CICS on the VSE/ESA platform:

e-business support

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Introduction

CICS e-business support enables end-users at Web browsers or network computers to access CICS application programs and transactions using standard internet protocols.

This paper provides a technical overview of the CICS technology choices available to enable this on the VSE/ESA platform, including CICS Web Support which has been recently delivered with CICS Transaction Server for VSE/ESA V1.1.1.

As shown in Figure 1, there are two main architecture models for connecting from Web browsers or network computers to CICS as follows:

1. The 3-tier model, which has connectivity via a Web server running on an intermediate system. Tier-1 is the client Web browser, tier-2 is the Web server platform, and tier-3 is the S/390 server running CICS. IBM's Application Framework for e-business is based on the 3-tier model and is implemented for CICS running on VSE/ESA via the CICS Transaction Gateway.

2. The 2-tier model, which has a direct connection to CICS without the need for an intermediate system. This is implemented within CICS Transaction Server for VSE/ESA via services known as CICS Web Support.
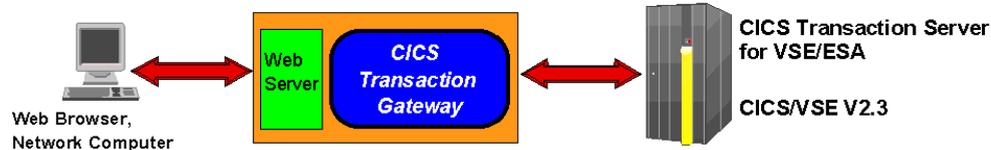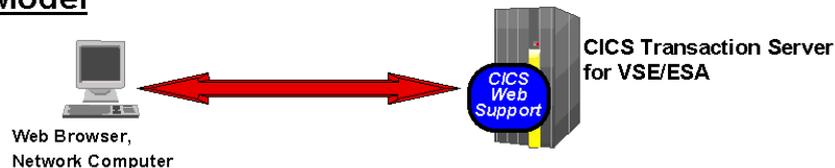
Figure 1: e-business connection models

The CICS Transaction Gateway

Overview
The CICS Transaction Gateway provides a comprehensive set of Java-based Web server facilities for accessing CICS application programs and transactions from a Web browser in a 3-tier model, and is a connector component of IBM's Application Framework for e-business. It runs on the same intermediate system as a Web server and communicates with all current CICS systems.

Java classes and JavaBeans are supplied for use in any Java program environment -- that is Java servlets (programs that run on a Web server), Java applets (programs that run on a Web browser), and Java applications which can run on any Java execution platform.

Java Support
The Java support provided can be used in the following main ways:
- Writing servlets: The CICS Transaction Gateway supplies Java classes and JavaBeans that allows servlets to be written to handle browser requests that require services from CICS. Servlets are programs that are loaded by the Web server and run in the Web server environment.
- Writing applets: The same Java classes and JavaBeans can be used to write an applet to access CICS in the same ways as a servlet, the difference being that an applet executes in a Web browser on the end-user workstation after being downloaded from a Web server. It requires a Java-enabled browser on the workstation. Applets have some restrictions compared to Java servlets and Java applications -- for example they may not access local resources such as local files.
- Writing applications: Again, the same Java facilities are available to access CICS as for servlets and applets. The main difference is that Java applications do not run with a Web server or Web browser, but run in any other Java execution environment and have none of the limitations that an applet has. A Java application can run on the same system as the CICS Transaction Gateway, or remotely on another system or workstation.
- Turnkey access to 3270 transactions: The CICS Transaction Gateway supplies one pre-written servlet, called the Terminal Servlet. This provides turnkey Web browser access to CICS 3270 based transactions. The Terminal Servlet translates Web browser requests to CICS interactions on a on a one-for-one basis, so that the user sees the browser equivalent of the "green" screens that would appear on a real 3270 terminal.
- Customised access to 3270 transactions: The CICS Transaction Gateway also provides facilities for customising (without programming) the default screen appearance on a Web browser produced by the Terminal Servlet. For example it is possible to map specific screens to specific HTML pages and to insert screen output fields into HTML pages via variable substitution and HTML templates.
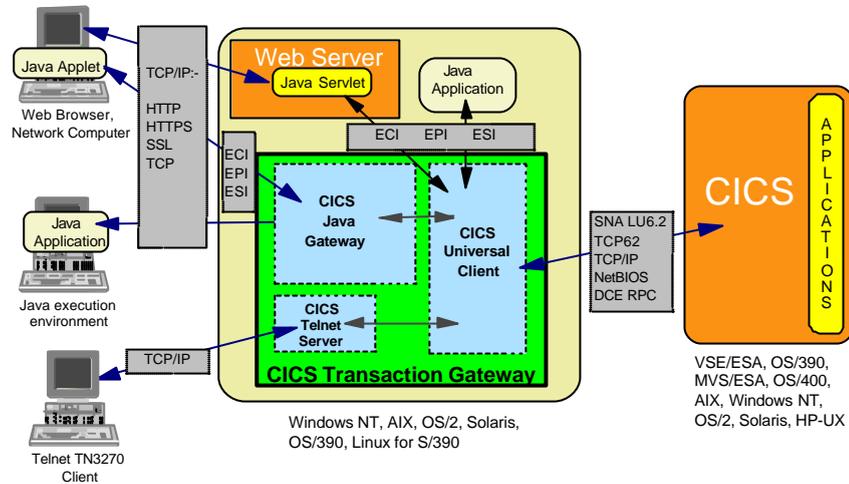
Figure 2: CICS Transaction Gateway structure and interfaces

Major Components

The CICS Transaction Gateway structure and its interfaces are illustrated in Figure 2. The following are the major Gateway components:

- The Java Gateway application. On non-OS/390 platforms, it communicates with CICS applications through facilities provided by the CICS Universal Client component. On OS/390 systems, it communicates with CICS applications via the CICS External Communication Interface (EXCI).

- A CICS Universal Client that provides the basic interfaces and connectivity to host CICS systems, as well as terminal emulation function.

- A CICS Java class library that provides the Java API's for the communication between a user-written Java program and a CICS system.

- A set of EPI JavaBeans for creating Java front-ends to existing CICS 3270-based applications without the need for programming. JavaBeans are self contained reusable software components that can be visually composed into applications, applets, or servlets via the use of visual application builders -- for example via the IBM VisualAge for Java product.

- The Terminal Servlet that allows a Web browser to be used to access existing 3270-based CICS transactions.

- A set of Common Connector Framework (CCF) Java classes which are supplied in support of IBM's Common Connector Framework strategy. The objective of CCF is to provide consistent client application interaction with enterprise resources such as CICS or DB2 from any Java execution environment.

- A TN3270 server which provides support to allow multiple end-users using telnet TN3270 clients to connect to CICS.

Application Programming Interfaces

The <u>External Call Interface</u> (ECI) enables a client Java application to call a CICS program and is equivalent to Distributed Program Link. It uses a COMMAREA interface and to the target CICS application program it appears as if it is being called by another program in the same CICS system. Multiple CICS programs can be called, either in the same CICS system or in different systems, within the same invocation of the client.

The <u>External Presentation Interface</u> (EPI) enables a client Java application to emulate a 3270 terminal and so drive a CICS 3270-based application. Essentially the client application simulates a 3270 terminal, and there is no change to the CICS 3270 application. The basic interface is at the 3270 datastream level, but there are higher level Java EPI classes and Java EPI beans that can be used to shield the programmer from this. The same client can be connected to multiple CICS systems or act as multiple 3270's to the same CICS system. Note that the EPI is not supported when the Gateway is running on OS/390.

The <u>External Security Interface</u> (ESI) enables a client application to invoke services provided by APPC Password Expiry Management (PEM) -- for example to verify or change passwords. The ESI requires an External Security Manager on S/390 on which the host CICS system is running. This provides support for an APPC architected sign-on transaction that signs on users to a CICS host system and which can processes requests for a password change.

Connectivity

The CICS Transaction Gateway supports connection to CICS systems using a variety of protocols. The only form of connectivity currently supported to CICS on the VSE/ESA platform is SNA LU6.2, but IBM's direction is to also provide support for TCP/IP in the future.

From Windows NT, Windows 95/98 and OS/2, there is also support for TCP62 via the IBM Communications Server, which enables transport of SNA LU6.2 data over TCP/IP connections to CICS on MVS or OS/390.

The CICS Transaction Gateway also supports TCP/IP and DCE RPC connection to a CICS system running on AIX, HP-UX, Solaris, and Windows NT. This could also be used as an intermediate CICS system which can connect to CICS on S/390 using SNA. The NetBIOS protocol is also supported for connection to CICS for OS/2.

Network protocols supported for connectivity to Web browsers and other Java environments include TCP/IP Sockets, SSL, HTTP and HTTP-S. Support of Secure Sockets Layer (SSL) enables data encryption and authentication for network security.

Supported environments
Access to CICS via the CICS Transaction Gateway is supported via any Java enabled Web browser at the JDK 1.1 level or later, for example Netscape or Internet Explorer. The Terminal Servlet requires a Web server or servlet engine that provides support equivalent to the Java Servlet Development Kit (JSDK) V1.1 or later, for example as provided by the IBM WebSphere products.

The CICS Transaction Gateway is supported on the following platforms:
- Windows NT, Windows 98/95 (Development puposes only)
- OS/2, AIX, Solaris, OS/390
- Linux for S/390 (Availability planned for 12/00)

CICS systems supported:
- CICS Transaction Server for OS/390
- CICS for MVSE/ESA V4.1
- CICS Transaction Server for VSE/ESA
- CICS/VSE V2.3
- CICS Transaction Server for OS/2
- TXSeries (now part of WebSphere Enterprise Edition) which provides CICS on AIX, Solaris, HP-UX, and Windows NT
- CICS for OS/400

Licensing and packaging
The CICS Transaction Gateway is licensed and delivered with:
- CICS Transaction Server for OS/390
- CICS Transaction Server for VSE/ESA
- TXSeries Version 4.2, for AIX, Solaris, Windows NT, HP-UX
- CICS Transaction Server for OS/2 Warp
- VisualAge for Java Professional or Enterprise Edition
- WebSphere Application Server Advanced/Enterprise Edition

The CICS Transaction Gateway may also be downloaded from the CICS Web site for use under a license obtained via one of the products listed above. The license entitles unlimited use and unlimited right to copy. Note also that the license delivered with CICS Transaction Server for VSE/ESA entitles immediate use of the CICS Transaction Gateway with CICS/VSE V2.3.

CICS Web Support

Overview
CICS Web Support is a new set of services delivered as part of CICS Transaction Server for VSE/ESA Version 1 Release 1.1.1, enabling direct access to CICS applications and transactions from Web browsers or Network Computers. This uses the 2-tier model and

therefore does not require an intermediate system running a Web server or gateway. It provides support for TCP/IP and the HTTP protocol, new API's for "Web aware" applications, and the ability to access existing applications and 3270 transactions.

One or more TCP/IP ports are assigned to CICS on which CICS listens for incoming requests and then processes them. The CICS network address and port is specified in a standard Universal Resource Locator (URL) which is sent from a Web browser. Also included in the URL is the name of the CICS application program to process the request.

Architecture

A CICS application is invoked from a Web browser via a standard URL of the general form "http://machine.name:port/converter/alias/program?optional-token", where
- machine.name is the IP address or DNS name of the CICS region
- port is the configured CICS Web Support listening port number
- converter is the name of the program used for Decode & Encode processing
- alias is the transaction id of the alias transaction
- program is the name of the application program to be invoked
- optional-token is optional data to be passed with the request

For example, "http://cicstest.hur.ibm.com/cics/cwba/webpgm1".
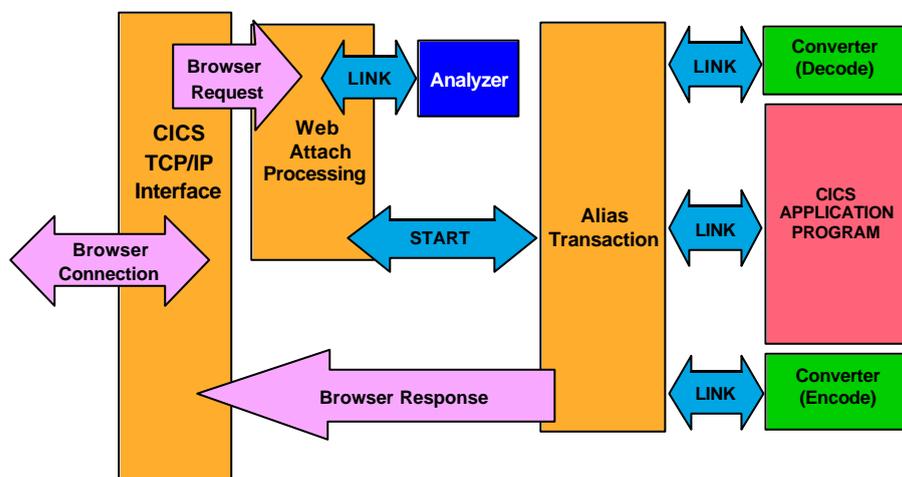
Figure 3: CICS Web Support architecture and flow

The architecture and flow is illustrated in Figure 3, and is as follows:
1. A request from a Web browser comes into CICS via the CICS TCP/IP interface and the CICS sockets listener which then attaches a transaction for Web attach processing.

2. Web attach processing receives the incoming request, translates the HTTP headers to EBCDIC and links to the Analyser. The analyser interprets the request and specifies the CICS resources needed to process it. On return, if requested by the analyser, the body of the HTTP request is translated to EBCDIC. Web attach processing then starts an alias transaction to handle all further processing of the request and terminates.

3. If requested, the alias first calls a Converter for decode functions to allow modification of the request before it is passed to the application in the COMMAREA. The alias then calls the CICS application program, passing the COMMAREA as setup by decode.

4. The CICS application program processes the request and builds a HTTP response using the new CICS Web-related API commands, or builds a HTTP response directly in the COMMAREA.

5. On return from the application, a Converter is called if requested for encode functions that can build or modify the headers and body of the HTTP response. If requested, the alias translates the response to ASCII and then returns the response to the CICS TCP/IP interface and terminates.

6. A call is then issued to the operating system TCP/IP services to send the complete HTTP response back to the Web browser.

The Analyser

The Analyser is a mandatory User Replaceable Module which interprets the incoming request and specifies the CICS resources needed to process it -- for example the name of the CICS program, name of the converter, user id or terminal id to be associated with the alias transaction, and codepage conversion definition. There is an analyser for each TCP/IP port on which CICS listens for requests.

A replacement analyser could be provided for a number of reasons -- for example to allow a different URL convention, to support multiple codepages, or to provide an audit trail. The supplied default analyser:
- Implements the general CICS Web Support URL format
- Supports an optional token of eight bytes in length
- Provides ISO-8859-01 codepage conversion (standard latin-1 HTML code page)

The Converter

This is an optional User Replaceable Module which provides Decode and Encode functions. Decode is invoked before the incoming request is passed to the CICS application program, and Encode is invoked after the CICS application program has processed the request.

The main purpose of Decode is to provide the COMMAREA in the format expected by the application. If no Converter decode function is specified in the URL, then the entire HTTP request is passed in the COMMAREA to the application program.

The main purpose of Encode is to provide a complete HTTP response, that is the HTTP response headers together with the body of the response. It can create or modify headers and the body supplied by the application program. If no Encode function is specified, then the application program must build the entire HTTP response in the COMMAREA.

New API's

There are two new sets of API's which are provided for the development of "Web aware" applications, which are summarised in Figure 4. It is recommended that these new API's be used, although it is possible to write COMMAREA style applications for handling HTTP requests and responses.

EXEC WEB	
EXTRACT	Get information about incoming HTTP request
READ	Get the value of a specific header or HTML form field
STARTBROWSE, READNEXT, ENDBROWSE	Get header information or HTML form fields sequentially
RECEIVE	Get the body of the HTTP request
WRITE	Add a specific output header to the response
SEND	Select document for delivery as body of the HTTP response
RETRIEVE	Get token of document sent via earlier WEB SEND
EXEC DOCUMENT	
CREATE	Create a new document
INSERT	Insert data into an existing document
SET	Add symbols and values to the document symbol table
RETRIEVE	Retrieve a document into application storage

Figure 4: CICS Web Support API summary

The new EXEC CICS WEB API provides an easier way of handling HTTP requests and responses compared to processing the data as one long string in a COMMAREA.

The new EXEC CICS DOCUMENT API introduces the concept of documents -- a collection of formatted data areas. Its prime use is for constructing HTML pages for sending to a Web browser, but is not restricted to this and other markup languages could be used. Documents can be made up of both text and binary elements, and can contain templates and symbols -- symbol substitution being performed at execution time. Bookmarks can be used to insert data at specific points in documents, and documents can be imbedded within documents. Templates which contain static data and symbols can be created offline and are new CICS resources defined via RDO with a resource type of DOCTEMPLATE which can reside in several places -- for example CICS files, Transient Data queues, Temporary Storage queues, VSE library members.

Accessing existing COMMAREA based applications

To access an existing application that is COMMAREA driven, then a Converter could be used to shield the application from HTTP and HTML.

A decode function could be used to reformat the COMMAREA into the form expected by the application. And similarly, an encode function could be used to build the HTTP headers and the HTML body of the response after the application program has processed the request and put its results in the COMMAREA.

Accessing existing 3270 transactions
Existing 3270 based transactions are accessed via use of the new 3270 Bridge function. The supplied Web bridge exit program automatically handles conversion of 3270 datastreams to and from HTML, and supports both BMS and 3270 terminal control. No user programming is required, and there are no changes required to the 3270 transaction or associated application programs.

Support is provided for customisation of the standard HTML output produced, both for BMS and 3270 terminal control applications. For example it is possible to suppress a PF Key or change the name of the text displayed to represent it, to supply a different HTML page background or its colour, or to insert additional text to be displayed in the HTML page.

The 3270 application is invoked with a URL that must specify DFHWBTTA as the CICS program to be invoked, followed by the 4 character ID of the required 3270 transaction to be executed. For example, http://testcics/cics/cwba/dfhwbtta/CECI.

Managing CICS Web Support
To enable CICS Web Support, CICS must be started with TCPIP=YES, a new parameter in the System Initialisation Table (SIT).

A new CICS resource type, TCPIPSERVICE, defines the instance and characteristics of a TCP/IP service. Multiple TCPIPSERVICE definitions can be used to enable CICS to listen on many TCP/IP ports concurrently. TCPIPSERVICE is defined online via the CEDA transaction in the same way as other CICS resources.

There are also new CEMT and System Programming Interface (SPI) commands to perform INQUIRE and SET operations on TCP/IP and Web resources.

The 3270 Bridge

The 3270 Bridge is a new function within CICS Transaction Server that provides the ability to run existing 3270 based transactions without a 3270 and without changing the associated applications. It enables invocation of existing 3270 appls in new ways, for example to add new GUI front-ends and to access CICS from non-CICS environments -- for example, from the Internet in conjunction with CICS Web Support, or via MQSeries.

For specified transactions, all 3270 terminal I/O requests are intercepted and handled by a Bridge Exit program which uses a special COMMAREA called the Bridge Exit Area for communication. The Bridge Exit program is a User Replaceable Module which essentially emulates a 3270 terminal transparently to the 3270 transaction being executed. It intercepts all the 3270 input and output commands issued by the application program, and does all necessary data transformation and routing. The 3270 Bridge environment is illustrated in Figure 5.
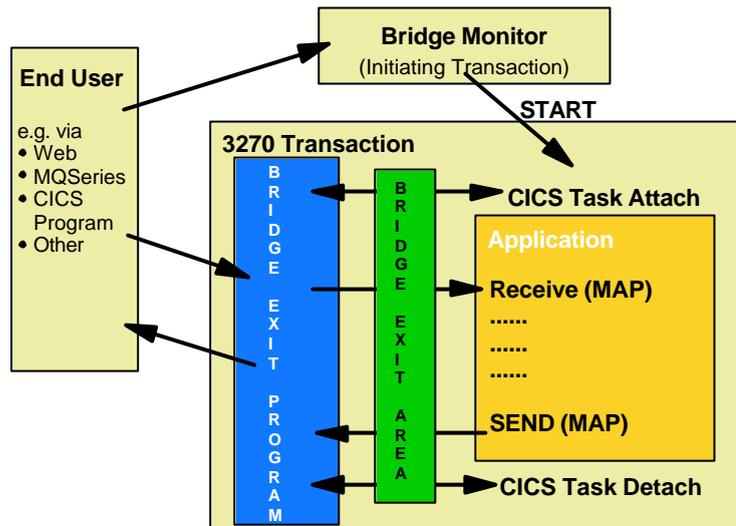
Figure 5: The 3270 Bridge environment

There are two supplied Bridge Exit programs. One is a sample supplied in source form which uses Temporary Storage or Transient Data queues for input and output. The other is a program for use only with CICS Web Support and is supplied in object code form.

Further Information

Further information can be found at the following websites:
- ibm.com/cics/library
  → CICS Web Enablement Selection Guide (White Paper)
  → The CICS Transaction Gateway Books
  → The CICS Transaction Server for VSE/ESA books
    ◆ The CICS Internet Guide (documents the CICS Web Support)
    ◆ The CICS External Interfaces Guide (documents the 3270 Bridge)
- ibm.com/redbooks (ITSO Red Books)
  → Revealed! Architecting Web Access to CICS
  → Revealed! CICS Transaction Gateway with more Clients Unmasked
  → CICS Transaction Server for VSE/ESA: Web Support

IBM also provides a services offering, Planning Services for CICS Web Enablement, and details can be found at ibm.com/cics/service