms, that meets this need.

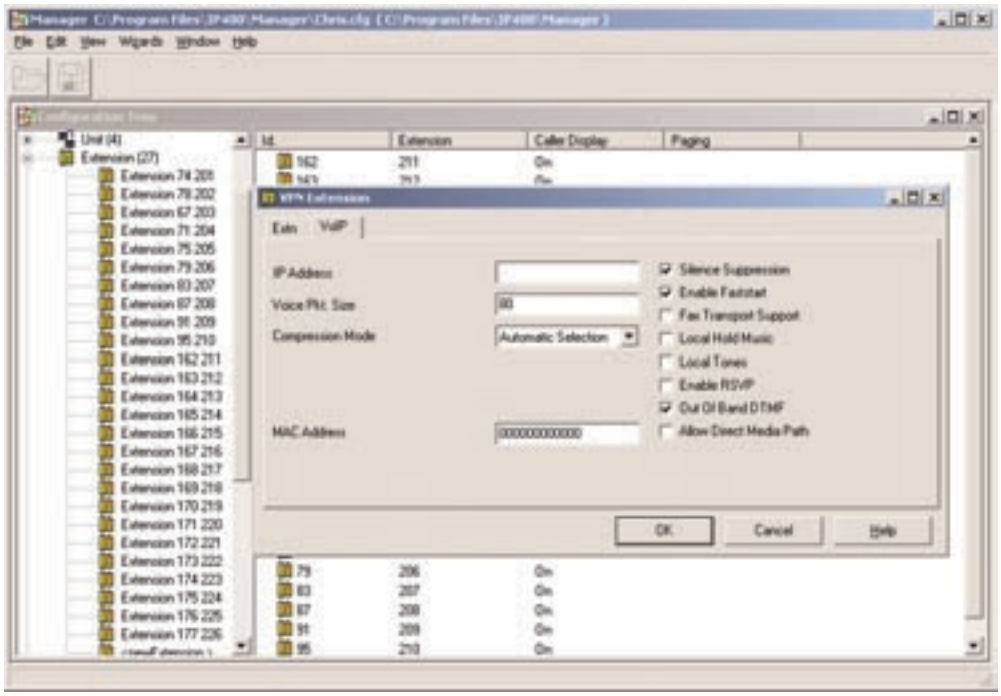
- **Manager**
  IP Office's main configuration tool
- **Call Status**
  Displays current call activity
- **Call Logger**
  Outputs call detail records for off switch processing
- **Monitor**
  A trace utility for trouble shooting
- **SNMP**
  SNMP support
- **LDAP**
  LDAP client

6. 1 Manager Client

This application is IP Office's main configuration tool. Utilizing Windows look & feel, Manager provides a familiar interface for both installation configuration and subsequent moves and changes. Protected by passwords and definable user rights, Manager provides customizable application that allows it to operate according to the individual users level of expertise. In doing so, Manager can be safely provided to users to allow them to easily carry out ongoing management of their installation without risk of causing system outages.

For installation and maintenance engineers, Manager allows them to prepare and review a configuration file for an IP Office unit 'off line' or extract the current configuration from a live system to a PC file and merge it with new data. A single

Manager Client Screenshot



Manager can manage multiple sites, pulling up configuration images whenever required to manage a remote site.

After editing a configuration, Manager can send the configuration file to the system. Manager is also used to upgrade the IP Office system software.

IP Office's Flash Memory always stores a copy of the last configuration sent to it via the Manager application. Whenever the main unit reboots, the configuration is sent from Flash to RAM. Therefore, if users make changes to the configuration via, for example, Phone Manager or short codes, the configuration in the Flash Memory will be updated to reflect these changes. This is done automatically every day between 00:00 and 00:30. However this will only occur if a user has made a change or a configuration has not been manually sent during that day. Manager can be used to manually initiate a backup of IP Office's configuration.

6.2 Call Status

The Call Status utility provides management information that displays all telephone and data calls that are currently active on the IP Office system on a PC.

This includes status of all of the active telephone and data calls on the system, and a list of incoming calls that have not been answered.

The Active Calls List displays the time the call was made, the extension either making or receiving the call, the number dialed (or received CLI, if any), the party at the other end of the call (if known), the direction of the call, the current status of the call (Idle, Ringing, Connected, Disconnected,

Suspended, Resuming, Dialing, Queued, Parked, or Held) and the length of time the call has been active.

The Missed Calls List displays the date and time the call was received, the extension that was receiving the given call, the number received via CLI, the party at the other end of the call (if known) and the length of time the third party waited for an answer before hanging up.

6.3 Monitor

Monitor is a real-time maintenance utility which displays input and output from IP onto the LAN or WAN. As an example, it can selectively display layer 1, 2 or 3 messaging between IP Office and the ISDN network. Monitor is provided to assist IP Office trouble shooting.

6.4 SNMP

IP Office provides basic SNMP support to allow polling of status/stats through standards based third party tools for sysDesc, TCP,IP, UDP, ICMP, and Interface groups.

6.5 LDAP

LDAP (Light weight Directory Protocol) is a standards based protocol for directory access. Most enterprise directories, such as Microsoft's Active Directory, support this industry standard. IP Office has built in LDAP client to support synchronization of users and phone numbers with LDAP complaint directories.

7 CTI Support

IP Office is an open call processing platform with rich support for both standards based and proprietary Computer Telephony Interfaces.

7.1 TAPI*Link* Lite and TAPI*Link* Pro Interfaces

This is a Microsoft TAPI 2.x and TAPI 3.0 interface that is enabled on each user's individual computer terminal. This interface translates Microsoft telephony commands (as defined by TAPI) to those understood by IP Office and is suitable for integration with personal productivity applications such as MS Outlook, Goldmine, ACT! and Maximizer. TAPI*Link* Lite is a first party sub-set, which provides commands and events for screen-popping and simple call control only.

7.2 Dev*Link* Lite and Dev*Link* Pro Interfaces

DEV*Link* Lite provides a simple API for capturing call details to be utilized by call costing systems. Dev*Link* Pro provides an APIs for real-time correlation between extension and trunk connections, and is provided for use with external call recording equipment.

8 Architecture Detail

8.1 Architecture drivers

IP Office has been designed as unified communications platform to meet the needs of Small and Medium enterprises. The key needs include:

- Value End User Pricing
- Ease of Install
- Ease of Maintenance and Support
- Appropriate and uncomplicated security
- Open system/ Standards based
- Embrace appropriate MS technology and roadmap
- Deliverable by 2-tier distribution model
- Indirect channel skills

The design challenge was to provide a cost effective and easy to use solution that did not compromise the rich voice and data functionality offered by other Avaya platforms.

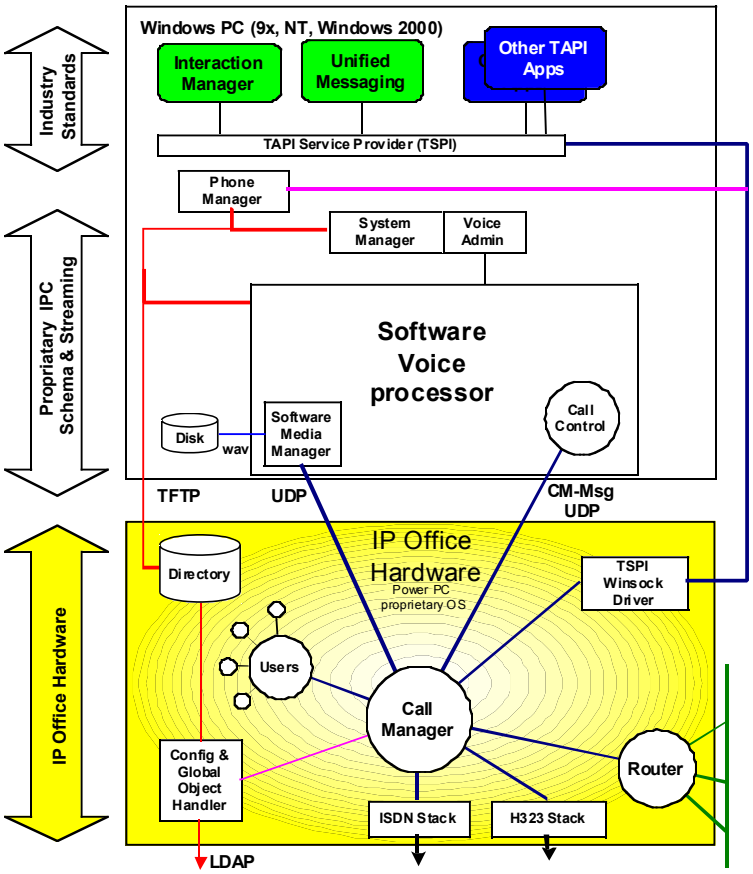
8.2 Software Architecture

The software architecture has been designed to provide consistent access by all system components to the Attributes and Capabilities of all Objects.

Objects include:

- Users and Groups
- Telephone Endpoints
- Media Endpoints
- TAPI
- Voice Processing
- H.323 'lines'
- ISDN lines
- Calls

IP Office Architecture



8.3 Hardware Architecture

IP Office hardware architecture has been designed for easy expansion of capabilities and capacity of the system.

8.3.1 External expansion bus

The external expansion bus supports four types of modules in an industry standard 19 inch form factor. These include:

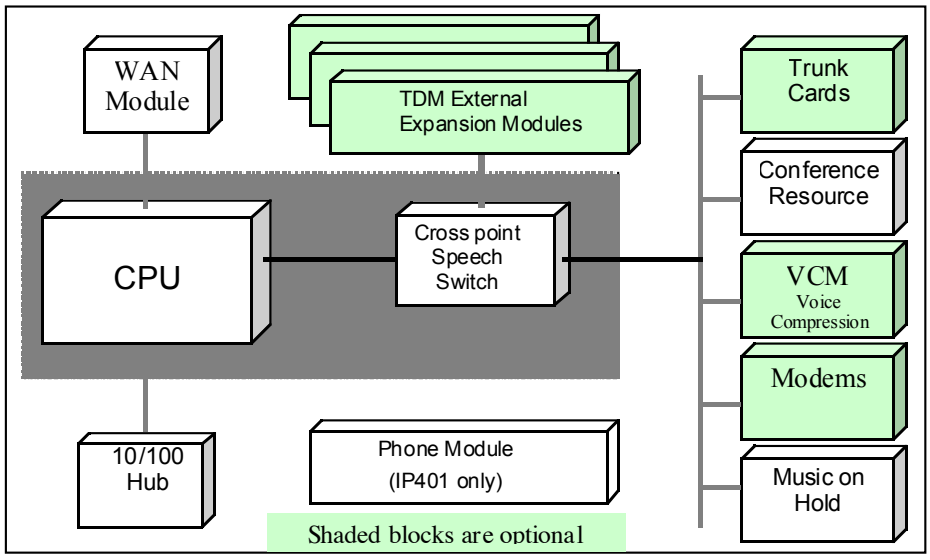
- IP400 Office Phone Module – three variants
- IP400 Office Display Terminal Module - two variants
- IP400 Office S0 8 Module
- IP400 Office Analog Trunk 16 (US Only)

The IP 403 platform supports any three of these modules, IP 406 supports any six modules, while IP 412 supports any twelve (up to a maximum of 180 Analog or digital extensions).

8.3.2 Trunk interface cards

Trunk interface cards plug into the main unit to meet the needs of all key international markets.

- IP400 Office Quad BRI
- IP400 Office PRI E1
- IP400 Office Dual PRI E1 (IP412 only)
- IP400 Office PRI T1
- IP400 Office Dual PRI T1 (IP412 only)
- IP400 Office Quad Alog Trunk (LS) (US only)



8.3.3 Voice Compression Modules – 5/10/20

The integral Voice Compression Module can be utilized for Voice over IP (VoiP) applications in all IP400 Office platforms (including the IP 401). The 2-channel variant is used on the IP 401 only, IP 403 supports the 5 and 10 channel variants, IP406 supports the 5, 10 and 20 channel variants and the 30-channel variant is supported by the IP 412 only. Up to two VCMs can be fitted to the IP412, all other IP400 Office platforms support only a single VCM.

The VCM also provides the embedded voicemail system on IP401 and IP403 systems – see 'The Integrated Applications' section.

8.3.4 IP400 Office Modem 2 Module

The integral dual V.90 (56kbps) digital Central Site modem module, allows termination of two simultaneous analog modem calls. These calls are presented over a digital BRI or PRI bearer. The IP Office Modem 2 Module is supported on the IP403, 406 and 412 platforms.

Note that not all variants and modules are available on all models.

9 Leveraging IP Office 'in a box'

For the first time, a single voice and data communications solution has been designed and optimized for small and mid-size businesses that satisfies the requirements for cost, convenience and performance. IP Office is available at a package price from a single vendor – Avaya.

IP Office's integrated open architecture provides converged voice, data and applications. Whether the business is stand-alone, multi-location or a branch office of a large corporation, IP Office is a flexible, standards-based package that allows enterprises to serve the specific needs of customers now, and to grow with their future requirements.

With its rich set of integrated applications and essential business functionality like messaging, contact center and CTI, IP Office is the ideal answer to the growing demand for IP-based communications and single-network systems.

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