

What is ICE ?

ICE is the PA State Civil Service Commission's \$1.5 million, multiyear project that completely automates the process used to develop, apply for, administer, and score civil service examinations. It has changed the way the Commission does business.

ICE is an acronym for "Integrated Computerized Examination" System. This system is not limited to the delivery of tests on computers. All applications for employment and promotion reside in the ICE System. As of June 11, 2003, nearly 150,000 applications had been entered into the ICE System. Thus far, about 71,000 tests had been administered to candidates on computers. ICE currently includes over 400 active examinations.

ICE has four components. "Candidate Manager" is the module that delivers the tests to candidates at computer test stations. "Test Suite Manager" allows test proctors to monitor and control the delivery of tests to candidates. "Systems Manager" is used by system administrators and network specialists to administer and maintain the system, including data replication, server and test station maintenance and readiness testing, updating builds, and database maintenance. "Test Manager" is the module used for the creation of tests (content, time limits, instructions, multi-media) and scoring. It is also the repository of applications, job announcements, examination history information, eligibility determinations, and reports.

Tests at SCSC facilities are now taken exclusively on computers. For some examinations, video scenes are viewed on test station monitors and candidates listen to audio components of tests through headphones. Accommodations for candidates with disabilities are also available at all test sites.

Computerized ICE examinations were first administered at the Commission's Harrisburg, Philadelphia, and Pittsburgh offices in late August and early September 2002. Since then, five additional test centers have opened in Lock Haven, Allentown, Scranton, Johnstown and Erie. Four of these testing locations are in the same buildings that house Team PA CareerLink offices, Pennsylvania's one-stop facilities for job seeker services, employer services, social services, and training.

Every effort has been made to help candidates easily become acclimated to the ICE system. SCSC staff prepared ICE educational materials, which include a "Mouse Tutorial," a "Quick Help Tutorial" and a list of "Frequently Asked Questions." This information is available on the SCSC website (<u>http://www.scsc.state.pa.us</u>). Notwithstanding our pre-ICE concerns, most candidates seem to enjoy taking tests on computers and most have little difficulty navigating through the tests. We have also noticed that most candidates complete tests faster when taking the test on a computer.

The final phase of the ICE project is now underway. It will include improvements to workflow within the Commission and automation of operations where feasible. As part of the final phase, paper applications and related documents will be imaged and electronic images will be available to Commission staff. Another part of this phase of the project will allow applicants to self-schedule for examinations.

As a result of the efficiencies of ICE, the Commission has streamlined and improved the assessment process with additional improvements expected with the completion of the final phase of the project. Candidate and client agency feedback on ICE has been very positive. - SB 6/16/03

Sample ICE screens follow:



Sample Test Question

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Candidate Statistics

ICE – COMPUTERIZED TESTING MISSION ACCOMPLISHED

By Steve Berkley, Project Manager

Four years ago, SCSC issued a Request for Proposal for the ICE system, envisioning a day when nearly all job applicants would be tested on computers, and paper and pencil testing would be a distant memory. With the recent official opening of our last two "statewide" testing centers in Allentown and Erie, that day has arrived.

More than 70,000 tests have been administered on computers since ICE went "live" at the end of August 2002. Currently over 150,000 applications reside in the ICE system and all test scoring occurs in ICE. Thus far, 471 announcements and 483 tests have been released in ICE. The ICE database is the repository of 23,828 test items, about half of which appear in released tests.

The Commission still does some limited paper and pencil testing when tests need to be administered at sites where we do not have ICE test suites. For example, scannable answer sheets are used for Aide Trainee testing at state hospitals (although computer administration of this test at SCSC test centers is being explored) and recently in Marienville, Commission staff administered paper tests to candidates for employment at a new correctional facility (SCI-Forest).

The Commission now has eight computerized test centers – Harrisburg, Pittsburgh, Philadelphia, Allentown, Erie, Johnstown, Lock Haven, and Scranton. Combined, these centers have a total of 250 candidate test stations. SCSC also has 60 laptop computers that eventually will be available for use in administering tests, at remote locations such as job fairs and college campuses.

At four of our test sites (Harrisburg, Philadelphia, Pittsburgh, and Johnstown) a test station in a separate room is available for testing candidates with disabilities who need accommodations. At the other sites, special testing times can be arranged to accommodate candidates with special needs. Each site also has one or more stations with an adjustable desktop to accommodate wheelchairs and all sites have at least one large screen monitor. Also, for each test location, we will be installing ZoomText, screen magnification software that can be used by visually impaired test-takers.

The testing at our Harrisburg, Philadelphia, and Pittsburgh offices continues to take place Monday through Friday. Each of these sites now has a main test room for the administration of computerized tests and an "overflow" room. The five remote sites currently test ten days each month - Tuesdays and Wednesdays with some evening and Saturday testing. In addition, to catch up on a backlog, the Scranton and Allentown centers expanded testing to 19 days in June.

As a result of multiple testing days per month and the capability of accommodating stand-by candidates, SCSC has been able to improve customer service considerably compared to "the old days" (less than a year ago) - when testing was scheduled only one Saturday each month at statewide centers.

Ribbon-cutting ceremonies or ICE demonstration events were held at all eight test sites between October 2002 and April 2003. These events generated favorable newspaper and TV coverage and helped to publicize ICE to the general public and to our client agencies.

In Allentown, an open house was held to showcase renovations to the Lehigh Valley CareerLink, where the test center is located, and to highlight the wide range of services it offers to job seekers and employers. "The building has been completely re-engineered," Edward Murray, president and chief executive officer of the Private Industry Council that operates the Lehigh Valley CareerLink, said.

The ICE project engineer for Raytheon, the vendor, has spent the last couple of months working on changes the SCSC wanted in the ICE database, a merger of the SCSC's on-line application database with the ICE database, and the coding changes the combined database requires. Raytheon also has been dealing with scoring and eligibility issues, and preparing SCSC's IT staff for a takeover of the ICE source code.

Raytheon and SCSC also will continue to deal with database security issues. Combining the databases, installing new releases of the ICE software components, and implementing security measures is anticipated within the next couple of months. The SCSC then will take over the ICE source code and Commission IT staff will be responsible for all future software modifications.

Meanwhile, many other public jurisdictions continue to want to make the transition from paper and pencil testing to computerized testing and have expressed interest in the ICE system. On June 25, the Commission's ICE Project Manager made a presentation on ICE at the IPMA Assessment Council's Annual Conference in Baltimore, MD.

Thanks to hard work by SCSC staff, their willingness to adapt to change and their perseverance in overcoming obstacles, computerized testing has become a reality.

It actually works and candidates have had overwhelmingly favorable comments. As the final ICE system refinements near completion, the Commission is now forging ahead on other fronts – imaging, workflow, selfscheduling for examinations, and on-line completion of supplements for ratings of training and experience.

July 2003



Integrated Computerized Examination (ICE) System

Précis

Raytheon is engaged in web strategy consulting, digital media production, enterprise applications development, and information architecture for customers within the Department of Defense, federal and state agencies, and the commercial sector.

1.0 BACKGROUND

The Integrated Computerized Examination (ICE) System is a secure employment recruiting, testing, and candidate management system that was originally developed to improve the Commonwealth of Pennsylvania State Civil Service Commission's ability to fill open positions and reduce its annual operating costs. It provides a centralized test item and candidate data repository, support for numerous geographically dispersed testing centers, incorporation of multimedia testing and assessment components, streamlined intra-agency and customer information exchange, and submission of candidate basic employment data over the Internet. More than 100,000 applications and 50,000 examinations are processed annually at fixed-site testing centers in 8 cities, with 2 mobile testing suites being deployed in 2003.

The Department of Administrative Services for the State of Oklahoma now uses ICE for statewide employment testing. Fully computerized testing is available in Oklahoma City with plans to expand to 22 fixed site testing centers around the state. During the transition period, the ICE system supports the simultaneous administration of both computerized and paper based versions of the same tests with seamless integration, enabling a phased migration driven by customer requirements.

ICE has been modified since its initial delivery to serve the larger public sector and corporate intellectual capital market space, and is available under a variety of purchase, lease, and/or other usage options.

1.1 ICE System Level Architecture

The ICE System-level architecture is based on a distributed deployment of Microsoft Windows 2000 servers running a combination of standard and custom application programs and communicating via Internet Protocol (IP) transport. At the highest level of abstraction is the total ICE System with its external interfaces as shown in Exhibit 1. Four (4) broad categories of users interact with the ICE System in its operational environment:

- System Managers
- Test Developers (and other staff)
- Test Administrators
- Candidates/Students/Customers

Executive Summary

Raytheon



Exhibit 1 – ICE System Interfaces



Other external interfaces may be added or removed as required to interface with customer specific systems. Through database resident descriptions of each external system and its associated properties, coupled with an interface specific application program, the ICE System provides a framework of extensibility for interfacing with generic external systems.

The most recent ICE deployment was configured with two external system interfaces: a customer specific legacy system, in this case an AS/400 DB2 database for selected data interchange, and an Optical Character Recognition (OCR) system for importing scanned answer sheets.

The legacy database interface was accomplished using Open Database Connectivity (ODBC) sessions layered on the Transport Control Protocol/Internet Protocol (TCP/IP). The OCR interface was established using remote Windows directory share access to scanned answer sheet files. These files are indexed, parsed, and integrated into the ICE database.

The conventional ICE System architecture has two classes of subsystems: a single Central Management Suite and multiple distributed Test [Administration] Suites as shown in Exhibit 2. The Central Management Suite hosts the consolidated system database and provides a test development and item analysis environment for test developers and analysts. The Test Administration Suites serve as a distribution, administration, and testing data collection point for all forms of electronic testing materials.



Exhibit 2 – ICE System Subsystems

Data flow and communications between ICE subsystems are as follows:

- SQL Server database replication (two-way)
- Test content file distribution
- External transcript (e.g., Typing/Data entry test) file collection
- Application specific, sockets-based protocol for Remote Monitoring & Control

Alternatively, a compatible but simplified distributed architecture is available, as shown in Exhibit 3. This approach provides a single repository of all test item content and manages all development, distribution, delivery, and scoring of released exams, but does not have the same level of fault tolerance as the distributed architecture presented in Exhibit 2.



Exhibit 3 – Central System Distribution and Management

1.2 System Software Platform

While there are a number of commercially available testing systems, the ICE System is specifically designed for large-scale, distributed environments which require ease of distributed management, fault-tolerance, and immunity to common inter-site communication link failures.

Within the framework of a Microsoft-based enterprise solution, Raytheon's ICE System focuses on usability, effectiveness, scalability, and maintainability. All ICE System applications and tools are built on top of the Microsoft Office application suite and the Microsoft BackOffice Server suite. Specifically, workstations consist of Windows 2000 Professional with optional Microsoft

Word/Excel, and servers consist of Windows 2000 Server running SQL Server and Internet Information Server (IIS).

Specialized ICE System applications build upon the underlying features of these Microsoft products to empower the user agency to fulfill its mission with ease and effectiveness. Custom applications are developed in a combination of Microsoft Visual Basic, Visual Basic for Applications (VBA), Active Server Pages (ASP) with VBScript, and Hyper-Text Markup Language (HTML).

1.3 Security

The ICE System is completely hosted and integrated with the Microsoft Windows 2000 operating system and layered software products. Microsoft Windows 2000 provides the ICE System with the full security features, including access control and auditing, that are built into the operating system architecture. Microsoft SQL Server natively allows security down to the database table level, and Microsoft Internet Information Server (IIS) provides additional security appropriate for internet-based services.

Candidate test stations are protected from the introduction of data, applications, or malicious programs during testing sessions by disabling all floppy, CD-ROM, or other external transfer medium through the use of specific settings in the Windows 2000 Group Policies. As well, Candidates are unable to print, print to file, or otherwise remove data from the testing system; only a system administrator has these privileges.

2.0 ICE APPLICATIONS

The ICE System features four major end-user applications:

- **System Manager** is used by system administrators to manage ICE System-specific functions and augment the standard Microsoft Windows BackOffice Server administration tools.
- **Test Manager** is used by test developers to create tests and supplemental questionnaires, analyze test item responses, manage candidate data, and generate statistical reports.
- **Test Suite Manager** is used by test proctors or system administrators to manage the test suite resources, monitor test suite activity, override selected test parameters, respond to alert conditions, and receive requests for assistance.
- **Candidate Manager** is used by candidate workstations to direct, monitor, and control all interactions of the candidate with the ICE System, including test delivery control and navigation, item presentation, scoring, and recording of results to the database.

2.1 Background Applications

Additionally, the ICE System includes the following background applications:

- **Monitor & Control** runs on all ICE workstations and servers and provides remote status monitoring and control of specific ICE features.
- File Distribution/Collection runs on the Test Suite Servers as a scheduled task and provides file synchronization capabilities.



3.0 SYSTEM ADMINISTRATION

The ICE System design minimizes the new tools that test administrators have to master; the majority of system administration functions are accomplished utilizing the standard MS BackOffice administration tools. For example, user accounts and privileges are administered using the standard User Manager or Active Directory for Users, Policy Editor, Disk Administrator, Event Viewer, etc. Further, the ICE System database is administered using SQL Server's SQL Enterprise Manager tool.

An additional customized tool provides for ICE System-specific administration. A sample of this tool's top-level screen is shown in Exhibit 4.



Exhibit 4 - Sample ICE System Manager

4.0 FEATURE HIGHLIGHTS

4.1 Microsoft Office Compatibility

Through specialized Microsoft Word templates, ICE allows test content developers to develop and edit test items directly in Microsoft Word. The specialized templates, with embedded VBA code, communicate with ICE-specific ActiveX components in order to seamlessly coordinate with the system database, convert items to HTML, and store them in their appropriate network storage share.

Similarly, hardcopy test booklets are generated by another specialized Microsoft Word template, further empowering the test developer with the rich and familiar features of Microsoft Word.

4.2 Microsoft Office Compatibility

Test preparation is accomplished utilizing the Test Manager application, a powerful and intuitive environment for test developers. Based on Microsoft Office Automation, it provides test developers with a suite of tools for creating, revising, and maintaining examinations and supplements.

Test and subtest instructions, as well as test item questions, can be entered using Microsoft Word's embedded document controls. Thus, the underlying word processor used within the ICE Test Manager is actually Microsoft Word.

4.3 Question/Item Types

By allowing for multiple types of presentation templates and question response evaluations, the capability to administer and evaluate alternate forms of tests and supplements is inherent within the ICE System. Currently, the ICE question templates include:

- Multiple Choice, including True/False and Yes/No, support for up to 20 answer options each with unique point values
 - Single Select
 - Multiple Select
- Numeric Matching, including a numeric range
- Pattern Matching, including exact matching and embedded wildcards
- Narrative, providing evaluation by human raters

4.4 Branching

Branching is supported between test parts based on user response to a question. Branching may be activated on Correct or Incorrect responses.

4.5 Test Structure

Tests consist of optional test-level instructions followed by a set of subtests (sub-sections) which in turn consist of optional subtest-level instructions followed by a set of test items (or questions). Using this three-tier approach, subtests may be shared between multiple tests, and test items may be shared between multiple subtests. This approach offers maximum flexibility and reusability.

4.6 Multimedia and Reference Material

Test, subtest, and test items may contain multimedia components and references to documents and manuals. Multimedia components may include still pictures, graphics, video, simulations, and audio files. All conventional file formats are acceptable for use within ICE; most common among them are: .jpg, .doc, .txt, .wav, .mp3, .avi, .mpeg, and .swf.

4.7 Subject Area Grouping

The ICE System permits customer definition of hierarchical item bank and subject area categorization schema. Thus, each test, subtest, and test item may be associated with a subject area.

4.8 Equivalent Items

Each test item may be designated to be equivalent to any number of other items within the item bank.

4.9 Test Session Storage

In the current system architecture, each test session is stored in the local suite database, including selected or entered response, dwell times, times visited, and other parametric data. This data is subsequently replicated from the local test suite to the central database server. For the OPM testing system, each test session is stored on the central database server and is updated with each candidate's response in real time.

4.10 Revision Control

Each test, subtest, and question is stored under revision control. Once a revision is released for publishing, it is frozen; any further edits force a new revision of the item. Each revision tracks creation and last revision timestamps as well as the revision author.

4.11 Scoring Options

ICE System test scoring:

- Supports entry of narrative data for later evaluation by human raters
- Allows for differential score weighting between test items
- Allows for differential score weighting of various answers to an individual test item
- Calculates a final raw score or converted score using several block conversions and statistical scoring choices

4.12 Report Generation

With the ICE System, reports may be generated using an array of tools including standard SQL, custom Microsoft Word & Excel templates, and any third party data report tool (such as Crystal Reports) and statistical analysis tool (such as SPSS) which supports one of Microsoft SQL Server's interfaces. These interfaces include Open Database Connectivity (ODBC), ActiveX Data Objects (ADO), and Object Linking & Embedding Database (OLEDB), among others.

4.13 Automated Test Item Migration

Customized test item bank imports have been developed to automate the migration of legacy test items into the ICE System. This option can save thousands of labor hours and many calendar months in efforts in which large test item banks are resident in legacy databases.

4.14 Simultaneously Administered Tests

The Candidate Manager application running at each candidate workstation controls the candidate testing process such that each candidate workstation operates independently from all other candidate workstations.



Under this scheme, the Candidate Manager application determines and recommends examination choices to the test administrator, initiates tests under direction from the test administrator, and administers the selected test to the candidate. Because the test is administered under control of the candidate workstation's Candidate Manager application, test and subtest timer controls for individual candidate workstations operate independently from all other workstations.

4.15 Question Skip, Review, and Revision

Test developers control the setting of the skip/review flag for each subtest within the ICE System database. Tests may contain a mixture of subtests with this option **ON** for some subtests and **OFF** for others. For subtests that have the skip/review flag **ON**, the Candidate Manager application enables and controls the skip/review options.

Options available to the Candidate include:

- Skip to the next question without answering the current question
- Move to the previous question, first question, or last question
- View a condensed list of all questions and their associated status (e.g., answered, unanswered) and proceed directly to a question within the list
- Revise the answer to the currently viewed question

4.16 External Tests

The ICE System accommodates externally administered, third party tests. Currently supported external tests include typing and data entry tests published by R.D. Craig. Other externally administered test applications may be added with minimal software modifications.

External tests are shelled out to execute in their own sub-process under parent control of the Candidate Manager application. Depending on the external test, software modifications may be required for the Candidate Manager to extract score information from the external test package.

4.17 Test Distribution and Results Collection

File-based content is distributed automatically from the Master Suite server to Test Suite servers. This distribution process is controlled by a special File Distribution/Collection process that can be scheduled to run automatically based on a user-defined schedule. This same process also collects any external record files from the Test Suite servers and migrates them back to the Master Suite server.

The Candidate Manager application running on each candidate workstation stores the candidates' test results on the local Test Suite server. The Test Suite server automatically migrates all local test results from its database to the Master Suite database. Database content is replicated between the Central Suite server and Test Suite servers using Microsoft SQL Server's replication technology.

4.18 Inter- and Intra-Test Site Expansion

Under the ICE System, additional test suites are easily added by modifying the Test Suite definition list within the Master Suite configuration. This process is accomplished using the ICE System Manager application.

With standard Windows 2000 administration features, each workstation is configured with the requisite commercial software and administratively added to the workgroup, domain, or active directory. The ICE System Candidate Manager software is then loaded and configured.

4.19 Monitoring, Controlling, and Recording of Tests and Subtests

The Candidate Manager application initializes countdown timers upon entering a test, subtest, and questions. The timers track the total test time remaining as well as the time remaining for each subtest section and the question dwell time. If one of the countdown timers zeros out before the candidate completes the section, the application software will inform the candidate that the allotted time for the section or test, as appropriate, has elapsed. Test, subtest, and question dwell times are recorded in the candidate response tables.

4.20 Monitoring of Testing Activity

The Test Suite Manager application provides a view of all candidate workstations and servers within the Test Suite. This application is similar to the System Manager application but is restricted to the test administrator's local Test Suite. Using the Detail View option within this application, test proctors can monitor the identification of the candidate's test, subtest, and test item currently in progress. This view also provides indication of any alert conditions that may be occurring.

The Test Suite Manager application also provides for proctor control of candidate workstations. By selecting one or more candidate workstations and applying the appropriate menu option, the proctor can:

- Enable/Disable Candidates to proceed
- Pause/Resume the Candidate's test session
- Abort the testing session
- Override selected parameters such as time remaining
- Send an administrative one-line message

4.21 Accommodations for Persons with Disabilities

Because the ICE System is built on top of the MS Office suite of applications, it inherits the basic "Accessibility Properties" built into the Windows operating system. These features include sticky keys, filter keys, special audible keys, visual cues, and a keyboard-controlled mouse. These options can be turned on by the use of alternate candidate login account profiles.

4.22 Backup and Recovery of Tests In Progress

Upon starting a test, the Candidate Manager application will initialize a new test session for the candidate within the local Test Suite database. Candidate responses to questions are also stored in this database that provides automatic transaction logging by Microsoft SQL Server. The Candidate Manager also checks for incomplete tests within the local Test Suite database following candidate identification. When this condition occurs, an option to resume the incomplete test session is provided.

4.23 Test Security Features

Each subtest contains a "Randomize" flag that can be enabled or disabled by the test developer. By using the randomize option, the Candidate Manager application can randomize the presentation order of test items for the given subtest. Since each candidate workstation operates independently of other workstations, each Candidate Manager will randomize the order differently. Therefore, even if two or more candidates are taking the same subtest at the same time, each will have a different ordering to the questions. This feature provides a reasonable level of assurance that any collaboration is unlikely without alerting the attention of the test proctor.

4.24 Integration of Electronic and Paper Tests

Test results can be incorporated and integrated with other test score data through the use of an import function within the System Manager application. Test records created by an OCR system can be electronically copied or made accessible to ICE applications through use of a Windows share directory.