
# Testing IVR Systems

## White Paper

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# Abstract

Interactive Voice Response (IVR) systems are complex network elements providing a comprehensive set of features and functionality in order to complete or even substitute human call agents.

The IVR system is very often the only contact a caller has with a company when he requests a service, such as reserving a ticket for a movie. It is therefore very important that the IVR system provides high quality, in terms of robustness, stability, correctness of the menu branches and quality of the voice announcements.

This White Paper discusses key objectives and requirements for the efficient and comprehensive testing of Interactive Voice Response (IVR) systems.

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# Interactive Voice Response Systems

Interactive Voice Response systems represent a powerful means for automating business and customer-facing processes. IVR systems process phone calls, play pre-recorded messages, provide callers with real-time data from any number of databases and potentially route calls to service agents. IVR technology requires virtually no human interaction over the telephone, as the user's interaction with the database is predetermined by what the IVR system will allow the user access to. For example, banks and credit card companies use IVR systems so that their customers can receive up-to-date account information instantly and easily without having to wait to speak with someone directly. IVR technology is also used to gather information, as in the case of telephone surveys or tele-votes in which the user is prompted to answer questions by pushing the numbers on a touch-tone telephone. IVR systems can combine touch-tone input, speech recognition and text-to-speech capabilities, resulting in high customer satisfaction and operational effectiveness.

# The Challenge of Testing IVR Systems

IVR systems are complex. While they offer a wide range of features and functionality such as DTMF tone detection and voice recognition, they also provide different interfaces to other applications, literally rendering countless transactions possible:

- Bank account information and payments management
- Customer Relationship Managements (CRM) systems
- Personal voice mail systems
- All reservation systems, including airline reservation and check-in systems and cinema bookings

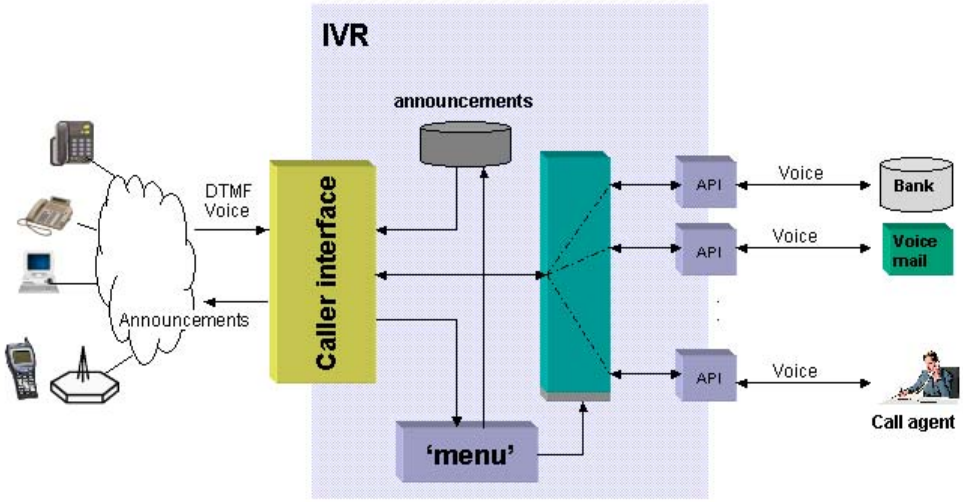


**Figure 1: IVR system - principle architecture overview**

If managing an IVR system isn't challenging enough, consider the complications related to the testing of an IVR system.

## The Human Element

The testing of IVR systems requires a test tool that can simulate the behavior and abilities of the caller - a rather daunting task indeed.

### Pushing the keys of a phone to send DTMF digits

The DTMF tone is the basic unit used to communicate with and take control over an IVR system. A caller sends the DTMF tones by pressing appropriate keys on a touch-tone phone to move through the menu tree of the IVR system. This menu can be a complicated maze of menus, branches and choices. Complex systems of this type require in-depth testing to ensure that customers are not confused or become stuck without a defined exit.

### Distinguishing between different languages

Advanced IVR systems offer caller-selectable languages in which to play announcements.

### Speaking, listening and understanding voice prompts

Many IVR systems do not only accept caller interactions with DTMF tones, they are increasingly capable of recognizing voice prompts spoken by the caller.

### Rating the voice quality of an announcements

IVR system announcements must be of good quality. They must be transmitted clearly to ensure the caller can understand every word.

### Behavior under load conditions

An IVR system can be put under very different load conditions once it is deployed in a live network (e.g., during a tele-voting event, when many callers setup up a call within a very short time). Thus IVR systems must be tested under different load conditions prior to their deployment to ensure:

- The IVR system works correctly under real load conditions in a live network.
- The IVR system recovers properly from overload conditions
- The IVR system is stable over a long period of time

### Integration of the IVR system in a complete network

Since IVR systems do not exist as "island" devices but are always integrated into an entire network, it is important to test them not only as stand-alone components but also as integrated parts of the network.

# The Test Solution

These challenges can be addressed by smart test solutions that offer a wide range of interfaces, applications, testing features and functionality. Figure 2 shows a typical setup for testing an IVR System.

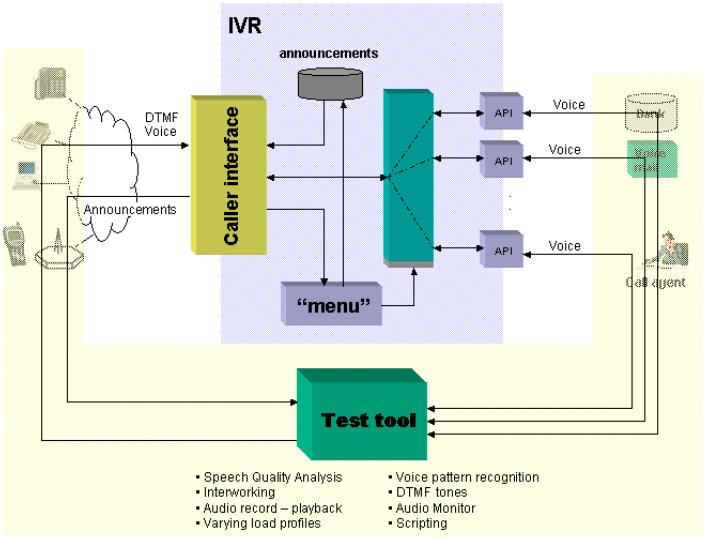


**Figure 2: Test setup for testing IVR**

To support this test setup, the test tool must provide the following key features:

- It needs to be able to setup calls on different interfaces and applications in order to simulate the behavior of human callers. Since calls usually are established using DTMF tones, the tool must be capable of sending any sequence of DTMF tones. In order to test the behavior of the IVR system with different caller profiles, changing the executable test scripts must also be quick and easy.
- It must be capable of simulating the interfaces to the various applications, including access to a bank account information system or to a personal voice mail system. In fact, the test tool must support all relevant interfaces provided by the IVR system to the outside world, thus allowing testers to treat the IVR system as a "black-box." Thus the tool has to provide multi-interface / multi-application capability for test execution on multiple interfaces running different applications.

- To test the voice recognition functionality of advanced IVR systems, the test tool needs to support the sending of pre-recorded voice prompts (e.g., *wav files) and DTMF tones. More importantly, it must be easy to both import available and generate new *wav files into the tool. This is crucial as IVR systems are often deployed with different language sets, all of which need to be tested prior to their rollout.
- Testing the voice quality of the IVR system is necessary to ensure that it plays its announcements clearly when deployed later in the live network.
- On-line audio access to the content of the voice channels during test execution is very helpful in terms of getting immediate information about the status of the IVR system that is being tested.

# Nexus8610 Traffic Simulation System

Nexus8610 is a call simulator / traffic generator that simulates user behavior of various communications technologies, including 3G / 2G Mobile, VoIP and PSTN.

User behavior simulation is based on executable test scripts that perform all necessary signaling operations in combination with comprehensive features for testing the payload in the voice channels of the user-plane.

Nexus8610 performs all kinds of call types on its various applications; from basic to complex calls, including any kind of supplementary services such as 3rd party calls, call forwarding, call diversion and many more, the test scripts can easily be written and modified to cover any individual needs.

## Specific scope of testing with Nexus8610 for IVR Testing

As outlined earlier, testing IVR systems requires smart tools that offer a wide range of features for checking the voice channel content of individual connections.

Nexus8610 offers all major testing functionality. This includes the following:

### Powerful and flexible scripting for test scenarios

Nexus8610 offers OPTEC, an easy-to-use, macro-based method for writing test scripts. OPTEC supports all kinds of testing functionality, including DTMF tone handling, speech path verification, voice pattern recognition, the sending and receiving of *.wav files, speech quality analysis and the ability to make numerous caller and load profiles.

### DTMF tones handling

Nexus8610 is capable of simultaneously sending DTMF tones of any length and at any level on all supported user-plane interfaces, including IuCS, TDM (E1 / T1) and RTP, in all available voice channels.

### Audio Monitor

During test execution, the tester can individually access the payload channels and directly listen to any voice patterns that are sent to or received by the IVR system.

### Audio record - playback of *.wav file

Nexus8610 supports the sending and receiving of payload through the voice channels, made available as a pre-recorded *.wav file. In conjunction with the audio monitor feature, payload of individually accessible voice channels can be recorded and stored directly as a *.wav file.

### Voice pattern recognition

Nexus8610 is capable of simultaneously receiving and analyzing voice patterns sent by the IVR system on all supported user-plane interfaces, including IuCS, RTP, TDM (E1/T1) and RTP, in several voice channels. The received voice pattern is automatically converted to a signature file, a sequence of 20ms in length, and then compared to the internally stored signature information. The signature comparison test further allows voice pattern recognition testing under load conditions.

Thus Nexus8610 voice pattern recognition allows in-depth testing of the menus, branches and choices of any IVR system.

### Speech Quality Analysis

Since networks are increasingly converging, new issues related to voice quality are arising when voice is transported over IP networks, including the usage of non-linear codecs (i.e., G72.x series in wireline networks or AMR, GSM-EFR and GSM-FR in wireless networks) and other typical effects such as Jitter, delays and packet loss. Nexus8610 performs voice quality analysis according to standardized algorithms, including PAMS, PSQM/PSQM+ and PESQ on individually selectable voice channels on all supported user-plane interfaces.

### Varying load profiles

Nexus8610 simulates different traffic models to vary the load conditions that are applied to the IVR system. These traffic models can even be based on the same test scripts, but with changed parameters such as the number of parallel callers, inter-call delays, call setup delays, call duration and many more.

## Interworking testing

IVR systems are always integrated into the entire network. There are two major types of interfaces used to integrate an IVR system:

- The interfaces toward the callers.
- The interfaces toward intelligent peripherals, including databases, IN platforms, the call agent in a call center and others.

For the complete and comprehensive testing of an IVR system, the interactions between these interfaces must be tested to ensure the IVR system performs as specified. With its support of multi-interfaces / multi-application testing, Nexus8610 is the ideal tool for interworking testing.

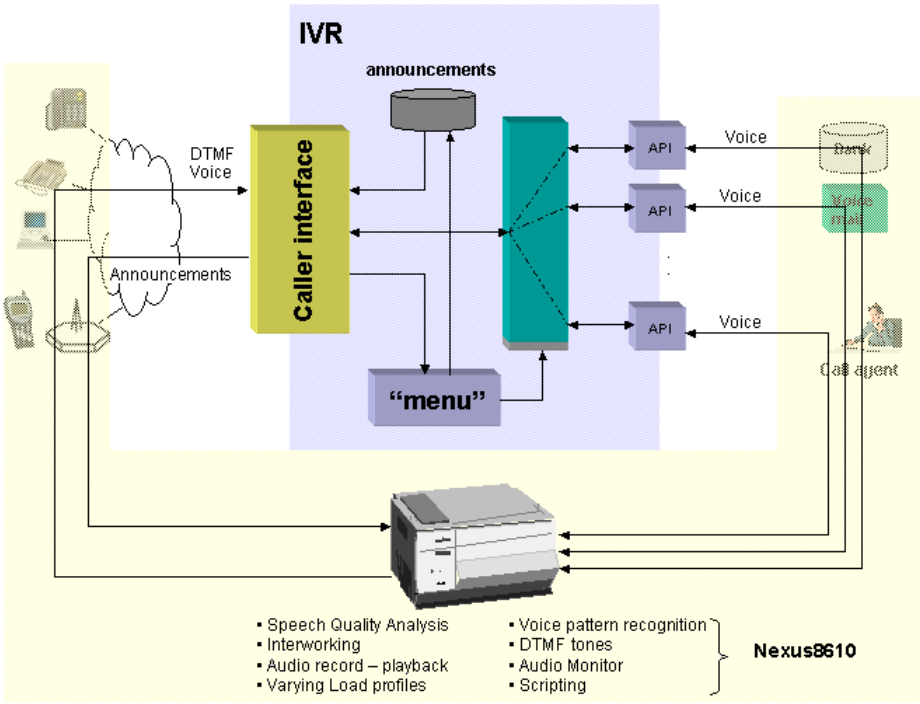


**Figure 3: Testing IVR systems with Nexus8610 Traffic Simulation System**

# Abbreviations

| | |
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| DTMF | Dual Tone Multi Frequency |
| ISDN | Integrated Services Digital Network |
| IVR | Interactive Voice Response |
| OPTEC | Optimised Test Case Composer |
| PAMS | Perceptual Analysis Measurement System |
| PESQ | Perceptual Evaluation of Speech Quality |
| POTS | Plain Old Telephony System |
| PSQM | Perceptual Speech Quality Measurement |
| QoS | Quality of Service |
| RTP | Real Time Protocol |
| SIP | Session Initiated Protocol |
| UE | User Equipment |
| UMTS | Universal Mobile Telecommunications System |

# About Nexus Telecom

Founded in 1994, Nexus Telecom (www.nexustelecom.com) is a privately-held company with headquarters in Zurich, Switzerland and a North American subsidiary in Ottawa, Canada. With over 200 employees, Nexus Telecom is a major OSS/BSS vendor delivering sophisticated state-of-the-art telecom management solutions to 2G, 3G, NGN and VoIP service providers and network operators worldwide.

Nexus Telecom specializes in Service Assurance, Revenue Assurance and Network/Service Testing solutions, supporting the most recently developed technologies and standards. Nexus Telecom's fast time-to-market strategy is to gain early in-depth know-how about upcoming network technologies through strong development partnerships with leading network manufacturers such as Siemens, Lucent, Nortel, Nokia, and Ericsson, to name a few.

Nexus Telecom
Zurich Headquarters

With solutions deployed in over 100 countries, Nexus Telecom's installed customer base spans the globe, assuring service quality and revenue streams for many of the world's best-known telecom operators. For small and large service providers alike, including the world's largest GSM/UMTS network operated by T-Mobile, the highly scalable and modular E2E solutions from Nexus Telecom maximize the service provider's competitive edge through excellent ROI, quick and smooth launch of new services, and greatly increased end-customer satisfaction.

Nexus Telecom is certified according to the ISO 9001 Quality and Management Standards.



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