Dialogic®
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White Paper

Choosing the Right Media Board for IVR Systems

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Executive Summary

Interactive Voice Response (IVR) is one of the most widely implemented, cost-effective, and useful technologies around. For example, IVR functionality is used in applications for obtaining movie schedules, bank transfers, plane ticket reservations, and prescription refills; and even for televoting in TV Shows. Most businesses today some form of IVR system.

IVR has become ubiquitous, with new applications being developed every day. Independent software vendors (ISVs) and system integrators need the right tools to develop these applications. Choosing the right hardware platform (media board) is essential, resulting in reduced costs, faster time to market, and more satisfied customers.

This white paper discusses what ISVs and system integrators should consider in a media board for IVR systems, and why they must carefully select the right board for their needs. It also describes how Dialogic® Diva® V-xPRI-Series Media Boards can provide the elements needed for an IVR solution at a cost-effective price.

Note: The lower priced Dialogic® Diva® CTI Version Media Boards may be an option for an entry level IVR system, while the higher priced Dialogic® Diva® UM-Series Media Boards offers additional features like fax and modem support for implementing a contact center. For small IVRs, there are also Dialogic® Diva® Analog Media Boards and Dialogic® Diva® BRI (ISDN) Media Boards that provide a similar feature set as the Diva V-xPRI Boards covered in this white paper.

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Overview of the IVR Market

Anyone with a phone has likely encountered an Integrated Voice Response (IVR) system. Companies of all types and sizes use IVR to help customers get fast and easy service. IVR connects people (or callers) with the information they need, using any telephone at any time. With IVR, callers can press buttons on a touch-tone phone or use speech to choose between menus or options, allowing for the automation of customer services. IVR systems help to assure that callers reach the right department and that they can retrieve the necessary information or conduct a transaction without having to wait in queue for a live agent. This results in less time on hold for callers and reduced costs for businesses.

IVR systems use Dual-Tone Multi-Frequency (DTMF), the audio signal generated when buttons are pressed on a touch-tone telephone phone, to determine the user's response to recorded prompts. Newer systems also support speech recognition technologies, which enable callers to respond to prompts using natural language. Speech-enabled IVR systems increase the number of choices available to a user, since they recognize words and phrases, as well as numbers and letters. They can also make it easier to navigate the system, resulting in a better user experience.

Using a Media Board in IVR Systems

A media board offers a variety of functions that greatly impact the overall performance of an IVR system. In an IVR environment, the media board transmits information between the caller and the IVR server. This makes it possible for the IVR server to play pre-recorded prompts to the caller, and to receive and interpret the DTMF or voice commands that the caller enters in response to the pre-recorded prompts.

IVR applications can greet callers with digitized welcome messages. The caller can then use DTMF or speech to instruct the system where to route the call, and the media board can complete the call transfer by routing the call without requiring a human operator.

Using a Media Board in DTMF IVR Systems

There are several capabilities that ISVs, VARs, and system integrators look for in a media board when developing a DTMF IVR system:

- **Call routing** can be done based on the calling number or user input. In sophisticated systems, calls can even be routed based on the estimated age of the caller. For example, callers older than 60 years can be routed to a human operator.
- **PBX integration** is an integral part of IVR systems, and the media board should support corresponding supplemental services such as call hold, call transfer, and the QSIG protocol.
- **Call recording** is important for legal reasons at banks and insurance companies, and is also important for quality assurance and service improvement.
- **DTMF suppression** allows an IVR system to recognize DTMF tones and remove them from the signal stream so other people cannot hear them. This is an important feature for conferences, because it removes the DTMF tones from all non-muted participants.
- **Silence detection** is used to make an IVR system aware if a caller does not respond, and can be used to trigger a prompt like: "I cannot hear you. Please enter or say your account number."
- **Barge-in** is used to skip prompts and proceed to the next part of the application as soon as the caller says something. The implementation of this feature requires the media board to be able to play a prompt while listening to "tone events" like Human Talker.
- **Signaling capabilities** are also important, and the media board needs to support the various ISDN flavors that vary around the globe. All or most of the supplementary services, such as Call Transfer with Path Replacement, should be supported by the chosen platform.

Choosing the Right Media Board for IVR Systems

Using a Media Board in Speech-Enabled IVR Systems

Although the large majority of IVR systems on the market still support DTMF, many of the new systems being developed focus more on natural speech input, while preserving the DTMF or pulse detection option.

The following additional media board capabilities are important for a speech-enabled IVR system:

- **Integration with the leading speech engines** currently on the market relies on echo cancellation, full-duplex voice channel support, and Voice Activity Detection (VAD) capabilities.
- **Barge-in** allows the caller to interrupt the speech prompts by speaking over them.
- **Full duplex voice channel support** (also called continuous speech processing) allows speech recognition in parallel with prompt playing. Full duplex channel support also controls the pace of the conversation and helps complete the interaction more quickly, resulting in a better user experience and more efficient platform utilization.
- **Voice Activity Detection (VAD)** reduces the volume of the voice stream and offloads host platform resources for speech recognition. By being able to detect a live voice and keeping out extraneous noises, VAD can keep the line cleaner and only pass on real voices to the application. This not only saves bandwidth, but also makes it easier for the application to work effectively. While this function can be done in the PC, it is important to also have a board that can perform VAD.
- **Echo cancellation** improves recognition accuracy. Without echo cancellation, the speech recognizer gets confused when it "hears" its own outgoing prompts. The better the system is at removing the echo (additional signal reflected in the network), the more reliable the link, resulting in a greater ability to recognize DTMF tones.
- **DTMF processing** is a CPU-intensive task that can be better accomplished with a board than with a PC. Also, since some speech recognizers cannot process speech and recognize DTMF at the same time, using a board that can process DTMF on its own is an important requirement for speech-enabled IVR systems.

Without these capabilities, the speech system is not positioned to provide the high performance necessary to address the challenges of demanding end-user customers, and companies may not experience the time and cost savings that can be realized by implementing speech-enabled IVR systems.

Benefits of Using Dialogic® Diva® Media Boards in IVR Systems

Diva Media Boards and software provide digital, analog, and IP network interfaces with rich media processing for voice, speech, and conferencing. The Diva Media Boards support speech technologies such as speech recognition, voice authentication, and text-to-speech, enabling developers and integrators to create a range of IVR systems and applications.

Diva Media Boards support the capabilities needed to develop an IVR application, including:

- DTMF detection and generation, with one dedicated DSP per channel for the single-span Diva PRI/E1/T1, BRI, and analog boards. The multi-span Diva Media Boards use fewer, but larger, DSPs.
- Multi-Frequency (MF) tone detection and generation
- Onboard (line interconnect) and cross-board switching
- Pulse Code Modulation (PCM)
- Voice/DTMF barge-in
- Silence, speech, fax/modem, answering machine, and generic tone detection
- Human talker detection (also called speech detection)
- Adaptive Differential Pulse Code Modulation (ADPCM)
- Support for low bit rate coders such as GSM, G.726, G.729, and other VoIP codecs

When used in a speech-enabled IVR environment, Diva Media Boards also offer:

- Full-duplex voice channel support
- Echo cancellation
- VAD
- Onboard speech processing with dedicated connectivity per channel, resulting in increased recognition accuracy and reduced system latency

Signaling and Resource Allocation

What sets Diva Media Boards apart is that they handle signaling and resource allocation on the board rather than requiring the application to allocate DSP resources, which makes the application more complicated. By using a media board with automatic resource allocation, a developer or integrator does not need to know how the board works and what resources are available, thus reducing overhead and development time.

The same applies for the signaling protocol. With Diva Media Boards, the application does not have to know which signaling protocol is used. Whether the application works on Diva Media Boards with analog, BRI, or PRI/T1/E1 signaling, the application simply calls the required function. It is the Dialogic® Diva® software layer that translates "making a call," "transferring a call," or "hanging up a call" into the required activity on the line. IP (SIP) and SS7 signaling are supported in the same way. Therefore, an application initially written for a Dialogic® Diva® analog board will work on boards that support T1, E1, or J1 lines, and ISDN BRI/PRI, SS7, or IP (SIP) signaling — a feature that can greatly reduce development and maintenance costs.

For example, when barge-in is required, a Diva Media Board automatically provides the resources needed without a developer or integrator having to take special actions to achieve this function. The Diva Media Board also automatically disconnects the resources when a call finishes. When using boards without automatic resource allocation, a developer or integrator would need to instruct the system when to disconnect the resource and return the resource back to the pool of resources.

Developing a speech-enabled IVR system usually requires the following five resources per active connection:

- Two resources for full-duplex voice (one per voice stream in each direction)
- One resource for tone detection
- One resource for echo cancellation
- One resource for voice activity

Without dedicated resources, an E1 board with 30 channels and 30 resources could allow only six concurrent calls before using up the resources on the board. This results in the need for additional boards, increasing the cost and complexity of the system. When using Diva Media Boards, the required resources are on the same board, and they are automatically allocated and freed.

PBX Integration

Diva Media Boards have a very broad coverage of QSIG-based services among the different PBX switches, providing supplementary services such as call transfer, call hold, and others based on ISDN or QSIG. Diva Media Boards support a wide array of PBX vendors, enabling the boards to be used in heterogeneous networks with a variety of PBXs from different manufacturers, while all connecting to the same IVR platform. This helps large enterprises with heterogeneous networks save money and resources.

An application can stay unchanged no matter what PBX or switch it is connected to. The person that installs the application simply selects the appropriate line protocol (PBX, switch type, and so forth). The selection of the line protocol allows the Dialogic® Diva® software layer to translate correctly between the application and the physical line, while the application remains unaware of the line protocol.

Call Routing

Diva Media Boards implement call routing based on their Explicit Call Transfer (ECT) capability, which enables the boards to "know" what they need to know about transferring a call. The boards mask the complexity of call routing and call transfer from the application, so that the programmer does not have to construct special messages to perform specific call transfers. The programmer simply calls the DivaBlindTransfer() function, and the boards perform the correct call transfer type in the configured environment.

Call Transfer

Call transfer is a critical part of IVR systems, and Diva Media Boards support the known types of call transfer. Basically, there are two types of call transfer:

- **Blind transfer** puts the call on hold, dials the new number, and immediately hands the call to the switch.
- **Trombone transfer** dials the new number, and when connected, it actively bridges the call to the new number. At the same time, the Diva Media Board signals to the switch that it wants to do a Call Transfer with Path Replacement. It usually takes the switch some seconds until it establishes the Path Replacement, but due to "call tromboning," the two parties can already talk to each other. After the Path Replacement is complete, the Diva Media Board can free the two channels that it used for connecting the two calls. All of this functionality is performed automatically in the background.

Dialogic® Diva® Media Board Offerings

The Diva Media Board family offers the following types of media boards:

- Analog (2, 4, and 8 port) in PCI and PCIe
- BRI (ISDN Basic Rate Interface) (1 and 4 BRI) in PCI and PCIe
- Single E1/T1/PRI (ISDN Primary Rate Interface) in PCI and PCIe
- Multi-span E1/T1/PRI (ISDN Primary Rate Interface) (1, 2, 4 and 8 trunks) in PCI and PCIe
- VoIP (SIP/RTP) software offering a "virtual IP board" using host-based media processing to support Voice over IP (VoIP) and Fax over IP (FoIP). The "virtual IP board" is implemented in software and is called "Dialogic® Diva® softIP for SIP Software."

Diva Media Boards have four different levels of feature sets (CTI, V-Series, UM-Series, and Universal Series) to allow different price performance ratios for different applications. They are RoHS 6/6, and are available in PCI and PCI Express. Depending on the number of electrical components and connectors, the Diva Media Board form factors scale from low profile (half height and half length) to half size (full height and half length) to full size (full height and full length).

Dialogic has tested Diva software on up to eight Diva Media Boards or to a maximum of 480 channels per server; however, customers can use more than eight Diva Media Boards per server. For large systems, it is important to select a suitable high-performance server (power supply, cooling, CPU and memory) that can host the user application.

Scalability

Designed to be scalable, any combination of Diva Media Boards can be mixed and matched in a system. All Diva Media Boards use a single set of driver software and a single set of APIs, enabling ISVs to develop applications that work across the entire range of Dialogic® Diva® products. Diva Media Boards share the same architecture, using a RISC CPU and several DSPs. This allows developers or integrators to mix and match Diva Media Boards in a single implementation. The application can stay the same, regardless of which Diva Media Board is used.

Standard Interface Support

Diva Media Boards support many standard interfaces, including COM port, AT-Command Set, WAN Miniport, TTY, and CAPI. Diva Media Boards also support three different proprietary APIs for C, C#, C++, VB, .NET, and other development languages and environments. For more information, see the Dialogic® Diva® Software Development Kit (SDK) Technology Brief.

The Diva SDK is free of charge and can be downloaded for Windows® and for Linux from the Dialogic website. There are no run-time fees for applications using the Diva SDK.

Table 1 shows which Diva Media Boards are well suited for particular IVR functionality:

Dialogic® Diva® Media Board	Basic IVR	Standard IVR	IVR Plus (Unified Messaging Functionality)
Analog 2,4,8(PCI/PCIe)	UM-Analog	UM-Analog	UM-Analog
BRI 1, 4 (PCI/PCIe)	BRI-CTI	UM-BRI	UM-BRI
PRI/E1/T1 (PCI/PCIe)	PRI-CTI	V-PRI	UM-PRI
V-xPRI/E1/T1 1,2,4,8 (PCI/PCIe)	V-xPRI	V-xPRI	V-xPRI + SW licenses for Fax & Modem
IP (SIP) (Software, uses host NIC for Ethernet)	softIP (Telephony)	softIP (Telephony)	softIP (Telephony&Fax)

Table 1. Dialogic® Diva® Media Boards and IVR Functionality

By providing all of these features, Diva Media Boards make it easier for developers and integrators to create fully-functional IVR solutions.

A patent pending feature called the M-Adapter brings even more scalability to the Diva Media Boards, as well as the ability to mix different types of boards. The M-Adapter is a further abstraction layer that combines various physical Diva Media Boards into one virtual Diva Media Board, enabling developers and integrators to combine the channels of various physical Diva Media Boards into a single virtual Diva Media Board. This feature can further simplify IVR application development, as the application can just deal with the one virtual media board.

Moving Toward IP Telephony

No discussion about IVR is complete without addressing IP telephony. As companies migrate to a single IP network for carrying voice and video data, both the circuit switched (TDM) and the packet switched (IP) worlds must coexist. When looking at telephony servers that provide the platform for network access and media processing, there is a lot to be done to interwork both voice and signaling in such disparate networks. While the actual network access is changing from analog or digital (E1, T1, ISDN PRI/BRI) lines to IP, the media processing requirements largely remain the same. For speech-enabled applications, real-time media processing is especially important, as it is the foundation for accurate and dependable implementations of speech recognition applications.

In TDM-based environments, media processing is typically provided as an enhanced function of telephony boards; but when migrating to an IP-based environment, the legacy telephony board may no longer be needed.

Diva Media Boards enable you to use both TDM and IP options. When migrating to IP, applications that run on Diva Media Boards do not need to change, except when IP-specific parameters are added (for example to extract an email address from the SIP INVITE message). The same application can run solely on TDM lines, be hybrid on IP and TDM lines, or run solely on IP connections.

Dialogic's approach combines existing APIs that abstract IP telephony protocols and allow host-based processing for smaller systems with dedicated hardware-based media processing resources. Developers and integrators stand to benefit from using a common programming interface for legacy telephony boards, host-based media processing, and pure IP media processing. They also benefit from reusing field proven and hardened DSP firmware and stacks, enabling them to achieve superior price performance due to industry standard PCI form factor and server technologies.

Customer Installation Experience

The customer installation experience is important to all companies in the value chain of selling and providing products. Diva Media Boards are focused on making installation and diagnostics work easily. Diva Media Boards are fully supported and certified under Windows® XP, Windows Vista®, Windows Server® 2003, and Windows Server® 2008. Linux support is provided via a "one for all" installation package that installs automatically for most of the known Linux distributions and their latest kernel versions. This includes SUSE, Red Hat, Debian, Fedora, OpenSuse, Slackware, Mandrake, Gentoo, and Ubuntu.

Installation is as simple as installing a modem card into a PC. The Windows® operating system automatically recognizes the Diva Media Board and installs the appropriate driver (Plug and Play). Diagnostic support tools like the Dialogic® Diva® LineTest tool are provided to allow the system integrator to diagnose telecom issues without the IVR program active or present. This makes supporting the Diva Media Board easier and reduces potential downtime.

Summary

IVR continues to play a vital role providing customers with self-service capabilities that benefit both the customers and the companies they do business with. IVR systems continue to rely on traditional DTMF technology, while also ushering in new speech-enabled capabilities.

Diva Media Boards and "virtual IP boards" comprise a product line well suited for voice and speech applications. They provide a full set of voice processing functions as well as efficient integration with speech engines. The powerful hardware architecture and rich media processing features of Diva Media Boards allow companies to develop and deploy IVR applications that deliver enhanced performance, greater accuracy, and reduced costs.

Developing IVR systems based on Diva Media Boards allows the same application to work on analog, digital, and IP connections. This enables developers and integrators to reduce their time to market and total cost of ownership, while providing the capabilities and functionality that their customers need both today and tomorrow.

Acronyms

ADCPM	Adaptive Differential Pulse Code Modulation
BRI	Basic Rate Interface
CAPI	Common ISDN Application Programming Interface
CTI	Computer Telephone Integration
DSP	Digital Signal Processor
DTMF	Dual-Tone Multi-Frequency
ECT	Explicit Call Transfer
FoIP	Fax over IP
GSM	Global System for Mobile Communications
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISV	Independent Software Vendors
IVR	Interactive Voice Response
MF	Multi-frequency
NIC	Network Interface Card
PBX	Private Branch Exchange
PCM	Pulse Code Modulation
PRI	Primary Rate Interface
PSTN	Public Switched Telephone Network
RoHS	Restriction of Hazardous Substances
RTP	Real-time Transport Protocol
SIP	Session Initiation Protocol
TDM	Time Division Multiplexing
VAD	Voice Activity Detection
VAR	Value-Added Reseller
VoIP	Voice Over IP
WAN	Wide Area Network

For More Information

Dialogic® Diva® Media Boards and Software page on the Dialogic website
Describes the different Diva Media Board families and enables you to understand which of the different Diva Media Boards is suited for you. The Diva Media Board families address the analog, ISDN BRI, single-span E1/T1/J1/ISDN PRI, multi span E1/T1/J1/ISDN PRI, and IP segments.

Dialogic® Diva® Software Development Kit: Development Toolkit for Voice, Speech, Conferencing, Unified Messaging, and Modem
Describes the benefits and highlights of the three Dialogic® Diva® Application Programming Interfaces (APIs) in the Dialogic® Diva® Software Development Kit (SDK).

Dialogic® Diva® System Release for Windows
Enables the configuration, management, and use of Dialogic® Diva® Media Boards with Windows®.

Dialogic® Diva® System Release for Linux
Enables the configuration, management, and use of Dialogic® Diva® Media Boards with Linux.

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